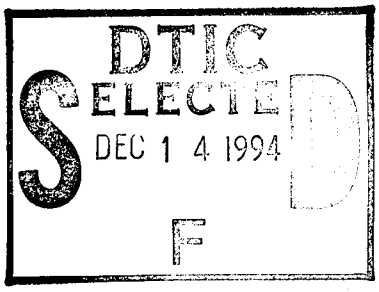


United States Air Force
11th Air Control Wing
11th Civil Engineering
Operations Squadron

Elmendorf AFB, Alaska



FINAL

Indian Mountain LRRS, Alaska

REMEDIAL INVESTIGATION/ FEASIBILITY STUDY SAMPLING & ANALYSIS PLAN

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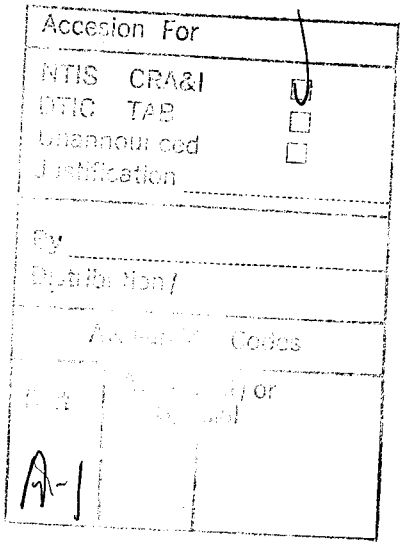
PREFACE

This Sampling and Analysis Plan (SAP) describes the requirements for the expected tasks and activities needed to complete the investigation activities at Indian Mountain Long Range Radar Station according to the requirements of Contract No. F41624-94-D-8046, Delivery Order 4, between the U.S. Air Force and Jacobs Engineering Group Inc. It was developed to make certain that all environmental data generated for the project are scientifically valid, defensible, comparable, and of known and acceptable precision and accuracy. The SAP has been prepared in accordance with format and content requirements, as applicable, of the *Handbook to Support the Installation Restoration Program Statements of Work* prepared by the Air Force Center for Environmental Excellence (AFCEE), Brooks Air Force Base, dated September 1993.

The Jacobs Engineering Group Inc. Project Manager for this contract is Ms. Lynn Schuetter. The Contracting Officer's Representative for the AFCEE is Mr. Mike McGhee.

Approved:

for Warren H. Reeser
Robert Siek
Program Manager



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The remedial investigation (RI) will investigate sources at both the Upper Camp and Lower Camp, as well as assess the potential for migration of contaminants from the sources. Media to be sampled include surface water, surface soil, subsurface soil, sediment, and groundwater. Field screening techniques will be used, as well as the services of offsite laboratory.

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NOTICE

This report has been prepared for the U. S. Air Force by Jacobs Engineering Group Inc. for the purpose of aiding in the implementation of a final remedial action plan under the Air Force Installation Restoration Program (IRP). As the report relates to actual or possible releases of potentially hazardous substances, its release before an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the IRP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate. Acceptance of this report in performance of the contract under which it is prepared does not mean that the Air Force adopts the conclusions, recommendations or other views expressed herein, which are those of the contractor only and do not necessarily reflect the official position of the U.S. Air Force.

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LIST OF ACRONYMS

ADEC	Alaska Department of Environmental Conservation
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
Air Force	U.S. Air Force
ASTM	American Society for Testing and Materials
BCA	Brown and Caldwell Analytical
CAD	Computer Assisted Design
CCV	Continuing Calibration Verification
CEC	Cation Exchange Capacity
CEOS	Civil Engineering Operations Squadron
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm	Centimeter
COR	Contracting Officer's Representative
DIS	Data Interpretational System
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DOT	U. S. Department of Transportation
DRO	Diesel-Range Organics
DTIC	Defense Technical Information Center
EC	Electrical Conductivity
EDS	Environmental Database System
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
FSP	Field Sampling Plan

LIST OF ACRONYMS

GAC	Granular Activated Carbon
GC	Gas Chromatograph
GFAA	Graphite Furnace Atomic Absorption
GIS	Geographic Information System
GMS	Geological Modeling System
GRO	Gasoline-Range Organics
HSA	Hollow Stem Auger
HSP	Health and Safety Plan
ICP	Inductively Coupled Plasma
ICV	Initial Calibration Verification
ID	Inside Diameter
IDW	Investigation-Derived Waste
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
ITIR	Informal Technical Information Report
Jacobs	Jacobs Engineering Group Inc.
JEMS	Jacobs Environmental Management System
LNAPL	Light Non-Aqueous Phase Liquid
LQAPP	Laboratory Quality Assurance Project Plan
LRRS	Long Range Radar Station
MAR	Minimally Attended Radar
MDL	Method Detection Limit
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter

LIST OF ACRONYMS

mL/L	Milliliters per liter
MS	Mass Spectrometry
MSA	Method of Standard Additions
MSL	Mean Sea Level
NIST	National Institute of Standards and Technology
NTIS	National Technical Information Service
NTU	Nephelometric Turbidity Unit
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyls
POL	Petroleum, Oil, and Lubricants
PPE	Personal Protective Equipment
ppm	Parts per Million
PQL	Practical Quantitation Limit
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RPD	Relative Percent Difference
RRO	Residual-Range Organics
SAP	Sampling and Analysis Plan
SOPs	Standard Operating Procedures
SPT	Standard Penetration Test
SVOCs	Semivolatile Organic Compounds

LIST OF ACRONYMS

TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
VOC	Volatile Organic Compound
WACS	White Alice Communication System
Work Plan	Remedial Investigation/Feasibility Study Work Plan
µg/L	Micrograms per Liter
°C	Degrees Celsius
µmhos	micromhos
%R	percent recovery

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Appendix B Data Validation Activities and Required Documents

Appendix C Field Forms

Appendix D Instrument Operation Manuals

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1.0 QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan (QAPP) is the first part of the Indian Mountain Long Range Radar Station (LRRS) Sampling and Analysis Plan (SAP) prepared by Jacobs Engineering Group Inc. (Jacobs). Section 2.0 is the Field Sampling Plan (FSP). The QAPP describes quality assurance (QA) and quality control (QC) procedures that will be performed during the 1994 fieldwork and laboratory analyses. The fieldwork and analyses will be conducted as part of the 1994 remedial investigation/feasibility study (RI/FS). These investigations are part of the U.S. Air Force (Air Force) Installation Restoration Program (IRP), which is administered by the Air Force Center for Environmental Excellence (AFCEE), Brooks Air Force Base (AFB). This QAPP is a companion document to the RI/FS Work Plan (Work Plan).

1.1 INTRODUCTION

The RI/FS at Indian Mountain LRRS is based on a literature review, a site visit, and field work. The analytical scope of work will include fixed laboratory analyses for chemical data collection. These data are intended to support the preparation of decision documents; therefore, the data generated must comply with data quality deliverables suitable for site characterization and risk assessment.

The FSP describes specific field operations including procedures for field sampling, sample handling, the field QA/QC program, and record keeping. Appendices for this SAP include Appendix A, Fixed Laboratory Quality Assurance Project Plan (LQAPP); Appendix B, Data Validation Activities and Required Documents; Appendix C, Field Forms; and Appendix D, Instrument Calibration and Operation Manuals and Standard Operating Procedures (SOPs).

1.1.1 The U.S. Air Force Installation Restoration Program

This SAP was prepared in accordance with all applicable Air Force and U.S. Environmental Protection Agency (EPA) guidance including EPA's *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans,* QAMS-005/80 (EPA 1980). As appropriate, this document follows the outline for Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) RI planning documents, as provided in the *Handbook to Support the Installation Restoration Program (IRP) Remedial investigations/Feasibility Studies (RI/FS), Volume I,* (Air Force 1993a) and the EPA manual, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988a). The RI/FS will provide data for preparing site conceptual models and risk assessments, and evaluating applicable or relevant and appropriate requirements (ARARs).

1.1.2 Purpose and Scope

The purpose of this QAPP is to define the QA and QC procedures that will be used to make certain that data generated during the investigation are precise, accurate, representative, comparable, and complete. The SAP defines the function, specific responsibilities, and authorities for data quality. It also prescribes the requirements for ensuring that the environmental investigation for Indian Mountain LRRS is planned and executed in a manner consistent with Air Force guidelines. The Work Plan describes the rationale for the field investigation and the preliminary conceptual

model for each site. This plan provides guidance and specifications to make certain that the following are accomplished:

- A consistent framework is established for the generation of analytical data.
- Data quality goals are defined.
- Field measurements and laboratory analytical results are of known and acceptable quality and quantity (including precision and accuracy) through the use of standard methods; preventive maintenance; standardized calibration and analytical protocols; and QC measurements, reviews, and audits. Sample collection methods are performed in accordance with written standard operating procedures (SOPs). Procedures are established to recognize out-of-control conditions and to correct these conditions.
- Actions are identified and implemented to ensure the validity of laboratory data.
- Procedures for record keeping, including sample tracking and chain of custody protocols, are established and followed.

1.2 PROJECT DESCRIPTION

The following subsections provide a brief description of Indian Mountain LRRS RI/FS field efforts and subcontractors that will contribute to the project activities. Details pertaining to the 1994 field investigation and project scope are described in the Work Plan.

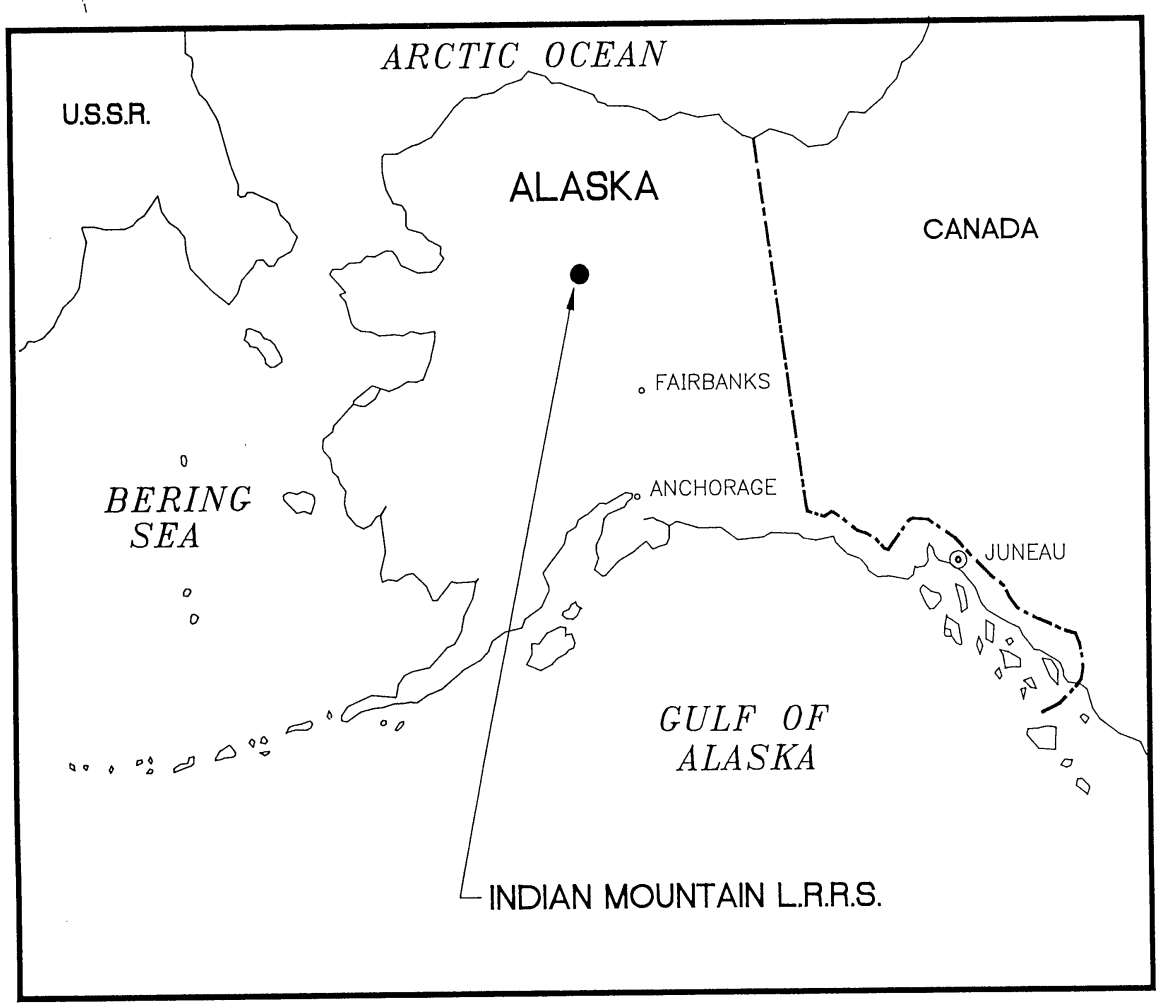
1.2.1 Site Background

Indian Mountain LRRS is located in the interior of Alaska, about 410 miles north of Anchorage and 195 miles northwest of Fairbanks (Figure 1.2-1). Indian Mountain is accessible only by air. The installation is divided into two camps: Upper Camp and Lower Camp. The camps are connected by 8 miles of steep, winding road. Indian Mountain LRRS was constructed in 1951 and currently supports a Minimally Attended Radar (MAR) facility. A White Alice Communication System (WACS) was in use from 1958 until 1979, and a satellite earth terminal was in use from 1979 until 1984 when the MAR facility was completed. Martin Marietta currently operates the facility with a crew of seven employees.

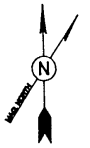
Most of the Indian Mountain facilities were demolished in 1986. The MAR and an emergency generator are all that remain at Upper Camp. At Lower Camp, existing structures include the industrial-residential composite facility, two storage buildings, a pump house, and several aboveground fuel tanks.

Previous IRP activities at Indian Mountain LRRS were presented in the following reports:

- *Phase I, Records Search Report* (Air Force 1985);
- *Phase II, Stage 1 Confirmation/Quantification Report* (Air Force 1989);
- *Installation Restoration Program Remedial Investigation/Preliminary Feasibility Study, Stage 2* (Air Force 1991a); and
- *Final Site Investigation Report, Indian Mountain LRRS, Alaska* (Air Force 1993b).



LOCATION MAP



MAGNETIC DECLINATION : 24° 42'
ANNUAL RATE OF CHANGE : 4.1'
U.S.G.S. EPOCH 1985

LEGEND

◎ CAPITAL

INDIAN MOUNTAIN
LONG RANGE RADAR STATION
LOCATION MAP

PROJ. MGR.	ACAD FILE NO.	FIGURE NO.	
L.SCHUETTER	FIG1_1-1	1.2-1	
DRAWN BY	PROJ. NO.		DATE
HUNTER	05-G-46200		4/28/94

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These investigations are discussed in more detail in the Indian Mountain LRRS RI/FS Work Plan, the companion document to this SAP. Additionally, information from these reports was used to develop the field investigation approach for the RI/FS.

1.2.2 Project Scope and Objectives

The project scope and objectives are described in detail in the Work Plan for the RI/FS for Indian Mountain LRRS, Alaska. An RI will be conducted to accomplish the following:

(1) characterize environmental conditions;

(2) define the nature and extent of contamination; and

(3) qualitatively estimate the risk to human health and the environment at various sites through the collection of geologic, geophysical, hydrogeological, ecological, chemical, and physical data.

These objectives will be met through fixed laboratory analysis of environmental samples for potential contaminants and evaluation of analytical results and field measurements with respect to QC data. In addition, validation of data will be used to support decisions. The ultimate goal of data collection, sample collection, and laboratory analysis is to determine whether any contaminants generated from installation activities have entered the environment and pose a risk to human health or the environment. The remedial investigation will provide data to determine the source of any identified contaminants and the magnitude of contamination. This data will be compared to ARARs and any naturally occurring or background concentrations for specific compounds. This will be used as the basis for developing a qualititative risk assessment.

The feasibility study for remediating contaminated areas will be conducted concurrently and during the early stages of the RI/FS process. Alternatives will be examined to develop and evaluate a range of treatment and containment actions. The scope and level of effort of the FS will be driven primarily by the nature and complexity of the type and extent of contamination. Impractical treatment alternatives will be eliminated early in the process.

1.2.3 Subcontractors

This section identifies subcontractors that will contribute to the investigations at Indian Mountain LRRS. Subcontractors will be used to provide analytical and data validation services. The 11th Civil Engineering Operations Squadron (CEOS) will provide drilling services.

1.2.3.1 Fixed Analytical Laboratory

Brown and Caldwell Analytical (BCA) Laboratories, located in Glendale, California, will conduct the fixed analytical laboratory analyses. The following chemical analyses will be performed:

- volatile organic compounds (VOCs), SW8240, SW8260;
- organochlorine pesticides and polychlorinated biphenyls (PCBs), SW8080;

- total fuel hydrocarbons (gasoline-range organics [GRO], diesel-range organics [DRO] and residual-range organics [RRO]), SW8015 (Alaska modified), SW8100 (Alaska modified), and AK103, respectively;
- semivolatile organic compounds (SVOCs), SW8270;
- inductively coupled plasma (ICP) screen for metals, SW6010;
- arsenic by graphite furnace atomic absorption (GFAA), SW7060;
- lead by GFAA, SW7421;
- cadmium by GFAA, SW7131;
- chromium by GFAA, SW7191;
- mercury by cold vapor, SW7470 and SW7471;
- common anions, SW9056;
- total organic carbon, SW9060; and
- toxicity characteristic leaching procedure (TCLP), Federal Regulation Volume 55, Number 61, 29 March 1990 (Extraction Method 1311);
    - VOCs, SW8240;
    - SVOCs, SW8270;
    - organochlorine pesticides and PCBs, SW8080;
    - arsenic, SW7060;
    - barium, SW7080;
    - cadmium, SW7130;
    - chromium, SW7190;
    - lead, SW7420;
    - mercury, SW7470;
    - selenium, SW7740; and
    - silver, SW7760.

The following geotechnical analyses will also be performed:

- soil cation exchange capacity (CEC), SW9081;
- determination of water content, American Society for Testing and Materials (ASTM) D2216;
- grain size analysis, ASTM D422;
- specific gravity, ASTM D854; and
- vertical permeability, ASTM 2434.

BCA, which has been audited by AFCEE, will provide data package deliverables suitable for site characterization and risk assessment purposes. All samples sent

offsite will be analyzed by this laboratory. The laboratory will not be allowed to subcontract chemical analytical services for this project.

BCA will subcontract geotechnical analysis to Kleinfelder located in San Ramon, California. Data generated for geotechnical parameters will be reported to BCA. The geotechnical data will be compiled by BCA and reported to Jacobs in hardcopy and electronic format.

1.2.3.2 Data Validation

Five percent of data generated by BCA will undergo data validation according to EPA Contract Laboratory Program (CLP) Level D guidelines. In addition to the review of data summary forms, this type of validation includes a review of the raw data. Data will be validated for technical and non-technical compliance to the AFCEE program and project-specific documents and contracts. A statistically significant number of calculations and algorithms will be verified by the data validation firm. In addition, data package completeness will be reviewed and noted for deficiencies. The project QA Coordinator will select the data to be validated.

Data validation will be conducted by QuantaLex, Inc., Lakewood, Colorado. Data validation will be performed in accordance with the Air Force IRP Handbook (Air Force 1993a), the CLP *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis* (EPA 1988b), *Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses* (EPA 1988c), and the EPA CLP *Functional Guidelines for Inorganic and Organic Analyses* (EPA 1991a). Those analyses and QC elements not within the scope of the national functional guidelines will be validated using protocols identified by the data validation firm. Data from all of the analytical methods identified in the SAP will be validated. Appendix B of the SAP contains a brief description of the scope of work for data validation.

1.3 PROJECT ORGANIZATION AND RESPONSIBILITY

An organization chart that shows all key project personnel for implementing the field investigations has been prepared (Figure 1.3-1). An organization chart for the laboratory is included in Appendix A. The following are responsibilities of the key personnel:

Contracting Officer Representative. The AFCEE Contracting Officer's Representative (COR) for Delivery Order No. 4 is Mr. Mike McGhee, who is located at Brooks AFB, Texas. The point of contact for this RI/FS (identified as the Remedial Project Manager) is Ms. Patricia Striebich, who is located at Elmendorf AFB, Alaska. The Jacobs project team will coordinate all activities conducted under this delivery order with these Air Force representatives through the Jacobs Project Manager, Ms. Lynn Schuetter, located at the Jacobs Denver, Colorado office.

Jacobs Program Manager. The Jacobs Program Manager, Mr. Robert Siek, has overall responsibility for work performed for the Air Force under this contract. The Program Manager will ensure high-quality work, make resources available, and approve all work under this delivery order. In addition, the Program Manager will review progress, anticipate and resolve problems, and ensure client satisfaction.

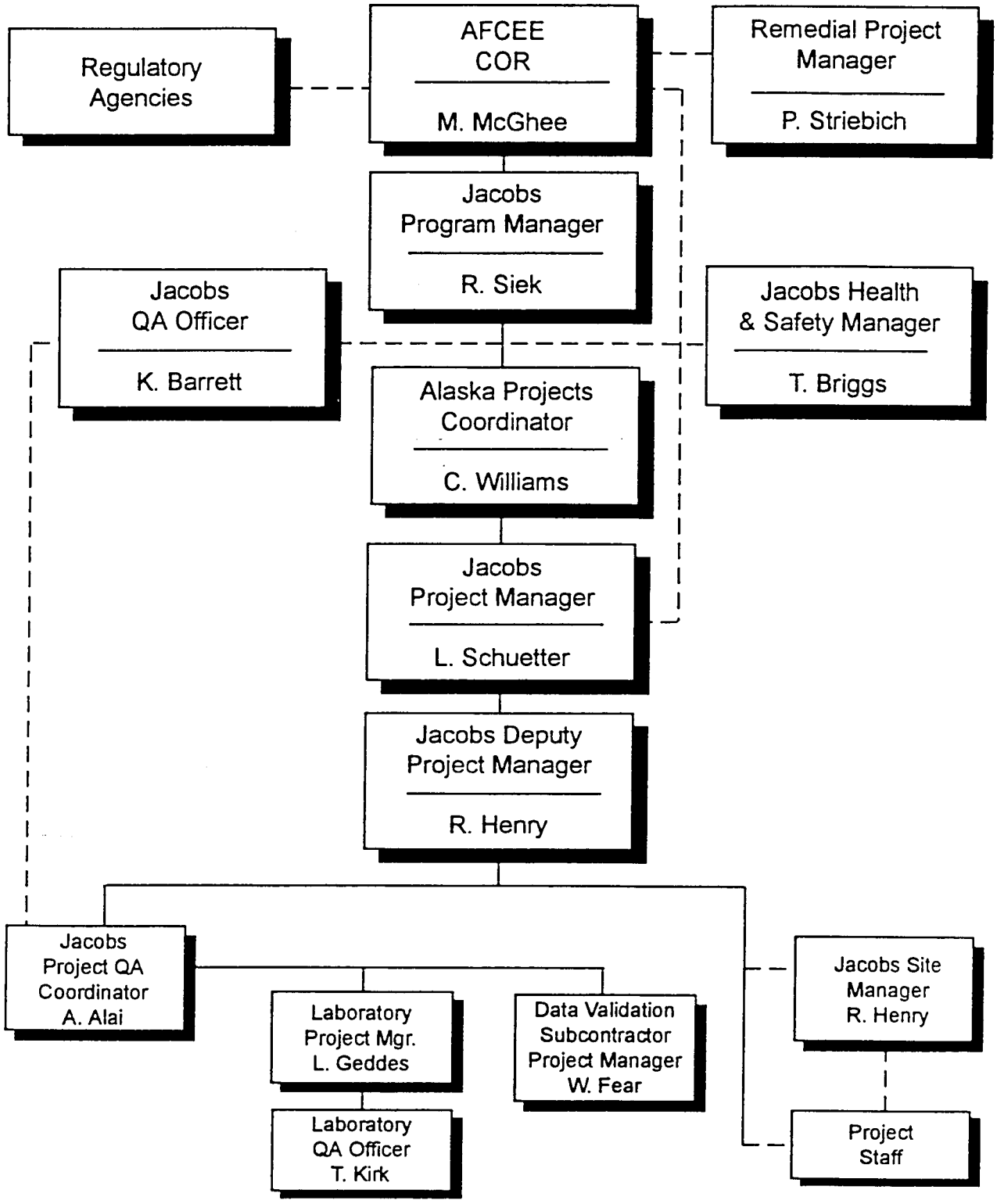


FIGURE 1.3-1
PROJECT ORGANIZATION CHART
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
INDIAN MOUNTAIN LONG RANGE RADAR STATION, ALASKA

AFCEE IRP Alaska Projects Coordinator. The Jacobs Alaska Projects Coordinator, Mr. Chris Williams serves as the central point of contact between AFCEE's Alaska Team Chief and Jacobs Denver Operations Project Managers. The Jacobs Alaska Projects Coordinator is responsible for addressing and resolving Alaska-project issues with the AFCEE staff. In addition, he conducts frequent delivery order reviews, tracks major deliverables, monitors Alaska projects budgets and responds to programmatic issues.

Jacobs Project Manager. The Jacobs Project Manager, Ms. Lynn Schuetter, has the day-to-day responsibility for all aspects of the Jacobs work on Delivery Order No. 4. The Project Manager maintains close communication and coordinates all activities with the AFCEE COR and the point of contact at Indian Mountain LRRS. She is responsible for identifying appropriate staff for each task and providing oversight of all work to ensure its successful completion. The Project Manager uses the information provided by Jacobs Project Controls and Accounting to (1) track the progress of costs and schedules and (2) prepare monthly summary reports for the COR.

Jacobs Quality Assurance Officer. The Jacobs QA Officer, Mr. Kris Barrett, will ensure that all work is performed according to the specifications of this QAPP. This responsibility includes performing audits, reporting to the Air Force, and reviewing deliverables.

Jacobs Health and Safety Manager. The Health and Safety Manager will make certain that all work is performed in accordance with the approved Health and Safety Plan (HSP) and the provisions of the Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 for worker health and safety. Dr. Terry Briggs, the Jacobs Health and Safety Manager, will provide assistance, oversight, and senior review of the HSP. The Health and Safety Manager or his designee will perform audits to make certain that fieldwork is conducted to the specifications of the HSP.

Jacobs Project Quality Assurance Coordinator. The Jacobs Project QA Coordinator will make certain that the laboratory is performing the analytical protocols as specified in the IRP Handbook (Air Force 1993a), the QAPP, and EPA Method SW-846 methods manual. Mr. Alan Alai will act as the Jacobs QA Officer's designee when reviewing and auditing any laboratory operations. He will report to both the Jacobs Project Manager and the Jacobs QA Officer. In addition, he will oversee all data validation activities and schedules, and he will serve as the primary point of contact for all analytical technical issues that require resolution.

Brown and Caldwell Analytical Project Manager. Ms. Linda Geddes has been assigned as the BCA Project Manager. She will have ultimate responsibility for analytical performance, including adherence to contract requirements and QC requirements. Ms. Geddes will serve as the primary BCA laboratory contact person, and any change in the scope of work will be processed by her. She will monitor the progress and timeliness of the work and will review work orders and all laboratory reports.

As the analytical laboratory project manager, she is responsible for ensuring that corrective action has been taken to address problems identified by QC sample results or QA audit findings (Appendix A). Ms. Geddes or her designee will have the responsibility for project administration, including assisting Jacobs with coordinating shipments of samples to the laboratory, sample receipt, project updates, sample

bottle orders, and sample receiving. The BCA Project Manager or designee will review and sign correspondence with Jacobs personnel or third-party validation firms.

Brown and Caldwell Quality Assurance Manager. Mr. Tom Kirk is the Project QA Manager for BCA. He has responsibility for coordination and oversight of this project-specific QA program, which includes preparing written documents defining QA/QC procedures, reviewing and approving laboratory QC procedures, supervising sample analysis operations, and overseeing interlaboratory testing programs and laboratory certifications. Mr. Kirk will be responsible for implementing corrective actions and reporting to the Jacobs QA Coordinator and Project Manager concerning QA/QC procedures. He will also coordinate corrective actions associated with analytical problems. In addition, Mr. Kirk will evaluate the effectiveness of the laboratory QA/QC program through audits.

Jacobs Site Manager. The Jacobs Site Manager, Mr. Robert Henry, will be in the field during all activities to assist with sampling activities, make field decisions, provide direction to the field team, provide progress reports and attend briefings with the Air Force, and implement the provisions of the SAP and HSP. The Site Manager will maintain logbooks and other documentation of field activities. The Site Manager will report directly to the Jacobs Project Manager.

Data Validation Project Manager. The Data Validation Project Manager will coordinate all data validation activities. Mr. William Fear with QuantaLex (or his designee) will review and sign all data validation reports. He will ensure high quality and consistency, make resources available, and review progress of all data validation tasks. All correspondence concerning data validation needs or requirements will be reviewed and approved by the Data Validation Project Manager.

1.4 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this investigation is to make certain that all decisions based on laboratory and field data are technically sound, statistically valid, and properly documented.

To meet the project objectives specified in Section 3.1 of the Work Plan, specific QA/QC protocols that will be executed are described for all activities related to the collection of environmental samples, the analyses of these samples at the laboratory, and the handling of data generated during the investigation.

Data will be obtained under the constraints and controls of the IRP Handbook (Air Force 1993a). Analytical data will be generated by a laboratory audited by AFCEE for Air Force IRP work. In addition to the QA discussed in this document, analytical data quality measures are discussed in the LQAPP (Appendix A). Any variances from the referenced methodology are stated in Appendix A and will be approved by AFCEE before any analyses are performed. Analytical data will be generated using EPA, ASTM, and other standard methods.

The level of deliverables required for all offsite analyses requires that the laboratory provide a data package equivalent to the EPA CLP data package or QAPP-specified deliverables, whichever is more inclusive. Data may require complete validation (summary forms and raw data); therefore, complete deliverables or equivalent (Appendix A) will be provided by the laboratory. These validated data are

essentially equivalent to EPA Level IV data. Data at this level can be used for risk assessment, site characterization, evaluation of alternatives, and engineering design.

The following onsite field tests will be conducted:

- field headspace analysis;
- explosive vapor survey;
- water-level measurement;
- immiscible layer measurement; and
- conductivity, salinity, pH, temperature, dissolved oxygen and turbidity, oxygen and carbon dioxide, and surface water velocity.

All activities conducted onsite will be performed using SOPs or manufacturer's instructions that detail the tested and proven procedures that are to be followed when conducting fieldwork. Sections 2.1 and 2.3 detail these procedures.

1.4.1 Definition of Criteria

The statistical acceptance criteria for the specific analyses used will be expressed in terms of precision, accuracy, representativeness, comparability, and completeness. The following are definitions for these terms:

Precision. Precision is defined as the degree of agreement between repeated measurements of the same parameter under prescribed, similar conditions. Precision, therefore, represents the repeatability of the measurement. The precision of a series of measurements can be expressed in terms of relative percent difference (RPD). Precision between matrix spikes and matrix spike duplicates is determined by calculating the RPD between the spike recoveries.

The RPD will be calculated as follows:

$$RPD = (D1 - D2)/([D1 + D2]/2) \times 100$$

where:

RPD = relative percent difference;
D1 = first duplicate value; and
D2 = second duplicate value.

Accuracy. Accuracy is the measure of the degree of agreement between an analyzed value and the true or accepted value, where it is known. For this document, accuracy will be statistically represented by calculating percent recovery (% R) of a known standard added to the sample of interest.

Percent recovery will be calculated as follows:

$$\% R = Q_d/Q_a \times 100$$

where:

% R = percent recovery;
Q_d = quantity determined by analysis; and
Q_a = true or accepted reference quantity or value.

Representativeness. Samples collected during field activities will represent the population from which they were collected. Representativeness is defined as the degree with which the data collected accurately and precisely characterize a population, a parameter of interest, variations at a sampling point, a process, or an environmental condition.

Comparability. Comparability, as used within this QAPP, is the confidence with which one data set can be compared with another. Each value reported for a given measurement should be similar to other values within the same data set and within other related data sets.

Completeness. Completeness, as it pertains to the laboratory and for the purposes of this QAPP, is defined as the ratio of the number of valid sample results to the total number of samples run with a specific analysis and/or on a specific matrix. In terms of sampling protocols, completeness is the ratio of the number of valid samples collected to the total number of samples required to be representative.

Completeness is expressed as a percent of the overall data that were generated and is calculated as follows:

$$C = V/T \times 100$$

where:

C = percent completeness;
V = number of measurements judged valid; and
T = total number of measurements.

1.4.2 Goals for Assessment Criteria

As specified in the IRP Handbook (Air Force 1993a), accuracy and precision control limits will be established by the laboratory and will be unique to the laboratory performing the analysis.

The laboratory-established control limits will be evaluated at regular intervals, and scheduled control measurements will be taken to detect trends and out-of-limit values. The laboratory will maintain records of these activities. EPA CLP or method-specified control limits are unacceptable substitutions for laboratory-generated control limits, except when the laboratory limits are outside the method-specified limits. However, the laboratory must be in the process of performing corrective actions to bring their limits to within those of the published method.

Criteria assessment is discussed below.

Precision. Precision will be assessed by analyzing matrix spikes, duplicates, and field replicates; determining the RPD; and comparing the RPD with the acceptance criteria presented in Appendix A.

Accuracy. Laboratory accuracy will be assessed by analyzing instrument calibration verification standards, laboratory control samples, matrix spiked samples, surrogate spiked samples, and performance evaluation QC check samples. The degree of accuracy depends on the sample matrix, method of analysis, sample preparation method, and the analyte being determined. The concentration of the analyte relative to the detection limit is also a major factor in determining the accuracy of the measurement. The analytical laboratory will perform all analyses within the prescribed limits of accuracy required by the Air Force IRP Handbook (Air Force 1993a) or as described in this QAPP.

True values for field tests such as pH, specific conductance, and temperature are not known for the program matrices and specific sampling locations. Therefore, the accuracy of the data produced by field instruments will be maintained and documented by performing proper instrument calibration and maintenance in accordance with manufacturer's instructions and appropriate SOPs.

Representativeness. Sampling protocols are developed to make certain that the collected samples represent the media. Sample handling protocols (e.g., storage and transportation) are selected to protect the representativeness of the collected sample. Measurements will be made so that results are as representative of the media (e.g., air, soil, and water) and conditions being measured as possible. Proper documentation will establish that protocols have been followed and sample identification and integrity are ensured.

Procedures presented in the FSP address issues such as collecting surface water, groundwater, sediment, and soil samples; monitoring pH, specific conductance, and temperature during monitoring well evacuation; and using disposable sampling devices when possible. Additionally, representativeness of specific analyses will be achieved by the following means:

- selecting appropriate numbers of samples and locations to adequately characterize the actual and current site conditions;
- using appropriate sample procedures and equipment;
- selecting appropriate analytical methodologies that provide required detection limits;
- selecting appropriate analytical parameters;
- collecting appropriate numbers of QC samples to statistically verify proper functioning of the analytical method and equipment;
- documenting sampling activities and sampling locations in field logs, on chain-of-custody records, and in laboratory books that are signed and dated by sampling and analysis personnel; and
- using appropriate sample device decontamination techniques.

In addition, other QC samples, including field and matrix spikes/spike duplicates, will be analyzed as a part of the overall QA program. The QA program will help provide information on the representativeness of collected samples.

Comparability. To ensure data set comparability, the following steps will be taken:

- Instruments will be operated within their calibrated range, and appropriate analytical methodologies will be used. Analyses will be performed using standard EPA and ASTM methods. If ASTM or EPA methods do not exist, a comparable, standard method will be used. The laboratory will provide SOPs for these methods.

- The laboratory will participate in the EPA performance evaluation studies (water pollution and water supply).

- Measurements that appear as "outliers" will be reassessed. The determination of outliers will be based on assessing a statistically significant data set. Not all outlier data are a result of laboratory error or sampling technique. Data which do not compare to other data sets (e.g. BTEX results from the SW8240 or SW8260 analyses do not match GEO analytical data) will require additional assessment. No data will be eliminated because of lack of comparability. These data will, however, require explanation.

- Traceable standards will be used by the laboratory whenever possible.

- Techniques used to collect samples for previous studies will be implemented when possible.

- Data will be reported in conventional and standard units.

Completeness. Laboratory completeness will be based on the total number of samples that are analyzed under controlled conditions that meet the IRP or laboratory-established precision and accuracy objectives, as applicable. Data produced by the fixed laboratory should achieve completeness of greater than or equal to 90 percent for both solid and aqueous matrices.

Field completeness is defined as the ratio of the number of valid samples to the total number of samples required to be representative. (The number of valid samples collected is determined during the data validation process.) Validation of data is described in Section 1.9.

Section 2.0 of this SAP describes specific field procedures to ensure the completeness of field-collected samples. Field QC samples, including trip blanks and decontamination rinsate blanks, will be collected to verify that sampling and decontamination procedures are not introducing trace constituents of concern.

1.5 SAMPLING PROCEDURES

Sampling protocols and sample handling are described in the following sections. Section 2.0 describes the types of field activities in more detail. The rationale for field activities that are proposed for each site is provided in the Work Plan.

1.5.1 Sampling Protocols

This section lists references and guidance documents used as the basis for preparing soil, sediment, floating product, and surface water and groundwater sample collection, handling, preservation, and shipping procedures. These procedures are designed to ensure that (1) samples are properly collected, (2) samples are labeled, preserved, and transported so that they represent field conditions, (3) sampling results are repeatable, (4) monitoring wells are installed properly, and (5) boreholes and wells are properly sealed (as required).

1.5.2 Sample Handling

Sample handling procedures and documentation are discussed in Section 2.0. Tables 1.5-1 and 1.5-2 summarize the containers, preservation techniques, and holding times for solid and aqueous samples for the 1994 Indian Mountain LRRS field investigation. Sample containers that are certified as analyte-free will be provided with the appropriate preservatives added by the laboratory. Spilt-spoon soil samples will be collected in brass liners as described in the FSP (Section 2.0). All samples collected for analysis of VOCs will be collected in a manner that reduces agitation and loss of volatile constituents.

1.6 SAMPLE CUSTODY

The following sections describe sample handling and identification, both in the field and at the laboratory. Detailed sample handling, identification, and custody procedures for the laboratory are described in the LQAPP (Appendix A).

1.6.1 Field Operations

Procedures for establishing sample custody in the field and during shipment to the laboratory are identified in Section 2.2.3 of the FSP. All samples will be secured in the field until relinquished for transport to the offsite laboratory. Custody procedures in the laboratories are described below.

1.6.2 Fixed Laboratory Operations

The following sections describe the sample handling techniques, sample identification methods, and sample custody records associated with the fixed laboratory operations.

1.6.2.1 Sample Handling

Upon receipt of the samples, the laboratory will sign and keep copies of the air bill. The custody form will be signed. The temperature of the cooler will be measured and documented, and the condition of the samples will be documented. If any breaks occur or discrepancies arise between the custody form, sample tags, and requested analysis, the sample custodian will notify the QA Coordinator, Project Manager, or Site Manager within 24 hours. Any discrepancy or improper preservation will be noted by the laboratory as an out-of-control event, which will be documented and proper corrective action will be taken. The Site Manager or designee will be responsible for maintaining contact with the laboratory.

1.6.2.2 Sample Identification

The sampling team will assign a unique sample number to each sample based on the information included in Section 2.2.2 of the FSP. If this number will not be used

TABLE 1.5–1
CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
SOLID SAMPLES
INDIAN MOUNTAIN LRRS, ALASKA

Parameter	Analytical Method	Containers[1]	Preservation Techniques[2]	Maximum Allowable Holding Times[3]
Volatile Organic Compounds	SW8240	120 ml (4 oz)[4]	Cool, 4°C	14 days
Semivolatile Organic Compounds	SW8270	120 ml (4 oz)	Cool, 4°C	14 days until extraction 40 days after extraction
Organochlorine Pesticides & PCBs	SW8080		Cool, 4°C	14 days until extraction 40 days after extraction
ICP Metals, total	SW6010	120 ml (4 oz)	Cool, 4°C	6 months
Total Fuel Hydrocarbons: Gasoline–Range Organics Diesel–Range Organics Residual–Range Organics	SW8015 (Modified) SW8100 (Modified) and Ak103	2 x 120 ml (4 oz)	Cool, 4°C	Volatiles: 14 days Semivolatiles: 14 days until extraction 40 days after extraction
TCLP	SW1311/SW8240	2 x 16 oz	Cool, 4°C	14 days from field collection to ZHE, 14 days from ZHE to analysis
	SW1311/SW3510/SW8270, SW8080		Cool, 4°C	7 days from field collection to TCLP extraction; 7 days from TCLP extraction to organic extraction; 40 days from organic extraction to analysis
	SW1311/SW7060, SW7130, SW7190, SW7420, SW7740, SW7760, SW7080		Cool, 4°C	6 months from field collection to TCLP extraction; 6 months from digestion (SW3005) to analysis
	SW1311/SW7470		Cool, 4°C	28 days from field collection to TCLP extraction; 28 days from TCLP extraction to analysis
Water Content	ASTM D2216	2 brass sleeves	Cool, 4°C	As soon as possible
Soil Cation Exchange Capacity	SW9081		Cool, 4°C	Not applicable
Grain Size Analysis	ASTM D422		Cool, 4°C	Not applicable
Vertical Permeability	ASTM D2434		Cool, 4°C	Not applicable
Specific Gravity	ASTM 854		None	Not applicable
Total Organic Carbon	SW9060		Cool, 4°C	28 days

Recycled

TABLE 1.5–1
CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
SOLID SAMPLES
INDIAN MOUNTAIN LRRS, ALASKA

NOTE:

1 Soil containers for all measurements are widemouthed glass jars with Teflon–lined caps. A double volume sample will periodically be sent to the laboratory for quality assurance/quality control tests.

2 Sample preservation is performed immediately upon sample collection. Soil samples are cooled immediately to 4°C.

3 Samples are analyzed as soon as possible after collection. Times listed are the maximum times samples are to be held before analysis and still considered valid.

4 Soil samples for volatile organic analysis may also be collected in a brass or stainless–steel liner from a split–spoon sampler. Both ends of the liner will be covered with oil–free aluminum foil and capped with Teflon end–caps.

ASTM = American Society for Testing and Materials
GFAA = Graphite Furnace Atomic Absorption
ICP = Inductively Coupled Plasma
L = Liter
ml = Milliliter
oz = ounce
PCB = Polychlorinated Biphenyl
TCLP = Toxicity Characteristic Leaching Procedure
ZHE = Zero Headspace Extraction

TABLE 1.5–2
CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
AQUEOUS SAMPLES
INDIAN MOUNTAIN LONG RANGE RADAR STATION, ALASKA

Parameter	Analytical Method	Containers	Preservation Techniques[1]	Maximum Allowable Holding Times[2]
Volatile Organic Compounds	SW8260	2x40 ml, glass vial, Teflon–lined septum cap	Cool, 4°C, HCl to pH<2, 0.008% $Na_2S_2O_3$	14 days
Semivolatile Organic Compounds	SW8270	2x1 L, amber glass jar, Teflon–lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$	7 days until extraction 40 days after extraction
Organochlorine Pesticides & PCBs	SW8080	2x1 L, glass jar	Cool, 4°C, pH 5–9	7 days until extraction 40 days after extraction
ICP Metals, total and dissolved	SW6010	1L, plastic	Cool, 4°C, HNO_3 to pH<2	6 months
Metals by GFAA	SW7060, SW7421, SW7131, SW7740, SW7191			6 months
Mercury by cold vapor	SW7470			28 days
Common Anions	SW9056	125 ml, plastic or glass	None required	28 days for F, Cl, SO_4; 48 hours for NO_3, NO_2, PO_4
Total Fuel Hydrocarbons: Gasoline–Range Organics Diesel–Range Organics	SW8015 (Modified) and SW8100 (Modified)	2x1 L, glass jar, and 2x vials 40 ml Teflon–lined cap	Cool, 4°C, HCl to pH<2	Volatiles: 14 days Semivolatiles: 7 days until extraction 40 days after extraction

NOTES:

[1] Sample preservation is performed immediately upon sample collection.
HCl = hydrochloric acid. HNO_3 = nitric acid. $Na_2S_2O_3$ = sodium sulfate.
Samples collected for dissolved metals are filtered (0.45 µm) before preservation with HNO_3.

[2] Samples are analyzed as soon as possible after collection. Times listed are maximum times samples are to be held before analysis and still considered valid.

Cl = Chloride
F = Fluoride
GFAA = Graphite Furnace Atomic Absorption
HCl = Hydrochloric Acid
HNO_3 = Nitric Acid
ICP = Inductively Coupled Plasma
L = Liter
ml = Milliliter
$Na_2S_2O_3$ = Sodium Thiosulfate
NO_3 = Nitrate
NO_2 = Nitrite
PCB = Polychlorinated biphenyl
PO_4 = Phosphate
SO_4 = Sulfate
°C = degrees Celsius

Recycled

by the laboratory, a cross-reference table that identifies the sample designation and the laboratory number will be provided.

Samples will be analyzed by the fixed laboratory in laboratory batch numbers not to exceed 20 samples. Sample batches may be smaller than 20 samples based on the number of samples the laboratory receives from the field team and the sample holding times. The numbering convention for the laboratory batches is discussed in Appendix A.

1.6.2.3 Sample Custody Records

Custody procedures will be followed in the laboratory from the time of sample receipt to the time of sample disposal. Signed custody records will be sent with the data package deliverable. Specific custody procedures for the fixed laboratory to follow are described in the LQAPP (Appendix A).

1.7 CALIBRATION PROCEDURES AND FREQUENCY FOR FIELD TEST EQUIPMENT

Section 2.3 describes the field measurements and field equipment calibration procedures.

1.8 ANALYTICAL PROCEDURES

Reporting limits will be established for reagent (blank) water using procedures outlined in one of the following references:

- applicable analytical method (these are the methods specified by the Air Force for analysis of the various study analytes);
- 40 CFR 136, Appendix B;
- *Principles of Environmental Analysis* in Analytical Chemistry, Vol. 55, pp. 2210-2218, December 1983; and
- EPA CLP, latest Statement of Work.

Any variances or deviations to the established method detection limits (MDLs) must be approved by the Jacobs Project Manager. Upon approval, the Jacobs Project Manager will request the variance on behalf of the laboratory for approval by the Air Force. No deviations or variances will be considered for approval during or 30 days before any scheduled analytical performance period.

The procedures used to establish the detection limits for organic compounds will be performed before analyzing environmental samples and are verified once a year. The limits for metals are verified semiannually. Documentation to demonstrate the established detection limits will be provided by the laboratory for review by the Jacobs QA Officer before any sampling event. No sample analyses will be performed until the established detection limits are approved in writing by the Jacobs QA Officer. Definitions for MDL, quantitation limits, and reporting limits are presented in Appendix A.

The laboratory will not establish quantitation limits by multiplying the detection limits by an arbitrary factor.

1.8.1 Identification of Fixed Laboratory Methods

The analytical method numbers, the source for each method, and the Air Force required maximum reporting limits for laboratory analyses are presented in Table 1.8-1. The laboratory established reporting limits for each method are provided in the LQAPP (Appendix A). For those analytes that exceed the maximum reporting limit indicated in the Air Force IRP Handbook, variances and a record of approval by AFCEE are included in Appendix A. Analytical procedures will be in accordance with those specified in the Air Force IRP Handbook (Air Force 1993a), laboratory SOPs, and the analytical method. The LQAPP and SOPs provide the laboratory's established interpretation of the methodology. Corrective action and other QC measures identified in Appendix A will serve to demonstrate laboratory compliance with its QA program and Air Force requirements. The use of tables and flowchart will illustrate laboratory procedures and method interpretation.

Gas Chromatograph Methods. For gas chromatograph (GC) methods, analyte retention times and retention time windows will be established to accurately identify chromatographic peaks. Demonstration of appropriate retention time windows will be included in the laboratory data packages. The confirmation analyses will be performed to include all the necessary QC components and deliverables required by the method. The laboratory will identify the most reliable value and report that value as the primary quantitation. All analyses to be used for confirmation will be identified as such and reported. If it becomes necessary to confirm the presence and quantitation of a compound via GC/mass spectrometry (MS) methodology, the concentration of the chemical will be equal to or greater than the GC/MS MDL.

Tentatively Identified Compounds (TIC) will not be reported for the GC/MS analyses provided by the laboratory.

GC Second-Column Analysis. The maximum number of second-column confirmational analyses will not exceed the specified number in the Sample Analyses Summary tables in the FSP (Section 2.0). If the number of samples requiring second-column confirmation exceeds this allowance, the COR will be contacted. If GC/MS or a combination of second-column GC and GC/MS is used, the total cost of all such analyses for a particular parameter will not exceed the funding allowed for positive confirmation using only second-column GC.

All confirmation analyses will be reported in the data package and discussed in the laboratory case narrative. Data from both the primary analysis and the confirmation will be reported for all compounds of interest within the scope of the specific method. Any compound not reported in the primary analysis, but found in the confirmation analysis, will be discussed in the laboratory case narrative. This discussion will identify those sample analyses that did not match the primary analysis and provide a rationale for the nonconformance (e.g., lack of sample homogeneity or potential laboratory contamination).

Residual Range Organics (RRO), AK103.0. Lubricating or motor oils or other heavy petroleum products (C25-C44 carbon range) as well as asphalts (>C44) and midrange petroleum products such as diesel and bunker C are detectable under the conditions of this method. This method is based on a solvent extraction, gas chromatography (GC) procedure. Soil samples are spiked with a surrogate compound and extracted with methylene chloride. The extract is concentrated to a volume of 1.0 mL. An aliquot of the extract is injected into a GC equiped with a

TABLE 1.8–1
FIXED LABORATORY REPORTING LIMITS
INDIAN MOUNTAIN LRRS, ALASKA

Parameter	Method w=water s=soil	Analyte	Air Force Practical Quantitation Limit Water (µg/L)
Volatile Organic Compounds	SW8260(w)	Benzene	2.0
		Bromobenzene	5.0
		Bromodichloromethane	1.0
		Bromoform	2.0
		Bromomethane	10.0
		Carbon tetrachloride	1.0
		Chlorobenzene	2.0
		Chlorodibromomethane	1.0
		Chloroethane	5.0
		Chloroform	0.5
		1–Chlorohexane	5.0
		Dibromomethane	5.0
		1,2–Dichlorobenzene	2.0
		1,3–Dichlorobenzene	3.0
		1,4–Dichlorobenzene	2.0
		1,1–Dichloroethane	1.0
		1,2–Dichloroethane	1.0
		1,1–Dichloroethene	1.0
		trans–1,2–Dichloroethene	1.0
		cis–1,2–Dichloroethene	1.0
		1,2–Dichloropropane	1.0
		Ethylbenzene	2.0
		Methylene chloride	2.0
		Styrene	5.0
		1,1,2,2–Tetrachloroethane	1.0
		1,1,1,2–Tetrachloroethane	5.0
		Tetrachloroethene	1.0
		Toluene	2.0
		1,1,1–Trichloroethane	1.0
		1,1,2–Trichloroethane	1.0
		Trichloroethene	1.0
		Trichlorofluoromethane	1.0
		Vinyl chloride	2.0
		Xylenes (total)	2.0

TABLE 1.8-1 (continued)
FIXED LABORATORY REPORTING LIMITS
INDIAN MOUNTAIN LRRS, ALASKA

Parameter	Method w=water s=soil	Analyte	Air Force Practical Quantitation Limit	
			Water (µg/L)	Soil/ Sediment (mg/kg)
Volatile Organic Compounds (continued)	SW8240 (s)	Acetone	100	0.100
		Benzene	5	0.005
		Bromodichloromethane	5	0.005
		Bromoform	5	0.005
		Bromomethane	10	0.010
		2-Butanone (MEK)	100	0.100
		Carbon disulfide	5	0.005
		Carbon tetrachloride	5	0.005
		Chlorobenzene	5	0.005
		Chlorodibromomethane	5	0.005
		Chloroethane	10	0.010
		2-Chloroethyl vinyl ether	10	0.010
		Chloroform	5	0.005
		Chloromethane	10	0.010
		1,1-Dichloroethane	5	0.005
		1,2-Dichloroethane	5	0.005
		1,1-Dichloroethene	5	0.005
		cis-1,2-dichloroethene	5	0.005
		trans-1,2-Dichloroethene	5	0.005
		1,2-Dichloropropane	5	0.005
		cis-1,3-Dichloropropene	5	0.005
		trans-1,3-Dichloropropene	5	0.005
		Ethylbenzene	5	0.005
		2-Hexanone	50	0.050
		Methylene Chloride	5	0.005
		4-Methyl-2-pentanone (MIBK)	50	0.050
		Styrene	5	0.005
		1,1,2,2-Tetrachloroethane	5	0.005
		Tetrachloroethene	5	0.005
		Toluene	5	0.005
		1,1,1-Trichloroethane	5	0.005
		1,1,2-Trichloroethane	5	0.005
		Trichloroethene	5	0.005
		Vinyl acetate	50	0.050
		Vinyl chloride	10	0.010
		Xylenes (total all isomers)	5	0.005

TABLE 1.8–1 (continued)
FIXED LABORATORY REPORTING LIMITS
INDIAN MOUNTAIN LRRS, ALASKA

Parameter	Method w=water s=soil	Analyte	Air Force Practical Quantitation Limit	
			Water (µg/L)	Soil/Sediment (mg/kg)
Semivolatile Organic Compounds	SW3510/SW8270(w) SW3550/SW8270(s)	Base/Neutral Extractables		
		Acenaphthene	10	0.7
		Acenaphthylene	10	0.7
		Anthracene	10	0.7
		Benzo(a)anthracene	10	0.7
		Benzo(b)fluoranthene	10	0.7
		Benzo(ghi)perylene	10	0.7
		Benzo(a)pyrene	10	0.7
		Benzyl alcohol	20	1.3
		Bis(2–chloroethoxy) methane	10	0.7
		Bis(2–chloroethyl)ether	10	0.7
		Bis(2–chloroisopropyl) ether	10	0.7
		Bis(2–ethylhexyl)phthalate	10	0.7
		4–Bromophenyl phenylether	10	0.7
		Butyl benzyl phthalate	10	0.7
		4–Chloroaniline	20	1.3
		2–Chloronaphthalene	10	0.7
		4–Chlorophenyl phenylether	10	0.7
		Chrysene	10	0.7
		Dibenz(a,h)anthracene	10	0.7
		Dibenzofuran	10	0.7
		di–n–Butylphthalate	10	0.7
		1,2–Dichlorobenzene	10	0.7
		1,3–Dichlorobenzene	10	0.7
		1,4–Dichlorobenzene	10	0.7
		3,3'–Dichlorobenzidine	20	1.3
		Diethyl phthalate	10	0.7
		Dimethyl phthalate	10	0.7
		2,4–Dinitrotoluene	10	0.7
		2,6–Dinitrotoluene	10	0.7
		di–n–Octyl phthalate	10	0.7
		Fluoranthene	10	0.7
		Fluorene	10	0.7
		Hexachlorobenzene	10	0.7
		Hexachlorobutadiene	10	0.7
		Hexachlorocyclopentadiene	10	0.7
		Hexachloroethane	10	0.7

TABLE 1.8-1 (continued)
FIXED LABORATORY REPORTING LIMITS
INDIAN MOUNTAIN LRRS, ALASKA

Parameter	Method w=water s=soil	Analyte	Air Force Practical Quantitation Limit	
			Water (µg/L)	Soil/Sediment (mg/kg)
Semivolatile Organic Compounds (Continued)	SW3510/SW8270(w) SW3550/SW8270(s) (Continued)	Indeno(1,2,3-cd)pyrene	10	0.7
		Isophorone	10	0.7
		2-Methylnaphthalene	10	0.7
		Naphthalene	10	0.7
		2-Nitroaniline	50	3.3
		3-Nitroaniline	50	3.3
		4-Nitroaniline	50	3.3
		Nitrobenzene	10	0.7
		n-Nitrosodiphenylamine	10	0.7
		n-Nitrosodipropylamine	10	0.7
		Phenanthrene	10	0.7
		Pyrene	10	0.7
		1,2,4-trichlorobenzene	10	0.7
		Acid Extractables		
		Benzoic acid	50	1.6
		4-Chloro-3-methylphenol	20	1.3
		2-Chlorophenol	10	0.3
		2,4-Dichlorophenol	10	0.3
		2,4-Dimethylphenol	10	0.3
		4,6-Dinitro-2-methylphenol	50	3.3
		2,4-Dinitrophenol	50	3.3
		2-Methylphenol	10	0.3
		4-Methylphenol	10	0.3
		2-Nitrophenol	10	0.3
		4-Nitrophenol	50	1.6
		Pentachlorophenol	50	3.3
		Phenol	10	0.3
		2,4,5-Trichlorophenol	50	3.3
		2,4,6-Trichlorophenol	10	0.3

TABLE 1.8–1 (continued)
FIXED LABORATORY REPORTING LIMITS
INDIAN MOUNTAIN LRRS, ALASKA

Parameter	Method w=water s=soil	Analyte	Air Force Practical Quantitation Limit	
			Water (mg/L)	Soil/ Sediment (mg/kg)
Inductively Coupled Plasma Screen for Metals	SW3005/SW6010(w) SW3050/SW6010(s)	Aluminum	0.500	50
		Antimony	0.400	40
		Arsenic	0.600	60
		Barium	0.020	2
		Beryllium	0.003	0.3
		Cadmium	0.040	4
		Calcium	0.100	10
		Chromium	0.070	7
		Cobalt	0.070	7
		Copper	0.060	6
		Iron	0.070	7
		Lead	0.500	50
		Magnesium	0.300	30
		Manganese	0.020	2
		Molybdenum	0.080	8
		Nickel	0.150	15
		Potassium	5	500
		Selenium	0.800	80
		Silver	0.070	7
		Sodium	0.300	30
		Thallium	0.400	40
		Vanadium	0.080	8
		Zinc	0.020	2
Arsenic by GFAA	SW7060 (w)	Arsenic	0.005	NA
Lead by GFAA	SW3020/SW7421(w)	Lead	0.005	NA
Mercury by Cold Vapor	SW7470(w)	Mercury	0.001	NA
Cadmium by GFAA	SW3020/SW7131(w)	Cadmium	0.001	NA
Chromium by GFAA	SW3020/SW7191(w)	Chromium	0.005	NA
Common Anions	SW9056 (w)	Chloride	0.2	--
		Fluoride	0.2	--
		Sulfate	0.2	--
		Nitrate – Nitrite	0.1	--
		Total Phosphate	0.1	--
Total Fuel Hydrocarbons	AK103(s)	Residual–Range Organics	--	100

TABLE 1.8–1 (continued)
FIXED LABORATORY REPORTING LIMITS
INDIAN MOUNTAIN LRRS, ALASKA

Parameter	Method w = water s = soil	Analyte	Air Force Practical Quantitation Limit	
			Water (µg/L)	Soil/ Sediment (mg/kg)
Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)	SW3510/SW8080(w) SW3550/SW8080(s)	Aldrin	0.04	0.003
		alpha–BHC	0.03	0.002
		beta–BHC	0.06	0.004
		delta–BHC	0.09	0.006
		gamma–BHC (Lindane)	0.04	0.003
		gamma–Chlordane	0.14	0.009
		4,4'–DDD	0.11	0.007
		4,4'–DDE	0.04	0.003
		4,4'–DDT	0.12	0.008
		Dieldrin	0.02	0.010
		Endosulfan I	0.14	0.009
		Endosulfan II	0.04	0.003
		Endosulfan sulfate	0.66	0.040
		Endrin	0.06	0.004
		Endrin aldehyde	0.23	0.020
		Heptachlor	0.03	0.002
		Heptachlor epoxide	0.83	0.060
		Methoxychlor	1.76	0.100
		Toxaphene	2.4	0.200
		PCB–1016	1.0	1.0
		PCB–1221	1.0	1.0
		PCB–1232	1.0	1.0
		PCB–1242	1.0	1.0
		PCB–1248	1.0	1.0
		PCB–1254	1.0	1.0
		PCB–1260	1.0	1.0
Total Fuel Hydrocarbons	SW8015 (mod.)	Gasoline – Range	100	1.0
	SW8100 (mod.)	Diesel – Range	1,000	10
Total Organic Carbon	SW9060 (s)	Total Organic Carbon	--	20

TABLE 1.8–1 (continued)
FIXED LABORATORY REPORTING LIMITS
INDIAN MOUNTAIN LRRS, ALASKA

Parameter	Method w=water s=soil	Analyte	Regulatory Limit Aqueous (mg/L)
Toxicity Characteristic Leaching Procedure	FED. REG.	Arsenic	5.0
	VOL. 55	Barium	100
	NO. 61	Cadmium	1.0
	29 MAR 90	Chromium	5.0
	Extraction:	Lead	5.0
	SW1311	Mercury	0.2
	Analysis:	Selenium	1.0
	SW8240	Silver	5.0
	SW3510/SW8270	Endrin	0.02
	SW3510/SW8080	Lindane	0.4
	SW3510/SW8080	Methoxychlor	10.0
	SW7060	Toxaphene	0.5
	SW7080	2,4–D	10.0
	SW7130	2,4,5–TP (Silvex)	1.0
	SW7190	Benzene	0.5
	SW7420	Carbon Tetrachloride	0.5
	SW7470	Chlordane	0.03
	SW7740	Chlorobenzene	100
	SW7760	Chloroform	6.0
		o–Cresol	200
		m–Cresol	200
		p–Cresol	200
		Cresol (total)	200
		1,4–Dichlorobenzene	7.5
		1,2–Dichloroethane	0.5
		1,1–Dichloroethylene	0.7
		2,4–Dinitrotoluene	0.13
		Heptachlor (and its epoxide)	0.008
		Hexachlorobenzene	0.1
		Hexachloro–1,3–butadiene	0.5
		Hexachloroethane	3.0
		Methyl ethyl ketone	200
		Nitrobenzene	2.0
		Pentachlorophenol	100
		Pyridine	5.0
		Tetrachloroethylene	0.7
		Trichoroethylene	0.5
		2,4,5–Trichlorophenol	400
		2,4,6–Trichlorophenol	2.0
		Vinyl Chloride	0.2
Soil Cation Exchange Capacity	SW9081 (s)	NA	----
Water Content	ASTM D2216 (s)	NA	----
Grain Size Analysis	ASTM D422 (s)	NA	----
Specific Gravity	ASTM D854 (s)	NA	----
Vertical Permeability	ASTM D2434 (s)	NA	----

(1) Air Force maximum reporting limit in µg/L

TABLE 1.8–1 (continued)
FIXED LABORATORY REPORTING LIMITS
INDIAN MOUNTAIN LRRS, ALASKA

References:

Standard Methods for the Examination of Water and Wastewater, 16th Edition (1985).
Methods for Chemical Analysis of Water and Wastes, EPA Manual, 600/4–79–020 (USEPA, 1983 – with additions).
Tesst Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW–846, 3rd Edition (USEPA, 1986a).

Notes:

ASTM	=	American Society for Testing and Materials
BHC	=	benzene hexachloride
DDD	=	dichlorodiphenyldichloroethane
DDE	=	dichlorodiphenyldichloroethene
DDT	=	dichlorodiphenyltrichloroethane
GFAA	=	graphite furnace atomic absorption
mg/kg	=	milligrams per kilogram
mg/L	=	milligrams per liter
MEK	=	methyl ethyl ketone
MIBK	=	methyl isobutyl ketone
NA	=	not applicable
PCB	=	polychlorinated biphenyl
µg/kg	=	micrograms per kilogram
µg/L	=	micrograms per liter
----	=	not established

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flame ionization detector (FID). Quantitation is performed by comparing the total chromatographic area of the sample to the total area response of the Residuals Calibration Standard. The total chromatographic area is determined to be the sum of the peaks which elute within the C_{25} - C_{45} carbon range. Method AK103.0 is subject to organic interferences. An evaluation of site-specific background results will be used to determine impact of interference on the results.

Solid Matrix Sample Analysis. All results will be reported on a dry weight basis for soil and sediment samples. The percent moisture will be reported for all solid samples. An adequate mass of solid will be used in the extraction and/or preparation phase to make certain that the detection limits are achieved. Samples that contain greater than 30 percent moisture will be noted in the laboratory case narrative, and any potential bias will be discussed.

The detection limits for all fixed laboratory analyses will be established in accordance with Appendix B of 40 CFR Chapter 1, Part 136, Guidelines Establishing Test Procedures for the Analysis of Pollutants. The documentation for all methods will be kept at the laboratory for review by the Jacobs QA Officer. This information will be verified for completeness and accuracy before any sample analyses. As necessary, this information will be provided to any subcontractors providing third-party validation.

Quantitation for all methods will be performed in accordance with the specific methodology. For GC analyses, all positive values will be quantitated using the average response factors or calibration factors from the initial calibration.

1.8.2 Practical Quantitation Limits

The following discussion defines the practical quantitation limit and the procedures for establishing practical quantitation limits (PQLs).

1.8.2.1 Terminology

The practical quantitation limit is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine analysis as defined by AFCEE (Air Force 1993a) and EPA (EPA 1986a). The PQLs for the compounds listed in Table 1.8-1 are identical to those found in the IRP handbook.

1.8.2.2 Procedures

The PQLs as defined above are verified by the laboratory with each initial calibration. The initial, multipoint calibration curve must include a standard at a concentration below the PQL values list in Table 1.8-1. All analytes reported must be present in the initial and continuing calibration standards and all calibration criteria specified must be met.

1.8.2.3 Values

The PQLs that are applicable to the Indian Mountain RI/FS are presented in Table 1.8-1.

1.8.3 Method Calibration for Fixed Laboratory

Calibration of fixed laboratory instrumentation will be performed as specified in the analytical methodology. Sample analyses will only be conducted using calibrated equipment. Appendix A lists the calibration criteria for all analyses to be performed by the offsite fixed laboratory.

For GC/MS methods, the response factor from the daily calibration standard will be used to quantitate target compounds. In cases where the sample analyses immediately follow the initial calibration and are within the 12-hour calibration time-frame of the MS tuning standard, the midpoint standard response factors will be used for quantitation. This standard must meet the criteria for daily calibration standard for these analyses to be acceptable.

1.8.4 Calibration Procedures

Calibration procedures for the laboratory instruments required for the specified analytical methods and information on the type of laboratory instruments is found in the LQAPP for the fixed laboratory in Appendix A. Additional information on laboratory QA is found in Section 1.10.

The materials used for all calibration standards, internal standards, surrogate standards, and QC check samples will be from EPA-certified reference or National Institute of Standards and Technology (NIST) traceable reference standards for all organic and inorganic analyses, if available. The Jacobs QA Officer will verify that the appropriate standards will be used by the laboratory before any analytical work.

1.9 DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction, validation, and reporting procedures will include evaluating both the field data and laboratory analytical data package. The overall data QA goals for the project can only be met if the data generated in the field and by the analytical laboratory can be demonstrated to be valid.

Data validity will be a function of both the magnitude of data qualification and overall data quality. That is, nonqualified and estimated (J) data will be assessed to determine the usability of the data. Data that are rejected (R) because of failure to meet established QC limits or because of systematic problems will not be used. Those data found to be suspect and outside of acceptable bias will not be used or will be downgraded for screening use only.

1.9.1 Data Management

Laboratory data will be presented in hard copy and computerized formats consistent with the Statement of Work, the Air Force IRP Handbook (Air Force 1993a), and the Installation Restoration Program Information Management System (IRPIMS) Data Loading Handbook (Air Force 1991b).

A flowchart of the data management activities is presented in Figure 1.9-1.

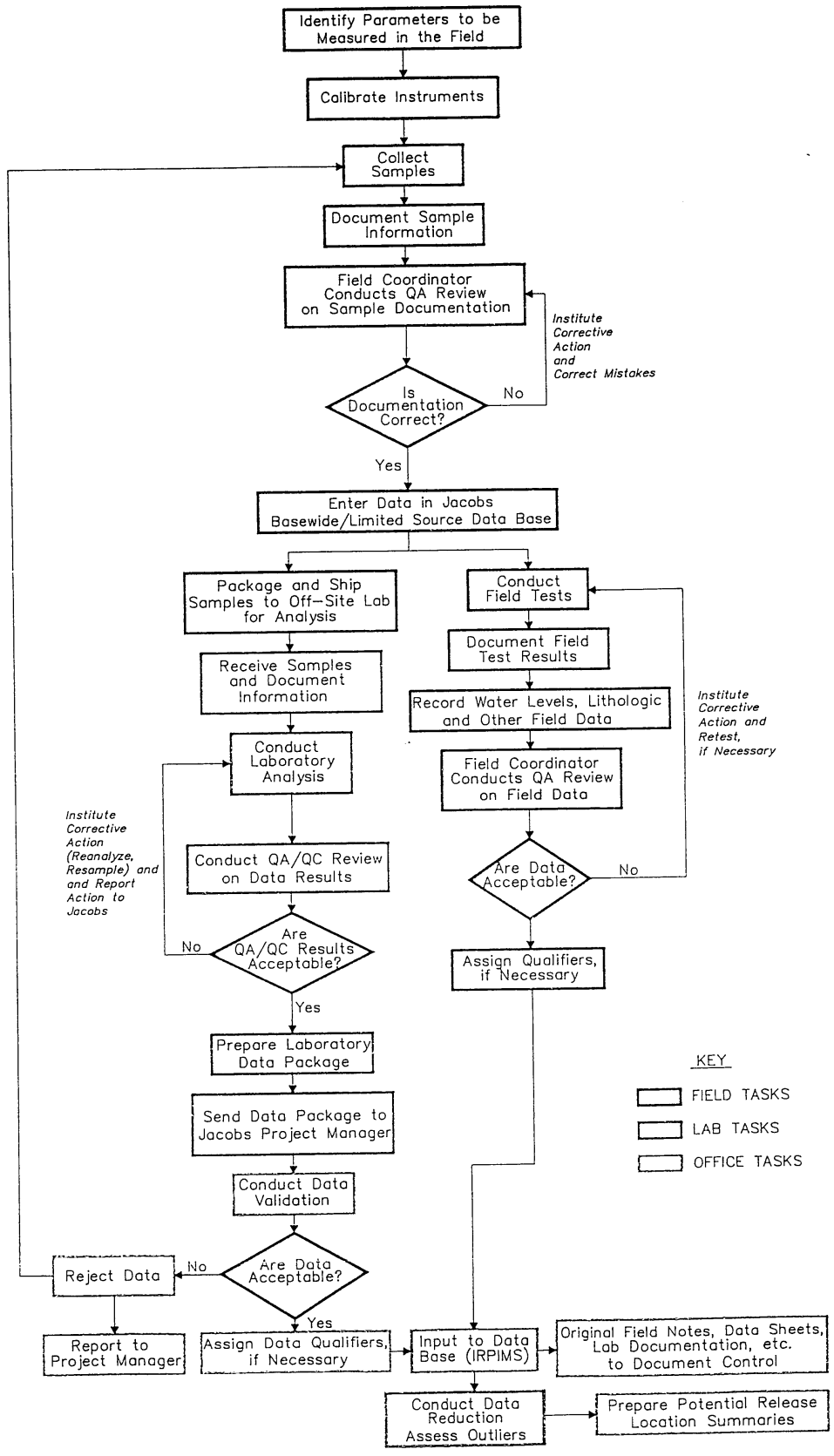


Figure 1.9-1
Data Management Flow Chart

Indian Mountain Long Range Radar Station, Alaska

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The field team will collect the samples described in the FSP. After the team collects the samples, the sample documentation (sample tags, chain-of-custody records, etc.) will be completed as described in Section 2.2.7. QC checks will be conducted on the sample documentation. The sampler will correct mistakes by making a line through the mistake and printing the correct information next to it. The sampler will also initial and date the correction. A black waterproof pen will be used for all sample documentation. If the sample documentation is acceptable, the samples will be shipped to the offsite laboratory or will be kept by the samplers for field tests.

All resampling will be requested by the Jacobs project manager, as necessary. Because of the length of the sampling event (less than six weeks), there will be no opportunity to resample if data are rejected. Jacobs intends to maintain contact with the laboratory during the entire sampling event to minimize data loss. The laboratory has been contracted to provide analyses within the extraction and analytical holding times.

1.9.2 Jacobs Environmental Management System

The Jacobs Environmental Management System (JEMS) is an integration of commercially available "off-the-shelf" hardware and software with a sample tracking and field data entry system developed by Jacobs. JEMS constitutes a corporate-wide system for Jacobs' environmental programs, providing a baseline of performance for data management and data interpretation/presentation.

JEMS consists of two subsystems:

- Environmental Database System (EDS); and
- Geographic Information System (GIS)/Geological Modeling System (GMS) Data Interpretational System (DIS).

The EDS consists of a comprehensive data management application based on the Oracle Relational Data Base Management System. Functionally, the EQUIS database (licensed from Egret Technologies) receives electronic upload of location, sample, and lithologic data from the Jacobs Environmental Sampling System (JESS). The EQUIS system also receives electronic uploads of test and result data from the analytical laboratories through the Jacobs Laboratory Data Submission Handbook specifications. EQUIS loads the electronic data and processes it through extensive error checking and QC routines before "certifying" the data as acceptable to the main database.

To meet the needs of the Air Force IRP, the certified data will be exported in accordance with the file specification of the IRPIMS Data Loading Handbook (currently Version 2.2) and then processed through the IRPIMS Quality Control Tool before being submitted to the Air Force. The EDS has extensive reporting capabilities, including the reports required by the IRP Handbook (Air Force 1993a).

The DIS includes on the capabilities of a GIS and a GMS. These graphics-oriented applications run on a UNIX workstation/server providing the "number crunching" capability needed for sophisticated three-dimensional modeling.

The GIS (Genamap/Genacell by Genasys) can directly access the data in the environmental database (EQUIS) and display both raw and interpreted data in map format. This capability will be used to produce the thematic maps and the

conceptual site models required by the IRP. The GIS will also facilitate the integration of data from such disparate sources as EQUIS, IRPIMS, an Air Force Base's comprehensive plan (maps), U.S. Geological Survey maps, and the Census Bureau. The GIS will also export maps to commonly used computer assisted design (CAD) applications such as AutoCAD and Intergraph.

The other major application in the DIS, GMS (by Lynx Geosystems), is used to perform subsurface geological and geostatistical modeling of lithologies, aquifers, and contaminants. The GMS will be used to produce cross-sections, fence diagrams, statistical and geostatistical analyses, 3-D volumetric modeling and analysis, and 3-D geostatistical modeling and analysis. The system can import from (and export to) GIS, CAD, and other interpretational and presentational programs.

1.9.3 Data Reduction

Data reduction is the process of converting measurement system outputs into an expression of parameters and information from which conclusions about the site can be made. These processes must be performed accurately, and with accepted statistical techniques. All calculations and data entries will be checked during a QA review to maintain the accuracy of this process.

The quantity of data generated from this investigation and previously collected data will be evaluated to determine the appropriate statistical techniques that can be applied to the data set. The statistical analysis may include classical statistics and geostatistical approaches. If necessary, additional data needs will be identified so that appropriate statistical techniques can be applied.

Statistical techniques will be applied to laboratory QC samples (such as matrix spikes and matrix spike duplicates, method blanks, surrogate spikes, and laboratory control samples) to assess the accuracy and precision of the data. The formulas for calculating the precision, or RPD, and accuracy, or percent recovery, are presented in Section 1.4.1. Accuracy and precision data will be used to determine analytical data errors introduced through analytical procedures. This information may be used to determine the probability that the concentration of each analyte in the sample will exceed the site action levels.

In addition, the QC field samples (such as trip, equipment, and ambient blanks and duplicate or replicate samples) will be evaluated to determine any systematic or random errors introduced by field procedures.

1.9.4 Data Quality Assessment and Data Validation

Data quality assessment and data validation involve reviewing the field records, maintaining proper laboratory record keeping, and assessing the laboratory data. These steps are discussed in the following sections.

1.9.4.1 Review of Field Records

Field records, at a minimum, will be evaluated for the following:

- completeness;
- identification of valid samples;

- correlation of field test data with previous results, if available;
- identification of anomalous field test data; and
- assessment of the accuracy and precision of the field test data and measurements.

The check of field record completeness will verify that (1) all requirements for field activities in this SAP have been fulfilled, (2) complete records exist for each field activity, and (3) the procedures specified in program planning documents have been implemented. Field documentation will ensure verification of sample integrity and provide sufficient technical information to re-create each field event. The results of the completeness check should be documented. Environmental data affected by incomplete records will be identified in technical reports.

The identification of valid samples involves interpreting and evaluating the field records to detect problems affecting the representativeness of environmental samples. For example, field records can indicate whether a well is properly constructed or if unanticipated environmental conditions were encountered during construction. The lithologic and geophysical logs may be consulted to determine whether a well is screened only in the water-bearing zone of concern. Pumping records indicate proper stabilization of measured water parameters, clarity, and color. Photographs may show the presence or absence of sources of potential contamination, such as operation of combustion engines near a well during sampling.

Field audit reports are another source of data for review. Those judgments of sample validity will be documented in the technical report. Environmental data associated with poor or incorrect fieldwork will be identified.

To the extent possible, anomalous field data will be identified and explained. For example, water temperature for one well that is 5 degrees higher than that for any other well in the same aquifer will be explained in the report. Widely differing calculations of aquifer characteristics from test data obtained at several wells will be explained. Similarly, differences in well depths between construction records and field measurements could be evaluated and explained. The assessment of the quality of field measurements will be based on instrument calibration records and a review of any corrective action reports. The accuracy and precision of field measurements will be discussed.

1.9.4.2 Laboratory Record Keeping

Record keeping procedures for the laboratory are listed below and described in more detail in the LQAPP (Appendix A):

- The laboratory will maintain records sufficient to re-create each analytical event conducted. At a minimum, the records will contain the following:
  - chain-of-custody records;
  - initial and continuous calibration records including preparation of standards traceable to the original material and lot number;
  - instrument tuning records, if applicable;

- method blank analyses;
- internal standard results;
- surrogate spiking and results (if required);
- spike and spike duplicate records and results;
- laboratory duplicate records and results (if done);
- raw data including instrument printouts, laboratory bench work sheets and/or chromatograms with compound identification and quantitation reports; and
- other QC samples and results (e.g., ICP interference check standards results, results of the matrix quantitation limit studies, and the results of blank spiking).

- The laboratory written procedures for each analytical method and QA/QC function are presented in the LQAPP (Appendix A).
- The following units of measure will be used for reporting analytical results:
  - water samples - inorganics and metals (mg/L);
  - water samples - organics (μg/L);
  - soil and sediment samples - organics, inorganics, and metals (mg/kg, dry basis);
  - soil samples - TCLP (mg/L for metals; μg/L for pesticides and herbicides);
- moisture content for each soil/sediment sample. The following equation for moisture content given in ASTM D-2216 will be used:

$$W = [(W_1-W_2)/(W_1-W_c)] \times 100$$

where:

W = moisture content, percent;
W_1 = weight of container and moist soil, grams;
W_2 = weight of container and oven-dried soil, grams; and
W_c = weight of container, grams.

1.9.4.3 Assessment of Laboratory Data

During validation, the review of laboratory data will focus on the subjects listed below. Any trends or problems associated with the data will be noted and evaluated in the Analytical Data Report and the Data Summary Report provided by the data validation subcontractor.

Chain-of-Custody Records. Chain-of-custody records will be reviewed to verify that sample preservation and temperature were checked when the laboratory received

the sample. Sample preservations will be compared with requirements listed in Tables 1.5-1 and 1.5-2.

Holding Times. The time elapsed between the date of sampling and the date of analysis and/or extraction will be compared with the requirements shown in Tables 1.5-1 and 1.5-2. Sample extraction is defined as completion of the sample preparation process as described in the applicable method including any necessary cleanup before volume reduction procedures. Sample analysis completion is defined as completion of all analytical runs including dilutions, second-column confirmations, and any required reanalyses. If holding times are exceeded, evidence of resampling and analysis within proper holding times will be noted.

Method Calibration Limits. Initial Calibration Verification (ICV) and continuing calibration verification (CCV) standard results will be reviewed to ensure conformance to acceptance criteria. To verify results, selected ICVs and CCVs will be recalculated from the raw data. The review will also determine whether the calibration events can be re-created. In addition, using correlation coefficients or ion abundances, a verification will be performed to determine whether the instrument was in proper tune or calibration during sample analyses.

Method Blanks. The review will verify that no sample results greater than three times the Air Force MDLs or laboratory-established MDLs are present in any of the method blanks. The review will also verify that no analytical data were corrected for the presence of analytes in the method blanks.

Laboratory-Established Reporting and Quantitation Limits. Any laboratory-established reporting quantitation limit that exceeds those in this SAP or the Air Force IRP Handbook (Air Force 1993a) will be identified. The absence of records supporting the establishment of reporting and quantitation limits will also be noted.

Analytical Batch Control Records, Including Laboratory Control Sample Results, Spike Recoveries, and Duplicate Results. The results of analytical batch QC samples will be compared with SAP-specified, laboratory-established acceptance criteria. Data not within control limits require corrective action, and reviewers will check that corrective action reports and the results of reanalysis are available. Samples associated with out-of-control QC data will be identified, and an assessment of the utility of such analytical results will be recorded. Corrective action reports will be referenced in this assessment.

Corrective Actions. The review will verify that SAP-specified corrective actions have been implemented whenever contamination is detected or QC sample results exceed control limits.

Surrogates. The preparation and results of surrogate spikes will be reviewed, and selected surrogate concentrations will be recalculated.

Completeness of Data. The check of laboratory data completeness will make certain that (1) all samples and required analyses have been processed, (2) complete records exist for each analysis and the associated QC samples, and (3) the procedures specified in the Work Plan, QAPP, and SOPs have been implemented. The results of the completeness check will be documented in project reports.

In addition, formulas and examples of analyte quantitation will be reviewed along with sample preparation logs. Also, because method validation is a continuous process, the reviewer will make certain that control charts and statistical calculations have been updated to include recent data.

Certain laboratory analytical data will be validated according to the EPA guidelines in the CLP Functional Guidelines for Inorganic Analyses (EPA 1988b), Functional Guidelines for Organic Analyses (EPA 1988c), and *Functional Guidelines for Inorganic and Organic Analyses* (EPA 1991a). Data validation will be conducted as specified in the Work Plan.

The data qualifiers to be used for this project are listed below, as applicable.

1.9.5 Reporting

Analytical data will be reported in Analytical Data Informal Technical Information Reports (ITIRs) as required by the Air Force IRP Handbook (Air Force 1993a). This report will be submitted after data have been validated. QC results and cross references will be reported in data tables in accordance with the Air Force IRP Handbook (Air Force 1993a). In addition, methods, detection limits, control limits, and holding time compliance will be summarized. The Analytical Data ITIR will include a QA/QC narrative and data qualifiers when appropriate.

Laboratory Data Qualifiers for Organic Compounds

The following definitions of qualifiers will be used:

U Compound was analyzed for but was not detected.

J Value is estimated either for a tentatively identified compound, if applicable, or when a compound is present (spectral identification criteria are met, but the value is less than the method detection limit).

B Analyte was found in associated blank as well as in sample.

E Concentration exceeds calibration range of instrument.

D Compound in analysis at a secondary dilution factor.

A The tentatively identified compound is a suspected aldol-condensation product as applicable.

X Additional flags defined separately.

Laboratory Data Qualifiers for Inorganic Chemical Data

The following definitions of qualifiers will be used:

U Compound was analyzed for but was not detected.

E Value is estimated because of matrix interferences.

M Duplicate injection precision criteria were not met.

N Spiked sample recovery was not within control limits.

S As determined by the Method of Standard Additions (MSA).

W Postdigestion spike for furnace atomic absorption analysis is out of control limits; sample absorbance is less than 50 percent of spike absorbance.

* Duplicate analysis was not within control limits.

+ Correlation coefficient for MSA was less than 0.995.

1.10 INTERNAL QUALITY CONTROL CHECKS FOR FIELD AND LABORATORY OPERATIONS

Field and laboratory QC samples are defined below. The frequency for collection of field QC samples is discussed in Section 2.2.4. Field QC samples will apply only to those sample locations designated for fixed laboratory analyses.

1.10.1 Quality Control for Field Activities

The following are field activities for QC:

- Trip Blank. A VOC sample bottle is filled with ASTM Type II reagent-grade water in the laboratory or at an offsite location, transported to the site, handled like a sample, and returned to the laboratory for analysis. (trip blanks are not to be opened in the field.) The trip blank for soils is Type II reagent-grade water. In this case, the laboratory will report the trip blank results (complete data package) with the associated soils data package.

- Ambient Conditions Blank. ASTM Type II reagent-grade water is poured into a sample container at the site, then is handled like a sample and transported to the laboratory for analysis of VOCs. The laboratory will report the ambient conditions blank results (complete data package) with the associated soil or water data package.

- Equipment Blank. ASTM Type II reagent-grade water is poured into the sampling device or pumped through it (in the case of sampling pumps), transferred to sample bottles, and then transported to the laboratory for analysis. The laboratory will report the equipment blank results (complete data package) with the associated soil or water data package.

- Duplicate. Field duplicates are two co-located samples collected independently at a sampling location during a single sampling act. Field duplicates will be labelled so that laboratory personnel performing the analyses are not able to determine which samples are duplicates.

- Replicate. A replicate is a single sample that is homogenized and divided or split into two equal parts for analysis. Replicates are often called splits. Field replicates will be identified so that laboratory personnel are unable to distinguish them from other field samples. Replicates will not be used when collecting samples for volatile organic analysis.

Note: Type II reagent-grade water will be certified by the manufacturer to verify that (1) it is free of analytes and contaminants and (2) the electrical conductivity is less

than 1.0 micromhos per centimeter (μmhos/cm) at 25 degrees Celsius (°C). Type II reagent-grade water will be stored in glass, stainless-steel, or Teflon containers. Distilled water from supermarkets will not be used in place of Type II reagent-grade water.

When equipment water that meets the ASTM Type II criteria (via deionization and carbon filter) can be obtained or generated in the field, the field sampling team may substitute this material for Type II reagent-grade water.

1.10.2 Quality Control for Fixed Laboratory Activities

QC for fixed laboratory activities consists of the following:

- Method Blank. Method blanks consist of analyte-free water or soil, processed in the exact manner as the samples within a batch using identical reagents and solvents. Method blanks are generated by the laboratory.

- Sample Matrix Spike. A sample that represents the matrix will be selected by the Jacobs Site Manager. The laboratory will spike this sample in duplicate (matrix spike and matrix spike duplicate) with analytes specified for each method by the laboratory. For the offsite laboratory, a minimum of one sample per 20 project samples will be selected for the matrix spike and matrix spike duplicate.

- Surrogate Spikes. Surrogate spikes are compounds that are added to every sample analyzed including the standards, blanks, matrix spikes, and QC check samples to assess the recovery of the method. Not all analytical methods are amenable to the use of surrogate spikes. Before any sampling event, any analyses that require surrogate spikes will be identified. All applicable surrogate recovery control limits will be reviewed for approval by the Jacobs QA Officer.

- Standard Matrix Spike/QC Check Sample. A QC check sample consists of either an EPA reference or NIST traceable reference material. The QC check sample or standard matrix spike will be used to assess laboratory performance and to evaluate whether any systematic problems occurred during analysis. Any QC check sample that is found to be outside control criteria for any compound or analyte will require corrective action by the laboratory and reanalyses of all associated samples.

1.10.3 Fixed Laboratory Analytical Batches

Environmental samples will be grouped in specific analytical batches. Each batch will include sufficient calibration events and QC samples to allow the results of that batch to stand as an autonomous data set. That is, all associated data for an analytical batch will be reported with each data package. An analytical batch will consist of no more than 20 environmental samples. Laboratory QC samples will be used to assess the desired precision, accuracy, representativeness, comparability, and completeness of the data.

1.10.4 Control Limits

Appendix A presents the control limits for each analytical method. The summary includes the checks, their frequency, acceptance criteria, and the corrective action, if outliers occur. Additional information on laboratory QC is included in Appendix A.

1.11 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits for sampling and analysis may be conducted. Audits may include a review of field and laboratory QA systems and onsite review of equipment for sampling calibration and measurement. Audits may evaluate the capability and performance of project personnel, items, activities, and documentation. The audits will ensure and document that QC measures are being used to provide data of acceptable quality and that subsequent calculations, interpretation and other project output are checked and validated. Scheduled and unscheduled audits will be conducted. System and performance audits may be conducted by the Jacobs QA Officer or his designee. The QA Officer or designee will audit fieldwork and review the project documentation.

During a system audit, the entire QA process is evaluated. The project or field team organization is reviewed for compliance with the proposed organization and clarity of assigned responsibility. Qualifications of personnel assigned to the project will be reviewed to make certain that assigned responsibility, skill, and training are properly matched.

A system audit may be conducted on all components of a measurement system to determine proper selection and use. The system audit includes evaluation of both field and laboratory procedures.

During a performance audit, proper execution of SOPs or QC procedures is evaluated. The audit will address whether field equipment and analytical instruments are selected and used to meet requirements specified by the project objectives stated in this QAPP. Equipment and facilities provided for personnel health and safety may also be evaluated. Calibration procedures for field instruments will also be audited.

A review of analytical methodology with respect to data requirements for the project will be performed. An onsite observation of analytical technique, data reduction, and record keeping may be performed, if necessary.

QA audits are conducted at the request of project management or the Air Force. A written report of a QA project audit will include the following:

- an assessment of project team status in each major project area;
- clear statements of areas requiring improvement or problems to be corrected;
- recommendations and assistance regarding proposed corrective actions or system improvements; and
- a timetable for any corrective action required.

The Jacobs QA Officer will be responsible for the coordination of audits and the disposition of audit records.

1.12 PREVENTIVE MAINTENANCE PROCEDURES AND SCHEDULES

Preventive maintenance procedures are established to make certain that laboratory and field instrumentation perform their intended functions. Instrument maintenance records for both laboratory and field instrumentation will be kept in permanently bound notebooks assigned to each individual instrument. Field equipment maintenance procedures are discussed in Section 2.3.

Preventive maintenance is a crucial element of the QA program in any laboratory. Analysts will perform routine preventive maintenance such as replacing minor parts, cleaning exterior components, and providing the instruments with a clean, climate-controlled environment. Major instruments, such as GCs, atomic absorption (AA) spectrophotometers, ICPs, analytical balances, and GC/MS systems, will be maintained under commercial service contracts or by qualified in-house service technicians. All instrument maintenance is recorded in the associated instrument logbook for reference and verification of scheduled maintenance.

Instruments will be constantly monitored by using daily calibration, sensitivity, and response checks to determine when nonscheduled maintenance is required. In the event that an instrument does fail, every effort will be made to meet obligations to clients concerning holding times and analysis due dates.

Laboratory support systems such as the deionized water supplies, refrigerators, and ovens will also be monitored and serviced regularly. In many instances, the improper functioning of such basic equipment as a refrigerator is enough to invalidate costly data. The laboratory QA program has been designed to minimize data loss by monitoring and recording the functioning of these systems, allowing rapid correction of any malfunction before data loss can occur. Maintenance schedules and a list of critical spare parts for the laboratory are included in the LQAPP (Appendix A).

1.13 FIELD AND LABORATORY PROCEDURES TO BE USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Formulas for determining data accuracy, precision, and completeness are presented in Section 1.4.1.

Data quality assessments will make certain that generated data are accurate and consistent with project objectives. The quality of the data will be assessed based on precision, accuracy, representativeness, consistency, and completeness.

Before data collection, sampling and analysis procedures will be evaluated with regard to their ability to generate appropriate, technically acceptable information required to achieve project objectives.

During data collection, results will be assessed to make certain that (1) the selected procedures are efficient and effective and (2) the data generated provide sufficient information to achieve project objectives. The appropriateness of the precision and accuracy of selected measurement systems will also be evaluated. In general, data evaluation will be based on performance audits, results of spiked sample analyses, and review of completeness objectives.

Following completion of data collection activities, an assessment of the adequacy of the database generated with regard to completing project objectives will be performed by the Jacobs Project Manager and QA Officer. Recommendations for improved QC will be developed, if appropriate. If data gaps are identified, the Jacobs QA Officer may recommend the collection of additional raw data to fully support the project's findings and recommendations.

The quality of data generated during analysis will be assessed through the use of laboratory control charts and QA reviews by the chemists and the laboratory supervisor. The quality of the data will be verified using EPA guidance for the data validation process for inorganic and organic analyses (EPA 1988b; 1988c; 1991a).

In addition, the quantity of data generated from this investigation and previously collected data will be evaluated to determine the appropriate statistical techniques that may be applied to the data. The statistical analyses may include classical statistics such as trend analyses, measures of variability and significance tests, and geostatistics for determining spatial distribution of the contaminants.

Specific aspects of documentation, analytical procedures, and office procedures that will be assessed were discussed in Section 1.9.

1.14 QUALITY ASSURANCE REPORTS

The following subsections discuss QA reporting procedures and QA reporting scope and content.

1.14.1 Reporting Procedure

The Jacobs QA Officer or his designee may, at the request of the Air Force, prepare QA reports that document all audited field or laboratory QC activities. These reports will be submitted to the Project Manager upon completion of fieldwork.

1.14.2 Reporting Scope and Content

If a QA report is requested, the Jacobs QA Officer or designated auditor will prepare the report. Information in the report may include the following:

- QA activities and quality of collected data;
- equipment calibration and preventive maintenance activities;
- results of data precision and accuracy calculations;
- evaluation of data completeness and contract compliance;
- field and/or laboratory QA problems and recommended and/or implemented corrective actions;
- results of QA audit findings;
- project status and anticipated completion dates for important tasks; and
- any changes to procedures documented in the QAPP.

Summary audit reports may be prepared after each task is completed to inform the staff and management of QA status. A final audit report for the project will include the following:

- periodic assessment of measurement data accuracy, precision, and completeness;
- results of performance audits and/or systems audits;
- significant QA problems and recommended solutions for future projects; and
- status of solutions to any problems previously identified.

Any incidents requiring corrective action will be documented. The summary of findings will be factual, concise, and complete. These reports will be addressed to the Jacobs Project Manager and QA Officer.

2.0 FIELD SAMPLING PLAN

This FSP prepared by Jacobs describes procedures that will be used to conduct activities during the 1994 field investigations for Indian Mountain LRRS, Alaska. The description and rationale for the field activities are described in the RI/FS Work Plan for Indian Mountain LRRS, Alaska. This FSP is a companion document to the Work Plan. The FSP was prepared based on guidance found in the *Handbook to Support the Installation Restoration Program Remedial Investigations and Feasibility Studies* (Air Force 1993a) and in *Recommended Practices for Monitoring Well Design, Installation, and Decommissioning* (Alaska Department of Environmental Conservation [ADEC 1992]), as applicable. The following sections describe the procedures and requirements for field operations, environmental sampling, field measurements, field QA/QC, record keeping, and site management during the 1994 field investigations.

2.1 FIELD OPERATIONS

The field investigation at Indian Mountain LRRS will include the following activities:

- site reconnaissance, preparation, and restoration;
- soil-gas surveys;
- surface soil, surface water, and sediment sampling;
- borehole drilling, lithologic sampling, and logging;
- monitor well construction, development, and sampling; and
- aquifer tests.

Associated activities include geologic mapping, borehole abandonment, metal detector surveys, equipment decontamination, and waste handling. The following subsections describe the procedures for the RI field activities.

2.1.1 Site Reconnaissance, Preparation, and Restoration Procedures

Site Reconnaissance. A site reconnaissance will be conducted before initiation of the field investigations. Reconnaissance activities will be completed during the first five to seven days of the field investigation. The following tasks will be performed during the site reconnaissance. Where appropriate, details on specific tasks listed below are included in this FSP.

- Locate known source areas based on aerial photographs, previous data, literature, and field observations.
- Field verify planning document maps.
- Confirm source area boundaries and locations with a metal detector survey.
- Locate surface water features including groundwater seeps and surface water drainages.
- Identify potentially contaminated areas not previously documented (e.g., debris, soil staining, and ground disturbances).
- Verify and locate proposed sampling locations.
- Assess sample locations for ease of access and usefulness of data.

- Document field reconnaissance findings.
- Evaluate observations and update maps.

Preparation. Site preparation tasks will be completed during the first five to seven days of the field investigations.

- Complete requirements for a water discharge permit or facility approval to discharge.
- Construct decontamination facility and waste conditioning unit.
- Verify office space, communications, vehicles, utilities, etc.
- Become familiar with Indian Mountain LRRS rules, policies, procedures, names of local points of contact, and emergency telephone numbers.
- Verify location of emergency equipment.
- Determine digging permit and utility location procedures.
- Locate underground utilities for drilling boreholes or other excavations.

Site Restoration. Each sample location will be restored as nearly as possible to its pre-investigation condition. Unused or surplus materials and supplies, stakes, flagging, and waste material will be removed from each sample location as the work is completed at that area. Equipment staging, temporary storage, and waste treatment areas will be restored to original conditions. Site restoration will be coordinated with the station point of contact to ensure that the restoration is conducted in accordance with facility requirements. All materials and equipment that are brought to the installation will be removed from the installation at the conclusion of the RI/FS.

2.1.2 Metal Detector Survey

Metal detector surveys will be performed in an effort to (1) locate conductive metallic objects that should be avoided during any subsurface activities, such as drilling and excavating, and (2) to help define locations and boundaries of former waste accumulation areas, landfills, and dump areas. Planned sampling locations will be surveyed with the metal detector, the results mapped, and locations revised if necessary based on survey results.

It is anticipated that buried metal will be detected throughout Upper Camp and at many locations at Lower Camp. For this reason, it may be difficult to delineate specific waste accumulation areas and dumps. Preliminary survey results will be evaluated to determine the usability of results and the value of performing larger surveys. A grid pattern on approximately 10-foot spacings will be established for the metal detector surveys after the site reconnaissance.

The metal detector will also be used during ground intrusive activities as a final check for locating buried utilities.

2.1.3 Soil-Gas Surveys

Soil-gas surveys will be performed at Lower Camp to evaluate the presence of contamination and to determine subsurface sampling locations. Soil-gas surveys at the Upper Camp may be limited because of the rocky surface and subsurface conditions.

Soil-gas sampling grids and sampling points will be based on the findings of the field reconnaissance and historical data including previous soil-gas sampling data, maps, and aerial photographs. If elevated concentrations are detected further soil gas sampling will be performed to spatially delineate zones of contamination. Soil-gas sampling probe locations will be cleared for utilities by the station point of contact and a metal detector before the survey begins. Soil-gas samples will be monitored directly from the soil gas probe using an HNu and a Landtec portable gas monitor. The volume of each soil gas probe will be calculated to determine the required purge volumes. Approximately two soil-gas probe volumes will be purged from each probe before recording instrument results. It is expected that duplicate measurements will be made at a minimum of 10 percent of the soil-gas points. Equipment blanks will be recorded each day soil-gas samples are collected.

Sampling equipment includes a half-inch-diameter solid-steel rod with a slide hammer (slam bar) to drive the probe into the ground, a hollow stainless-steel sampling tube, a section of 3/16-inch Tygon tubing, a Landtec GA-90 portable gas monitor, and an HNu. The monitor is equipped with a pump for drawing the sample from the soil. The Landtec monitor has an internal pump that draws at a rate of 500 cubic centimeters per minute. A small pump, with a similar pump rate, will be used in conjunction with the HNu to collect soil gas samples.

Decontamination of the soil-gas equipment will follow procedures outlined in Section 2.1.8. The Landtec monitor will be operated and calibrated according to the manufacturer's specifications (Appendix D). Daily calibrations of each instrument will be performed using the appropriate standards. Sections 2.3 and 2.4 describe field measurements and field quality control procedures.

The target depth for driving soil-gas probes is 5 feet below ground surface. Based on the soil-gas survey performed by Woodward-Clyde (W-C) in 1989 and descriptions of the geology at Indian Mountain LRRS, it may not be possible to follow a defined grid spacing or drive the probe to a depth of 5 feet at all proposed locations. Where soil-gas probes meet with refusal before reaching the target depth of 5 feet, a second attempt will be made approximately one foot from the location of the initial attempt. If the target depth is not reached on the second attempt, then the depth of refusal will be used as the sampling depth if it is greater than 3 feet. If the refusal depth is less than 3 feet, the probe location will be abandoned.

The following soil-gas field information will be recorded on a soil-gas field data form (Appendix C).

- Site information:
  - location, date;
  - soil conditions;
  - barometric pressure;
  - instrument calibration; and
  - field observations.

- Drive probe data:
  - target depth in feet below ground surface;
  - refusal depth and offset attempted; and
  - rationale of abandonment of point.

- Purge data:
  - time;
  - flow rate; and
  - purge volume.

- Sampling data:
  - flow rate;
  - number of samples, duplicates;
  - total collection time;
  - volume monitored;
  - monitoring instrument(s);
  - parameter monitored; and
  - results.

Soil-gas probes will be removed from the ground after sampling is completed. Upon completion, each location will be field mapped and flagged for future surveying.

2.1.4 Borehole Drilling, Logging, Lithologic Sampling, Borehole Abandonment, and Test Pit Excavation

This section describes borehole drilling methods and associated activities for collecting subsurface soil and lithological samples, performing borehole logging procedures, and abandoning the boreholes. The purpose of borehole drilling is to determine geotechnical, geological, hydrogeological, and geochemical characteristics of subsurface materials and to determine the presence of contamination in soil samples. After the target depth has been reached and desired soil and groundwater samples collected, the borehole will either be abandoned or completed as a groundwater monitoring well. The rationale for well installation is described in the Work Plan. Borehole abandonment is discussed in Section 2.1.4.4 of the SAP. Monitoring well construction is discussed in Sections 2.1.5.1 and 2.1.5.2 of the SAP.

All drilling and sampling activities will be supervised by a licensed geologist, hydrogeologist, or professional geotechnical engineer.

Detailed logs of drilling activities and subsurface materials will be maintained by the site geologist or hydrogeologist. Drilling and sampling methods will follow procedures described in the IRP Handbook (Air Force 1993a).

All borehole locations and depths will be approved by the COR before onsite activities begin. All permits, applications, and other documentation requirements by state, local, and facility authorities will be completed before starting drilling activities.

The drill rig will be cleaned and decontaminated before the field investigation and before use at each individual source area, as specified in Section 2.1.8. Other drilling equipment, such as augers and rods, will be decontaminated before each borehole. The rig will be maintained so that it does not leak fluids that may enter the borehole or contaminate equipment that is placed into the borehole. Lubricants,

with the exception of Teflon tape, will not be used on any equipment that enters the borehole without prior approval by the COR.

Formation samples for lithologic description will be obtained at each change in lithology and at intervals no greater than 5 feet. Samples will be logged following standard professional nomenclature, as described in Section 2.1.4.3.

Samples collected for headspace analysis and ambient air in the breathing zone above the borehole will be monitored by field personnel using an organic vapor monitor (HNu) with a PID.

Subsurface samples collected from within augers will be collected for the following purposes:

- to determine the presence of contaminants;
- to assess contaminant transport through soil and groundwater; and
- to determine physical and chemical characteristics of soil and groundwater to support the feasibility study.

The sampling rationale is detailed in Section 3.0 of the Work Plan.

Soil sample headspace measurements will be made for samples from each borehole. Soil sample headspace analysis will be conducted by placing soil in a brass liner or glass jar, and sealing the container with aluminum foil or Teflon. The brass liners will then be sealed with end caps. A quantity of soil will be placed in the container so that the headspace volume is approximately equal to the sample volume. The container will be labeled with the following information:

- boring number or sample location;
- sample interval and number; and
- date and time of collection.

The container will be placed in an environment where fluctuations in temperature can be avoided for approximately 30 minutes, at which time the headspace will be measured by inserting the HNu probe through the aluminum foil or Teflon, or inside of the end cap.

Following headspace measurements, the VOC concentration will be recorded in the field logbook or on the sampling form.

At some locations, the soil sample with the highest headspace analysis from each borehole will be analyzed with field test kits for petroleum hydrocarbons to determine which sample should be sent to the laboratory for analysis. If headspace analyses for multiple samples are the same, or if all headspace results are at background levels, the sample nearest to the water table will be sent to the fixed laboratory.

The following information will be recorded in the field logbook, borehole log, or sampling form for each borehole:

- purpose of the boring;
- unique boring or well identification number;

- location relative to an easily identifiable landmark;
- drilling method;
- depth at which saturated conditions are first encountered;
- lithologic descriptions and depths to lithologic boundaries;
- sample intervals and depths;
- blow count for split-spoon sampling;
- headspace measurement;
- field screening results;
- percent recovery from split spoon or ring liners;
- zones of caving or heaving;
- drilling rate;
- drill rig reactions (e.g., chatter, rod drops, bouncing);
- name of the drilling contractor and logger; and
- start and finish dates and times.

2.1.4.1 Drilling Methods

The drilling method that will be used for borehole drilling and subsurface soil sampling at the Lower Camp will be hollow stem auger (HSA). Soil and monitoring well boreholes will be drilled in unconsolidated alluvial and colluvial materials to relatively shallow depths (10 to 30 feet). The Upper Camp field investigation will not use HSA methods for subsurface investigations due to fractured rock and gravels present that will not permit HSA drilling. Test pits excavated with a backhoe will be used at Upper Camp for subsurface soil or groundwater sampling.

At each borehole location the following steps will be performed using the HSA drilling method:

- utility and subsurface metal debris clearance before drilling;

- area around borehole will be covered with plastic sheeting; and

- Jacobs will contain soil cuttings and other investigation-derived wastes in 55-gallon U.S. Department of Transportation (DOT) approved drums, properly label and store the drums on wood pallets and transport drums to the temporary waste staging area with the assistance of the 611 CES.

The inside diameter of the auger for boreholes that will be completed as monitoring wells will be at least 4 inches greater than the outer diameter of the well casing.

Augers to be used at Indian Mountain will have an inner diameter of 6.25 inches and the outer diameter of the well casing will be 2.0 inches. For some boreholes, it may be necessary to ream the original boring with larger diameter augers to obtain sufficient clearance to construct the well.

2.1.4.2 Sampling Unconsolidated Materials

Unconsolidated material samples will be collected according to the ASTM D1586 procedure, Standard Penetration Test (SPT):

Standard Penetration Test. The SPT spoon will comply with the above-referenced ASTM standard procedure. The spoon will be attached to the sampling rods and lowered gradually to the bottom of the hole. An anvil will be attached to the top of the sampling rods, and a 140-pound hammer will be positioned above the anvil.

The dead weight of the sampler, rods, anvil, and hammer will rest on the bottom of the borehole, and a seating blow will be applied. If excessive cuttings are encountered at the bottom of the hole, the sampling assembly will be removed and the excess cuttings removed. The sampling assembly will be advanced with blows from the hammer that will be repeatedly dropped from 30 inches. The hammering action will be produced by using a trip, automatic, or semiautomatic drop system or a cathead-rope assembly attached to the hammer. An automatic hydraulic hammer which simulates a 140-pound weight dropped 30 inches may also be used. After the sampling assembly has been driven to the desired depth, the number of blows required for each 6 inches of advance and other observations on advancing the sampling assembly will be recorded.

Sample Collection. The split-spoon sampler will be brought to the surface and opened. The sample's composition, color, stratification, and percent recovery will be logged as described in Section 2.1.4.3. Representative portions of the sample will be placed in appropriate containers for headspace analysis, field screening, and laboratory analysis. Subsurface soil sample collection procedures are described in Section 2.2.1.4.

2.1.4.3 Lithologic Logging

A complete lithologic log of subsurface conditions will be maintained by the geologist or hydrogeologist supervising operations. A boring log will be used to record observations. An example of a boring log form is included in Appendix C. Boring log descriptions will be prepared in accordance with the IRP Handbook (Air Force 1993a).

Descriptions of bedrock drill cuttings will include rock type, mineralogy, color, and grain size. Descriptions of igneous, metamorphic, and sedimentary rocks will follow standard professional nomenclature (Tennisen 1983). Special attention will be given to describing fractures, vugs, solution cavities and their fillings or coatings, and any other characteristics affecting permeability. Characteristics of unconsolidated materials will also be documented using the Unified Soil Classification System shown in Figure 2.1-1. Cuttings will be logged at changes in lithology, visual indication of contamination, or at a minimum of 5-foot intervals using a split-spoon sampler for collection. Special attention will be given to describing depth to permafrost, changes in lithology, and any other characteristics affecting permeability and fate and transport of contamination and/or groundwater migration. A grab sample will be taken from the sample tubes or from the augers for lithologic description. Logs will provide qualitative data pertaining to lithology of material penetrated by the drilling assembly.

2.1.4.4 Borehole Abandonment

Borehole sealing and abandonment will comply with state and local regulations. The method used to abandon boreholes is sealing the borehole with bentonite chips to prevent surface water from entering the borehole. Bentonite chips will be slowly poured into the borehole by hand. The borehole will be topped off with additional bentonite chips until they overflow at the surface. The chips will be hydrated with potable water. The bentonite will be allowed to set overnight. The surface will then be reclaimed to its original condition, if necessary. Before demobilization, all abandoned boreholes will be examined for settling and topped off with additional bentonite chips, if necessary.

FIGURE 2.1–1
UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION SCHEME				
Major Divisions				General Description
Coarse–Grained Soils More than half is larger than No. 200 Sieve	Gravels More than half coarse fraction is larger than No. 4 Sieve	Clean gravels with little or no fines	GW	Well graded gravels, gravel sand mixtures.
			GP	Poorly graded gravels, gravel–sand mixtures.
		Gravels with over 12% fines	GM	Silty gravels, poorly graded gravel sand–silt mixtures.
			GC	Clayey gravels, poorly graded gravel sand–clay mixtures.
	Sands More than half coarse fraction is smaller than No. 4 Sieve	Clean Sands with little or no fines	SW	Well graded sands, gravelly sands.
			SP	Poorly graded sands, gravelly sands.
		Sands with over 12% fines	SM	Silty sands, poorly graded sand–silt mixtures.
			SC	Clayey sands, poorly graded sand–clay mixtures.
Fine–Grained Soils More than half is smaller than No. 200 Sieve	Silts and Clays Liquid limit less than 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands. Clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic clays and organic silty clays of low plasticity.
	Silts and Clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Organic clays of medium to high plasticity, organic silts.
			CH	Organic clays of medium to high plasticity, organic silts.
Highly Organic Soils			Pt	Peat and other highly organic soils

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The volume of bentonite grout emplaced in the borehole and the estimated volume of the borehole will be recorded in the field logbook.

A piece of ferrous metal or short length of pipe will be emplaced in the bentonite near the surface so that a magnetometer or metal detector can be used to relocate the boring if maps are not available, or the area is covered with snow or vegetation.

2.1.4.5 Test Pit Excavation

The purpose of performing test pit excavations is to facilitate the evaluation of physical and chemical characteristics of subsurface soils and groundwater at the Upper Camp. The fractured rock and gravels of the Upper Camp terrain do not allow use of soil borings to investigate subsurface conditions.

Test pits will be excavated to bedrock, approximately 5 feet, using a backhoe. Excavations will be approximately 5 feet in length and 3 feet wide. Adequate precautions and controls shall be taken to prevent field personnel from falling into the excavation and to prevent exposure to hazardous atmospheres. The location of underground metal debris and utilities will be determined with a metal detector before digging test pits. Field personnel will not enter the excavation for any reason during collection of samples.

In situ groundwater grab samples and subsurface soil samples will be collected from test pit locations. Groundwater grab samples will be collected if water infiltrates the test pit naturally after a limited amount of time. Groundwater sample collection will be similar to pond sampling; the sample container will be submerged until full. Subsurface soil samples from test pit excavations will be collected directly from the backhoe bucket once the selected sample interval is encountered. Test pit subsurface samples will be collected from the middle of the backhoe bucket and lithologically logged and handled similarly to borehole soil samples. Test pit excavated materials will be placed on plastic during excavation and returned to the pit once sampling is completed. Each test pit location will be marked in the field, located on base maps, and surveyed similarly to soil boring locations.

2.1.5 Monitoring Well Construction and Development

The purpose of installing groundwater monitoring wells is to facilitate the evaluation of the following physical and chemical characteristics:

- groundwater quality;
- groundwater levels;
- hydrogeologic properties of water-bearing units; and
- contaminant distribution within the aquifer.

Groundwater monitoring wells will be installed in accordance with the EPA Publication 330/9-S1-002, National Enforcement Investigations Center *Manual for Groundwater/Subsurface Investigations at Hazardous Waste Sites* (EPA 1981) and the IRP Handbook (Air Force 1993a). Decisions on locations, depths, screened intervals, and other construction details will be made cooperatively by the project AFCEE representative and the site geologist.

2.1.5.1 Well Construction Methods and Materials

All permanent groundwater monitoring wells will be constructed in the HSA annular space that is at least 4 inches greater than the outer diameter of the well casing and screen. Smaller diameter augers (4½-inch inside diameter [ID]) may be used to drill a pilot hole during subsurface sample collection. Later, augers providing the required annular space will be advanced to the desired depth for well construction purposes.

At all times, reasonable precautions will be used to prevent tampering and inclusion of foreign materials in the borehole or well. Any well that is temporarily removed from service or left uncompleted during construction (overnight or longer) will be secured to prevent vandalism and introduction of precipitation or runoff.

Monitoring wells will be constructed of flush-threaded well screen and riser casing. Casing materials will be new or unused Schedule 40 polyvinyl chloride (PVC). All casing will be decontaminated before use as specified in Section 2.1.8. Monitoring well screens and casing will have a 2-inch nominal diameter. Screen slot size will be 0.010 inches and will be compatible with the grain size of the filter pack. The screen size was determined by limited subsurface data and should be capable of retaining 90 percent of the filter pack. The screened interval in monitoring wells may be as long as 15 feet to allow for anticipated large seasonal fluctuations in groundwater levels. Shorter screened intervals may be used depending on the depth to and vertical extent of groundwater relative to permafrost.

The position of the well screen in relation to groundwater will depend on (1) the sampling/observational objectives of the specific well, (2) the vertical extent of groundwater, and (3) the depth to permafrost.

Glues and solvents will not be used to join monitoring well casing or screen. A threaded end cap will be securely attached to the bottom of the well screen to seal the well bottom.

The well string (casing and screen) will be lowered slowly into the borehole using clamps, elevators, or other mechanical devices to make certain that the well will maintain alignment, plumbness, and roundness during installation. The well string will not be dropped into place or lowered by hand in an uncontrolled manner. All wells will be constructed with the well casing and screen set round and true-to-line. The casing will be straight and plumb within 3 degrees of vertical at locations where depth to groundwater is less than 30 feet. If the casing length is greater than 30 feet, then the casing will be set to within 1 degree of vertical. The casing will be fully supported from the top and held in tension during emplacement of the filter pack and seal. Because monitoring wells are anticipated to be approximately 25 feet deep, the use of centralizers is not required. A notch will be cut on the top of the casing to be used as a measuring point for water levels.

The annular space around and above the screened interval will be filled with a silica sand filter pack. The filter pack material will be placed to extend a minimum of 2 feet above the screened interval to prevent annular-seal invasion of the screen during well construction. The filter pack will be emplaced using a bottom discharge tremie pipe with a diameter of at least 1.5 inches that is raised at the same rate at which the filter pack is emplaced or slowly hand-poured from the surface. After emplacement of the filter pack, the well will be surged for 10 minutes. Additional silica sand will be

added to return the filter pack to the desired level. The well will be surged for five minutes, and then additional silica sand will be added, if necessary.

Filter Pack. The filter pack will consist of a clean, sorted, well-rounded, acid-resistant silica sand that contains less than 2 percent flat particles. The filter pack will be certified free of contaminants by the vendor. The filter pack will be #20-40 mesh size which is compatible with 0.010-inch screen slots.

Seal. Bentonite to be used for the seal above the filter pack will be a 100 percent sodium bentonite in a chip form with a minimum dry bulk density of 70 pounds per cubic foot. The bentonite will consist of Enviroplug brand, 3/8-inch chips. The bentonite seal will be hydrated with potable water. No more than one 50-pound bag of bentonite will be emplaced before being hydrated. The amount of water introduced into a well will be kept to a minimum, and the quantity and source will be recorded in the field logbook. Because of the shallow depth of these wells, the bentonite chips will be hand-poured, without the use of a tremie pipe, as an alternative to that specified in the IRP Handbook (Air Force 1993a).

The bentonite seal will be allowed to set for 24 hours before the surface completion materials are introduced. The annular space of the well will be sealed with bentonite chips from the upper surface of the filter pack to within 1 to 2 feet of ground surface. Well completion using bentonite seal to near the ground surface is proposed because it limits the well movement resulting from possible frost action.

Surface Completions. Monitoring wells will be either flush-mounted or completed above the ground surface. The station point of contact will determine which type of surface completion will be most acceptable at each location. Figures 2.1-2 and 2.1-3 show schematic diagrams of flush and above-surface well completions.

If an above-surface completion is used, the well casing will extend 2 to 3 feet above the ground surface. The well casing will be fitted with a watertight casing cap. The extended well casing will be protected with an external steel sleeve or protective casing that will be placed over the outside of the well casing and cap. Because of the possibility of frost heaving, the protective casing will be seated in a gravel pad, which will be sloped away from the well sleeve. The well sleeve will be at least 4 inches greater than the diameter of the well casing. The pad and well sleeve will be free floating from the well casing to minimize the effects of frost heaving. The protective casing will be fitted with a lockable cap or lid. The well designation will be permanently marked on the well casing cap and on the protective casing.

Three concrete-filled 3-inch-diameter traffic posts will be installed if the station point of contact determines that the well is in an area where it needs protection. The traffic posts will be 5 feet in total length. The site geologist or hydrologist will direct the installation of the posts radially from the wellhead. The traffic posts will be recessed at least 2 feet into the ground and set in concrete. The traffic posts will be installed separately from the concrete well pad. The protective casing and posts will be painted with a color specified by the station point of contact.

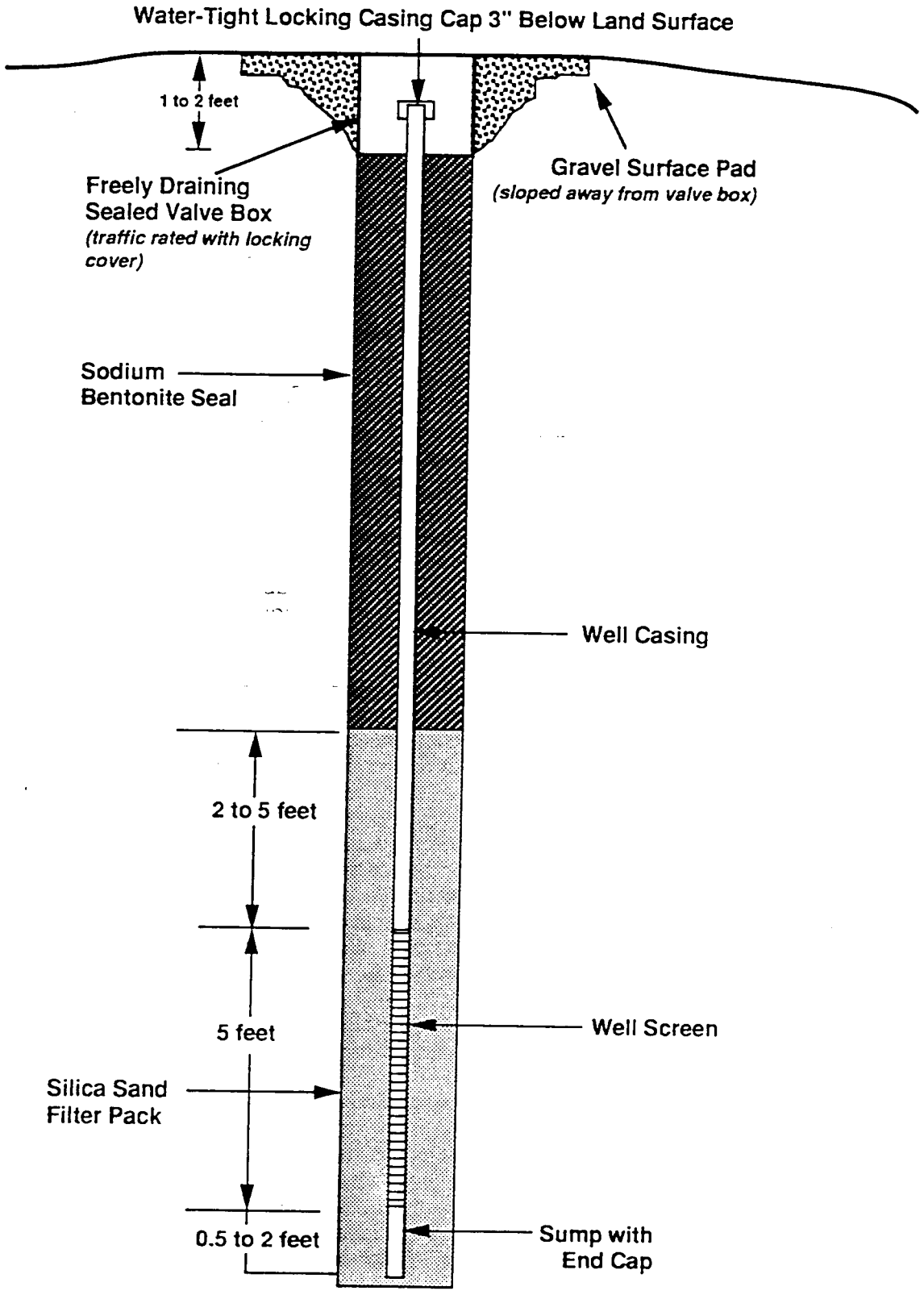


Figure 2.1-2

Schematic Diagram of a Shallow Aquifer Monitoring Well

(Flush-Mount Completion)

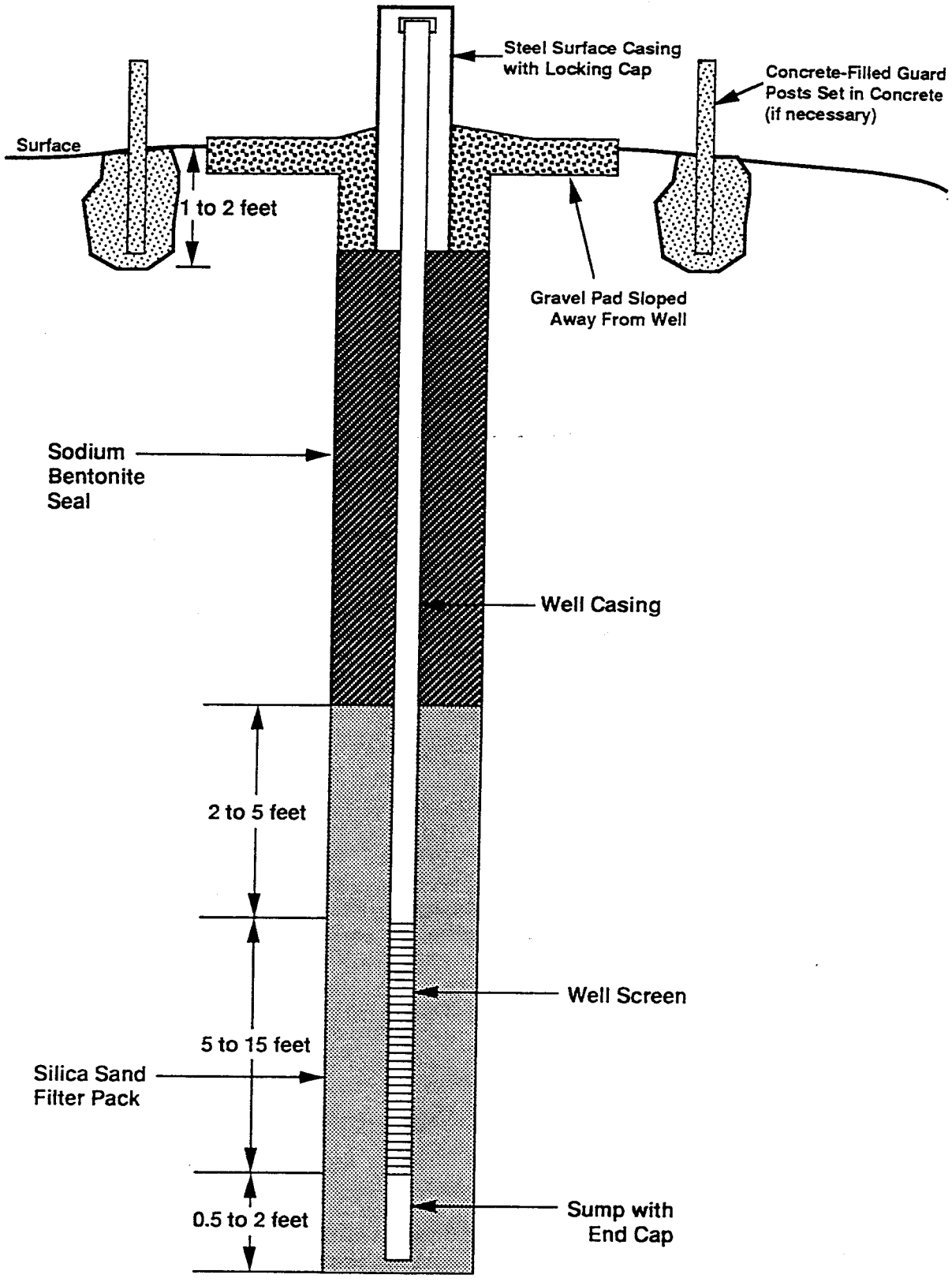


Figure 2.1-3
Schematic Diagram of a Shallow Aquifer Monitoring Well
(Aboveground Completion)

For flush-mounted surface completions, the well casing will be cut approximately 3 inches below the land surface and fitted with a watertight casing cap. A freely draining valve box with a locking cover will be placed over the casing. The top of the casing will be at least 1 foot above the bottom of the box. The valve box will be centered in a gravel pad that slopes away from the box. The identity of the well will be permanently marked on the valve box lid and the casing cap.

All wells will be secured as soon as possible after drilling. Corrosion-resistant locks will be used for both flush and above-surface completions. The locks will be keyed alike. Keys will be delivered to the 11th CEOS following completion of the field effort.

Well completion diagrams showing well construction details will be completed by the geologist or hydrogeologist who supervised the well installation. Well construction activities will be documented in the field logbook and on well construction forms, and any changes from the planned well construction will be noted. Completion diagrams will be submitted in the RI/FS Report.

Well completion diagrams will include the following information:

- well identification;
- drilling method;
- installation date;
- elevation of ground surface and measuring point notch;
- total boring depth;
- borehole diameter;
- length and description of the screen and casing;
- length and description of filter pack, bentonite seal, casing, and surface completion materials;
- elevation of water surface after well completion;
- total well depth;
- casing diameter and stick up;
- surface elevation; and
- summary of material penetrated during drilling.

An example of the well completion form is included in Appendix C.

2.1.5.2 Temporary Monitoring Well Construction

Groundwater samples for field screening and laboratory analysis will be collected from temporary monitoring wells. These wells will be constructed in the same way as permanent monitoring wells described in Section 2.1.5.1, except for the bentonite

seal and surface completion. A 2- to 3-foot bentonite seal will be installed above the filter pack, and the remainder of the borehole will be left open. To prevent excessive formation collapse and possible casing damage in wells deeper than 20 feet, a 4-inch diameter PVC or steel casing will be emplaced into the borehole to protect the 2-inch well.

Temporary monitoring wells will be developed and sampled in the same way as permanent wells (see Sections 2.1.5.2 and 2.2.1.1). Temporary monitoring wells will be abandoned by removing all casing and screen, and then abandoning the borehole as described in Section 2.1.4.4.

2.1.5.3 Well Development

All newly installed wells will be developed no sooner than 24 hours after installation to allow adequate curing of the well completion materials (bentonite seal, surface pad).

Each time a well casing cap is removed, the air in the breathing zone will be checked with an HNu, and air in the well bore will be checked with both the HNu and explosimeter. If organic vapors or explosive gases are detected, procedures provided in the HSP will be followed.

Wells will be developed by using surge blocks, bailers, or pumps. All well development equipment will be decontaminated according to procedures in Section 2.1.8. If a pump is used for well development, a check valve will be attached to the pump to prevent purged water from flowing back into the well. Wells will be developed until the following criteria are met:

- the suspended sediment content of the water is less than 0.75 milliliter per liter (mL/L) as measured by an Imhoff cone according to Method E160.5;
- the turbidity remains within a 10 nephelometric turbidity unit (NTU) range for at least 30 minutes; and
- temperature, pH, and electrical conductivity (EC) have stabilized to plus or minus (±) 1 °C, ± 0.1 pH Standard Units and to ± 5 percent EC, respectively.

A monitoring well development field data sheet will be used to record (1) the method used for well purging, (2) the purge volume calculated, (3) the amount of water purged, and (4) associated field parameter measurements. Discharge water color and volume will also be documented. No chemical additives will be used for well development.

Well development water will be contained in a portable tank or 55-gallon drums that will be pumped into the water conditioning unit. Treatment of generated waters is described in Section 2.1.9.2.

2.1.6 Aquifer Tests

Aquifer testing at Indian Mountain LRRS will include groundwater-level measurement surveys and slug tests. The procedures for aquifer tests are described in the following paragraphs. Aquifer pumping tests will only be performed if monitoring wells are installed.

Groundwater-Level Surveys. Water levels will be measured in boreholes and monitoring wells using electric sounders or pressure transducers. Electric sounders will be the preferred method for obtaining water-level measurements. Electronic or pneumatic pressure transducers with automatic data recorders will be used for single well aquifer testing. Water-level measurements using an electric sounder will be recorded on a water level measurement form. Separate measurements will be made until two measurements are obtained that differ by less than 0.01 foot. Any conditions that may affect water-level measurements will be recorded on the form and in the field logbook.

Electric sounders will be battery powered. The sounder line will be marked and labeled at intervals of 1 foot, with 0.1 foot and 0.01 foot subdivisions. Water-level measurements will be recorded to an accuracy of 0.01 foot.

Transducers used for water-level measurements during aquifer testing will be positioned approximately 1 foot above the bottom of the well. The exact depth to the sensing tip of the transducer and the water level at time of placement will be measured and recorded. Conditions, such as barometric pressure, that could affect transducer operation will be noted and recorded. Pressure transducers will be periodically checked using electric sounders during continuous monitoring of groundwater levels. The frequency of the calibration checks will be determined by the type of test being conducted and time interval during which measurements will be made. Water-level measurements will be taken in all monitoring wells at least once within a 24-hour period. These measurements will be taken after all monitoring wells have been installed and developed, and water levels have recovered completely. All water-level measuring equipment will be decontaminated according to procedures listed in Section 2.1.8.

Slug Tests. Slug tests will be used to estimate the hydraulic conductivity of the unconfined aquifer near the monitoring well being tested. The test consists of instantaneously inserting and/or removing a slug of known volume from the monitoring well. The slug will be constructed of compatible materials (e.g., PVC, stainless steel, etc.) and will have a specific gravity greater than water. The water level will be automatically recorded using a pressure transducer connected to a data logger.

The slug test procedure consists of placing the pressure transducer approximately 1 foot from the bottom of the well and allowing the water level to equilibrate to the previously measured static water level. When the water level has equilibrated, the pressure transducer is set to zero or some predetermined reference point. The water level will be recorded to determine the static conditions, and the slug will be "instantaneously" placed in the well with its top just below the elevation of the recorded water level. The water-level fluctuations for this slug test will be recorded by the data logger.

After the aquifer returns to equilibrium conditions, the slug will be removed (slug-out test) and water levels will be automatically recorded until equilibrium is again achieved. The date, location, transducer zero or reference value, time of slug extraction, and other comments will be noted in the field logbook.

Slug testing data will be reviewed and analyzed using the computer software program AQTESOLV, Version 1.0 developed by Geraghty & Miller, Inc. (Duffield and Rumbaugh 1991). Data analysis techniques that will be used by this software include the Bouwer and Rice method for determining hydraulic conductivity of

unconfined aquifers. All equipment used for slug testing will be decontaminated as detailed in Section 2.1.8.

2.1.7 Surveying

All surveying will be conducted in accordance with the IRP Handbook (Air Force 1993a). Surveying will be performed by the 11th CEOS.

Sampling locations, including soil borings and groundwater monitoring wells, will be surveyed to establish both horizontal and vertical position. All locations will be established using Alaska State Plane coordinates depending on which system is in use at the station. The values will be reported in North American Datum (1983) and converted from meters to feet above mean sea level (MSL).

Several surveying tasks will be performed as part of the field activities at Indian Mountain LRRS. The initial phase will involve establishing a horizontal and vertical control network of permanent monuments located throughout the area. All surveying conducted for establishing the control network will be performed under the direct supervision of a professional land surveyor licensed to practice in the State of Alaska. All monuments making up the control network will be permanent (re-bar, steel pipe, disk in concrete, etc.), and sketches of monument locations will be made for future reference.

All control monuments will be established to a minimum of third order accuracy standards. All established monuments will be mapped in relationship to existing monuments in the area and all elevation will be relative to MSL benchmarks. The control network will be established by means of a closed traverse, and coordinate computations will be performed to confirm traverse closure. Monuments will be located in areas that provide the greatest visibility of field activities.

Instruments including total station/data collector theodolites with electronic distance measuring capability and automatic levels will be used to establish the control network. The use of these modern instruments will provide the most accurate means of conducting field surveys

The final phase of surveying activities will involve establishing the horizontal and vertical location of subsurface soil borings and groundwater monitoring wells. Vertical locations will have an accuracy of 0.01 foot on a notch cut into the top of the PVC casing of each monitoring well. Horizontal accuracy will be ± 3 feet. An elevation will also be established at ground surface adjacent to the well and on top of the concrete surface seal of each well. All soil boring and groundwater monitoring well locations will be established by means of a closed traverse to minimize any potential for errors in position.

2.1.8 Equipment Decontamination

All equipment will be decontaminated in accordance with IRP Handbook, Section 2.1.1.3 (Air Force 1993a).

All equipment that may directly or indirectly contact samples will be decontaminated before and after each use. Decontamination may consist of varying combinations of steam cleaning, high-pressure hot water rinse, Liquinox or Alconox wash, ASTM

Type II reagent-grade water rinse, pesticide-grade methanol, and/or pesticide-grade hexane solvent rinse.

Drilling, sampling, monitoring well installation, and other equipment will be decontaminated using the following procedures:

- Drill rig augers, drill rods, bits, etc., will be steam cleaned before use and between borings, except in the case where a boring is moved a short distance because of auger refusal. Visible soil and grease will be removed before drilling at the alternative boring location.

- Soil, groundwater, surface water, and sediment sampling equipment will be cleaned with an Alconox or Liquinox and potable water solution, triple rinsed with potable water, rinsed with ASTM Type II reagent-grade water, and rinsed with pesticide-grade methanol and pesticide-grade hexane.

- A temporary decontamination area will be erected at Upper Camp to decontaminate the backhoe bucket between test pits. The bucket will be brushed to remove soil and debris, and then steam cleaned. Decontamination water will be transported for treatment through the water conditioning unit.

- Casing, screen, and caps used in monitoring well construction will be steam cleaned before installation. Visible foreign matter will be removed.

- The exterior surfaces and accessible interior portions of submersible pumps will be steam cleaned before each use. Inaccessible interior portions of the pumps will be cleaned before each use by purging with 1) an Alconox or Liquinox solution, 2) potable water, and 3) ASTM Type II reagent-grade water through the pump and discharge lines.

- Steel tapes, well sounders, transducers, and water-quality probes will be scrubbed in tap water and Liquinox or Alconox, rinsed with potable water, rinsed with ASTM Type II reagent-grade water, and then rinsed with methanol and hexane. All sections of these devices that contact the monitoring well or borehole will require decontamination.

- Water-sampling containers will be cleaned and prepared by the analytical laboratory.

- Groundwater field screening equipment used for monitoring well sampling may consist of disposable bailers. These bailers will be factory-cleaned and sealed, and will only be used for one-time sampling. No decontamination of disposable bailers will be performed.

- All sampling equipment will be allowed to air dry before reuse. Equipment will be placed on a clean surface such as laboratory-grade (oil-free) aluminum foil. (If the sampling device will not be used immediately after decontamination, it will be wrapped in laboratory-grade aluminum foil.)

2.1.9 Waste Handling

During the process of collecting environmental samples at Indian Mountain LRRS, several types of investigation-derived wastes (IDW) will be generated. They include nonhazardous trash and debris, nonhazardous IDW, and potentially hazardous IDW. This section documents the waste handling and management procedures that will be followed during field activities.

All IDW generated during the performance of the field program will be handled in a manner consistent with federal, state, local, and Air Force requirements for waste materials handling and management.

All IDW generated during field investigations will be classified in one of three categories: trash and other miscellaneous debris, IDW nonhazardous waste, or IDW hazardous waste. Trash and other miscellaneous debris consists of inert, unclassified household-type trash such as miscellaneous paper, wrappers, cups, and plastics. IDW wastes include soil cuttings, well development water, well purge water, aquifer test water, decontamination rinse water, personal protective equipment (PPE) wastes (Tyveks, gloves, spent respirator cartridges, etc.), and plastic sheeting. IDW subcategories are defined in the following paragraphs.

Soil Cuttings. Soil cuttings are the materials brought to the surface during drilling of subsurface boreholes.

Well Development Water/Purge Water/Aquifer Test Water. Well development and purge water will be generated when flushing and sampling the monitoring wells. Additional well purge and aquifer test water will also be generated during routine sampling and aquifer testing.

Decontamination Water. Decontamination water will be produced from cleaning drilling rigs, well development, and sampling equipment, and miscellaneous tools. Decontamination water will be generated and contained at individual drilling and sampling sites and at the temporary decontamination and waste staging area constructed for this investigation.

Solvent Rinse Wastes. During decontamination of sampling equipment, waste methanol and hexane will be generated. This waste will be considered hazardous and will be properly contained for offsite disposal.

Disposable Personal Protective Equipment and Supplies. Disposable PPE and supplies will be used during sampling activities and monitoring well installation. The PPE and supplies consist of Tyvek suits, nitrile and latex gloves, respirator cartridges, tape, plastic sheeting, and other disposable materials associated with the field investigations.

2.1.9.1 Waste Characterization

Trash and other miscellaneous debris will be classified as either nonhazardous or hazardous IDW, depending on the day's activities and the potential classification of the waste handled during that day. Jacobs will place potentially hazardous PPE and supplies in 55-gallon drums. Nonhazardous waste will be collected and contained in plastic bags. These bags will be disposed of with other station debris with approval from the station point-of-contact.

Field screening results and field observations will be considered when characterizing IDW. IDW expected to have elevated concentrations of constituents of concern based on field data, will be analyzed for Resource Conservation and Recovery Act (RCRA) characteristics according to the TCLP by the fixed laboratory. Potentially hazardous IDW will be stored at the station until laboratory analytical data are reviewed. After data review, a Jacobs representative will travel to the station to coordinate waste management. All drums containing IDW designated as RCRA hazardous waste will be labeled according to U.S. Air Force and EPA requirements

and transported to Elmendorf AFB by the 11th CEOS. Labels will include source, date, and observations or data regarding potential contamination.

Jacobs will provide a licensed subcontractor to transport waste from Elmendorf to a permitted disposal facility. No liquid or solid hazardous IDW other than solvent rinse wastes is expected to be generated. Soils that are not identified as being contaminated will be considered nonhazardous IDW and will be scattered on the ground at locations chosen by the station point of contact.

Well Development Water/Purge Water/Aquifer Test Water. Water purged from groundwater monitoring wells during well development, sampling, or aquifer testing will be pumped into drums or portable tanks as generated and later pumped into the tanks connected to the onsite temporary water conditioning system.

Development and purge water will not be directly sampled but will be assumed to have contaminant levels similar to groundwater samples screened at that location. Groundwater samples will be analyzed for total petroleum hydrocarbons (TPH) using field testing methods and analyzed for a complete suite of analytes by the fixed laboratory. Waters from wells or boreholes with elevated HNu readings (more than 50 parts per million [ppm] above background), elevated field test TPH measurements, or that are considered potentially contaminated based on visual observations, such as an oily sheen, will be temporarily stored at the well site in drums until field laboratory analyses confirm the presence or absence of contamination. Jacobs will label all drums with borehole or well number, date, contents, "Awaiting Analytical Results", and the station point-of-contact name and phone number.

Decontamination Water. Decontamination water will not be characterized but will be pumped into the storage tanks connected to the water conditioning unit and treated.

2.1.9.2 Water Conditioning Unit

A granular activated carbon (GAC) conditioning system will be designed and assembled to condition water contaminated with dissolved petroleum, oil, and lubricants (POL) and/or low concentrations of volatile organics. The GAC conditioning unit will be designed so that effluent may be discharged directly into the Indian Mountain LRRS sewage treatment system. Jacobs will obtain any necessary approval or permits for the operation of the GAC conditioning unit. Water generated from monitoring well development, purging, sampling, and equipment decontamination will be conditioned. Three samples of treated water will be collected to assess the performance of the conditioning unit. These samples will be collected soon after the system is operational, at some time during the field investigation, and at the end of the investigation, and will be shipped to the laboratory for DRO/GRO, VOC, and TPH (if necessary) analysis. Specifications for the water conditioning unit are provided in Appendix E.

2.1.10 Buried Utility Clearance

Before performing any drilling or excavation activities, Jacobs will coordinate with the station point of contact, the 11th CEOS, and appropriate station management personnel. Clearance work will be performed by station personnel using utility maps and information from previous clearances. Based on this information, actual or suspected utility locations will be staked or painted for reference. All utility

location tasks will be documented in the field logbook to aid any subsequent utility clearance work.

Metal detector surveys will be conducted before all intrusive activities, such as borehole drilling or excavations, to verify the absence of buried utilities and debris.

2.1.11 Field Operations Summary

Table 2.1-1 summarizes the planned field survey and field screening activities and Table 2.1-2 summarizes the activities performed to collect samples for field screening and laboratory analysis. These tables are broken down into previously identified source areas.

In general, the field activities will include the following:

- preliminary site reconnaissance to locate or verify known source areas, verify field maps, and refine sampling locations;
- metal detector survey to verify landfill, dump, and drum burial boundaries, and located buried metal objects;
- soil-gas survey to screen proposed sampling points and collect soil-gas parameters that may be indicative of processes related to the natural degradation of hydrocarbons;
- surface soil collection to detect the potential of a release of constituents to surface soils;
- subsurface soil collection to characterize potential contamination and determine the vertical extent of potential contamination in subsurface soils;
- surface water, groundwater seep, and sediment sample collection to detect the potential release or migration of constituents to surface waters, groundwater, and sediments;
- groundwater monitoring and sample collection to provide information concerning the hydrogeologic conditions and potential impacts to the groundwater by the constituents of concern at the Lower Camp; and
- background soil and water sample collection.

Details pertaining to the sampling approach, rationale, field screening measurements, and laboratory analysis of samples are discussed in Section 3.0 of the Indian Mountain LRRS RI/FS Work Plan.

2.2 ENVIRONMENTAL SAMPLING

This section describes the field sampling methods for various environmental media and procedures for sample handling and QC that are required for the field investigation. Rationale for collecting samples is described in the Work Plan. Sampling equipment decontamination procedures were described in Section 2.1.8. Waste characterization and handling were discussed in Section 2.1.9.

2.2.1 Sampling Procedures

The following subsections describe sample collection procedures for groundwater, surface water, sediment, and surface and subsurface soil. These procedures will be followed for laboratory samples. Samples collected for field testing will follow the same general collection methods although containers will not be preserved. Field test samples will be labeled and stored in a cooler containing ice and will be screened at the end of the day. Soil-gas sampling was described in Section 2.1.3. Sample container, preservation, and holding time requirements were summarized in Tables 1.5-1 and 1.5-2.

2.2.1.1 Groundwater Sampling Procedures

Groundwater samples for fixed laboratory analysis will be collected from temporary and permanent monitoring wells.

Monitoring Well Sampling. Groundwater sampling of monitoring wells will follow techniques described in the *RCRA Ground Water Monitoring Technical Enforcement Guidance Document* (EPA 1986) and the IRP Handbook (Air Force 1993a). These procedures are summarized in the following paragraphs.

Each time a well casing cap is removed, the air in the breathing zone will be measured for total organic vapors with an HNu, and air in the well bore will be analyzed with both the HNu and an explosimeter. If organic vapors or explosive gases are detected, procedures provided in the HSP will be followed.

Static fluid levels, including immiscible light nonaqueous-phase liquids (LNAPLs), dense nonaqueous-phase liquids (DNAPLs), and total well depth will be measured using an interface probe and the information will be recorded in the field logbook and on the field forms. The condition of the well will also be recorded. The well bore volume will be calculated using the well completion information and the field measurements. The calculation will be recorded in the field logbook and on a well purging form. Examples of these forms are included in Appendix C. The well bore volume is defined as the volume of submerged casing, screen, and filter pack less the estimated volume of sand in the filter pack. If the well sufficiently recharges during purging, at least three well bore fluid volumes will be purged from the well before it is sampled.

A purge method will be selected depending on the volume of water that will be purged from the well before sampling and the suspected rate of recharge. A submersible electric pump may be used to purge deep wells or wells that have large purge volumes. The purge pump will be equipped with check valves to prevent purge water from flowing back into the well. For low volume wells and slowly recharging wells, either a Teflon or a disposable PVC bailer will be used to purge the well. Purging and sampling of the wells will be performed in a manner that minimizes agitation of sediment in the well and formation. Equipment will not be allowed to free fall into the well.

TABLE 2.1–1
FIELD ACTIVITIES SUMMARY
INDIAN MOUNTAIN LRRS, ALASKA

POTENTIAL SOURCE AREA	METAL DETECTOR	SOIL GAS SURVEY	SURFACE WATER SAMPLES	SEDIMENT SAMPLES	SURFACE SOIL SAMPLES (0–0.5 FT)	SHALLOW SUB–SURFACE SOIL SAMPLES (0.5–3 FT)	SUBSURFACE SOIL SAMPLES (1) (>3 FT)	TEST PITS (SS10)	GROUND–WATER SAMPLES (2)	MONITORING WELL INSTALLATION	AQUIFER TESTING
UPPER CAMP											
SS10			X	X				X	X		
SD07			X	X							
SD01			X	X							
OT08		X	X	X	X	X					
GENERAL			X	X							
BACKGROUND		X	X	X	X	X					
TOTAL	0	2	6	6	2	2	0	1	1	0	0
LOWER CAMP											
SS11		X	X	X			X		X	X	X
LF06											
WAA 4							X		X		
LANDFILL 3			X	X		X					
LANDFILL 4			X	X	X	X					
LF04	X			X		X	X		X	X	X
SS02		X					X		X		
SS09			X	X	X	X	X		X	X	X
SS03	X						X		X		
LF05	X		X	X			X		X	X	X
SD07			X	X							
AOC 1			X	X	X	X					
AOC 2					X	X					
AOC 3	X	X	X	X	X	X					
AOC 4		X			X	X					
AOC 5	X		X	X		X					
AOC 6	X		X	X		X					
AOC 7	X		X	X							
AOC 8					X						
AOC 9				X							
AOC 10			X								
OTHER (3)			X								
INDIAN RIVER			X	X							
UTOPIA CREEK			X	X							
BACKGROUND		X	X	X	X		X		X		
TOTAL	7	5	16	16	8	10	8	0	8	4	4

(1) Requires a drill rig.
(2) Groundwater samples collected from temporary wells (Lower Camp) or test pits (Upper Camp).
(3) Includes water treatment system.
(X) Activity to be performed.

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TABLE 2.1-2
FIELD SCREENING/LABORATORY ANALYSIS FIELD ACTIVITIES SUMMARY
INDIAN MOUNTAIN LRRS, ALASKA

POTENTIAL SOURCE AREA	SOIL GAS SURVEY	SURFACE SOIL SCREENING PH (0-0.5 FT)	SURFACE SOIL SCREENING PCB (0-0.5 FT)	SURFACE SOIL SAMPLES LAB (0-0.5 FT)	SCREENING SUB-SURFACE SOIL (0.5-3 FT) PH	SCREENING SUB-SURFACE SOIL (0.5-3 FT) PCB	SUB-SURFACE SOIL (0.5-3 FT) LAB	SUBSURFACE SOIL SCREENING (>3 FT) PH	SUBSURFACE SOIL (>3 FT) LAB	GROUNDWATER SAMPLES SCREENING	GROUNDWATER SAMPLES LAB	SURFACE WATER SAMPLES	SEDIMENT SAMPLES
UPPER CAMP													
SS10	-	-	-	-	-	-	-	-	3	3	3	9	9
SD07	-	-	-	-	-	-	-	-	-	-	-	4	4
SD01	-	-	-	-	-	-	-	-	-	-	-	6	6
OT06	3	-	13	3	-	-	2	-	-	-	-	1	1
GENERAL	-	-	-	-	-	-	-	-	-	-	-	6	6
BACKGROUND	2	-	-	2	-	-	2	-	-	-	-	2	2
TOTAL	5	0	13	5	0	0	4	0	3	3	3	28	28
LOWER CAMP													
SS11	35	-	-	-	-	-	-	3	4	1	1	1	1
LF06													
WAA 4	-	-	-	-	-	-	-	4	2	2	2	-	-
LANDFILL 3	-	-	-	-	4	-	1	-	-	-	-	3	3
LANDFILL 4	-	-	-	1	4	-	1	-	-	-	-	2	2
SD07	-	-	-	-	-	-	-	-	-	-	-	3	3
LF04	-	-	-	-	-	-	4	-	-	3	4	-	1
SS02	12	-	-	-	-	-	-	-	3	3	3	-	-
SS09	-	-	8	1	-	5	2	-	4	4	5	2	2
SS03	-	-	-	-	-	-	-	-	2	2	2	-	-
LF05	-	-	-	-	-	-	-	-	1	1	2	3	3
AOC 1	-	4	-	2	4	-	1	-	-	-	-	1	1
AOC 2	-	16	16	2	9	9	2	-	-	-	-	-	-
AOC 3	8	4	4	2	2	2	1	-	-	-	-	1	1
AOC 4	4	3	-	1	1	-	1	-	-	-	-	-	-
AOC 5	-	-	-	-	2	-	1	-	-	-	-	1	1
AOC 6	-	-	-	-	2	-	1	-	-	-	-	1	1
AOC 7	-	-	-	-	-	-	-	-	-	-	-	7	7
AOC 8	-	-	-	1	-	-	-	-	-	-	-	-	-
AOC 9	-	-	-	-	-	-	-	-	-	-	-	-	1
AOC 10	-	-	-	-	-	-	-	-	-	-	-	1	-
WATER COND. UNIT	-	-	-	-	-	-	-	-	-	3	-	-	-
WASTE CHARACTER.	-	-	-	-	-	-	-	-	10	-	-	-	-
INDIAN RIVER	-	-	-	-	-	-	-	-	-	-	-	2	2
UTOPIA CREEK	-	-	-	-	-	-	-	-	-	-	-	2	2
BACKGROUND	2	3	-	3	-	-	-	-	2	2	-	4	2
TOTAL	61	30	28	13	28	16	15	7	28	21	19	34	33

PCB: Polychlorinated Biphenyls
PH: Petroleum hydrocarbons
(-) Activity/sample not planned.

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The temperature, pH, electrical conductivity, salinity, dissolved oxygen (DO) and turbidity will be measured and recorded after removing each well bore volume during purging. The sample may be collected after three well bore volumes have been removed and the above parameters have stabilized. Stabilization is defined as two consecutive measurements of the following parameters measured within these ranges: temperature ±1°C, pH ± 0.1 unit, EC ± 5 percent. If parameters have not stabilized by the time that three bore volumes have been removed, the sample will be collected immediately after two consecutive measurements indicate stabilization. If these parameters do not stabilize, the sample will be collected after six well bore volumes have been removed. Details for field parameter meter use, calibration, and duplicate measurements are provided in Section 2.3. The total number of volumes removed will be recorded in the field logbook or on the sampling form.

Groundwater samples will be collected after the water level has recovered to 80 percent of its static level or 16 hours after completion of purging, whichever is first. If a monitoring well is pumped dry before three well-bore fluid volumes have been removed, the sample will be collected as soon as sufficient water to fill the sample containers has reentered the well. Groundwater samples will not be collected within 24 hours of monitoring well development. Groundwater samples will be collected from wells using a decontaminated Teflon bailer. The portions of bailer lines that enter the water shall be stainless-steel or Teflon coated. Samples will be collected in order of decreasing analyte volatility. For example, samples destined for volatile organic compound analysis will be collected before those for semivolatile organic compound analysis.

2.2.1.2 Surface Water Sampling Procedures

Surface water samples will be collected from ponds, drainages, streams, springs, and seeps. Different methods will be used to collect the samples depending on the size and depth of the surface water source. All samples will be collected in a manner that does not cause cross contamination. The sample that is farthest downstream will be collected first.

The following procedures apply to all surface water sample collection:

- surface water samples will be collected before sediment samples;
- pH, specific conductance, salinity, dissolved oxygen (DO), and temperature measurements will be collected at each surface water sampling location;
- instrument calibrations will be recorded at each surface water sampling location;
- specific characteristics such as stream width, depth, flow rate, surface water appearance (turbidity, floating debris, etc.), and location of any pipes, sewers, or tributaries will be recorded in the field logbook;
- all samples will be stored and shipped in a cooler packed with ice;
- sample locations will be marked with a flag or stake; and
- sample locations will be recorded on project maps.

All surface water sampling equipment will be decontaminated between sampling locations according to the procedures specified in Section 2.1.8.

Samples collected from shallow depths will be obtained by submerging a stainless-steel, Teflon, or glass container into the pond, stream, or drainage or by holding the container under the water discharge point of a seep or spring. The container will be submerged in a manner that minimizes agitation of sediment and the water sample. If a seep or spring has minimal discharge flow, gravel, boulders, and soil may be removed to make the area more accessible and sufficient time allowed to elapse before sampling to allow sediment and debris to settle. Depending on site-specific conditions and spring or seep accessibility, points may not be sampled if the discharge is not sufficient to collect a sample in a manner that does not cause sediment agitation and cross contamination between media and sampling locations.

2.2.1.3 Surface Soil Sampling Procedures

Surface soil samples will be collected from soils that are 0 to 6 inches below ground surface. Samples will be collected using a decontaminated stainless-steel scoop or trowel. Soil layers will be removed to the desired depth and the sample collected. The soil will be transferred to the appropriate sample containers. Gravel, rock, and vegetation will be excluded from samples. All sampling equipment will be decontaminated between sample locations as described in Section 2.1.8.

Unusual surface conditions that may affect chemical analysis will be documented. Examples of such conditions include the following:

- distance to roadways, aircraft runways, or taxiways;
- obvious deposition of contaminated or clean soil at the site;
- evidence of chemical releases; and
- soil discoloration, unusual condition of vegetation, etc.

2.2.1.4 Subsurface Soil Sampling Procedures

Subsurface soil samples will be collected using a drill rig or by digging test pits. Borehole drilling using a drill rig and associated sample collection were described in Section 2.1.4.

Test Pits. If subsurface soil samples are required in areas where soil or bedrock conditions prohibit the use of hand tools and a drill rig is not required, a backhoe will be used to excavate a test pit. Before excavation, a utility clearance will be conducted at each proposed test pit location. The backhoe will excavate the test pit to the maximum required depth. The backhoe will then be used to excavate soil from the bottom of the pit, and the subsurface soil sample will be collected directly from the backhoe bucket. Care will be used to ensure that the soil collected was not in contact with the bucket.

The following information will be recorded in the field logbook:

- test pit depth, length, and width;
- type of backhoe and operator's name;
- depth and thickness of distinct soil or lithologic units;
- lithologic descriptions;
- description of any man-made material; and
- other pertinent information and observations.

Groundwater samples may be collected for laboratory analysis from some of the test pits. The water sample will be collected using a long-handled pond dipper. The sampling personnel will not enter the test pit. The sample will be collected as soon as possible after groundwater is encountered to minimize equilibration of the groundwater with atmospheric oxygen and carbon dioxide.

Test pits will be excavated, sampled, and documented within one field day. Test pits will not be left open overnight. The pits will be backfilled and compacted after sampling, and marked or flagged, as appropriate. Site restoration is discussed in Section 2.1.1.

2.2.1.5 Sediment Sampling Procedures

Depending on conditions at the sample location, different methods may be used to collect sediment samples from ponds, drainages, streams, springs, and seeps.

If the liquid layer overlying the sediment in streams, drainages, and ponds is sufficiently shallow or is not present, the sediment will be sampled directly using a stainless-steel scoop, trowel, or spoon to transfer the material directly to the sample container. This method will also be used to collect sediment from around spring and seep discharge points. Gravel, boulders, soil, and vegetation will be removed where necessary to access underlying sediment.

If the liquid layer is not shallow enough for the above method, a stainless-steel, Teflon, or glass cup will be used to collect a sediment sample. Water will be carefully poured from the container to limit agitation or loss of sediment. The remaining sediment will be transferred to the sample container.

Sediment sampling devices will be decontaminated according to procedures described in Section 2.1.8. Sediment samples will be collected after surface water sampling has been completed. The order of sediment sampling will begin with the farthest downgradient sample and move progressively upgradient to avoid cross contamination between locations and media. Where appropriate, samples will be collected from the active stream bed on the stream side nearest the contamination source.

2.2.1.6 Test Kit Screening

During the field investigation, field test kits for rapid screening of TPH and PCBs in soils and TPH in groundwater using immunoassay methods will be performed. The test kits come with all materials, equipment, and supplies to perform tests at two different detection levels as preset by the factory (e.g., gasoline at 10 and 100 ppm; PCBs [arochlor 1248] at 1 and 10 ppm). Higher detection limits other than specified above can be achieved by additional dilution.

Although some variation between the TPH and PCB test kits exist, both are similar in use as briefly summarized below. The kits have several "phases" of procedures to be performed. For example, phase one includes extraction and preparation of the sample (weighing, extracting, and filtering); phase two includes sample and standard preparation; phase three is the actual immunoassay; and phase four is the interpretation of the results. Appendix D includes detailed procedures on TPH and PCB test kit operation, as well as typical detection limits for TPH components (diesel, kerosene, etc.) and arochlor congeners.

The screening data will be used for two primary purposes: (1) to identify the potential extent of contamination and locate downgradient samples; and (2) to help select samples to be sent to the laboratory for analysis. If field screening indicates the presence of contamination, samples will be collected downgradient until no contamination is detected. The non-detect sample will be sent to the laboratory for rapid turnaround (5-day) analysis to confirm the absence of contamination. The sample with the highest concentration based on field screening will also be sent to the laboratory to identify the maximum contaminant level at each potential source area for risk assessment purposes.

2.2.1.7 Product Sampling Procedures

An interface probe will be used to detect product in monitoring wells. The depth of product will be recorded in the field logbook. If a sample of floating product is required, a disposable PVC bailer will be used to collect the sample. The bailer will be slowly lowered into the well to a depth just above the bottom depth of the product layer. The contents of the bailer will be transferred to the appropriate sample container. The depth of the product layer will be measured again using the interface probe. If there is sufficient product left on the water, the sampling procedure will be repeated until the container is filled.

2.2.2 Sample Handling

Tables 1.5-1 and 1.5-2 in Section 1.0 of this SAP present the types of sample containers, sample volumes, methods of preservation, and sample holding times that will be used to collect laboratory samples. Sample containers, preserved for each analysis, will be supplied by the analytical laboratory. The pH of nonvolatile, preserved samples will be checked using pH paper. If the pH is not equal to, or less than 2, acid will be added. If the pH is consistently above 2, extra acid will be added to all containers before sample collection. The following subsections describe sample identification, packaging, and shipping.

2.2.2.1 Sample Identification

Field identifiers will be assigned to all environmental and QC samples and will appear on the sample labels, chain-of-custody forms, field sampling forms, and field logbooks. All samples collected during the field investigation will have identifiers compatible with IRPIMS. IRPIMS is a relational database maintained by the Air Force to store, analyze, and report information used for the Air Force Environmental Restoration Division (Air Force 1991a).

Specifically, the IRPIMS compatible identifiers will consist of the following:

- Air Force Installation Identification. This unique identifier is assigned to a location within an Air Force installation, plant, or base. For Indian Mountain LRRS, the Air Force installation identification is INDMT.

- Location Identification. The location identification is a unique identifier assigned to a sampling location within an Air Force installation where measurements or samples are taken.

- Log Date. The log date is the date that a sample is collected, a field test performed, or a QC sample created.

- Sample Matrix. The following IRPIMS sampling matrix codes will be used:

DC	Drill Cuttings	WD	Well Development Water
LF	Floating Product	WG	Groundwater
LO	Oil	WP	Drinking Water
SE	Sediment	WQ	Water QC Matrix
SO	Soil	WS	Surface Water
SQ	Soil QC Matrix	WW	Wastewater

- Sample Type. Coded value identifying the type of QC sample collected.

N	Normal Environmental Sample	EB	Equipment Blank
FD	Field Duplicate	TB	Trip Blank
AB	Ambient Blank		

- Sample Beginning Depth. Sample beginning depth is the upper depth in feet from the ground surface or the water surface at which a sample is collected. All values will be positive. Zero will be entered when depth is not used to identify where the sample was collected (e.g., QC samples and most water samples).

- Sample Ending Depth. Sample ending depth is the lower depth in feet relative to the ground surface at which a soil sample is collected for analysis. Water or field QC samples will have a 0 in this field; space characters will not be used. Zero will be entered when depth is not used to identify where the sample was collected. Sample ending depth, if greater than 0, will not be a smaller value than the sample beginning depth.

The unique Jacobs sample identifiers will be created for each sample and entered in the data management system. An example of the field identifier for one surface water sample collected at the fifth sampling point located at LF03 follows:

WS-05-LF03-WS5-0-0

An example of the field identifier for a soil sample collected from Borehole 2 at LF01 from a depth of 5 to 6 feet follows:

SO-LF01-BH02-5.0-6.0

2.2.2.2 Sample Packaging and Shipping

Immediately after samples are collected and labeled for offsite laboratory analysis, they will be placed in a sturdy ice chest. Each sample will be sealed in a plastic bag. The samples will be packed with shock-absorbent materials, such as bubble wrap, to prevent movement of sample containers during transport. The ice chest will be packed with resealable double-bagged ice packs and sealed with packaging tape. Custody tape will be affixed over the ice chest lid to prevent or indicate tampering.

Sample Packaging. Samples and ice will be placed in a cooler along with the appropriate chain-of-custody records. The chain-of-custody sample log sheet(s) will be filled out in indelible ink, placed in a resealable plastic bag, and taped to the inside lid of the cooler. Each collected sample fraction contained in the cooler will be specified on the chain-of-custody records by the field sampling identification number. Sample containers will be packaged to minimize potential breakage.

Sample packaging for offsite laboratory shipping will meet Air Force and DOT requirements.

Shipping Containers. At least three bands of strapping tape will be wrapped completely around the cooler to secure the lid. The cooler will be sealed with evidence tape and labeled "Fragile" and "This End Up" on all four sides. The containers will be shipped to the laboratory for analysis in accordance with DOT regulations and procedures. Shipping air bills will be properly completed; copies will be retained and placed in the project file.

Chain-of-Custody Record. A chain-of-custody record will be completed for every cooler containing fixed laboratory samples and will accompany every shipment of samples to the laboratory to establish the documentation necessary to trace sample possession from time of collection. An example of the chain-of-custody record is shown in Appendix C. The record will contain the following information:

- sample or station identification number;
- signature of collector, sampler, or recorder;
- date and time of collection;
- place of collection;
- sample matrix;
- number of containers making up the sample;
- analysis requested for sample;
- additional notes pertaining to suspected high contaminant concentrations;
- signatures of persons involved in chain of custody; and
- inclusive dates of possession.

A form describing each sample shipment will be faxed to ChemTel, the Jacobs 24-hour emergency contact for sample shipments. A copy of the form is included in Appendix C.

The laboratory portion of the form will be completed by the designated laboratory personnel and will contain the following information:

- name of person receiving the sample;
- laboratory sample number;
- date of sample receipt;
- analyses requested; and
- sample condition and temperature.

Transfer of Custody and Shipment. Samples will be accompanied by chain-of-custody records. When transferring the samples, individuals relinquishing and receiving the samples will sign, date, and note the time on the chain-of-custody record. The field coordinator will notify the laboratory coordinator when samples are shipped to the offsite laboratory for analysis.

Daily Logs. Field logs summarizing daily activities (Appendix C) and the field logbook will be used to record sampling activities each day. Entries in the field logs will include the following information:

- name of author, date, and time of entry;
- location of activity;
- names and affiliations of personnel onsite;
- sample collection or measurement methods;

- number of samples collected;
- sample identification numbers; and
- field observations and comments.

Sufficient information will be recorded in the field logbook to reconstruct the sampling event, if necessary.

Correction of Documentation. Original entries recorded in field logbooks, chain-of-custody records, and other forms will be written in indelible ink. None of these documents will be altered, destroyed, or discarded, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on a document assigned to one individual, that individual will make corrections by drawing a line through the error, entering the correct information, and initialing and dating the change. The erroneous information will not be obliterated. Any subsequent error(s) discovered on a document will be corrected by the person who made the entry or the Jacobs Project Manager. All corrections must be initialed and dated.

Sample Labels. Sample labels are necessary to prevent misidentification of samples. Each sample container will have a sample label attached. Where necessary, the label will be protected from water and solvents with clear tape. Each label will contain the following information:

- names of sample collectors;
- date and time of collection;
- place of collection;
- sample number;
- analysis required; and
- preservative.

2.2.3 Sample Custody

As discussed in Section 2.2.2.2, a chain-of-custody record will accompany samples to the laboratory. The chain-of-custody record is included in Appendix C. A sample label will be affixed to the outside of the sample container immediately following sample collection. The sample label will prevent misidentification of samples.

The completed chain-of-custody record will be returned promptly to Jacobs by laboratory personnel when samples have been received and the form has been completed. The original chain-of-custody record will become a permanent part of the project records. The chain-of-custody record has four carbonless sheets. Copies will be distributed as follows:

- white and canary: analytical laboratory;
- pink: data management; and
- goldenrod: field file copy.

A sample is in a person's custody if any one of the following occurs:

- It is in that individual's possession.

- It is in an individual's view after being in their possession.

- It is in an individual's physical possession and then locked or otherwise sealed to prevent tampering.

- It is kept in a secure area that is restricted to authorized personnel only.

2.2.4 Field Quality Control

The types of field QC samples that will be sent to the laboratory for analysis include the following:

Trip Blanks. A trip blank consists of ASTM Type II reagent-grade water in a 40-milliliter (mL) vial. The laboratory prepares the trip blanks under controlled conditions and ships the blanks to the site with the pre-cleaned sample containers. The trip blank, which consists of three vials, accompanies the sample cooler throughout the sample collection effort and is handled as a field sample. The trip blank vials are sent back to the laboratory with each cooler containing samples that will be analyzed for volatile organic compounds. The purpose of the trip blank is to determine whether cross contamination between samples occurs during shipment to the laboratory. Trip blank samples are not opened in the field. Only vials that have remained intact will be sent to the laboratory for analysis. Trip blanks are included in both water and soil/sediment shipment containers.

Ambient Blanks. Ambient blanks are prepared in the field by the members of the sample team. ASTM Type II reagent-grade water is poured into 40-mL vials at or near the actual sample location and downwind of possible sources of volatile organic compounds at the same time as environmental sample collection. The ambient blank, which consists of two vials, is labeled and handled as other field samples and analyzed for volatile organic compounds. The purpose of the ambient blank is to determine whether ambient conditions are affecting field sample results. Ambient blanks will be collected at both Lower and Upper Camps, and whenever sampling is conducted downwind of possible volatile or other airborne contaminants.

Duplicate Samples. Duplicate samples are two samples collected independently at a sampling location during a single act of sampling. Field duplicate samples will be collected to assess the variations in field sampling methods and contaminant concentrations within a like sample. Duplicate samples will be collected in the same type of containers and analyzed for the same parameters as the primary sample. The duplicate samples will have unique sample identification numbers so that the laboratory cannot distinguish the duplicate sample from primary samples. Care will be taken to make sure that the samples represent the matrix sampled. The number of duplicate samples will equal 10 percent of the number water samples.

Equipment Blank. Equipment blanks are collected following decontamination of field sampling equipment. ASTM Type II water is poured or pumped through the sampling equipment, collected into sample containers, and analyzed for the same parameters as the samples that were collected using the equipment. When possible, the equipment blank will be collected at the sample location either before or after a sample is collected. The purpose of the equipment blank is to evaluate the decontamination process and determine if it is sufficient to prevent cross contamination between sample locations. One equipment blank will be collected each time sampling equipment has been used to collect a minimum of 10 samples.

2.2.5 Sample Analysis Summary

Tables 2.2-1 through 2.2-6 summarize by media the locations, collection and analytical methods, and estimated numbers of field and QC samples that will be collected during the 1994 RI. The exact number of field samples can not be provided because sample collection is dependent on conditions encountered at the site. Additionally, the number of QC samples is dependent on the number of field samples collected and shipped to the laboratory and is therefore presented as an estimate.

2.3 FIELD MEASUREMENTS

The following sections discuss the field measurements that will be performed during the 1994 field investigation. Field measurement equipment, equipment calibration, and equipment maintenance are also described. Instrument calibration and operation manuals are included in Appendix D. All field measurements will follow procedures in the IRP Handbook (Air Force 1993a) and equipment operating manuals.

2.3.1 Parameters

The following field measurements will be performed during drilling and/or sampling and recorded in field logbooks or on sampling forms.

Organic Vapor Analysis. During drilling operations and each time a well casing cap is removed, the air in the breathing zone and within the well bore will be checked with an HNu for organic vapors. If organic vapors are detected, procedures provided in the HSP will be followed. Soil sample headspace measurements will be made with an HNu and will follow the procedures described in Section 2.1.4.

Explosive Vapor Survey. During drilling operations and before sampling monitoring wells, measurements of the lower explosive limit and oxygen content will be taken inside the well bore.

Metal Detector. Metal detector surveys will be performed during site reconnaissance activities to define source area boundaries, and as a final check for buried utilities or other foreign materials before starting any ground intrusive activities.

Water-Level Measurement. The groundwater level will be measured to within 0.01 foot in monitoring wells and augers where groundwater samples are collected. The total depth of each monitoring well and borehole will also be measured.

Immiscible Layer Measurement. Groundwater that is sampled through augers and monitoring wells will be monitored for immiscible layers using an interface probe. Depths and thicknesses will be measured to within 0.01 foot.

Conductivity, Salinity, pH, Temperature, Dissolved Oxygen, and Turbidity. These water quality parameters will be measured using a single instrument for each water sample and during monitoring well development.

TPH and PCBs. Field test kits that use immunoassay methods will be used to obtain qualitative concentrations of these constituents in soil and groundwater samples.

TABLE 2.2-1
SURFACE SOIL ANALYTICAL SUMMARY
INDIAN MOUNTAIN LRRS, ALASKA

POTENTIAL SOURCE AREA	LABORATORY ANALYSES					
	DRO/GRO/RRO SW8100/ SW8015/AK103 (mg/kg)	VOLATILE ORGANICS SW8240 (mg/kg)	SEMI-VOLATILES SW8270 (mg/kg)	PESTICIDES/ PCBs SW8080 (mg/kg)	ICP METALS, total SW6010 (mg/kg)	TOTAL LAB
UPPER CAMP						
SS10	–	–	–	–	–	0
SD07	–	–	–	–	–	0
SD01	–	–	–	–	–	0
OT08	3	3	3	3	3	15
BACKGROUND	2	2	2	2	2	10
TOTAL	5	5	5	5	5	25
LOWER CAMP						
SS11	–	–	–	–	–	0
LF06						
WAA 4	–	–	–	–	–	0
LANDFILL 3	–	–	–	–	–	0
LANDFILL 4	1	1	1	1	1	5
SD07	–	–	–	–	–	0
LF04	–	–	–	–	–	0
SS02	–	–	–	–	–	0
SS09	1	1	1	1	1	5
SS03	–	–	–	–	–	0
LF05	–	–	–	–	–	0
AOC 1	2	2	2	–	–	6
AOC 2	2	–	2	2	–	6
AOC 3	2	2	2	2	2	10
AOC 4	1	1	1	–	–	3
AOC 5	–	–	–	–	–	0
AOC 6	–	–	–	–	–	0
AOC 7	–	–	–	–	–	0
AOC 8	1	1	1	–	1	4
AOC 9	–	–	–	–	–	0
AOC 10	–	–	–	–	–	0
BACKGROUND	3	3	3	3	3	15
TOTAL	13	11	13	9	8	54

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TABLE 2.2-2
SUBSURFACE SOIL ANALYTICAL SUMMARY
INDIAN MOUNTAIN LRRS, ALASKA

POTENTIAL SOURCE AREA	LABORATORY ANALYSES							
	DRO/GRO/RRO SW8100/ SW8015/AK103 (mg/kg)	VOLATILE ORGANICS SW8240 (mg/kg)	SEMI-VOLATILES SW8270 (mg/kg)	PESTCIDES/ PCBs SW8080 (mg/kg)	ICP METALS, total SW6010 (mg/kg)	GEOTECH SAMPLE	TCLP	TOTAL LAB
UPPER CAMP								
SS10	3	3	3	3	3	–	–	15
SD07	–	–	–	–	–	–	–	0
SD01	–	–	–	–	–	–	–	0
OT08	2	2	2	2	2	–	–	10
BACKGROUND	2	2	2	2	2	–	–	10
TOTAL	7	7	7	7	7	0	0	35
LOWER CAMP								
SS11	4	4	4	–	–	1	–	13
LF06							–	0
WAA 4	2	2	–	2	2	–	–	8
LANDFILL 3	1	1	1	1	1	–	–	5
LANDFILL 4	1	1	1	1	1	–	–	5
SD07	–	–	–	–	–	–	–	0
LF04	4	4	–	4	4	–	–	16
SS02	3	3	3	–	3	–	–	12
SS09	6	6	6	6	6	1	–	31
SS03	2	2	2	2	2	–	–	10
LF05	1	1	1	1	1	–	–	5
AOC 1	1	1	1	–	–	–	–	3
AOC 2	2	–	2	2	–	–	–	6
AOC 3	1	1	1	1	1	–	–	5
AOC 4	1	1	1	–	–	–	–	3
AOC 5	1	1	1	–	1	–	–	4
AOC 6	1	1	1	–	1	–	–	4
AOC 7	–	–	–	–	–	–	–	0
AOC 8	–	–	–	–	–	–	–	0
AOC 9	–	–	–	–	–	–	–	0
AOC 10	–	–	–	–	–	–	–	0
WASTE CHAR.	–	–	–	–	–	–	10	10
BACKGROUND	2	2	2	2	2	–	–	10
TOTAL	33	31	27	22	25	2	10	150

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Alkalinity. Field titration kits will be used to measure this general water quality parameter that is used to verify that site samples are obtained from the same groundwater or surface water system. Alkalinity also measures the buffering capacity of the system.

Methane, Oxygen, and Carbon Dioxide. These parameters will be measured at soil-gas points as an indication of the presence of aerobic and anaerobic degradation activity in the soil. A gas meter equipped with a pump will be used to make these measurements.

Redox Potential. Oxidation/reduction potential will be measured for groundwater samples as an indication of the suitability and activity of biological degradation of contaminants. Redox potential also affects the stability of various inorganic ions in water.

2.3.2 Equipment Calibration

To meet data quality objectives, proper calibration procedures for field equipment will be followed as described in the manufacturer's instrument manuals and the IRP Handbook (Air Force 1993a). Calibration is not necessary for the enzyme activity, metal detector, water velocity or equipment used for well development. Table 2.3-1 lists the expected accuracy and required calibration frequency of the field instruments as stated in the user manuals.

2.3.2.1 Calibration Frequencies

Daily, and in some cases more frequent, calibration of equipment will provide QA checks on all equipment used during implementation of the 1994 field investigation. Each instrument will have an individual identification number affixed. This number will be transcribed on field data records when using a particular instrument for a sampling event. All calibration, repair, and service records will be kept in individual equipment logbooks that will be maintained for each type of instrument. Equipment that consistently falls out of calibration or exceeds manufacturer's critical limits will be appropriately repaired or replaced.

2.3.2.2 Calibration Procedures

Photoionization Detector. These instruments require calibration at least daily. The PID instruments are calibrated using commercially available gases of known concentrations. Calibration will be performed according to the manufacturer's recommendations and will be recorded in the appropriate equipment logbook. Routine maintenance consists of battery charging to maintain that the instrument is ready to use when required and occasional lamp or fan cleaning.

Lower Explosive Limit/Oxygen Instrument. This instrument will be calibrated before use each day. Calibration will be in accordance with the manufacturer's recommendations using the standard calibration gas cylinders and will be recorded in the appropriate equipment logbook. Routine maintenance consists of battery charging.

Electronic Water-Level Meter. The audible tone is checked by immersing the probe in water. The tape is calibrated annually by using a surveyor's steel tape to adjust for stretching of the calibrated line.

TABLE 2.2–3
GROUNDWATER ANALYTICAL SUMMARY
INDIAN MOUNTAIN LRRS, ALASKA

POTENTIAL SOURCE AREA	LABORATORY ANALYSES: DRO/GRO SW8100/ SW8015 (µg/l)	VOLATILE ORGANICS SW8260 (µg/l)	SEMI–VOLATILES SW8270 (µg/l)	PCBs/ PESTCIDES SW8080 (µg/l)	ICP METALS, total SW6010 (mg/l)	COMMON ANIONS SW9056 (mg/l)	GFAA METAL * ARSENIC SW7060 (µg/l)	GFAA METAL * LEAD SW7421 (µg/l)	GFAA METAL * CADMIUM SW7131 (µg/l)	GFAA METAL * CHROMIUM SW7191 (µg/l)	COLD VAPOR EXTRACTION MERCURY SW7470 (µg/l)	TOTAL LAB
UPPER CAMP												
SS10	3	3	3	3	3	3	3	3	3	3	–	30
SD07	–	–	–	–	–	–	–	–	–	–	–	0
SD01	–	–	–	–	–	–	–	–	–	–	–	0
OT08	–	–	–	–	–	–	–	–	–	–	–	0
BACKGROUND	–	–	–	–	–	–	–	–	–	–	–	0
TOTAL	3	3	3	3	3	3	3	3	3	3	0	30
LOWER CAMP												
SS11	1	1	1	–	1	1	–	–	–	–	–	5
LF06												
WAA 4	2	2	–	2	2	2	2	2	2	2	2	20
LANDFILL 3	–	–	–	–	–	–	–	–	–	–	–	0
LANDFILL 4	–	–	–	–	–	–	–	–	–	–	–	0
SD07	–	–	–	–	–	–	–	–	–	–	–	0
LF04	4	4	4	4	4	4	4	4	4	4	4	44
SS02	3	3	3	–	3	3	3	–	–	–	–	33
SS09	5	5	5	5	5	5	3	4	3	3	4	47
SS03	2	2	2	2	2	2	2	2	2	2	–	20
LF05	2	2	2	2	2	2	2	2	2	2	2	22
AOC 1	–	–	–	–	–	–	–	–	–	–	–	0
AOC 2	–	–	–	–	–	–	–	–	–	–	–	0
AOC 3	–	–	–	–	–	–	–	–	–	–	–	0
AOC 4	–	–	–	–	–	–	–	–	–	–	–	0
AOC 5	–	–	–	–	–	–	–	–	–	–	–	0
AOC 6	–	–	–	–	–	–	–	–	–	–	–	0
AOC 7	–	–	–	–	–	–	–	–	–	–	–	0
AOC 8	–	–	–	–	–	–	–	–	–	–	–	0
AOC 9	–	–	–	–	–	–	–	–	–	–	–	0
AOC 10	–	–	–	–	–	–	–	–	–	–	–	0
WATER COND. UNIT	3	3	–	–	–	–	–	–	–	–	–	6
BACKGROUND	2	2	2	2	2	2	2	2	2	2	2	24
TOTAL	24	24	19	17	21	21	18	16	15	15	14	221

* GFAA Metals analytical suite dependent upon location.

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TABLE 2.2–4
SURFACE WATER ANALYTICAL SUMMARY
INDIAN MOUNTAIN LRRS, ALASKA

POTENTIAL SOURCE AREA	LABORATORY ANALYSES: DRO/GRO SW8100/ SW8015 (µg/l)	VOLATILE ORGANICS SW8260 (µg/l)	SEMI–VOLATILES SW8270 (µg/l)	PESTICIDES/ PCBs SW8080 (µg/l)	ICP METALS, total SW6010 (mg/l)	COMMON ANIONS SW9056 (mg/l)	GFAA METAL * ARSENIC SW7060 (µg/l)	GFAA METAL * LEAD SW7421 (µg/l)	GFAA METAL * CADMIUM SW7131 (µg/l)	GFAA METAL * CHROMIUM SW7191 (µg/l)	GFAA METAL * MERCURY SW7470 (µg/l)	TOTAL LAB
UPPER CAMP												
SS10	9	9	9	9	9	9	9	9	9	9	–	90
SD07	4	4	4	4	4	4	4	4	4	4	–	40
SD01	6	6	6	6	6	6	6	6	6	6	–	60
OT08	1	1	1	1	1	1	–	–	–	–	–	6
GENERAL	6	6	6	6	6	6	6	6	6	6	–	60
BACKGROUND	2	2	2	2	2	2	2	2	2	2	2	22
TOTAL	28	28	28	28	28	28	27	27	27	27	2	278
LOWER CAMP												
SS11	1	1	1	–	1	1	–	–	–	–	–	5
LF06												
WAA 4	–	–	–	–	–	–	–	–	–	–	–	0
LANDFILL 3	3	3	3	3	3	3	3	–	–	–	–	21
LANDFILL 4	2	2	2	2	2	2	2	–	–	–	–	14
SD07	3	3	3	3	3	3	–	3	–	–	–	21
LF04	–	–	–	–	–	–	–	–	–	–	–	0
SS02	–	–	–	–	–	–	–	–	–	–	–	0
SS09	2	2	2	1	2	2	1	2	1	1	1	17
SS03	–	–	–	–	–	–	–	–	–	–	–	0
LF05	3	3	3	3	3	3	3	3	3	3	3	33
AOC 1	1	1	1	–	–	–	–	–	–	–	–	3
AOC 2	–	–	–	–	–	–	–	–	–	–	–	0
AOC 3	1	1	1	1	1	1	1	1	1	1	1	11
AOC 4	–	–	–	–	–	–	–	–	–	–	–	0
AOC 5	1	1	1	–	1	1	1	1	1	1	1	10
AOC 6	1	1	1	–	1	1	1	1	1	1	1	10
AOC 7	7	7	7	7	7	7	7	7	7	7	–	70
AOC 8	–	–	–	–	–	–	–	–	–	–	–	0
AOC 9	–	–	–	–	–	–	–	–	–	–	–	0
AOC 10	1	1	1	1	1	–	–	–	–	–	–	5
INDIAN RIVER	2	2	2	2	2	2	2	2	2	2	2	22
UTOPIA CREEK	2	2	2	2	2	2	2	2	2	2	2	22
BACKGROUND	4	4	4	4	4	4	4	4	4	4	4	44
TOTAL	34	34	34	29	33	32	27	26	22	22	15	308

* GFAA Metals analytical suite dependent upon location.

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TABLE 2.2–5
SEDIMENT ANALYTICAL SUMMARY
INDIAN MOUNTAIN LRRS, ALASKA

POTENTIAL SOURCE AREA	LABORATORY ANALYSES: DRO/GRO/RRO SW8100/ SW8015/AK103 (mg/kg)	VOLATILE ORGANICS SW8240 (mg/kg)	SEMI–VOLATILES SW8270 (mg/kg)	PESTICIDES/ PCBs SW8080 (mg/kg)	ICP METALS, total SW6010 (mg/kg)	TCLP	TOTAL LAB
UPPER CAMP							
SS10	9	9	9	9	9	–	45
SD07	4	4	4	4	4	–	20
SD01	6	6	6	6	6	–	30
OT08	1	1	1	1	1	–	5
GENERAL	6	6	6	6	6	–	30
BACKGROUND	2	2	2	2	2	–	10
TOTAL	28	28	28	28	28	0	140
LOWER CAMP							
SS11	1	1	1	–	–	–	3
LF06							
WAA 4	–	–	–	–	–	–	0
LANDFILL 3	3	3	3	3	3	–	15
LANDFILL 4	2	2	2	2	2	–	10
SD07	3	3	3	3	3	–	15
LF04	1	1	–	1	1	–	4
SS02	–	–	–	–	–	–	0
SS09	2	2	2	1	2	–	9
SS03	–	–	–	–	–	–	0
LF05	3	3	3	3	3	–	15
AOC 1	1	1	1	–	–	–	3
AOC 2	–	–	–	–	–	–	0
AOC 3	1	1	1	1	1	–	5
AOC 4	–	–	–	–	–	–	0
AOC 5	1	1	1	–	1	–	4
AOC 6	1	1	1	–	1	–	4
AOC 7	7	7	7	7	7	–	35
AOC 8	–	–	–	–	–	–	0
AOC 9	–	–	–	–	–	1	1
AOC 10	–	–	–	–	–	–	0
INDIAN RIVER	2	2	2	2	2	–	10
UTOPIA CREEK	2	2	2	2	2	–	10
BACKGROUND	2	2	2	2	2	–	10
TOTAL	32	32	31	27	30	1	153

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Table 2.2-6
Estimated Field QC Samples
Indian Mountain LRRS, Alaska

Type of Sample	SW8100 DRO	SW8015 GRO	AK103 RRO	SW8260 Volatile Organics	SW8240 Volatile Organics	SW8270 Semivolatile Organics	SW8080 PCBs/ Pesticides	SW6010 ICP Metals	SW7000 GFAA Metals	SW7470 Mercury	SW9056 Common Anions
Environmental Sample (Solid)	118	118	118	0	114	111	98	103	0	0	0
Environmental Sample (Liquid)	89	89	0	89	0	84	77	85	81	80	84
Equipment Rinsate (1)	20	20	20	20	20	20	20	20	20	20	20
Duplicate (2)	9	9	0	9	0	9	8	9	9	8	9
Trip Blank (3)	0	0	0	50	0	0	0	0	0	0	0
Ambient Blank (4)	0	0	0	5	0	0	0	0	0	0	0
Total Samples	236	236	138	173	134	224	203	217	110	108	113

Notes:

DRO = Diesel-range organics
GFAA = Gas furnace atomic absorption
GRO = Gasoline-range organics
ICP = Inductively coupled plasma
LRRS = Long Range Radar Station
PCB = Polychlorinated biphenyls
QC = Quality Control

(1) Equipment rinsates estimated based on number of days of sampling and number of crews.
(2) Duplicates estimated at 10% of liquid samples
(3) Trip blanks based on 2 coolers/day x 5 shipments/week x 5 weeks
(4) Ambient blanks estimated at 5 for entire field program

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Table 2.3-1
Summary of Calibration and Internal Quality Control for Field Instruments

	Instrument/ Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SAFETY	HNu HW-101 PID	Volatile Organics	Calibrate	Daily	10% of scale	1) Recalibrate 2) Repair/Replace
	MSA 360 Combustible Gas Meter	LEL	Calibrate	Daily	10% of scale	1) Recalibrate 2) Repair/Replace
		Oxygen	Calibrate	Daily	10% of scale	1) Recalibrate 2) Repair/Replace
PHYSICAL PARAMETER	MAC 51B Metal Detector	Buried objects	Test Operation	Each Sample Point	Operational	Repair/Replace
	Water Level Meter	Water Level	Test Operation	Each Sample Point	Operational	Repair/Replace
	ORS Interface Probe	LNAPL/DNAPL	Test Operation	Each Sample Point	Operational	Repair/Replace
	Flo-Mate 2000 Flow Meter	Water Velocity	Test Operation/Review Data	Each Sample Point	Operational	Repair/Replace
	Grundfos Pump & Control Box	Well Development	Test Operation	Each Sample Point	Operational	Repair/Replace
	In-Situ Hermit Datalogger	Aquifer Testing	Test Operation/Review Data	Each Sample Point	Operational	Repair/Replace
	Horiba U-10 Water Quality Meter	pH	Calibrate	Daily	+/- 0.1 pH units	Repeat calibration
			Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate
		Temperature	Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate
		Conductivity	Calibrate	Daily	+/- 10 millimhos/cm	Repeat calibration
			Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate
		Turbidity	Calibrate	Daily	+/- 10 NTU's	Repeat calibration
			Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate
		Dissolved Oxygen	Calibrate	Daily	+/- 0.1 mg/L	Repeat calibration
		Salinity	Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate
	Orion 250A	Redox Potential	Calibrate	Daily	+/- 10 mV	Repeat calibration
			Duplicate Analysis	10 %	RPD<20%	a) Third value b) Recalibrate
	Hach Titration Kit	Alkalinity	Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate
REEN	EnSys TPH (soil and groundwater)	Petroleum Hydrocarbons	Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate
	EnSys PCB (soil)	PCBs	Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate
	Landtec GA-90 Gas Analyzer (soil gas)	Carbon Dioxide	Calibrate	Daily	+/- 0.5%	Repeat calibration
			Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate
		Oxygen	Calibrate	Daily	+/- 0.5%	Repeat calibration
			Duplicate Analysis	10%	RPD<20%	a) Third value b) Recalibrate

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Interface Probe. The audible tones are checked by immersing the probe in water and oil. The tape is calibrated annually by using a surveyor's steel tape to adjust for stretching of the calibrated line.

Electrical Conductivity, Salinity, pH, Temperature, Dissolved Oxygen, and Turbidity Meter. A single instrument will be used to measure all six of these parameters. This instrument will be calibrated at each surface water or groundwater sampling location and during well development. It may be calibrated either manually or automatically using a four-parameter auto-calibration solution.

In addition to the calibration described above, the pH function will be calibrated immediately before a well is purged and immediately before the final value is measured using at least two buffer solutions which bracket the expected pH.

The electrical conductivity function will be calibrated using two solutions that bracket the expected ranges of conductivities at Indian Mountain.

The dissolved oxygen function will be calibrated against temperature-compensated, air-saturated water.

The turbidity function will be checked using a standard within the expected range of sample turbidities. The temperature and salinity functions are self calibrating on this instrument.

Alkalinity. This parameter will be measured by titrimetric analysis using premeasured reagents and digital titrators. No calibration is necessary.

Methane, Oxygen, and Carbon Dioxide. The meter used to measure these parameters will be calibrated daily using calibration gas specified in the operation manual.

2.3.3 Equipment Maintenance

Field measurement equipment will be maintained according to the manufacturer's recommended procedures provided in the operations manual for each instrument. Copies of these manuals are included in Appendix D.

On a routine basis, instrument electrodes will be inspected for scratches, cracks, salt crystal buildup, and membrane/junction deposits. Probes will be cleaned with nonphosphate detergent and water or with a weak solution of hydrochloric acid. After acid soaking, electrodes will be thoroughly rinsed with deionized water.

2.3.4 Decontamination

Field measurement equipment will be kept free of contamination. Instruments, such as the water level indicator, that contact water to be sampled will be decontaminated following the procedures for sampling equipment described in Section 2.1.8. Instruments that are sensitive to soap and solvents, like the combination pH meter, will be rinsed with potable water and ASTM Type II reagent-grade water. The probes will be cleaned daily and stored overnight according to the manufacturer's recommended procedures.

2.4 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

To ensure that sampling and other RI activities will meet the data quality objectives, quality control checks will be implemented for parameters measured in the field. Table 2.3-1 summarizes the field methods, QC checks, frequencies, acceptance criteria, and corrective actions to be taken by the field personnel. All quality control check information will be recorded in project-specific field notebooks.

2.4.1 Control Parameters

Several parameters will be controlled during the field operations, sampling, and measurement activities. As described in Section 2.3, calibration of field instruments and operational checks will be conducted periodically. The frequency of the field control check duplicates will be a minimum of 10 percent of all field measurements. Temperature, pH, specific conductance, salinity, dissolved oxygen (DO), and turbidity will be checked at the same frequency. As applicable, the materials used to verify the measurements will be from certified sources. Instrument use, maintenance and calibration will follow manufacturers and IRP Handbook (Air Force 1993a) guidance.

2.4.2 Control Limits

Duplicate field instrument measurements will be considered suspect when a percentage difference of greater than 20 percent is observed. For the pH measurements, field readings that vary more than 0.1 Standard Units will be considered suspect.

2.4.3 Corrective Actions

The corrective action required for field instruments used to measure temperature, pH, conductivity, salinity, DO, and turbidity will include recalibrating and remeasuring the parameter. Corrective action for all field instruments will involve a review of the operator's manual.

2.5 RECORD KEEPING

All documentation related to field activities will follow procedures in the IRP Handbook (Air Force 1993a). These procedures include recording the details of each activity in field log books and field sampling forms prepared for the Indian Mountain LRRS field investigation.

The following two primary types of information are associated with the field investigation:

- information used to manage, monitor, and document project performance; and
- technical data required for, or generated by, a specific investigation task or activity.

These and other types of information such as project records will be kept in the Jacobs document control file for Air Force projects in Denver, Colorado. Access to the file is restricted, and documents are entered into the file by a trained document control clerk. Field records will be kept and maintained by field crew personnel in sufficient detail to recreate all sampling and measurement activities and to meet

IRPIMS data input requirements. Field logbooks will be waterproof and permanently bound with sequentially numbered pages. Copies of the forms that will be used during the 1994 field investigation are included in Appendix C.

All field personnel will be responsible for keeping accurate records of each field task performed. Field records will be of sufficient detail to relocate all sampling locations and measurement activities and to meet the IRPIMS data requirements. The field coordinator will be responsible for ensuring that all pertinent paperwork is filled out before the completion of each field task/sampling event. Field books will be permanently bound with sequentially numbered pages. A field file will be established by the field crew to store documentation accumulated during the field investigation. Copies of field documentation will be kept in the Jacobs document control file for Air Force projects. Field documentation will be attached to the RI/FS report. For all field activities, the following information will be included in field logbooks:

- location;
- date and time;
- identity of field personnel;
- field equipment and calibration information;
- weather conditions;
- sample type and collection method;
- sample preservation;
- detailed sample location and sample depths ;
- sample volume;
- chain-of-custody form and sample numbers;
- quality assurance/quality control samples; and
- identification of conditions that could affect sample integrity or representativeness.

As data become available, results will be tabulated using a data management system and a field office computer. This information will be used to monitor RI/FS field activity progress and analytical laboratory sample tracking.

2.6 SITE MANAGEMENT

The primary objective of site management is to conduct all field operations in an appropriate and efficient manner while minimizing impacts to station operations and personnel.

Facility procedures and points of contact will be researched during the site reconnaissance. All field personnel will be informed of site-specific rules or activities.

During the field investigation, Jacobs will immediately report by telephone to AFCEE and the 11th CEOS, conditions that may indicate an imminent health risk. Within three days after the telephone notification, a written notice will be prepared and delivered.

To minimize downtime because of equipment failure, sufficient time will be allotted for drillers to properly maintain their equipment and for personnel to maintain the sampling and monitoring equipment. A backup set of sampling and monitoring equipment and a selection of frequently used spare parts will be available. A primary field representative will be onsite during all field activities.

Mr. Mike McGhee is the AFCEE-ESO/ER Contracting Officer's Representative for the IRP RI/FS investigation at Indian Mountain LRRS. His office is at Brooks Air Force Base, Texas. His telephone numbers are (210) 536-5392 and (210) 536-9026 (FAX).

The Indian Mountain LRRS point of contact is Patricia Striebich. Her office is at Elmendorf AFB, Alaska and her telephone numbers are (907) 552-4542 and (907) 552-1591 (FAX).

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APPENDIX A

Fixed Laboratory Quality Assurance Project Plan and Standard Operating Procedures

INDIAN MOUNTAIN LONG RANGE RADAR STATION QAPP

REVISION 2

JULY 16, 1994

B C ANALYTICAL

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1.0 QUALITY ASSURANCE/QUALITY CONTROL

1.1.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) is provided in support of analytical data subcontracted under the United States Air Force Installation Restoration Program. This program directs the efforts at several Air Force installations to evaluate the degree of groundwater and soil contamination and remediate as necessary. This document was developed to focus on Indian Mountain Long Range Radar Station, Alaska.

The Indian Mountain site, located in central Alaska, is extremely remote. Samples may not be shipped to the laboratory until day 3 or 4 after sampling. Particular care must be taken to ensure meeting holding times. Jacobs will be using Alaska Airlines to ship the samples to the laboratory.

The QAPP is a laboratory guidance document to ensure that requirements set forth by the USAF Center for Environmental Excellence (AFCEE) are met. These requirements include precision, accuracy, completeness, representativeness and comparability of water, soil, and field chemistry data generated during the course of this project. The QAPP has been prepared in accordance with the requirements and guidelines established by the USAF and the U.S. EPA for data collection and program management. References used in preparing this document are:

- AFCEE, IRP Program Division Human Systems Program Office, Brooks AFB, Texas, September 1993, Handbook To Support The Installation Restoration Program (IRP) Statements of Work. Volume 1 - Remedial Investigation/Feasibility Studies (RI/FS)

- U.S. EPA. February 1983. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, EPA-600/4-83-004

- U.S. EPA. 1980. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, (QAMS-005/80)

- U.S. EPA. 1972. Handbook For Analytical Quality Control in Water and Wastewater Laboratories, Technology Transfer

1.1.2 PROJECT HEIRARCHY

This QAPP is the basic laboratory reference document for this project. In those cases where the QAPP does not give clear guidance, the next documents to check in order are the September 1993 IRP Handbook referenced in section 1.1, Third Edition SW-846 November 1986 and the 9th Edition BCA QA Manual.

1.2 PROJECT ORGANIZATION AND RESPONSIBILITY

1.2.1 Jacobs Engineering Group Inc.

Lynn Schuetter is the Indian Mountain project manager. She is headquartered at the Denver Jacobs office. Alan Alai is the project chemist and will handle day to day activities, such as faxing chain of custody documents and shipment problems. The project organization is presented in Figure 1-1. A quick reference to the primary contacts for this project are presented in figure 1-2.

1.2.2 B C Analytical (BCA)

Larry Penfold, Client Manager, has the overall management responsibilities for BCA's work with Jacobs at Indian Mountain. Larry's responsibilities include the preparation of project status reports for management, resource forecasting, resolution of technical issues and ensuring contract compliance.

Linda Geddes, Program Specialist, is the contact for daily concerns. Linda reviews incoming work requests, coordinates the work of the Federal Program Team, reviews final reports and directs preparation of electronic downloads.

Tom Kirk is the QA Coordinator. He reports to the Business Unit Manager, Mark Valentini. His responsibilities include maintenance of control limits, preparation of quality control reports, QA/QC auditing, coordinating performance sample evaluation efforts and management of laboratory certification.

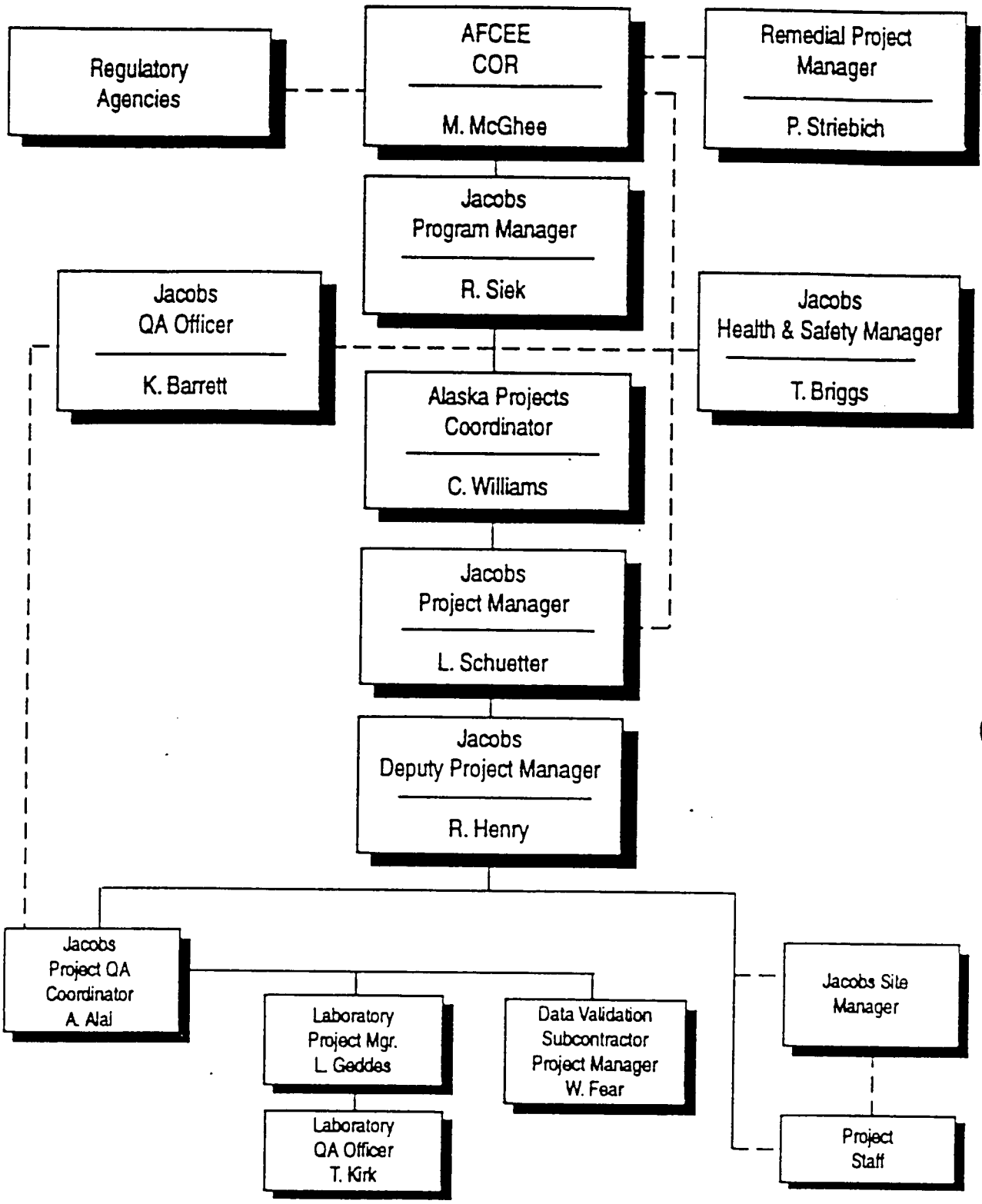
Ed Hefner, Contracts Administrator, issues invoices, prepares summary financial reports and monitors contract compliance.

Jim Hein, resource director, oversees the laboratory personnel and equipment to meet the project requirements.

Tom Robinson, located in the Pleasant Hill office, provides data base management. Tom is the chief software writer for Electronic Data Transfer (EDT) and oversees changes to the data base programs.

The BCA project organization is presented in Figure 1-3.

Figure 1-1



PROJECT ORGANIZATION CHART
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
INDIAN MOUNTAIN LONG RANGE RADAR STATION, ALASKA

Figure 1-2

PROJECT ORGANIZATION

Jacobs Engineering

Jacobs Engineering Group Inc.
600 Seventeenth Street,
Suite 1100N
Denver, CO 80202
(303) 595-8855 PHONE
(510) 595-8857 FAX

B C Analytical

B C Analytical
801 Western Avenue
Glendale, CA 91201

(818) 247-5737 PHONE
(818) 247-9797 FAX

BC Analytical Organization for Jacobs/McClellan AFB Project

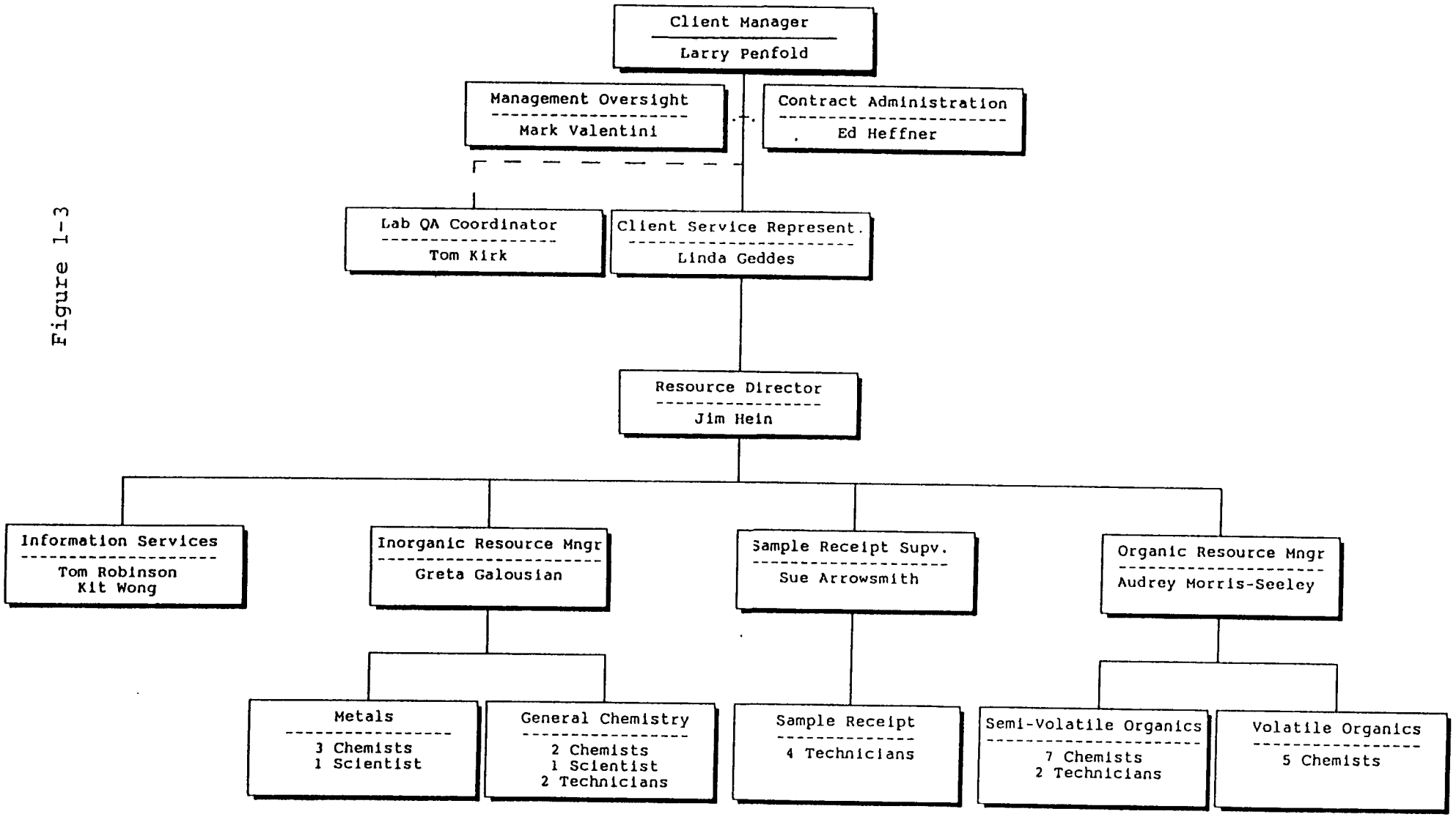


Figure 1-3

1.3 QA OBJECTIVES FOR MEASUREMENT DATA

Quality Assurance objectives for measurement data are expressed in terms of accuracy, precision, completeness, representativeness, and comparability. QA objectives provide the mechanism for ongoing control and evaluation of measurement data quality throughout the course of the program and will ultimately be used to define data quality for the various measurement parameters. The QA/QC effort will focus on controlling measurement error within the limits established and will ultimately provide a data base for estimating the actual uncertainty in the measurement data. Accuracy and precision limits are experimentally determined by the laboratory. Where the laboratory limits exceed EPA guidelines, EPA limits will be used. The current accuracy and precision control limits for this project are presented in Table 1.3.

1.3.1 Accuracy

Accuracy is somewhat difficult to assess. Spike recovery determinations, regular analysis of laboratory control standards, and use of external check samples contribute to the general assurance that the accuracy of a determination is within acceptable limits. The ultimate accuracy of a determination also depends on factors external to the laboratory such as sampling and storage conditions. Statistical treatment of the data can provide some objective measure of accuracy. The Federal Register includes calculations for accuracy on spike samples for several organics methods. The same calculation may be used for any test amenable to spiking:

$$P = 100(A - B)/T$$

Where:

P = Percent spike recovery
A = Concentration determined on spiked sample
B = Concentration determined on original unspiked sample
T = True value of spike added

1.3.2 Precision

The precision of data refers to the reproducibility of the analytical result. The question addressed by precision analysis is, given the same sample or sample type, how well can the laboratory replicate its work? Relative percent difference (% RPD) for a particular method on a general sample type can be estimated through the analysis of duplicates and matrix spike duplicates.

Table 1.3 Control Limits

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 7060\\7131\\7191 :
: BC ANALYTICAL : GLEN LAB : 13:16:53 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
Arsenic (7060/206.2)	0.05	mg/L	63	73	112	122
Cadmium (7131/213.2)	0.003	mg/L	67	78	123	134
Chromium (7191/218.2)	0.01	mg/L	67	80	134	148

***

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 7060\\7131\\7191 :
: BC ANALYTICAL : GLEN LAB : 13:17:12 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Arsenic (7060/206.2)	52	65	117	130	15	20
Cadmium (7131/213.2)	72	84	132	144	15	20
Chromium (7191/218.2)	72	82	124	134	15	20

***

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 7421\\7740 :
: BC ANALYTICAL : GLEN LAB : 13:17:27 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
Lead (7421/239.2)	0.05	mg/L	85	89	107	112
Selenium (7740/270.2)	0.1	mg/L	74	81	107	114

***

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 7421\\7740 :
: BC ANALYTICAL : GLEN LAB : 13:17:42 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Lead (7421/239.2)	54	69	129	144	15	20
Selenium (7740/270.2)	4	27	118	140	15	20

***

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 7470 :
: BC ANALYTICAL : GLEN LAB : 13:17:56 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
Mercury (7470/245.1)	0.004	mg/L	71	80	114	123

***

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 7470 :
: BC ANALYTICAL : GLEN LAB : 13:18:06 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Mercury (7470/245.1)	53	68	128	143	15	20

***

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 6010 :
: BC ANALYTICAL : GLEN LAB : 13:18:21 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
Silver (6010/200.7)	0.5	mg/L	72	79	109	117
Aluminum (6010/200.7)	5	mg/L	81	85	105	110
Arsenic (6010/200.7)	5	mg/L	76	82	107	114
Boron (6010/200.7)	10	mg/L	69	78	114	123
Boron (6010/200.7)	2	mg/L	73	82	116	125
Barium (6010/200.7)	1	mg/L	75	82	108	114
Beryllium (6010/200.7)	0.5	mg/L	79	84	105	110
Calcium (6010/200.7)	50	mg/L	85	90	111	116
Cadmium (6010/200.7)	1.0	mg/L	75	82	110	118
Cobalt (6010/200.7)	1.0	mg/L	71	78	105	112
Chromium (6010/200.7)	1.0	mg/L	76	81	105	110
Copper (6010/200.7)	1.0	mg/L	70	77	105	110
Iron (6010/200.7)	5.0	mg/L	80	85	105	110
Potassium (6010/200.7)	50	mg/L	81	84	105	110
Magnesium (6010/200.7)	50	mg/L	81	86	105	110
Manganese (6010/200.7)	1.0	mg/L	76	82	107	113
Molybdenum (6010/200.7)	1.0	mg/L	75	81	106	112
Sodium (6010/200.7)	50	mg/L	83	87	107	112
Nickel (6010/200.7)	1.0	mg/L	73	80	107	114
Lead (6010/200.7)	1.0	mg/L	73	80	109	116
Antimony (6010/200.7)	3	mg/L	79	85	109	115
Selenium (6010/200.7)	10	mg/L	74	80	107	113
Silicon (6010/200.7)	10	mg/L	77	85	121	129
Thallium (6010/200.7)	1.0	mg/L	71	78	104	110
Vanadium (6010/200.7)	1.0	mg/L	80	84	105	110
Zinc (6010/200.7)	1.0	mg/L	76	82	110	117

***

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 6010 :
: BC ANALYTICAL : GLEN LAB : 13:18:31 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Silver (6010/200.7)	74	81	106	112	15	20
Aluminum (6010/200.7)	82	88	115	121	15	20
Arsenic (6010/200.7)	70	77	105	112	15	20
Boron (6010/200.7)	72	79	107	114	15	20
Barium (6010/200.7)	74	79	105	110	15	20
Beryllium (6010/200.7)	71	78	106	113	15	20
Calcium (6010/200.7)	73	81	114	122	15	20
Cadmium (6010/200.7)	69	76	104	111	15	20
Cobalt (6010/200.7)	67	74	105	110	15	20
Chromium (6010/200.7)	68	75	104	111	15	20
Copper (6010/200.7)	68	75	105	110	15	20
Iron (6010/200.7)	68	78	119	129	15	20
Potassium (6010/200.7)	79	84	106	111	15	20
Magnesium (6010/200.7)	78	84	107	112	15	20
Manganese (6010/200.7)	70	79	115	124	15	20
Molybdenum (6010/200.7)	71	77	105	110	15	20
Sodium (6010/200.7)	77	84	111	118	15	20
Nickel (6010/200.7)	65	73	105	113	15	20
Lead (6010/200.7)	70	76	104	111	15	20
Antimony (6010/200.7)	83	87	107	112	15	20
Selenium (6010/200.7)	62	72	113	123	15	20
Silicon (6010/200.7)	62	75	128	141	15	20
Thallium (6010/200.7)	66	72	105	110	15	20
Vanadium (6010/200.7)	72	77	105	110	15	20
Zinc (6010/200.7)	61	71	111	121	15	20

***

: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 6010 :
: BC ANALYTICAL : GLEN LAB : 13:18:41 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Silver (6010/200.7)	51	64	114	127	20	30
Aluminum (6010/200.7)	75	80	120	125	20	30
Arsenic (6010/200.7)	64	72	110	115	20	30
Boron (6010/200.7)	62	71	108	117	20	30
Barium (6010/200.7)	63	74	118	129	20	30
Beryllium (6010/200.7)	68	78	120	131	20	30
Calcium (6010/200.7)	40	60	137	157	20	30
Cadmium (6010/200.7)	55	67	114	125	20	30
Cobalt (6010/200.7)	59	69	108	117	20	30
Chromium (6010/200.7)	40	56	121	137	20	30
Copper (6010/200.7)	54	65	111	122	20	30
Iron (6010/200.7)	41	61	140	160	20	30
Potassium (6010/200.7)	50	67	139	157	20	30
Magnesium (6010/200.7)	61	73	123	136	20	30
Manganese (6010/200.7)	62	74	124	136	20	30
Molybdenum (6010/200.7)	59	68	105	114	20	30
Sodium (6010/200.7)	61	74	123	135	20	30
Nickel (6010/200.7)	52	64	113	126	20	30
Lead (6010/200.7)	42	58	123	139	20	30
Antimony (6010/200.7)	5	20	105	118	20	30
Selenium (6010/200.7)	61	69	110	115	20	30
Thallium (6010/200.7)	58	68	109	119	20	30
Vanadium (6010/200.7)	67	75	107	115	20	30
Zinc (6010/200.7)	43	60	125	142	20	30

***

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8015M :
: BC ANALYTICAL : GLEN LAB : 13:19:09 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
TPH-Volatile Hydrocarbons	1000	ug/L	74	87	142	155
a,a,a-Trifluorotoluene Reported	50	ug/L	75	82	110	117

***

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 8015M :
: BC ANALYTICAL : GLEN LAB : 13:19:37 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
TPH-Volatile Hydrocarbons	53	72	148	166	16	21
a,a,a-Trifluorotoluene Reported	75	82	110	117		

***

: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 8015M :
: BC ANALYTICAL : GLEN LAB : 13:20:06 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
TPH-Volatile Hydrocarbons	55	65	106	116	34	45
a,a,a-Trifluorotoluene Reported	63	75	123	136		

***

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8100M :
: BC ANALYTICAL : GLEN LAB : 13:24:55 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
TPH (as diesel)	1	mg/L	53	70	138	155
Napthalene reported		mg/L	55	67	115	127

***

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 8100M :
: BC ANALYTICAL : GLEN LAB : 13:25:08 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
TPH (as diesel)	88	94	116	122	15	20
Napthalene reported	55	67	115	127		

***_-

: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 8100M :
: BC ANALYTICAL : GLEN LAB : 13:25:19 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
TPH (as diesel)	43	61	133	151	29	38
Napthalene reported	52	68	129	145		

***

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8080 :
: BC ANALYTICAL : GLEN LAB : 13:26:40 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
Aldrin	0.50	ug/L	42	55	109	122
p,p'-DDD	0.50	ug/L	45	61	125	141
p,p'-DDE	0.50	ug/L	44	61	128	145
p,p'-DDT	0.50	ug/L	39	59	140	160
Dieldrin	0.50	ug/L	44	61	129	146
Endosulfan I	0.50	ug/L	45	62	129	146
Endosulfan II	0.50	ug/L	44	67	159	182
Endosulfan sulfate	0.50	ug/L	28	47	125	144
Endrin	0.50	ug/L	53	69	131	147
Endrin aldehyde	0.50	ug/L	42	64	154	176
Heptachlor epoxide	0.50	ug/L	49	64	126	142
Heptachlor	0.50	ug/L	44	64	146	166
Methoxychlor	0.25	ug/L	58	74	139	155
Aroclor 1260	10	ug/L	78	86	121	129
Total PCB's	10	ug/L	78	86	121	129
BHC, alpha isomer	0.50	ug/L	52	66	120	134
BHC, beta isomer	0.50	ug/L	17	34	105	122
BHC, delta isomer	0.50	ug/L	48	63	125	140
BHC, gamma isomer (Lindane)	0.50	ug/L	54	66	115	127
Decachlorobiphenyl Reported	0.50	ug/L	20	41	126	147
Tetrachloro-meta-xylene Rpt.	0.50	ug/L	30	48	123	142

***

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 8080 :
: BC ANALYTICAL : GLEN LAB : 13:26:50 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Aldrin	42	55	109	122	31	41
p,p'-DDD	31	49	123	141	30	40
p,p'-DDE	30	49	126	145	30	40
p,p'-DDT	40	55	115	131	25	33
Dieldrin	41	58	126	143	28	37
Endosulfan I	45	63	135	153	30	40
Endosulfan II	1	34	168	202	30	40
Endosulfan sulfate	26	46	124	144	30	40
Endrin	33	52	128	147	30	39
Endrin aldehyde	42	64	154	176	30	40
Heptachlor epoxide	37	54	124	142	30	40
Heptachlor	34	52	123	141	27	35
Aroclor 1260	40	55	115	130	17	22
Total PCB's	40	55	115	130	17	22
BHC, alpha isomer	37	53	118	134	30	40
BHC, beta isomer	17	39	125	147	30	40
BHC, delta isomer	19	39	120	140	30	40
BHC, gamma isomer (Lindane)	32	48	111	127	23	30
Decachlorobiphenyl Reported	20	41	126	147		
Tetrachloro-meta-xylene Rpt.	30	48	123	142		

***

: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 8080 :
: BC ANALYTICAL : GLEN LAB : 13:27:03 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Aldrin	42	55	109	122	18	24
p,p'-DDD	31	49	123	141	30	40
p,p'-DDE	30	49	126	145	30	40
p,p'-DDT	25	48	138	160	19	24
Dieldrin	36	54	128	146	28	37
Endosulfan I	45	63	135	153	30	40
Endosulfan II	1	34	168	202	30	40
Endosulfan sulfate	26	46	124	144	30	40
Endrin	30	50	128	147	32	43
Endrin aldehyde	42	64	154	176	30	40
Heptachlor epoxide	37	54	124	142	30	40
Heptachlor	40	58	130	148	37	52
Aroclor 1260	43	57	110	123	41	55
Total PCB's	21	39	108	125	36	48
BHC, alpha isomer	37	53	118	134	30	40
BHC, beta isomer	17	39	125	147	30	40
BHC, delta isomer	19	39	120	140	30	40
BHC, gamma isomer (Lindane)	32	48	111	127	23	32
Decachlorobiphenyl Reported	50	69	145	164		
Tetrachloro-meta-xylene Rpt.	38	58	136	155		

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: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8240 :
: BC ANALYTICAL : GLEN LAB : 13:27:22 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
1,1,1-Trichloroethane	20	ug/L	63	71	102	110
1,1,2,2-Tetrachloroethane	20	ug/L	60	69	108	118
1,1,2-Trichloroethane	20	ug/L	64	76	126	138
1,1-Dichloroethane	20	ug/L	69	79	121	132
1,1-Dichloroethene	20	ug/L	59	69	109	118
1,2-Dichloroethane	20	ug/L	51	66	124	139
1,2-Dichlorobenzene	20	ug/L	56	63	114	127
1,2-Dichloropropane	20	ug/L	71	82	127	138
1,3-Dichlorobenzene	20	ug/L	67	74	105	113
1,4-Dichlorobenzene	20	ug/L	64	73	109	117
Bromodichloromethane	20	ug/L	66	74	107	116
Bromomethane	20	ug/L	55	68	123	136
Benzene	20	ug/L	65	76	117	127
Bromoform	20	ug/L	58	67.	103	112
Chlorobenzene	20	ug/L	78	85	113	120
Carbon Tetrachloride	20	ug/L	60	70	111	121
Chloroethane	20	ug/L	55	69	127	141
Chloroform	20	ug/L	67	77	115	125
Dibromochloromethane	20	ug/L	67	76	110	118
Ethylbenzene	20	ug/L	73	79	103	110
Methylene chloride	20	ug/L	56	70	129	144
Styrene	20	ug/L	80	88	122	130
Trichloroethene	20	ug/L	75	83	115	123
Trichlorofluoromethane	20	ug/L	43	54	99	110
Toluene	20	ug/L	69	78	116	126
Tetrachloroethene	20	ug/L	69	78	115	124
Vinyl chloride	20	ug/L	29	50	131	151

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8240 :
: BC ANALYTICAL : GLEN LAB : 13:27:23 16 JUL 1994 - P. 2 :

	CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
	Total Xylene Isomers	60	ug/L	72	80	111	119
--	trans-1,2-Dichloroethene	20	ug/L	58	69	116	127
--	1,2-Dichloroethane-d4 Reported	50	ug/L	87	93	119	125
	4-Bromofluorobenzene Reported	50	ug/L	85	89	106	111
	Toluene-d8 Reported	50	ug/L	94	97	110	113

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: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 8240 :
: BC ANALYTICAL : GLEN LAB : 13:27:40 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
1,1,1-Trichloroethane	52	64	112	124	15	20
1,1,2,2-Tetrachloroethane	46	64	138	157	21	28
1,1,2-Trichloroethane	70	81	125	135	16	21
1,1-Dichloroethane	60	71	113	123	15	20
1,1-Dichloroethene	41	59	130	148	22	28
1,2-Dichloroethane	49	65	129	145	15	20
1,2-Dichlorobenzene	39	53	110	124	19	25
1,2-Dichloropropane	73	81	109	117	15	20
1,3-Dichlorobenzene	59	70	112	123	16	21
1,4-Dichlorobenzene	48	61	110	122	15	20
Bromodichloromethane	66	75	112	121	15	20
Bromomethane	27	40	110	120	25	
Benzene	59	71	121	134	19	25
Bromoform	46	63	132	149	18	23
Chlorobenzene	58	73	133	148	14	19
Carbon Tetrachloride	51	65	120	134	15	20
Chloroethane	34	46	110	120	29	38
Chloroform	56	66	109	119	15	20
Dibromochloromethane	64	75	117	128	15	20
Ethylbenzene	62	72	111	121	15	20
Methylene chloride	48	60	111	123	15	20
Styrene	71	78	110	120	15	20
Trichloroethene	53	67	122	135	22	29
Trichlorofluoromethane	52	60	110	120	19	25
Toluene	57	70	125	139	15	
Tetrachloroethene	64	74	114	125	15	20
Vinyl chloride	18	30	110	120	27	35

: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 8240 :
: BC ANALYTICAL : GLEN LAB : 13:27:40 16 JUL 1994 - P. 2 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Total Xylene Isomers	44	62	137	156	15	20
trans-1,2-Dichloroethene	54	64	110	120	15	20

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: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8260 :
: BC ANALYTICAL : GLEN LAB : 13:28:00 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
1,1,1,2-Tetrachloroethane	20	ug/L	64	74	115	126
1,1,1-Trichloroethane	20	ug/L	54	65	110	121
1,1,2,2-Tetrachloroethane	20	ug/L	66	77	123	135
1,1,2-Trichloroethane	20	ug/L	59	72	123	136
1,1-Dichloroethane	20	ug/L	70	80	124	135
1,1-Dichloroethene	20	ug/L	59	73	130	144
1,2-Dichloroethane	20	ug/L	70	80	121	131
1,2-Dichlorobenzene	20	ug/L	72	81	117	127
1,2-Dichloropropane	20	ug/L	63	73	113	123
1,3-Dichlorobenzene	20	ug/L	68	78	115	125
1,4-Dichlorobenzene	20	ug/L	55	63	105	110
Bromobenzene	20	ug/L	70	81	126	137
Bromodichloromethane	20	ug/L	60	71	118	130
Bromomethane	20	ug/L	49	66.	133	150
Benzene	20	ug/L	58	71	119	132
Bromoform	20	ug/L	59	71	117	129
Chlorobenzene	20	ug/L	69	80	122	133
Carbon Tetrachloride	20	ug/L	54	68	124	138
Chloroethane	20	ug/L	62	73	117	128
Chloroform	20	ug/L	62	73	116	127
Dibromochloromethane	20	ug/L	66	76	119	130
Dibromomethane	20	ug/L	62	76	128	141
Ethylbenzene	20	ug/L	71	81	123	133
Methylene chloride	20	ug/L	54	70	134	150
Styrene	20	ug/L	65	76	119	129
Trichloroethene	20	ug/L	48	62	120	134
Trichlorofluoromethane	20	ug/L	43	54	105	110

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8260 :
: BC ANALYTICAL : GLEN LAB : 13:28:01 16 JUL 1994 - P. 2 :

	CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
	Toluene	20	ug/L	68	78	120	130
--	Tetrachloroethene	20	ug/L	58	73	134	150
--	Vinyl chloride	20	ug/L	68	86	160	178
	cis-1,2-Dichloroethene	20	ug/L	65	75	117	128
	trans-1,2-Dichloroethene	20	ug/L	62	74	123	135

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: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 8260 :
: BC ANALYTICAL : GLEN LAB : 13:28:15 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
1,1,1-Trichloroethane	56	70	125	139	25	30
1,1,2,2-Tetrachloroethane	66	77	120	131	25	30
1,1,2-Trichloroethane	57	74	140	156	25	30
1,1-Dichloroethane	59	72	126	140	25	30
1,1-Dichloroethene	53	66	116	128	25	30
1,2-Dichloroethane	62	76	133	147	25	30
1,2-Dichlorobenzene	62	74	120	131	25	30
1,2-Dichloropropane	64	78	133	147	25	30
1,3-Dichlorobenzene	59	75	139	155	25	30
1,4-Dichlorobenzene	60	71	118	129	25	30

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: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8270 :
: BC ANALYTICAL : GLEN LAB : 13:28:33 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
1,2,4-Trichlorobenzene	100	ug/L	44	56	105	116
1,2-Dichlorobenzene	100	ug/L	35	50	112	127
1,3-Dichlorobenzene	100	ug/L	32	45	105	110
1,4-Dichlorobenzene	100	ug/L	35	47	105	110
2,4,5-Trichlorophenol	100	ug/L	23	45	132	154
2,4,6-Trichlorophenol	100	ug/L	37	55	126	144
2,4-Dichlorophenol	100	ug/L	39	54	114	129
2,4-Dimethylphenol	100	ug/L	32	46	105	119
2,4-Dinitrophenol	100	ug/L	1	33	159	191
2,4-Dinitrotoluene	100	ug/L	39	56	122	139
2,6-Dinitrotoluene	100	ug/L	50	67	135	152
2-Chloronaphthalene	100	ug/L	32	44	105	110
2-Chlorophenol	100	ug/L	35	49	105	116
2-Methyl-4,6-dinitrophenol	100	ug/L	1	31.	151	181
2-Methylnaphthalene	100	ug/L	5	32	139	165
2-Methylphenol (o-Cresol)	100	ug/L	36	49	105	114
2-Nitroaniline	100	ug/L	38	56	127	144
2-Nitrophenol	100	ug/L	32	49	113	130
3,3'-Dichlorobenzidine	100	ug/L	1	44	218	262
3-Nitroaniline	100	ug/L	30	51	132	152
4-Bromophenylphenylether	100	ug/L	56	68	115	127
4-Chloro-3-methylphenol	100	ug/L	35	51	114	130
4-Chloroaniline	100	ug/L	31	47	110	126
4-Chlorophenylphenylether	100	ug/L	48	62	118	132
4-Methylphenol (p-Cresol)	100	ug/L	25	42	108	124
4-Nitroaniline	100	ug/L	3	34	156	187
4-Nitrophenol	100	ug/L	1	23	110	132

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8270 :
: BC ANALYTICAL : GLEN LAB : 13:28:33 16 JUL 1994 - P. 2 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
Acenaphthene	100	ug/L	47	61	118	132
Acenaphthylene	100	ug/L	35	51	116	132
Anthracene	100	ug/L	39	54	115	130
Benzo(a)anthracene	100	ug/L	44	60	122	138
Benzo(a)pyrene	100	ug/L	36	52	113	128
Benzo(b)fluoranthene	100	ug/L	24	43	118	137
Benzo(g,h,i)perylene	100	ug/L	25	47	135	157
Benzyl Alcohol	100	ug/L	3	29	135	161
Benzoic acid	100	ug/L	1	31	153	183
Butylbenzylphthalate	100	ug/L	37	56	132	151
Chrysene	100	ug/L	43	60	129	147
Di-n-octylphthalate	100	ug/L	21	42	125	146
Dibenzo(a,h)anthracene	100	ug/L	30	50	133	154
Dibenzofuran	100	ug/L	54	65	110	121
Dibutylphthalate	100	ug/L	53	65	113	125
Diethylphthalate	100	ug/L	47	63	126	142
Dimethylphthalate	100	ug/L	32	50	123	142
Fluoranthene	100	ug/L	39	55	121	137
Fluorene	100	ug/L	59	69	111	121
Hexachlorobenzene	100	ug/L	48	61	116	129
Hexachlorobutadiene	100	ug/L	29	44	105	116
Hexachlorocyclopentadiene	100	ug/L	18	39	122	143
Hexachloroethane	100	ug/L	40	52	105	113
Indeno(1,2,3-c,d)pyrene	100	ug/L	25	48	139	162
Isophorone	100	ug/L	27	44	116	134
N-Nitrosodiphenylamine	100	ug/L	11	27	105	110

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 8270 :
: BC ANALYTICAL : GLEN LAB : 13:28:33 16 JUL 1994 - P. 3 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
N-Nitrosodi-n-propylamine	100	ug/L	32	50	119	136
Nitrobenzene	100	ug/L	39	51	105	115
Naphthalene	100	ug/L	39	52	105	114
Phenanthrene	100	ug/L	54	65	109	120
Phenol	100	ug/L	7	23	105	110
Pentachlorophenol	100	ug/L	14	39	138	163
Pyrene	100	ug/L	52	68	133	149
Bis(2-chloroethoxy)methane	100	ug/L	37	52	114	130
Bis(2-chloroethyl)ether	100	ug/L	40	54	109	123
Bis(2-chloroisopropyl)ether	100	ug/L	36	53	123	140
Bis(2-ethylhexyl)phthalate	100	ug/L	41	58	130	147
2-Fluorobiphenyl Reported	50	ug/L	43	55	104	116
2-Fluorophenol Reported	100	ug/L	21	34	87	100
2-Fluorophenol Reported			21	34	87	100
2,4,6-Tribromophenol Reported	100	ug/L	40	54	109	123
Nitrobenzene-d5 Reported	50	ug/L	37	50	101	114
Phenol-d5 Reported	100	ug/L	10	24	79	93
Terphenyl-d14 Reported	50	ug/L	33	51	123	141

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: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 8270 :
: BC ANALYTICAL : GLEN LAB : 13:28:46 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
1,2,4-Trichlorobenzene	44	57	107	120	30	39
1,2-Dichlorobenzene	42	56	115	129	27	35
1,3-Dichlorobenzene	37	49	105	110	26	34
1,4-Dichlorobenzene	39	51	105	110	26	34
2,4,5-Trichlorophenol	49	65	129	145	20	26
2,4,6-Trichlorophenol	54	66	114	127	23	30
2,4-Dichlorophenol	49	60	105	116	17	22
2,4-Dimethylphenol	32	45	105	110	25	33
2,4-Dinitrophenol	1	33	159	191	31	41
2,4-Dinitrotoluene	48	63	124	139	19	25
2,6-Dinitrotoluene	2	66	127	143	27	36
2-Chloronaphthalene	23	39	105	114	29	[illegible]
2-Chlorophenol	43	53	105	110	18	24
2-Methyl-4,6-dinitrophenol	1	31	151	181	36	47
2-Methylnaphthalene	40	54	109	122	27	36
2-Methylphenol (o-Cresol)	7	28	110	131	25	33
2-Nitroaniline	41	59	129	147	26	33
2-Nitrophenol	52	63	105	116	21	28
3,3'-Dichlorobenzidine	1	44	214	257	33	42
3-Nitroaniline	1	30	147	176	40	50
4-Bromophenylphenylether	56	68	115	127	25	32
4-Chloro-3-methylphenol	48	61	114	127	24	31
4-Chloroaniline	1	27	131	157	40	50
4-Chlorophenylphenylether	49	65	129	145	24	32
4-Methylphenol (p-Cresol)	22	39	107	123	34	[illegible]
4-Nitroaniline	1	35	171	205	40	50
4-Nitrophenol	1	23	110	132	26	34

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 8270 :
: BC ANALYTICAL : GLEN LAB : 13:28:46 16 JUL 1994 - P. 2 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Acenaphthene	52	65	118	131	20	26
Acenaphthylene	33	50	120	138	38	50
Anthracene	47	62	118	133	19	25
Benzo(a)anthracene	54	69	127	142	20	26
Benzo(a)pyrene	35	53	126	145	31	40
Benzo(b)fluoranthene	33	50	116	133	22	29
Benzo(g,h,i)perylene	25	48	140	163	30	39
Benzyl Alcohol	2	26	122	146	40	50
Benzoic acid	1	34	167	200	40	50
Butylbenzylphthalate	41	62	147	168	27	36
Chrysene	53	70	137	154	19	25
Di-n-octylphthalate	19	46	156	184	30	39
Dibenzo(a,h)anthracene	23	47	144	169	31	41
Dibenzofuran	54	68	124	137	21	27
Dibutylphthalate	36	56	138	159	20	26
Diethylphthalate	45	64	137	155	19	24
Dimethylphthalate	55	69	124	138	21	27
Fluoranthene	46	64	132	150	21	27
Fluorene	59	69	111	121	15	20
Hexachlorobenzene	33	53	132	152	27	35
Hexachlorobutadiene	35	49	106	121	30	39
Hexachlorocyclopentadiene	12	40	151	179	25	32
Hexachloroethane	40	52	105	113	28	36
Indeno(1,2,3-c,d)pyrene	21	46	143	167	38	49
Isophorone	39	53	107	121	22	29
N-Nitrosodiphenylamine	1	25	120	144	40	50

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 8270 :
: BC ANALYTICAL : GLEN LAB : 13:28:46 16 JUL 1994 - P. 3 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
N-Nitrosodi-n-propylamine	33	50	118	135	19	25
Nitrobenzene	35	55	133	153	30	39
Naphthalene	40	53	107	120	19	25
Phenanthrene	54	65	109	120	22	29
Phenol	5	20	105	110	23	30
Pentachlorophenol	14	41	149	176	30	39
Pyrene	45	65	143	162	26	34
Bis(2-chloroethoxy)methane	33	50	118	135	24	31
Bis(2-chloroethyl)ether	34	49	110	125	24	31
Bis(2-chloroisopropyl)ether	36	54	126	144	27	35
Bis(2-ethylhexyl)phthalate	35	58	149	171	19	25
2-Fluorobiphenyl Reported	43	55	104	116		
2-Fluorophenol Reported	21	34	87	100		
2,4,6-Tribromophenol Reported	10	29	104	123		
Nitrobenzene-d5 Reported	35	48	105	114		
Phenol-d5 Reported	10	24	80	94		
Terphenyl-d14 Reported	33	51	123	141		

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: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 8270 :
: BC ANALYTICAL : GLEN LAB : 13:28:58 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
1,2,4-Trichlorobenzene	44	56	105	115	27	36
1,2-Dichlorobenzene	32	48	113	129	25	33
1,3-Dichlorobenzene	4	25	105	126	29	37
1,4-Dichlorobenzene	20	37	107	124	28	37
2,4,5-Trichlorophenol	39	57	132	151	25	33
2,4,6-Trichlorophenol	37	55	126	144	26	33
2,4-Dichlorophenol	48	60	108	120	24	32
2,4-Dimethylphenol	32	46	105	119	30	39
2,4-Dinitrophenol	1	33	159	191	32	42
2,4-Dinitrotoluene	39	56	122	139	28	36
2,6-Dinitrotoluene	50	62	112	124	29	38
2-Chloronaphthalene	39	51	105	110	27	35
2-Chlorophenol	45	56	105	110	22	29
2-Methyl-4,6-dinitrophenol	38	60	149	171	35	46
2-Methylnaphthalene	44	56	105	111	24	32
2-Methylphenol (o-Cresol)	35	50	113	129	25	33
2-Nitroaniline	35	53	123	140	27	35
2-Nitrophenol	33	55	140	161	31	40
3,3'-Dichlorobenzidine	1	38	186	223	35	45
3-Nitroaniline	1	25	135	162	35	45
4-Bromophenylphenylether	53	65	113	125	25	32
4-Chloro-3-methylphenol	40	56	120	137	25	32
4-Chloroaniline	14	37	127	150	36	47
4-Chlorophenylphenylether	40	55	116	131	25	32
4-Methylphenol (p-Cresol)	18	35	105	118	21	27
4-Nitroaniline	1	34	167	200	40	50
4-Nitrophenol	19	38	113	132	35	46

: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 8270 :
: BC ANALYTICAL : GLEN LAB : 13:28:58 16 JUL 1994 - P. 2 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Acenaphthene	47	60	110	122	26	34
Acenaphthylene	51	61	105	110	26	34
Anthracene	50	61	105	112	27	35
Benzo(a)anthracene	38	54	117	132	28	36
Benzo(a)pyrene	41	57	122	138	30	40
Benzo(b)fluoranthene	24	45	128	149	39	50
Benzo(g,h,i)perylene	39	55	118	134	36	46
Benzyl Alcohol	25	44	119	138	27	36
Benzoic acid	1	31	150	180	40	50
Butylbenzylphthalate	43	56	107	119	24	31
Chrysene	50	62	112	124	26	
Di-n-octylphthalate	30	48	121	139	33	43
Dibenzo(a,h)anthracene	46	61	122	138	31	41
Dibenzofuran	54	65	110	121	26	34
Dibutylphthalate	45	57	105	114	23	30
Diethylphthalate	43	57	110	124	25	32
Dimethylphthalate	56	66	107	117	27	35
Fluoranthene	52	63	108	119	24	31
Fluorene	59	69	107	117	27	36
Hexachlorobenzene	50	62	111	123	32	42
Hexachlorobutadiene	32	46	105	116	25	32
Hexachlorocyclopentadiene	1	31	153	183	38	49
Hexachloroethane	40	52	105	113	28	37
Indeno(1,2,3-c,d)pyrene	42	59	125	141	39	5
Isophorone	44	55	105	113	20	25
N-Nitrosodiphenylamine	8	28	112	133	37	48

: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 8270 :
: BC ANALYTICAL : GLEN LAB : 13:28:59 16 JUL 1994 - P. 3 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
N-Nitrosodi-n-propylamine	29	49	129	149	20	26
Nitrobenzene	35	50	110	125	23	29
Naphthalene	28	43	105	120	27	36
Phenanthrene	54	65	109	120	28	37
Phenol	34	49	107	122	30	38
Pentachlorophenol	20	44	141	165	36	47
Pyrene	52	62	105	115	28	36
Bis(2-chloroethoxy)methane	44	57	107	120	25	32
Bis(2-chloroethyl)ether	33	47	105	115	21	27
Bis(2-chloroisopropyl)ether	36	54	127	145	22	29
Bis(2-ethylhexyl)phthalate	19	40	123	143	29	38
2-Fluorobiphenyl Reported	38	49	105	110		
2-Fluorophenol Reported	25	39	105	110		
2,4,6-Tribromophenol Reported	28	40	105	110		
Nitrobenzene-d5 Reported	34	43	105	110		
Phenol-d5 Reported	31	44	105	110		
Terphenyl-d14 Reported	18	37	111	130		

***

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 9056 :
: BC ANALYTICAL : GLEN LAB : 13:14:38 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
Chloride (300.0/9056)	1.2	mg/L	90	93	107	110
Fluoride (300.0/9056)	0.8	mg/L	90	93	107	110
Sulfate (300.0/9056)	6	mg/L	90	93	107	110

***

: DRINKING WATER MATRIX SPIKE CONTROL LIMITS FOR METHOD 9056 :
: BC ANALYTICAL : GLEN LAB : 13:14:55 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
Chloride (300.0/9056)	63	73	114	125	10	15
Fluoride (300.0/9056)	52	59	105	110	10	15
Sulfate (300.0/9056)	73	80	109	116	10	15

***

: LABORATORY CONTROL STANDARD CONTROL LIMITS FOR METHOD 9060 :
: BC ANALYTICAL : GLEN LAB : 13:15:13 16 JUL 1994 - P. 1 :

CHEM NAME.....	CONC..	UNIT...	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV
TOC, Average		mg/L	80	86	110	116
TOC, 1st Replicate		mg/L	80	86	110	116
TOC, 2nd Replicate		mg/L	80	86	110	116
TOC, 3rd Replicate		mg/L	80	86	110	116
TOC, 4th Replicate		mg/L	80	86	10	116

***

: SOIL MATRIX SPIKE CONTROL LIMITS FOR METHOD 9060 :
: BC ANALYTICAL : GLEN LAB : 13:15:30 16 JUL 1994 - P. 1 :

CHEM NAME.....	MAND LCL %RCV	MAND LWL %RCV	MAND UWL %RCV	MAND UCL %RCV	MAND.... UWL REL%DIFF	MAND.... UCL REL%DIFF
TOC, Average	40	60	140	160	35	50
TOC, 1st Replicate	40	60	140	160	35	50
TOC, 2nd Replicate	40	60	140	160	35	50
TOC, 3rd Replicate	40	60	140	160	35	50
TOC, 4th Replicate	40	60	140	160	35	50

***

The calculation for relative percent difference is calculated using one of the following methods:

$$\frac{(R1 - R2) \times 100}{R\ Bar} \qquad \frac{(S1 - S2) \times 100}{S\ Bar}$$

where R1, R2 are the first and duplicate results and R Bar is the average of the two and S1, S2 are the spike and duplicate spike results and S Bar is the average of the two. Historical limits for RPD are determined from pairs of either replicates or spikes. The RPDs must be greater than zero to determine upper warning and control limits. Based on Shewhart's model from Handbook for Analytical Quality Control in Water and Wastewater Laboratories, upper control and warning limits can be determined. The Upper Control Limit for pairs of data can be defined as follows:

$$3.27\ R$$

where R = the average range divided by the number of sets of duplicate measurements.

The Upper Warning Limit is set at as 2.51 R. The current precision and accuracy control limits are presented in Table 1.3.

1.3.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. It is the most difficult characteristic to assess, depending as it does upon such factors as representativeness of sampling and subsampling, selection of the appropriate analytical constituents, and scope of the sampling program relative to the size of the environmental question being addressed. Many of these factors are determined exterior to the laboratory and without the involvement of laboratory staff.

The laboratory's impact on completeness is constricted to the validity of the data generated for the samples delivered to the laboratory. Sample storage, holding time compliance and the validity of data in terms of the acceptability of quality controls are the biggest factors controlled by the laboratory. Overall the laboratory accepts the responsibility that random error will occur in the operation of the laboratory. The comprehensive quality assurance plan described within this document is designed to minimize those errors and the effect they will have on the data generated by the laboratory.

Analytical data goals are specified at 95 percent completeness for this program. A further discussion for determining completeness can be found in section 1.10.6.

1.3.4 Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability of data is ensured through the use of standard analytical methods or methods with demonstrable equivalency in terms of method performance criteria and equivalent reported units. In addition BCA participates in semi-annual external EPA performance evaluations in the WS and WP series. As part of continuous quality improvement, BCA is currently reviewing these practices to include more EPA and NIST traceable materials at a higher frequency.

1.3.5 Quality Control Samples

Quality Control Samples are used to validate the sampling, transportation and laboratory conditions associated with the samples. The Sampling Plan details the number of trip blanks, equipment blanks and ambient blanks to be provided to the laboratory. It also lists the number of blind duplicates and/or spikes to be submitted. Once the samples are delivered to the lab, the Laboratory QC Samples, discussed in section 1.10.5, would apply. These include Laboratory Control Standards, Laboratory Control Standard duplicates, method and calibration blanks, duplicates, matrix spikes and matrix spike duplicates.

1.4 SAMPLING PROCEDURES

1.4.1 Container Preparation

The containers, preservation and holding times required for the Indian Mountain project are outlined in Table 1.4, WATER AND SOIL SAMPLE STORAGE AND PRESERVATION REQUIREMENTS.

1.4.2 Field Collection

Quality assurance of environmental data begins in the field at time of sample collection. Experienced field personnel, appropriate sampling equipment, rigorous sampling procedures and quality control checks are essential to quality data production. Procedures for sampling must include appropriate equipment, containers and preservation as well as the use of strict sample custody procedures to prevent loss of sample integrity. The contractor/sampler will provide the laboratory with a unique sample description, time and date of sample collection and the initials of the collector. This is to insure sample integrity and that all analyses are performed within the method specified holding time.

1.4.3 Preservation

Preservatives, analytical parameters, sample containers, and holding times are outlined in Table 1.4. Preservatives will be either added to sample containers before they are sent out to the field or provided on site. These will be checked in the field as well as upon receipt at the laboratory. Any deviations will be noted on the chain-of-custody when received at the laboratory. Jacobs will also be notified of any problems.

TABLE 1.4 CONTAINERS, PRESERVATION TECHNIQUES AND HOLDING TIMES - WATER SAMPLES

Applicable Parameter	Analytical Method	Container	Preservation Technique	Maximum Allowable Holding Times
VOC	SW8260	2 x 40ml glass, Teflon-lined septa	Cool, 4°, 0.008% $Na_2S_2O_3$, HCl to pH <2	14 days
Semivolatile Organic Compounds	SW8270	2 x 1L amber bottle, Teflon-lined cap	Cool, 4°, 0.008% $Na_2S_2O_3$	7 days to extraction 40 days after extraction
Organochlorine Pesticides and PCBs	SW8080	2 x 1L amber bottle, Teflon-lined cap	Cool, 4°	7 days to extraction 40 days after extraction
ICP Metals, Total and Dissolved	SW6010	1L plastic	HNO_3 to pH<2	6 months
Metals bu GFAA	SW7060, 7131, 7191, 7421, 7740	1L plastic (shared with ICP)	HNO_3 to pH<2	6 months
Mercury	SW7470	1L plastic (shared with ICP)	HNO_3 to pH<2	28 days
Total Fuel Hydrocarbons Gasoline - Range Diesel - Range Residual Hydrocarbons	SW8015 (Modified) SW8100 (Modified) AK103 (Modified)	2 x 40mL vials and 2 x 1L amber with Telfon-lined caps	Cool, 4°	Volatiles: 14 days Semivolatiles: 7 days to extraction 40 days after extraction
Anions by IC	SW9056	1 L plastic	Cool, 4°	28 days

TABLE 1.4 CONTAINERS, PRESERVATION TECHNIQUES AND HOLDING TIMES - SOIL SAMPLES

Applicable Parameter	Analytical Method	Container	Preservation Technique	Maximum Allowable Holding Times
VOC	SW8240	4 oz. jar	Cool, 4°	14 days
Semivolatile Organic Compounds	SW8270	4 oz. jar	Cool, 4°	14 days to extraction 40 days after extraction
Organochlorine Pesticides and PCBs	SW8080	4 oz. jar	Cool, 4°	14 days to extraction 40 days after extraction
ICP Metals, Total and Dissolved	SW6010	4 oz. jar		6 months
Metals bu GFAA	SW7060, 7131, 7191, 7421, 7740	4 oz. jar (same as 6010)		6 months
Mercury	SW7471	4 oz. jar (same as 6010)		28 days
Moisture	ASTM D2216	4 oz. jar		28 days
Total Fuel Hydrocarbons Gasoline - Range Diesel - Range Residual Hydrocarbons	SW8015 (Modified) SW8100 (Modified) AK103 (Modified)	2 x 4 oz. jars	Cool, 4°	Volatiles: 14 days Semivolatiles: 14days to extraction 40 days after extraction

TABLE 1.4 CONTAINERS, PRESERVATION TECHNIQUES AND HOLDING TIMES - SOIL SAMPLES

Applicable Parameter	Analytical Method	Container	Preservation Technique	Maximum Allowable Holding Times
Total Organic Carbon	E410.1 (Modified)	4 oz. jar	Cool, 4°	28 days
Cation-Exchange Capacity	SW9081	4 oz. jar	Cool, 4°	28 days
TCLP	SW1311/SW8240	4 oz. jar	Cool, 4°	14 days to ZHE, 14 days to analysis
	SW1311/SW3500/ SW8270, 8080	4 oz. jar	Cool, 4°	14 days to TCLP extraction, 7 days to SW3500 extraction, 40 days after extraction to analysis
	SW1311/SW6010/ 7740	4 oz. jar		6 months to TCLP extraction, 6 months from digestion to analysis
	SW1311/SW7470	4 oz. jar		28 days to TCLP extraction, 28 days to analysis

1.5 SAMPLE CUSTODY

Samples will be handled in accordance with the general programmatic procedures established. The procedures for sample tags, chain-of-custody, transfer of custody and shipment, and laboratory custody procedures are presented in this section. The purpose of these procedures is to maintain the integrity (i.e. quality) of all samples during collection, transportation, analysis and reporting. Procedures stated herein are necessary to validate the history of sample data from collection through reporting by providing adequate documentation.

1.5.1 Chain-of-Custody

1.5.1.1 Sample Labels

Sample labels, whether preprinted or blank, will contain an abbreviated summary of the logbook entry for the sample. Gummed paper labels which adhere strongly to glass or plastic will be used. Labels will be written on with waterproof indelible ink. The following information will be placed on the sample container label:

- Date and time sampled
- Base/sample identification number
- Sampler's initials
- Analyses to be performed
- Preservatives used

This information will also be documented in the field notebook. An example of a sample label is presented as Figure 1.5-1.

1.5.1.2 Chain-of-Custody Record

The Chain-of-Custody (C-O-C) form provides documentation of the handling of each sample from the time it is collected until it is disposed of. To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, a "Chain-of-Custody Record" is filled out for each sample type at each sampling location. Each time the samples are transferred to another custodian, signatures of the person relinquishing the sample and receiving the sample, as well as the time and date, will document the transfer. Also noted on the C-O-C are the requested analyses to be performed by the laboratory. A sample C-O-C is shown in Figure 1.5-2. The original record accompanies the shipment, with any additional information required by the client. The white original

Figure 1.5-1 Sample Labels

Jacobs Engineering Group, Inc.
2530 Arnold Drive
Martinez, CA 94553
Control #: MC-C412001
Sample Date: 11/18/93 Sample Time: 15:15
Analyses:
SW8015\3550
SW8270

Preservative: NONE
Samplers Initials: JE/RS

BC Analytical --- GLENDALE
3 9311284-14



Figure 1.5-2 Chain of Custody Form

JACOBS ENGINEERING GROUP INC.
251 S. LAKE AVE. PASADENA CALIFORNIA 91101-3063
TELEPHONE (213)681-3781 MC C9062

CHAIN OF CUSTODY RECORD

USE A BALLPOINT PEN, BLACK INK, AND PRESS FIRMLY. INSTRUCTIONS ARE ON THE BACK

PROJECT NAME: DEPT OF THE AIR FORCE-HRL
PROJECT NUMBER 21G11700
WBS CODE: 1500
LABORATORY NAME & ADDRESS: BC ANALYTICAL
801 Western Ave. 93-10-047
Glendale CA 91201

SAMPLE NUMBER	COLLECTION DATE	COLLECTION TIME	SAMPLER'S INITIALS	NUMBER OF CONTAINERS	CONTAINER SIZE AND TYPE	PRESERVATIVE	MATRIX CODE	ANALYSES REQUESTED	QC	CONDITION ON RECEIPT
BC-C906201	10/15/93	13:25	KSH J.V GHY HAY	1	SS Sleeve	NONE	SO	SW9060 SW9045 D2216		
BC-C906202	10/15/93	13:10	KSH J.V GHY HAY	1	SS Sleeve	NONE	SO	SW6010 SW9010 SW7060 SW7421 SW7471		
BC-C906203	10/15/93	13:25	KSH J.V GHY HAY	1	SS Sleeve	NONE	SO	SW8270 SW8080 SW8015\3550		
BC-C906204	10/15/93	13:40	KSH J.V GHY HAY	1	SS Sleeve	NONE	SO	SW9060 SW9045 D2216 SW8240		
BC-C906205	10/15/93	13:40	KSH J.V GHY HAY	1	SS Sleeve	NONE	SO	SW6010 SW9010 SW7060 SW7421 SW7471		
BC-C906206	10/15/93	13:30	KSH J.V GHY HAY	1	SS Sleeve	NONE	SO	SW8270 SW8080 SW8015\3550		
BC-C906207	10/15/93	14:05	KSH J.V GHY HAY	1	SS Sleeve	NONE	SO	SW9060 D2216		
BC-C906208	10/15/93	14:05	KSH J.V GHY HAY	1	SS Sleeve	NONE	SO	HOLD FOR SW6010 HOLD FOR SW7060 SW7421 HOLD FOR SW7471		
BC-C906209	10/15/93	14:05	KSH J.V GHY HAY	1	SS Sleeve	NONE	SO	HOLD FOR SW8270 SW3550 HOLD FOR SW8080 HOLD FOR SW8015		

COMMENTS: Temp = 5°C Seals ok (KSH)

COLLECTED & RELEASED BY Kenneth M. Hoshi	DATE 10/15/93	TIME 17:00	TURNAROUND TIME		
RECEIVED BY FED EX	DATE 10/15/93	TIME 17:00	RELINQUISHED BY	DATE / /	TIME :
[signature]	10/16/93	11:05			
RECORD RETURNED BY	DATE / /	TIME :			
			SHIPPING NUMBER 985463305		

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record is returned to Jacobs with the final report deliverable. Copies of all custody forms are filed with the laboratory report package.

1.5.1.3 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record. When transferring samples, the individual(s) relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer. Samples will be packaged properly for shipment to Kleinfelder in Pleasanton and the remainder wil be dispatched to the appropriate department for analysis. Copies of the C-O-Cs will be placed in the appropriate shipping container and accompany the sample(s). Shipping containers are sealed with Custody Seals (Figure 1.5-3) for shipment to the laboratory. The method of shipment, courier name, and other pertinent information (e.g. air bill number) may be entered in the "Remarks" section of the C-O-C.

1.5.1.4 Laboratory Custody Procedures

Upon receipt by the laboratory, the sample custodian will prepare a sample condition login sheet, Figure 1.5-4. This sheet is used to record condition at receipt and to notify the primary specialist of any discrepancies such as temperature, custody seal breakage, missing or broken containers. The sample custodian will examine the shipment, noting that the custody seals are still intact. The temperature of one sample is recorded on the on the login sheet and on the C-O-C. The C-O-C is signed and dated. The contents of the ice chests are compared to the C-O-C record. Any discrepancies are noted on the login sheet. The primary specialist will notify the designated Jacobs contact when discrepancies occur.

A laboratory tracking number is assigned to each shipment. This number is kept in a bound, paginated notebook. A unique laboratory number is assigned to each sample and transferred to the proper analyst or stored in the appropriate secured area. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the sample custodian. The samples are entered into the LIMS with the appropriate determination codes (DET.CODEs) listed in Table 1.5. If the client requests a test not listed in Table 1.5 or the basic contract, Lynn Schuetter, Ed Hefner and Jacobs contracts people should be notified immediately. We may not be paid for the analyses if this is not done. All soil samples must be logged in for MOIST.SOIL due to the AF requirement that the data be reported in dry weight.

CUSTODY SEAL

Sample ID

Client Date

BC Analytical

1255 Powell St.
Emeryville, CA
94608
(415) 428-2300

301 Western Ave.
Glendale, CA
91201
(818) 247-5737

1200 Pacifico Ave.
Anaheim, CA
92805
(714) 978-0113

Figure 1.5-3

SAMPLE CONDITION LOG-IN SHEET

Figure 1.5-4

Logbook _____ Logbook Page Number _____ BCA Log Number _____

Received By _____ (PRINT) _____ (SIGNATURE) Date Received At Lab _____

Sheet Reviewed By (2) _____ (PRINT) _____ Date Sheet Reviewed _____

Log-In Date _____

		RESULT	YES	NO
1	Does this project require special handling according to NEESA Levels C. D. AFCEE or CLP protocols?			
	If yes, complete (a) thru (c).			
	(a) Cooler Temperature			
	(b) pH Sample Aliquoted (Y/N)			
	(c) LOT #'s			
2	Are custody seals present on cooler?			
	If yes, are seals intact?			
3	Are custody seals present on sample containers?			
	If yes, are seals intact?			
4	Is there a Chain-Of-Custody (COC)?			
5	Is the COC complete?			
	Relinquished			
	Requested Analysis			
6	Is the COC in agreement with the samples received?			
	Number of Samples			
	Sample ID's			
	Matrix			
	Number of Containers			
7	Are the samples preserved correctly?			
8	Is there enough sample for all the requested analyses?			
9	Were the samples received cold?			
10	Were all sample containers received intact (ie. not broken, leaking, etc.)?			
11	Are samples requiring no headspace, headspace free?			
12	Are there special comments on the COC which require client contact?			
	If yes, was the Project Manager notified?			

Describe "NO" items: _____

Was client contacted? YES / NO

If yes, Name of Person Contacted: _____ Date Person Contacted: _____

Describe actions taken or client instructions: _____

PRICING SCHEDULE I
ANALYTICAL LABORATORY SERVICES
INDIAN MOUNTAIN LONG RANGE RADAR STATION, ALASKA

Water Analyses					
15	Chlorinated Pesticides/PCBs	SW3510/SW8080	109	$186.00	$20,492.00
16	ICP Metal Screen	SW3005/SW6010	119	$145.00	$17,255.00
17	Petroleum Hydrocarbon (GRO)	SW5030/SW8015	104	$93.00	$9,672.00
17A	5 DAY TAT	SW5030/SW8015	21	$120.90	$2,538.90
18	Petroleum Hydrocarbon (DRO)	SW3510/SW8100	104	$193.00	$20,072.00
18A	5 DAY TAT	SW3510/SW8100	21	$250.90	$5,268.90
19	Volatile Organics	SW8260	162	$218.00	$35,316.00
19A	5 DAY TAT	SW8260	21	$283.40	$5,951.40
20		SW8270	97	$320.00	$31,040.00
20A	5 DAY TAT	SW8270	21	$416.00	$8,736.00
21		GFAA	115	$36.88	$4,241.20
22		GFAA PREP	115	109.38	$12,578.70
22	Mercury (Liquid Waste)	SW7470	112	$51.18	$5,732.16
23		SW9056	165	$103.00	$16,995.00
				SUBTOTAL WATER:	$195,889.26
				TOTAL:	$344,667.96

Please provide the percent mark-up for the following rush turnaround times as listed:

24 hours	300%
48 hours	200%
72 hours	100%
5days	30%
14 days	15%

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PRICING SCHEDULE I
ANALYTICAL LABORATORY SERVICES
INDIAN MOUNTAIN LONG RANGE RADAR STATION, ALASKA

Billing Line Item	Description	Method	Estimated Quantity for Level 2 Data Deliverables	Unit Cost for Level 2 Data Deliverables	Total Level 2
Soil Analyses					
1	Volatile Organic Compounds	SW8240	132	$205.00	$27,060.00
2	ICP Metals Screen	SW3005/SW6010	119	$145.00	$17,255.00
3	Semivolatile Organics	SW3550/SW8270	129	$320.00	$41,280.00
4	Chlorinated Pesticides/PCBs	SW3550/SW8080	113	$188.00	$21,244.00
5	Petroleum Hydrocarbon (GRO)	SW5030/SW8015	129	$93.00	$11,997.00
5A	5 DAY TAT	SW5030/SW8015	7	$120.90	$846.30
6	Petroleum Hydrocarbon (DRO)	SW3550/SW8100	129	$144.00	$18,576.00
6A	5 DAY TAT	SW3550/SW8100	7	$187.20	$1,310.40
7	TCLP	SW1311	14	$94.00	$1,316.00
8		AK103	136	$38.00	$5,168.00
9	Cation-Exchange Capacity	SW9081	2	$88.00	$176.00
10	Percent Moisture	ASTM 2216	136	$10.00	$1,360.00
11	Total Organic Carbon	SW9060	2	$94.00	$188.00
12	Particle-Size Analysis of Soil	ASTM D422	2	$238.00	$476.00
13	Specific Gravity of Soils	ASTM D854	2	$75.00	$150.00
14	Permeability of Granular Soils	ASTM 2434	2	$188.00	$376.00
				SUBTOTAL SOIL:	$148,778.70

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Since we are contractually bound to a 30 day delivery of the report package and EDT, the reports must be ready for mailing by the 28th day after sample receipt. For tracking purposes the Jacobs chain-of-custody numbers will be entered in the PO field and the Jacobs project number will be entered in the project number field. .

1.5.1.5 Saturday Receipt of Samples

The person receiving samples on Saturday must be in the lab by 8:30 am. Alaska Airlines will deliver the samples to the laboratory. After the ice chests are at the lab, the custody seals are examined. The seals should be intact. The ice chest is opened and and the temperature of one of the samples is taken with a non-contact thermometer. The seal integrity and temperature information are recorded on the chain of custody. Each chain of custody document is signed and dated. If there is more than one ice chest per shipment, the temperature of every ice chest must be documented. Each ice chest should be uniquely identified and the associated temperature information recorded on a separate piece of paper. This information is dated, signed and placed in the plastic bag with the chain of custody documents. The ice chests are placed in the walk-in refrigerator for weekend storage. If there are problems or questions, the people below should be notified in the order listed below:

Linda Geddes	(818) 574-9149
Sue Arrowsmith	(818) 352-1798

1.5.1.6 Jacobs' Change Order for Chain of Custody

Jacobs personnel may initiate a request to change any information provided by the C-O-C. Normally these changes involve the tests to be performed, the sample descriptions or the project number. Jacobs will FAX the request to the lab as soon as possible. An example change order is presented in Figure 1.5-5.

UL 231 S. LAKE AVE., PASADENA, CALIFORNIA 91101-3063
TELEPHONE (213)681-3781 (818)449-2171

CHANGE ORDER FOR CHAIN OF CUSTODY

MC-C4093

PLEASE APPEND TO ORIGINAL

PROJECT NAME:	LABORATORY NAME & ADDRESS:
PROJECT NUMBER: DEPT OF THE AIR FORCE WRI	BC ANALYTICAL
WBS CODE: 21G11500 1500	SUBCONTRACT / D.O. No. 801 Western Ave. Glendale CA 91201

SAMPLE NUMBER	COLLECTION DATE	COLLECTION TIME	CARRIER INITIALS	NUMBER OF CONTAINERS	VOLUME / SIZE / TYPE	PRESERVATIVE	MATRIX CODE	ANALYSES REQUESTED	LAB USE ONLY	SPECIAL CONDITIONS / COMMENTS
MC-C4093[illegible]	/ /	:			1 SS Sleeve	NONE	SO	SW8080 SW8015\3550 SW9045		
MC-C4093[illegible]	/ /	:			1 SS Sleeve	NONE	SO	SW8080 SW8015\3550 SW9045		
MC-C4093[illegible]	/ /	:			1 SS Sleeve	NONE	SO	SW8080 SW8015\3550 SW9045		
MC-C4093[illegible]	11/04/93	09:20	JE RF		1 SS Sleeve	NONE	SO	SW9045 SW8015\3550 SW8080		

COMMENTS:

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Figure 1.5-5 Change Order Form

1.6 LABORATORY CHEMICALS AND EQUIPMENT

1.6.1 Laboratory Chemicals

All reagent chemicals used by BCA are of ACS reagent grade or better, and are purchased from reputable laboratory supply companies. Blanks are run with each analytical batch to check reagent quality. Pre-screening of chemical lots is performed on extraction solvents, such as methylene chloride, hexane, methanol and sodium sulfate to determine batch quality. Each analytical SOP (standard operating procedure) describes standard preparation. Standards are either prepared in-house from high-purity starting materials, or are purchased as standard concentrates.

1.6.2 Laboratory Equipment

The laboratory is equipped with refrigerated storage areas, fume hoods, central deionized water systems and general utilities appropriate for modern analytical work. Specialized instruments supplement common equipment such as ovens, incubators and distillation apparatus. Instrumentation is continually upgraded in order to provide state-of-the-art technology. Major equipment currently in use is presented in Table 1.6.

Table 1.6 Instrument List

>> GLENDALE LAB - 13:37:03 16 JUL 1994 >>

INSTRUMENT LIST

INSTRUMENT	DESCR.....	MANUF.....	MODEL.....	SER#.....
534-01	AA	Perkin Elmer	2380	
534-02	AA	Perkin Elmer	P/E-HGA-3030	
	***			
539-05	Analytical balance	Mettler	AE163	B81658
539-06	Analytical balance	Mettler	AE163	C95114
	***			
533-01	Autoanalyzer	Alpkem	RFA	000137
533-20	Autoanalyzer	Alpkem	RFA	000691
	***			
533-11	Conductance Meter	YSI	32	3922
	***			
533-17	FTIR	Perkin-Elmer	1600	144059
	***			
534-06	Flame AA	Perkin Elmer	3100	147084
	***			
533-13	Flash Tester	Precision	74537	100P/3
	***			
534-08	Furnace and Flame AA	Perkin-Elmer	5100	128924
	***			
536-25	GC FID	Varian	3400	3400-15717
	***			
536-16	GC Screener	SRI	8610	
536-17	GC Screener	SRI	8610	
	***			
516-24	GC with FID/PID Detectors	Hewlett-packard	5890	
	***			
536-02	GC/Dual ECD	Varian	3400	1282
536-18	GC/Dual ECD	Varian	3400	3405
536-24	GC/Dual ECD	Varian	3400	6556
536-26	GC/Dual ECD	Varian	3400	16850
536-27	GC/Dual ECD	Varian	3400	16851
536-29	GC/Dual ECD	Hewlett-Packard	5890	2643A11841
	***			

INSTRUMENT LIST

INSTRUMENT	DESCR.....	MANUF.....	MODEL.....	SER#.....
536-15	GC/Dual ELCD & PID	Hewlett-Packard	HP 5980	2919A-22354
536-28	GC/Dual ELCD & PID	Hewlett-Packard	5890 II	3235A46606
536-30	GC/Dual ELCD & PID	Hewlett-Packard	5890	2643A10390
	***			
536-13	GC/ECD	Varian	2700	2900-1808
536-14	GC/ECD	Varian	1400	1440-3019
	***			
536-22	GC/ECD & FID	Varian	3400	14303
	***			
536-07	GC/ELCD & PID	Varian	3400	2688
536-10	GC/ELCD & PID	Hewlett-Packard	5890	2643A10246
	***			
536-01	GC/FID	Varian	3400	1283
536-09	GC/FID	Hewlett-Packard	5890	2643A10245
	***			
536-08	GC/FID & ECD	Varian	3700	54910
	***			
536-21	GC/FID & PID	Hewlett Packard	5890	3115A34807
536-23	GC/FID & PID	Hewlett Packard	5890 II	3203A41263
	***			
536-19	GC/NPD & FPD	Hewlett-Packard	5890	2643A11061
	***			
536-04	GC/PID	Tracor	560	487-79
	***			
537-10	GCMS	Hewlett-Packard	5988A	2510A00142
537-11	GCMS	Hewlett-Packard	5971A	3050A01687
537-12	GCMS	Hewlett-Packard	5970B	3004A12630
537-14	GCMS	Hewlett-Packard	5971A	3188A03220
	***			
537-01	GCMS/P&T	Hewlett-Packard	5970B	2905A11710
537-02	GCMS/P&T	Hewlett-Packard	5970B	2905A11867
537-03	GCMS/P&T	Hewlett-Packard	5971A	3304A4371
	***			
534-04	Graphite Furnace AA	Perkin-Elmer	5100	

INSTRUMENT	DESCR.....	MANUF.....	MODEL.....	SER#.....
534-07	Graphite Furnace AA	Perkin-Elmer	5100	145375
	***			
536-20	HPLC	Hewlett-Packard	1090	
	***			
536-05	HPLC/UV/Fluorescence	Altex	HPLC	458
	***			
535-01	ICP	Perkin Elmer	ICP P2	
535-02	ICP	Baird	ICP 2000	262477-1581A
535-03	ICP	Thermo Jarrell Ash	61E	128390
	***			
533-03	Infrared Spectrometer	Perkin-Elmer	283	IR1693
	***			
533-02	Ion Chromatograph	Dionex	QIC	834206
533-23	Ion Chromatograph	Dionex	4000i	872014
	***			
533-08	Ionanalyzer	Orion	601A	68391
533-09	Ionanalyzer	Orion	701	45195
533-14	Ionanalyzer	Orion	EA940	QQ92A
533-16	Ionanalyzer	Orion	601A	71618
	***			
534-05	Mercury Analyzer	Bacharach	50B	VB0518
	***			
533-12	Spectrophotometer	B&L Spectronic	70	0508
	***			
533-06	TOC Analyzer	Dohrmann	DC-80	HA2025
533-07	TOC Analyzer	Beckman	915-B	
533-18	TOC Analyzer	OI Corporation	700	H251171
	***			
533-04	TOX Analyzer	Dohrmann	DX-20	HE1063
533-05	TOX Analyzer	Dohrmann	DX-20B	HF2050
533-19	TOX Analyzer	Dohrman Xertex	MC-3	HF1973
	***			
533-10	Turbidimeter	Hach	18900	870603849
	***			

INSTRUMENT LIST

INSTRUMENT	DESCR.....	MANUF.....	MODEL.....	SER#.....
533-15	UV-Vis Scanning Spectrophotometer	Milton Roy	Spec 1201	3721243008
	***			
533-22	UV/Vis Spec	Milton Roy	501	0883326
	***			
534-03	alpha/beta Counter	Canberra	2404F	688252
	***			
533-21	pH/ISE Meter	Orion	720A	007917
	***			

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1.7 CALIBRATION PROCEDURES AND INTERNAL QUALITY CONTROL PROCEDURES

The calibration criteria and corrective actions are provided by method below and in Table 1.7.

Each method has analytical control limits maintained for laboratory control standards, spike recoveries, duplicates, surrogate and quality control check standards recoveries. These limits must be met for non-matrix control items to validate the instrument and analyst performance. These have already been presented in Table 1.3.

It is BCA's goal to meet 100% of all criteria 100% of the time. For the times that this goal is not met for non-matrix QC control samples, the analyst is required to complete a batch corrective action sheet presented in Figure 1.7-1.

Corrective action may take several forms, but the following steps are almost always included:

1) Check the calculations

2) Check the instrument for proper setup

3) Re-analyze the control item

If these steps fail to eliminate the problem, more serious action is implemented. The LCS and spike recoveries may be compared to reveal matrix interferences. Recalibration of the instrument may be required. In certain cases an entire batch may be re-analyzed. A record of all corrective action is maintained in the laboratory notebook, signed and dated by the analyst.

If a problem cannot be corrected as outlined, or if a check sample failure is identified, the analyst will involve the Resource Manager, Resource Director, Client Manager and Quality Assurance Coordinator in accordance with SOP QA00789. This SOP is present in Figure 1.7-2.

1.7.1 SW8015 Modified Total Petroleum Hydrocarbons - Volatile

Initial calibration is performed with a minimum of five gasoline fuel concentrations. The Nelso software forces the curve through zero, eliminating detection limit effects. The calibration curve must have a correlation coefficient factor of 0.995 or greater to proceed with analysis. Any of the standards may be repeated as

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW 7060 SW7421 SW7131 SW7740 SW7191 SW7470 SW7471	Metals - AA As, Pb, Cd, Se, Cr, Hg	Five-point calibration	Daily calibration prior to sample analysis	R $\geq$ 0.995	1) Repeat test 2) Take corrective action 3)Repeat calibration and test
		Independently prepared calibration verification	Once per five-point calibration	Within $\pm$ 10% of expected value	1) Reanalyze verification standard 2) Prepare fresh primary claibration stock 3) Recalibrate for analytes not meeting criteria
		Calibration blank	After every 10 samples	$\leq$ 5 x method detection limit	1)Rerun 2) Clean system 3) Rerun samples back to last clean blank
	Refers to: SW846-7000 IRP Handbook	Calibration check	After every 10 samples	Within $\pm$ 10% or expected value	1) Replace graphite tube if necessary 2) Recalibrate 3) Rerun sample back to last standard that met criteria

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW 7060 SW7421 SW7131 SW7740 SW7191 SW7470 SW7471	Metals - AA As, Pb, Cd, Se, Cr, Hg	Digested LCS	Daily with every prep batch	Within laboratory established control limits	1) Reanalyze LCS 2) Take corrective action 3) Reanalyze associated samples
		Matrix spike (MS) and matrix spike duplicate (MSD)	1 MS and MSD per every 20 Air Force samples	Within laboratory established control limits	1) Flag data
		Reagent blank	Once per extraction batch	No analytes detected at > PQL	1) Source of contamination ivestigated 2) Appropriate corrective action taken 3) All samples processed witj a contaminated blank are to be redigested and reanalyzed
	Refers to: SW846-7000 IRP Handbook	MDL Study	Once per year	Laboratory established, instrument derived	Detection limits that exceed established criteria shall be submitted to the AF for apporval prior to project start

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW 6010	Trace Metals - ICPES	4 point calibration curve	Initially, prior to sample analysis	Correlation coefficient $\geq$ 0.995	1) Correct problem 2) Reanalyze standard
		High standard	Every day, prior to sample analysis	Within $\pm$5% of expected value	1) Rreun 2) If still out, recalibrate
		Midpoint calibration check	Every ten samples and at the enc of the run	Within $\pm$10% of expected value	1) Terminate analysis 2) Locate and correct problem 3) Recalibrate 4) Reanalyze associated samples
		Calibration blank	Every ten samples and at the end of the run	Within $\pm$3s of mean blank value	1) Repeat twice - average results 2) If average not within +3s of background mean, terminate analysis
	Refers to: SW846-6010 IRP Handbook	Interference check sample	Run at the more frequent of the following: 1) Beginning and end of analytical run; or 2)Twice during every 8 hour shift	Within $\pm$20 percent of expected value	1) Recalibrate 2) Repeat ICS 3) Reanalyze all samples after last successful ICS

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW 6010	Trace Metals - ICPES	Digested LCS	Daily with every prep batch	Within laboratory established control limits	1) Reanalyze LCS 2) Take corrective action 3) Reanalyze associated samples
		Matrix spike (MS) and matrix spike duplicate (MSD)	1 MS and MSD per every 20 Air Force samples	Within laboratory established control limits	1) Flag data
		Reagent blank	Once per extraction batch	No analytes detected at >PQL	1) Source of contamination ivestigated 2) Appropriate corrective action taken 3) All samples processed witj a contaminated blank are to be redigested and reanalyzed
	Refers to: SW846-6010 IRP Handbook	MDL Study	Once per year	Laboratory established, instrument derived	Detection limits that exceed established criteria shall be submitted to the AF for apporval prior to project start

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8015M	Total Petroleum Hydrocarbons - Volatile	Five-point calibration (for all analytes)	Initial calibration prior to sample analysis	Correlation coefficient $\geq$ 0.995	Repeat after corrective action
		Independently prepared calibration verfication (for all analytes)	Once per five-point calibration	All analytes within $\pm$15% of average RF	1) Reanalyze second source standard 2) Prepare fresh primary calibration stock 3) Recalibrate for analytes not meeting criteria
	Refers to: Alaska GRO SW846-5030 SW846-8000 IRP Handbook	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	Laboratory established limits	1) Recalculate results 2) Locate and fix problem with system 3) Rerun demonstration for those analytes that did not meet criteria

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8015M (Cont'd)		Initial daily calibration factor verification using one or more calibration standards	Daily, before sample analysis	Response for any analyte within ±15% of average RF or CF	1) Perform system maintenance as per SW846-8000 2) Prepare new calibration curve for any analyte not meeting criteria 3) Reinject any samples analyzed after criteria were exceeded
		Retention times (RT) windows	One 72 hour study performed on each GC column type	1.5% for Megabore, 2.0% for packed columns	1) Perform maintenance 2) Repeat test
		Ongoing calibration check	10% sample frequency, minimum of 2 per set	a) RF within 15% of daily calibration factor b) Ongoing calibration analytes elute within daily RT windows	1) Locate and correct source of problem-document actions taken 2) Repeat test 3) After repeated failures, perform system mintenance as per SW846-8000 4) Repeat test
		Laboratory Control Sample (LCS)	2 per batch of 20 samples	Laboratory established criteria	1) Repeat LCS ; If both LCSs are still out : 2) Rreun batch

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8015M (Cont'd)		Matrix spike, matrix spike duplicate	1 pair per every 20 Air Force project samples	Laboratory established criteria	1) Recalculate result 2) Reanalyze spike, if still out: 3) If LCS is within control limits, flag data 4) If LCS not within control limits, re-extract the batch
		Surrogate standard spike	Every sample, spike, standard and blank	Laboratory established criteria	1) Recalculate the result, if still out: 2) Reanalyze sample, if still out: 3) Flag result and document that steps 1 and 2 were performed
		Reagent blank (will include methanol if used for medium level soils)	One per preparation batch	No analytes detected at > PQL	1) Source of contamination investigated 2) Appropriate corrective action taken and documented 3) All samples processed with a contaminated blank are to be rerun
		MDL Study	Once per year	Laboratory established, instrument derived	Detection limits established shall be submitted to the Air Force for approval prior to project start

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8100M	Total Petroleum Hydrocarbons -Extractable	Five-point calibration (for all analytes)	Initial calibration prior to sample analysis	Correlation coefficient $\geq$ 0.995	Repeat after corrective action
		Independently prepared calibration verfication (for all analytes)	Once per five-point calibration	All analytes within $\pm$15% of average RF	1) Reanalyze second source standard 2) Prepare fresh primary calibration stock 3) Recalibrate for analytes not meeting criteria
	Refers to: Alaska DRO SW846-8000 IRP Handbook	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	Laboratory established limits	1) Recalculate results 2) Locate and fix problem with system 3) Rerun demonstration for those analytes that did not meet criteria

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8100M (Cont'd)		Initial daily calibration factor verification using one or more calibration standards	Daily, before sample analysis	Response for any analyte within ±15% of average RF or CF	1) Perform system maintenance as per SW846-8000 2) Prepare new calibration curve for any analyte not meeting criteria 3) Reinject any samples analyzed after criteria were exceeded
		Retention times (RT) windows	One 72 hour study performed on each GC column type	1.5% for Megabore, 2.0% for packed columns	1) Perform maintenance 2) Repeat test
		Ongoing calibration check	10% sample frequency, minimum of 2 per set	a) RF within 15% of daily calibration factor b) Ongoing calibration analytes elute within daily RT windows	1) Locate and correct source of problem-document actions taken 2) Repeat test 3) After repeated failures, perform system mintenance as per SW846-8000 4) Repeat test
		Matrix spike, matrix spike duplicate	1 pair per every 20 Air Force project samples	Laboratory established criteria	1) If one of the LCSs is within control limits, flag the data

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8100 (Cont'd)		Surrogate standard spike	Every sample, spike, standard and blank	Laboratory established criteria	1) Recalculate the result, if still out: 2) Reanalyze sample, if still out: 3) Flag result and document that steps 1 and 2 were performed
		Reagent blank	One per extraction batch	No analytes detected at >PQL	1) Source of contamination investigated 2) Appropriate corrective action taken and documented 3) All samples processed with a contaminated blank are to be re-extracted and re-analyzed if within holding times
		MDL Study	Once per year	Laboratory established, instrument derived	Detection limits established shall be submitted to the Air Force for approval prior to project start

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
AK103M	Residual Hydrocarbons -Extractable	Five-point calibration for motor oil	Initial calibration prior to sample analysis	Correlation coefficient $\geq$ 0.990	Repeat after corrective action
		Independently prepared calibration verfication (for all analytes)	Once per five-point calibration	All analytes within $\pm$25% of average RF	1) Reanalyze second source standard 2) Prepare fresh primary calibration stock 3) Recalibrate for analytes not meeting criteria
	Refers to: Alaska AK103 SW846-8000 IRP Handbook	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	Laboratory established limits	1) Recalculate results 2) Locate and fix problem with system 3) Rerun demonstration for those analytes that did not meet criteria

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
AK103M (Cont'd)		Initial daily calibration factor verification using one or more calibration standards	Daily, before sample analysis	Response for any analyte within ±25% of average RF or CF	1) Perform system maintenance as per SW846-8000 2) Prepare new calibration curve for any analyte not meeting criteria 3) Reinject any samples analyzed after criteria were exceeded
		Retention times (RT) windows	One 72 hour study performed on each GC column type	1.5% for Megabore, 2.0% for packed columns	1) Perform maintenance 2) Repeat test
		Ongoing calibration check	10% sample frequency, minimum of 2 per set	a) RF within 25% of daily calibration factor b) Ongoing calibration analytes elute within daily RT windows	1) Locate and correct source of problem-document actions taken 2) Repeat test 3) After repeated failures, perform system mintenance as per SW846-8000 4) Repeat test
		Matrix spike, matrix spike duplicate	1 pair per every 20 Air Force project samples	Laboratory established criteria	1) If one of the LCSs is within control limits, flag the data

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
AK103M (Cont'd)		Surrogate standard spike	Every sample, spike, standard and blank	Laboratory established criteria	1) Recalculate the result, if still out: 2) Reanalyze sample, if still out: 3) Flag result and document that steps 1 and 2 were performed
		Reagent blank	One per extraction batch	No analytes detected at >PQL	1) Source of contamination investigated 2) Appropriate corrective action taken and documented 3) All samples processed with a contaminated blank are to be re-extracted and re-analyzed if within holding times
		MDL Study	Once per year	Laboratory established, instrument derived	Detection limits established shall be submitted to the Air Force for approval prior to project start

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8080	Organo-chlorine Pesticides and PCBs	Five-point calibration (for all pesticides and PCB-1260)	Initial calibration prior to sample analysis	Correlation coefficient $\geq$ 0.995	Repeat after corrective action
		Independently prepared calibration verfication	Once per five-point calibration	All analytes within $\pm$15% of average RF	1) Reanalyze second source standard 2) Prepare fresh primary calibration stock 3) Recalibrate for analytes not meeting criteria
	Refers to: SW846-3500 SW846-8080 SW846-8000 IRP Handbook	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyses of a QC check sample	Once per analyst	Laboratory established limits	1) Recalculate results 2) Locate and fix problem with system 3) Rerun demonstration for those analytes that did not meet criteria

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8080 (Cont'd)		Initial daily calibration factor verification using one or more calibration standards	Daily, before sample analysis	Response for any analyte within ±15% of average RF or CF	1) Perform system maintenance as per SW846-8000 2) Prepare new calibration curve for any analyte not meeting criteria 3) Reinject any samples analyzed after criteria were exceeded
		Retention times (RT) windows calculated for each analyte	One 72 hour study performed on each GC column type	1.5% for Megabore, 2.0% for packed columns	1) Perform maintenance 2) Repeat test
		Ongoing calibration check	10% sample frequency, minimum of 2 per set	a) RF within 15% of daily calibration factor b) Ongoing calibration analytes elute within daily RT windows	1) Locate and correct source of problem-document actions taken 2) Repeat test 3) After repeated failures, perform system mintenance as per SW846-8000 4) Repeat test
		Breakdown check (Endrin and DDT)	Daily prior to analysis of samples	Degradation ≤20%, total ≤ 30%	1) Clean injection port 2) Remove front 2 feet of column 3) See EPA SW846-8000

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8080 (Cont'd)		Extracted mid-level Laboratory Control Standard (LCS)	Two per batch	Response for any analyte with in lab control limits	1) Rerun LCS; if both LCSs still out, 2) Re-extract batch
		Matrix spike, matrix spike duplicate	1 pair per every 20 Air Force project samples	Laboratory established criteria	1) Recalculate result 2) Reanalyze spike, if still out: 3) If LCS is within control limits, flag data 4) If LCS not within control limits, re-extract the batch
		Two surrogate standard spikes (Decachloro-biphenyl and TCMX)	Every sample, spike, standard and blank	Laboratory established criteria If low DCBP recovery or interference indicated, calculate TCMX. If both are out proceed with corrective action	1) Recalculate the result, if still out: 2) Reanalyze sample, if still out: 3) Flag result and document that steps 1 and 2 were performed
		Reagent blank	One per extraction batch	No analytes detected at >PQL	1) Source of contamination investigated 2) Appropriate corrective action taken and documented 3) All samples processed with a contaminated blank are to be re-extracted and re-analyzed if within holding times

(continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8080 (Cont'd)		MDL Study	Once per year	Laboratory established, instrument derived	Detection limits established shall be submitted to the Air Force for approval prior to project start

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8240/ SW8260	Volatile Organics	Check of mass spectral ion intensities using BFB	Initially, prior to calibration, again prior to sample analyses and once per shift every 12-hour shift	Established criteria in SW8240	1) Retune instrument 2) Repeat analysis tuning standard
		Five-point calibration for all commercially available analytes	Initial calibration prior to sample analysis	1) SPCCs average RF $\geq$ 0.30 (except bromoform) 2)RSD < 30% for CCCs RFs	Repeat after corrective action if either of the acceptance criteria is not met
		Independently prepared calibration verification	Once per five-point calibration	Analyte within 30% of average RF	1) Reanalyze verification standard 2) Prepare fresh primary calibration stock 3) Recalibrate for analytes not meeting criteria
	Refers to: SW846-5000 SW846-8240 SW846-8260 IRP Handbook				

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8240/ SW8260 (Cont'd)		Initial calibration factor verification	Once per 12 hours, prior to sample analysis	1) SPCCs averageRF $\geq$ 30%(except for bromoform) 2) CCC percent difference < 25% from average RF	1)Evaluate system and take corrective action 2) If source of problem cannot be determined, re-calibrate
		Internal Standard (IS) Retention Time (RT) and response check from calibration check standard	Immediately after or during data acquisition of calibration check standard	RT $\pm$ 30 seconds and EICP within -50% to +100% of last calibration verification (12 hours) for each IS	1) Inspect MS or GC for malfunctions 2) Take appropriate corrective actions 3) Mandatory reanalysis of samples analyzed while system was malfunctioning
		Mid-level Laboratory Control Standard (LCS) If medium-level soil samples analyzed, LCSs should be extracted as well	Two per batch	Within laboratory established limits	1) Repeat LCS if both LCSs are out, if still out : 2) Rerun batch

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8240/ SW8260 (Cont'd)		On-going calibration check	10% sample frequency (matrix spike may substitute for one check every 20 samples), minimum of two per set	QC Acceptance Criteria Table (SW846)	1) Repeat test only for analytes that failed to meet criteria 2) After repeated failures, locate and correct source of problem 3) Repeat test for all compounds of interest
		Matrix spike (MS) and matrix spike duplicate (MSD)	1 MS and 1 MSD per every 20 Air Force project samples	a) Laboratory established criteria	1) Recalculate result 2) Reanalyze spike, if still out: 3) If LCS is within control limits, flag data 4) If LCS not within control limits, re-analyze the batch

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8240/ SW8260 (Cont'd)		Surrogate standards spike	Every sample, spike, standard and reagent blank	Laboratory established limits	1) Recalculate result, if still out: 2) Check instrument performance, take corrective action, if necessary 3) Reanalyze sample, if still out: 4) Flag result if it does net meet criteria and document that steps 1-3 were performed
		Reagent blank	Daily prior to sample analysis for each matrix and once per extraction batch for medium level soil sample analysis up to 20 samples per batch	No analytes detected >PQL	1) Source of contamination investigated 2) Appropriate corrective action taken and documented
		MDL Study	Once per year	Laboratory established, instrument derived	Detection limits that exceed established criteria shall be submitted to the Air Force for approval prior to analysis

(Continued)

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8270	Semivolatile Organics	Check of mass spectral ion intensities using DFTPP	Initially, prior to calibration, again prior to sample analyses and once per shift every 12-hour shift	Establish criteria in SW8270	1) Retune instrument 2) Clean injection port, if necessary 3) Remove first 6 to 12 inches of column, if necessary 4) Repeat analysis tuning standard
		Five-point calibration for all commercially available analytes	Initial calibration prior to sample analysis (prepare fresh stock solutions once per year)	1) %RSD < 30% for each individual CCC 2) SPCCs average RF $\geq$ 0.050	Repeat after corrective action if any one of the acceptance criteria are not met
	Refers to: SW846-3500 SW846-8270 IRP Handbook	Independently prepared calibration verification	Once per five-point calibration	Analyte within 30% of average RF	1) Reanalyze verification standard 2) Prepare fresh primary calibration stock 3) Recalibrate for analytes not meeting criteria

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8270 (Cont'd)		Initial calibration factor verification	Once per 12 hours, prior to sample analysis	1) SPCCs average RF $\geq$ 0.050 2) CCC percent difference < 30% from average RF	1) Evaluate system and take corrective action 2) If source of problem cannot be determined, re-calibrate
		Internal Standard (IS) Retention Time (RT) and response check from calibration check standard	Immediately after or during data acquisition of calibration check standard	RT $\pm$ 30 seconds and EICP within -50% to +100% of last calibration verification (12 hours) for each IS	1) Inspect MS or GC for malfunctions 2) Reanalyze sample on different instrument to verify matrix effects
		Extracted Mid-level Laboratory Control Standard (LCS)	Two per batch	Within laboratory established limits	1) Repeat LCS ; if both LCSs arestill out : 2) Re-extract the batch

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8270 (Cont'd)		On-going calibration check	10% sample frequency (matrix spike may substitute for one check every 20 samples), minimum of two per set	QC Acceptance Criteria Table (SW846)	1) Locate and correct source of problem--document actions taken 2) Repeat test only for analytes that failed to meet criteria 3) After repeated failures, perform system maintainence as per SW846-8000 4) Repeat test for all compounds of interest
		Matrix spike (MS) and matrix spike duplicate (MSD)	1 MS and 1 MSD per every 20 Air Force project samples	a) Laboratory established criteria	1) Recalculate result 2) Reanalyze spike, if still out: 3) If LCS is within control limits, flag data 4) If LCS not within control limits, re-extract the batch

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8270 (Cont'd)		Surrogate standards spike	Every sample, spike, standard and reagent blank	Laboratory established limits	1) Recalculate result, if still out: 2) Check instrument performance, take corrective action, if necessary 3) Reanalyze sample, if still out: 4) Flag result if it does net meet criteria and document that steps 1-3 were performed
		Reagent blank	Once per extraction batch (up to 20 samples/batch)	No analytes detected >PQL, except phthalates at 3 times the PQL	1) Source of contamination investigated 2) Appropriate corrective action taken and documented
		MDL Study	Once per year	Laboratory established, instrument derived	Detection limits that exceed established criteria shall be submitted to the Air Force for approval prior to analysis

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW9056	Anions by IC	Five-point calibration	Daily calibration prior to sample analysis	Correlation coefficient $\geq$ 0.995	1) Repeat test 2) Take corrective action 3)Repeat calibration and test
		Independently prepared calibration verification	Once per five-point calibration	Within $\pm$10% of expected value	1) Reanalyze verification standard 2) Prepare fresh primary claibration stock 3) Recalibrate for analytes not meeting criteria
		Calibration blank	After every 10 samples	$\leq$5 x method detection limit	1)Rerun 2) Clean system 3) Rerun samples back to last clean blank
	Refers to: SW846-9056 IRP Handbook	Calibration check	After every 10 samples	Within $\pm$ 10% or expected value	1) Take corrective action 2) Recalibrate 3) Rerun sample back to last standard that met criteria

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW9056	Anions by IC	LCS	Daily with every batch	Within laboratory established control limits	1) Reanalyze LCS 2) Take corrective action 3) Reanalyze associated samples
		Matrix spike (MS) and matrix spike duplicate (MSD)	1 MS and MSD per every 20 Air Force samples	Within laboratory established control limits	1) Repeat analysis 2) Flag data
		Reagent blank	Once per batch	No analytes detected at >3 times detection limit	1) Source of contamination ivestigated 2) Appropriate corrective action taken 3) All samples processed witj a contaminated blank are to be redigested and reanalyzed
		MDL Study	Once per year	Laboratory established, instrument derived	Detection limits that exceed established criteria shall be submitted to the AF for apporval prior to project start
	Refers to: SW846-9056 IRP Handbook				

TABLE 1.7 SUMMARY OF CALIBRATION AND INTERNAL QUALITY CONTROL PROCEDURES

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW9060	Total Organic Carbon	Two-point calibration	Daily calibration prior to sample analysis	Correlation coefficient $\geq$ 0.995	1) Repeat test 2) Take corrective action 3)Repeat calibration and test
		Independently prepared calibration verification	Once per calibration	Within $\pm$ 10% of expected value	1) Reanalyze verification standard 2) Prepare fresh primary claibration stock 3) Recalibrate for analytes not meeting criteria
		Calibration check	After every 10 samples	Within $\pm$ 10% or expected value	1) Take corrective action 2) Recalibrate 3) Rerun sample back to last standard that met criteria
	Refers to: SW846-9060 IRP Handbook				

(Continued)

TABLE 1.7 (Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW9060	Total Organic Carbon	LCS	Daily with every batch	Within laboratory established control limits	1) Reanalyze LCS 2) Take corrective action 3) Reanalyze associated samples
		Matrix spike (MS) and matrix spike duplicate (MSD)	1 MS and MSD per every 20 Air Force samples	Within laboratory established control limits	1) Repeat analysis 2) Flag data
		Reagent blank (used in calculation)	One per batch	No analytes detected at >PQL	1) Source of contamination ivestigated 2) Appropriate corrective action taken 3) All samples processed witj a contaminated blank are to be redigested and reanalyzed
	Refers to: SW846-9060 IRP Handbook	MDL Study	Once per year	Laboratory established, instrument derived	Detection limits that exceed established criteria shall be submitted to the AF for apporval prior to project start

Figure 1.7-1 B C ANALYTICAL

Batch Corrective Action Note

Route completed document to Sample Receiving/Report Approval

1. Description:

Analyst _____

Determination _____

Date _____ Batch _____

Supervisor _____

Orders affected:

Sample Numbers	Client Codes

2. Condition Requiring Corrective Action:

3. Action Requested/Recommended:

Requested by _____ Date _____

4. Action taken:

Action taken by _____ Date _____

Action confirmed by _____ Date _____

5. Footnote for Analytical Report/Batch QC Report:

Note goes with (circle): LCS, MB, SPK, DUP, DSPK, SPL: _____

(See reverse for help)

Numbers refer to the corresponding section on the front:

1. Fill out batch-related information on the header.

2. Describe the condition or situation which requires corrective action.

3. Make a specific request or recommendation. This may be for your own analysis or a batch analyzed by someone else. Your name and the date go at the bottom of this section.

4. The analyst (or a senior troubleshooter, if involved) fills out this part. Be specific. This document may be needed to support data defensibility in court. Action-taker and second-party reviewer both sign this section.

5. Incorporate one of these standard footnotes by reference or create an equivalent free-form note. Again, be specific!

   Note #1. Method blank above RDL. Samples greater than ten times MB concentration or less than RDL were reported. Other samples were reanalyzed in another batch.

   Note #2. Spike recovery outside control limits. LCS and RPD are in control. Matrix interference is assumed. Batch reported.

   Note #3. Spike recovery outside control limits. Spike added less than one half sample concentration. LCS and RPD are in control. Batch reported.

   Note #4. RPD above control limit. Inhomogeneity in sample matrix observed. LCS and spike recoveries in control. Batch reported.

   Note #5. RPD above control limit. Sample concentration less than 5x RDL. LCS and spike recoveries in control. Batch reported.

   Note #6. Sample detection limit raised. Sample was diluted to reduce matrix interference.

   Note #7. No matrix QC reported in batch. Insufficient sample volume provided. Two LCSs were analyzed to provide precision data.

   Note #8. No matrix QC reported in batch. Sample used for matrix QC had to be diluted and reanalyzed in a later batch.

   Note #9. No matrix QC reported in batch. Sample used for matrix QC was reprepped in a later batch.

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Figure 1.7-2

DOCUMENTATION OF MAJOR CORRECTIVE ACTION

A. Summary

Corrective action procedures fall into two categories in the laboratories: QC failures, which are isolated and are documented on Batch Corrective Action notes, and systematic failures which require changes in procedures or extensive investigation to determine the cause of the failure. This SOP details procedures followed to implement and document corrective action with regard to system failures, which is named "major" corrective action to differentiate it from "batch" corrective action. All members of the laboratory staff can initiate major corrective action. Quality Assurance Coordinators (QAC) are responsible for major corrective action and maintaining records. The key tool in the documentation of corrective action is the Major Corrective Action Form (Attachement I). Its use is explained below.

B. Identification of a Problem

The first step in the major corrective action process is the identification of a situation which requires corrective action. In general any situation which involves an out of control process or failure to meet regulations requires corrective action. Specific examples are:

1. Quality control data consistently outside established control limits and the analyst is not able to resolve the problem.

2. A specific laboratory practice is not in compliance with requirements.

3. Performance evaluation results show repeated outliers for a given anaysis or particular analyte.

4. Assessment of accuracy, precision, or detection limits indicate that the laboratory is not meeting objectives stated in section 4 of the BCA Quality Assurance Manual.

C. Initiation of Major Corrective Action

1. The individual who recognizes the need for major corrective action obtains a Major Corrective Action Form from the QAC and completes Sections 1 and 2. Section 1 refers to the supervisor or manager of the section in which corrective action is required. Section 2,

Description of the Problem, should be as clear as possible and reference methods and SOPs when appropriate. The cause of the problem can be stated in Section 3, if known. Suggestions of steps to take to correct the problem are given in Section 4, if the originator is capable of providing assistance in this area. Sections 3 and 4 are not the responsibility of the originator and may be left blank at this point.

2. The form is returned to the QAC who reviews it for validity and to prevent multiple requests for the same reason. The QAC provides a number and initials the form. Copies are made for the QAC's records. The original is forwarded to the supervisor for response.

D. Corrective Action

1. The supervisor or manager completes Section 3 when the cause of the problem is fully understood. Data is unacceptable if the corrective action involves an out of control analysis. The supervisor or manager must determine the point at which data can no longer be reported to clients. If suspect data has been reported the program director, client managers, and quality assurance coordinator are contacted immediately and that group determines what action is to be taken in informing clients.

2. Once the problem is understood the plan of action, Section 4, is completed. Often personnel with appropriate technical knowledge will be involved in developing this plan and should always be considered a source of valid information, as well as the QAC. Responsible parties and completion dates are an integral part of the corrective action plan and must be included in Section 4. If no corrective action is possible a full explanation is provided in this section.

3. The form is returned to the QAC who completes Section 5. The follow-up schedule must be included in this section.

E. Follow-up

1. On all the followup dates the QAC checks progress on the problem and completes Section 6. Follow-up documentation must include the resolution of the problem in order to close out the entry.

2. The QAC keeps all completed Major Corrective Action Forms in a Corrective Action Notebook.

Reviewed and approved
T. Kirk 06/16/93
Issued _____

#_____
QAC_____

MAJOR CORRECTIVE ACTION FORM

SECTION 1 Originator_____Date_____

Manager or Supervisor_____Date_____

SECTION 2 Description of Problem (Originator):

SECTION 3 Cause of problem (Supervisor or Originator):

SECTION 4 Outline of corrective action (include responsible parties and dates of implementation) (Supervisor):

SECTION 5 Reviewed by_____Date_____

Followup dates_____

SECTION 6 Description of followup:

necessary to obtain the required correlation coefficient. The standard solutions may be prepared again as well. The column may be replaced if no other instrument problems are identified. The retention times are adjusted as needed.

Prior to running samples each day, a continuing calibration standard is run. The retention times may be adjusted at this point as well. The difference between the average response factor of the initial standard curve and the response factor of the continuing calibration standard must be less than 15 percent. If this is not met, the column may be clipped and the continuing calibration standard repeated. If a second failure is observed, the instrument must be recalibrated and meet the calibration criteria listed above.

Each analyst is required to demonstrate their ability to generate acceptable accuracy and precision by running four LCSs or a QC check sample.

The external standard calibration method is used to quantitate samples.

A blank and two LCSs are required for every batch of 20 samples. One LCS is run after 10 samples; the other after 20 samples. The blank must be rerun if any analytes are detected at > the PQL. If the amount found is greater than the PQL, any positive results in the batch samples must be "B" flagged. If it is determined to be a continuous problem, the batch must be rerun within holding times.

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is present, the two LCSs will serve as matrix QC. If the matrix spike/matrix spike duplicate are not within control limits, the LCSs must be within control limits to demonstrate matrix effects. If the LCSs are not within control limits, it may indicate a a bad standard solution or bad calibration. If the samples are still within holding times, the entire batch should be rerun. The LIMS system flags the out of control incidences.

Since there is only one surrogate per method, no surrogates are allowed to be out. If a surrogate failure is observed the result should be recalculated. If it is still out, the result should be flagged and document that it was recalculated and rerun.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

1.7.2 SW8100 Modified Total Petroleum Hydrocarbons - Extractable

Initial calibration is performed with a minimum of five diesel fuel concentrations. The Nelson software forces the curve through zero, eliminating detection limit effects. The calibration curve must have a correlation factor of 0.995 or greater. Any of the standards may be repeated as necessary to obtain the required correlation coefficient. The standard solutions may be prepared again as well. The column may be replaced if no other instrument problems are identified. The retention times are adjusted as needed.

Prior to running samples each day, a continuing calibration standard is run. The retention times are adjusted at this point as well. The difference between the average response factor of the initial standard curve and the response factor of the continuing calibration must be less than 15 percent. If this is not met, the continuing calibration standard must be repeated. If a second failure is observed, the instrument must be recalibrated and meet the calibration criteria listed above.

Each analyst is required to demonstrate their ability to generate acceptable accuracy and precision by running four LCSs or a QC check sample. The external standard calibration method is used to quantitate samples.

A blank and two LCSs are required for every batch of 20 samples. One LCS is run after 10 samples; the other after 20 samples. The blank must be rerun if any analytes are detected at greater than the PQL. If the amount found is greater than the PQL any positive results in the batch samples must be "B" flagged. If it is determined to be a contamination problem, the batch must be re-extracted within holding times if possible. If there isn't enough sample left or the holding times have been exceeded, the positive sample results should be flagged with a "B."

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is present, the two LCSs will serve as matrix QC. If the matrix spike/matrix spike duplicate are not within control limits, the LCSs must be within control limits to demonstrate matrix effects. If the LCSs are not within control limits, it may indicate an extraction failure. If the samples are still within holding times, the entire batch should be re-extracted and analyzed. The LIMS system flags the out of control incidences.

Since there is only one surrogate per method, no surrogates are allowed to be out. If a surrogate failure is observed the result should be recalculated. If it is still out the sample and/or QC samples should be rerun. If it is still out, the result should be flagged and document that it was recalculated and rerun.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

1.7.3 AK103 Modified Residual Range Organics

Initial calibration is performed with a minimum of five motor oil concentrations. The Nelson software forces the curve through zero, eliminating detection limit effects. The calibration curve must have a correlation factor of 0.990 or greater. Any of the standards may be repeated as necessary to obtain the required correlation coefficient. The standard solutions may be prepared again as well. The column may be replaced if no other instrument problems are identified. The retention times are adjusted as needed.

Prior to running samples each day, a continuing calibration standard is run. The retention times are adjusted at this point as well. The difference between the average response factor of the initial standard curve and the response factor of the continuing calibration must be less than 25 percent. If this is not met, the continuing calibration standard must be repeated. If a second failure is observed, the instrument must be recalibrated and meet the calibration criteria listed above.

Each analyst is required to demonstrate their ability to generate acceptable accuracy and precision by running four LCSs or a QC check sample. The external standard calibration method is used to quantitate samples.

A blank and two LCSs are required for every batch of 20 samples. One LCS is run after 10 samples; the other after 20 samples. The blank must be rerun if any analytes are detected above the PQL. If the amount found is greater than the PQL any positive results in the batch samples must be "B" flagged. If it is determined to be a contamination problem, the batch must be re-extracted within holding times if possible. If there isn't enough sample left or the holding times have been exceeded, the positive sample results should be flagged with a "B."

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is present, the two LCSs will serve as matrix QC. If the matrix spike/matrix spike duplicate are not within control limits, the LCSs must be within control limits to demonstrate matrix effects. If the LCSs are not within control limits, it may indicate an extraction failure. If the samples are still within holding times, the entire batch should be re-extracted and analyzed. The LIMS system flags the out of control incidences.

Since there is only one surrogate per method, no surrogates are allowed to be out. If a surrogate failure is observed the result should be recalculated. If it is still out the sample and/or QC samples should be rerun. If it is still out, the result should be flagged and document that it was recalculated and rerun.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

This method may be incorporated into the Extractable fraction by extending the temperature program and running the approved QC.

1.7.4 SW8080 Organochlorine Pesticides by Gas Chromatography

Initial calibration is performed with a minimum of five concentrations of pesticides or PCB 1260. The calibration curve must have a correlation factor of 0.995 or greater.

Prior to running samples each day, a continuing calibration standard is run. The compounds used in the continuing calibration standard are listed in the 8080 SOP. This continuing calibration standard, normally the midpoint, must calculate to be within 15% of the true value in order to proceed. If it is not, the column may be clipped and the continuing calibration standard is repeated. If it fails again, the instrument must be recalibrated. If the recalibration is unsuccessful, the column may be replaced if no instrument problem is identified. The calibration is then repeated.

Before sample analysis can begin, the endrin/DDT breakdown check must be performed. The degradation should be less than or equal to 20% for each compound, the total may not exceed 30% before analysis can proceed. The corrective action is to clean the injection port. If it fails again, remove 2 feet from the front of the column. If it fails again, replace the column and recalibrate.

Each analyst is required to demonstrate their ability to generate acceptable accuracy and precision by running four LCSs or a QC check sample.

The internal standard calibration method is used to quantitate samples. Any analyte will be confirmed using a secondary column, including the multiple peak compounds such as PCBs, chlordane and toxaphene.

The internal standards' retention time and response are evaluated. The retention times must be within 30 seconds and all of the sample internal standard area

counts must be within the -50% to +100% guidelines. If not, the sample must be rerun.

A blank and two LCSs are required for every batch of 20 samples. One LCS is run after 10 samples; the other after 20 samples. The blank must be rerun if any analytes are detected above the PQL. If it is greater than the PQL, flag the positive batch sample results with a "B" flag. If it is determined to be a contamination problem, the batch must be re-extracted within holding times if possible. If there isn't enough sample or the holding times have been exceeded, the positive sample results should be flagged with a "B."

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is present, the two LCSs will serve as matrix QC. If the matrix spike/matrix spike duplicate are not within control limits, the LCSs must be within control limits to demonstrate matrix effects. If the LCSs are not within control limits, it may indicate an extraction failure. If the samples are within holding times, the entire batch should be re-extracted and analyzed. The LIMS system flags the out of control data.

There are two surrogates for this method. If any of the surrogates is out of control, recalculate the results. If it is still out, flag the result with a "Q" flag and document that the recalculation was completed. If the decachlorobiphenyl result is low and matrix interference is present, the results will be acceptable if the TCMX is within control limits.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

1.7.5 SW8240/8260 Volatile Organics by GC/MS

Instrument sensitivity is checked with BFB (4-Bromofluorobenzene) every twelve hours of operation. Retention time, peak area and shape, and isotope ratios are examined. If the BFB check fails, retune the instrument and repeat BFB check. Continue until the BFB is within EPA guidelines.

The initial calibration of the GC/MS is conducted as necessary, usually at the time of installation or when the criteria listed here are not met. A five-point calibration curve is used to monitor the linear range. Response factors of five system performance check compounds (SPCC's) and six calibration check compounds (CCC's) are examined. The SPCC response factors must exceed 0.300 (except for bromoform at 0.250). The deviation of the CCC response factors from the

average response factor must be less than 25%. If these controls are not met, evaluate which of the standards need to be repeated. If this is not successful, clip the column or replace it and repeat the calibration.

A continuing calibration check is run every twelve hours. The SPCC response factors must meet the same criteria as in the initial calibration, and the CCC response factors may not deviate more than 25% from the average response factor of the initial calibration. Analysis may proceed only if the SPCC and the CCC criteria are met for eleven out of eleven compounds. If this criteria are not met, clip the column and repeat the continuing calibration check. If this fails, repeat the calibration. Replace the column as needed.

The internal standards' retention time and responses check are evaluated. The retention times must be within 30 seconds and the EICP should be -50% to +100% of the last calibration verification run for each internal standard. If this is not the case, inspect the MS or GC for malfunctions. Take appropriate action, such as tightening the transfer lines or any other connections. All of the sample internal standard area counts must be within the -50% to +100% guidelines. If not, the sample must be rerun.

Each analyst is required to demonstrate their ability to generate acceptable accuracy and precision by running four LCSs or a QC check sample. If this fails, recalculate results, locate and fix systematic problems and rerun.

A blank and two LCSs are required for every batch of 20 samples. One LCS is run after 10 samples; the other after 20 samples. The blank must be rerun if any analytes are detected above the PQL

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is present, the two LCSs will serve as matrix QC. If the recoveries of any spiking compound are not within control limits, the spike and spike duplicate must be rerun if the LCS at the end of the run is not within control limits. This procedure verifies instrument performance. If the LCS is not within control limits, any samples run after the last in control LCS must be rerun. The LIMS system flags the out of control data.

If a surrogate failure is observed the result should be recalculated. If it is still out the sample and/or QC samples should be rerun. If it is still out, the result should be flagged and document that it was recalculated and rerun.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

1.7.6 SW8270 Base/Neutral, Acid Extractable Organics by GCMS

Instrument sensitivity is checked with DFTPP (Decafluorotriphenylphosphine) every twelve hours of operation. The ion abundance criteria must be within the CLP Statement of Work, August 1991.

The initial calibration of the GC/MS is conducted using five concentrations. Response factors of four system performance check compounds (SPCC's) and thirteen calibration check compounds (CCC's) are examined. The SPCC response factors must exceed 0.050. The deviation of the CCC response factors from the average response factor must be less than 30%.

A continuing calibration check is run every twelve hours. The SPCC response factors must meet the same criteria as in the initial calibration, and the CCC response factors may not deviate more than 30% from the average response factor of the initial calibration. Analysis may proceed only if the SPCC and CCC criteria are met for all seventeen compounds. The column may be clipped and/or the injection port cleaned if this criteria is not met. The column may be replaced and calibrated if the criteria cannot be met.

The internal standards' retention time and responses check are evaluated. The retention times must be within 30 seconds and the EICP should be -50% to +100% of the last calibration verification run for each internal standard. If this is not the case, inspect the MS or GC for malfunctions. Take appropriate action, such as tightening the transfer lines or any other connections. All of the samples run in the batch should match this criteria as well. In the cases where the fifth and/or sixth internal standards fail this criteria, an LCS must be run after the samples in question to demonstrate that the GC/MS instrument is in control. If no LCS is run, the extracts must be re-analyzed on another instrument to verify the matrix effects.

Each analyst is required to demonstrate their ability to generate acceptable accuracy and precision by running four LCSs or a QC check sample. If this fails, recalculate results, locate and fix systematic problems and rerun.

A blank and two LCSs are required for every batch of 20 samples. One LCS is run at the start of the analytical batch and the other run at the end. The end LCS is particularly important because of the internal standard criteria mentioned earlier. The blank must be rerun if any analytes are detected above the PQL, with

the exception of phthlate contamination which may be no greater than 3 times the PQL. This is due to the closeness of the PQLs to the laboratory calculated method detection limits. If it is greater than 3 times the PQL, flag the positive batch sample results with a "B" flag. If it is determined to be a contamination problem, the batch must be re-extracted within holding times if possible. If there isn't enough sample or the holding times have been exceeded, the positive sample results should be flagged with a "B."

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is present, the two LCSs will serve as matrix QC. If the matrix spike/matrix spike duplicate are not within control limits, the LCSs must be within control limits to demonstrate matrix effects. If the LCSs are not within control limits, it may indicate an extraction failure. If the samples are within holding times, the entire batch should be re-extracted and analyzed. The LIMS system flags the out of control data.

There are 3 acid and 3 base-neutral surrogates for this method. If more than one of each type is out of control, recalculate the results. If it is still out, reanalyze the sample. Then flag the result with a "Q" flag and document that the recalculation and rerun were completed.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

1.7.7 Metals by ICP

A calibration curve of three standards including the blank, PQL verification and high standard is run daily, prior to analysis of samples and verified by a midpoint standard every ten samples. The apparent concentration of this standard must lie within 10% of the true concentration. The standards are prepared by diluting mixed-element concentrates, which are themselves prepared from commercially available solutions that are NIST traceable.

A calibration blank is run every 10 samples and at the end of the analytical run. The result should not exceed the absolute value of the reporting detection limit. If it is not, it should be repeated. If the repeat is not within this acceptance criteria, the batch must be rerun.

An interference check sample is run at the beginning and end of each analytical run and must be within 20% of the expected value. If it is not, the instrument must be recalibrated and the samples re-analyzed.

A blank and LCS are required for every batch of 20 samples. The blank must be rerun if any analytes are detected above the PQL. If it is determined to be a contamination problem, the batch must be re-prepped and re-analyzed within holding times.

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is present, the two LCSs will serve as matrix QC. If the matrix spike/matrix spike duplicate are not within control limits, the LCS must be within control limits to demonstrate matrix effects. If the LCS is not within control limits, it may indicate an extraction failure. If the samples are within holding times, the entire batch should be re-extracted and analyzed. The LIMS system flags the out of control data.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

1.7.8 Metals by Graphite Furnace and Mercury

A calibration curve of at least three standards is run daily, prior to analysis of samples. The calibration curve must have a correlation coefficient of 0.995 or greater. Afterwards, a midpoint standard is run every ten samples. The apparent concentration of this standard must lie within 10% of the true concentration. If it is not, replace graphite tube if necessary, recalibrate and rerun the samples back to the last standard that met the criteria.

Standards are prepared by diluting commercially available solutions that are NIST traceable.

A calibration blank is run every 10 samples and at the end of the analytical run. The result should not exceed the absolute value of the reporting detection limit. If it is not, it should be repeated. The system should then be cleaned and the samples run since the last blank should be rerun.

A blank and LCS are required for every batch of 20 samples. The blank must be rerun if any analytes are detected above the PQL. If it is determined to be a contamination problem, the batch must be re-prepped and re-analyzed within holding times.

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is

present, two LCSs may be analyzed as matrix QC. If the matrix spike/matrix spike duplicate are not within control limits, the LCS must be within control limits to demonstrate matrix effects. If the LCS is not within control limits, it may indicate an extraction failure. If the samples are within holding times, the entire batch should be re-extracted and analyzed. The LIMS system flags the out of control data.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

1.7.9 Anions by Ion Chromatography

A calibration curve of at least five standards is run daily, prior to analysis of samples. The calibration curve must have a correlation coefficient of 0.995 or greater. Afterwards, a midpoint standard is run every ten samples. The apparent concentration of this standard must lie within 15% of the true concentration. If it is not, recalibrate and rerun the samples back to the last standard that met the criteria.

Standards are prepared by diluting commercially available solutions that are NIST traceable.

A blank and LCS are required for every batch of 20 samples. The blank must be rerun if any analytes are detected above the PQL. If it is determined to be a contamination problem, the batch must be re-prepped and re-analyzed within holding times.

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is present, two LCSs may be analyzed as matrix QC. If the matrix spike/matrix spike duplicate are not within control limits, the LCS must be within control limits to demonstrate matrix effects. If the LCS is not within control limits, the entire batch should be re-analyzed. The LIMS system flags the out of control data.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

1.7.10 SW9060 Total Organic Carbon

Organic carbon in soils is measured using a carbonaceous analyzer. The soil samples are slurried with water and a portion of the water is analyzed in

quadruplicate. The instrument converts the organic carbon in the sample to carbon dioxide. The CO2 formed is measured by an infrared detector.

Since the instrument is linearized, a two point calibration curve is established daily. The calibration is checked with a midpoint LCS which must be within ± 10 percent to proceed with sample analysis. The curve is checked every ten samples with the midpoint. A blank and LCS are required for every batch of 20 samples. If the amount in the blank is greater than the PQL, the batch must be rerun within the holding time of 28 days.

A matrix spike/matrix spike duplicate must be run in every batch of samples. Whenever possible the Jacobs samples must be spiked. If insufficient sample is present, two LCSs may be analyzed as matrix QC. If the matrix spike/matrix spike duplicate are not within control limits, the LCS must be within control limits to demonstrate matrix effects. If the LCS is not within control limits, the entire batch should be re-analyzed within holding times. The LIMS system flags the out of control data.

An MDL study as outlined in Section 1.8.2 is completed annually for each instrument.

1.7.11 SW9081 Cation-Exchange Capacity of Soils

The soil sample is mixed with an excess of sodium acetate solution, resulting in an exchange of the added sodium cations for the matrix cations. Subsequently, the sample is washed with isopropyl alcohol. An ammonium acetate solution is then added, which replaces the absorbed sodium with ammonium. The concentration of displaced sodium is then determined using SW6010 described above. The results will be reported in meq/100 g.

1.7.12 ASTM D2216 Moisture Content

The soil samples must be reported in dry weight. In order to do this, the moisture content must be determined. A portion of sample is weighed into a pre-weighed dish and evaporated to dryness and constant weight at 103-105 degrees centigrade.

This analysis depends on the accuracy of the balance used. For this reason, balances are calibrated weekly with class "S" weights. The recorded weight must agree within 0.1% of the expected weight.

A blank and a duplicate analysis are run for every batch of 20 samples. Whenever possible use the Jacobs samples as the replicates.

1.7.13 Geotechnical Testing

Particle size, specific gravity and permeability will be subcontracted to Kleinfelder in Dublin, California. This laboratory has already performed analyses for McClellan AFB.

1.7.14 Maintenance

Each piece of equipment used in activities affecting data quality is maintained to specifications presented by the manufacturer.

A record of maintenance, including a description of specific activities performed, will be made in the equipment logbook. This book is kept nearby the instrument.

Instruments will be calibrated to proper specifications following maintenance to ensure proper completion of the maintenance procedure. If the equipment or instrument cannot be maintained to manufacturer's specifications or cannot be properly calibrated, it will be returned to the manufacturer or other repair facility for proper maintenance and repair. Upon return from the manufacturer, the instrument is checked for compliance to project specifications before returned to routine use.

1.8 ANALYTICAL PROCEDURES

1.8.1 Standard Methods

Analytical procedures will be in accordance with those specified in USAF HSD/TS Policy for Chemical Analysis of IRP Samples (1987) and the IRP Analytical Protocols (1987). Laboratory analytical methods to be used are taken from Test Methods for Evaluating Solid Waste, ,SW-846 Third Edition (USEPA, 1986), and Methods for Chemical Analysis of Water and Wastes, EPA Manual 600/4-79-020. A listing of the methods to be used for this project can be found in Table 1.8.

1.8.2 Method Detection Limits (MDLs)

The limit of detection is the minimum concentration of a substance that can be measured and reported with 99% confidence that the true value is greater than zero.

The laboratory will calculate the detection/quantitation limits for all requested parameters and matricies in accordance with the EPA Method as defined in the Federal Register, Volume 49 No. 209, page 199, 26 October 1984. Minimum detection limits achievable are based on methods and equipment used. The detection limit will be set at the "worst case" MDL, that is, the highest calculated MDL for the particular compound for the instruments to be used.

The detection limits are revised annually. When a new detection limit study is completed and the Air Force required detection limits are exceeded, the Jacobs project manager is notified. The project manager is then provided a list of those compounds and tests involved so that the Air Force can be made aware of the relief needed.

1.8.3 Practical Quantitation Limits (PQLs)

The PQLs that will be used for this project are given in Table 2-3 of the Handbook For The Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies (RI/FS) September 1993 with the exception of method 8260.

The detection limits and PQLs for this project are found in Table 1.8. Data between the MDL and PQL will be "J" flagged as estimated.

Table 1.8 Project MDLs and PQLs

	Water (mg/L)		Soil (mg/kg)	
	MDL	PQL	MDL	PQL
Chloride (9056)	0.04	0.2		
Fluoride (9056)	0.03	0.2		
Sulfate (9056)	0.09	0.2		
Total Organic Carbon (9060)			4	20
Arsenic (7060)	0.002	0.005	0.2	0.5
Cadmium (7131)	0.0001	0.001	0.007	0.1
Chromium (7191)	0.0005	0.005	0.05	0.5
Lead (7421)	0.002	0.005	0.2	0.5
Selenium (7740)	0.004	0.005	0.4	0.5
Mercury (7470/7471)	0.0001	0.001	0.04	0.1
Metals (6010)				
Aluminum	0.08	0.5	8	50
Antimony	0.04	0.4	4	40
Arsenic	0.04	0.6	4	60
Barium	0.002	0.02	0.2	2
Beryllium	0.0005	0.003	0.05	0.3
Cadmium	0.002	0.04	0.2	4
Calcium	0.06	0.1	6	10
Chromium	0.006	0.07	0.6	7
Cobalt	0.007	0.07	0.7	7
Copper	0.004	0.06	0.4	6
Iron	0.009	0.07	0.9	7
Lead	0.05	0.5	5	50
Magnesium	0.05	0.3	5	30
Manganese	0.002	0.02	0.2	2
Molybdenum	0.01	0.08	1	8
Nickel	0.02	0.1	2	10
Potassium	0.2	5	20	500
Selenium	0.05	0.8	5	80
Silver	0.009	0.07	0.9	7
Sodium	0.07	0.3	7	30
Thallium	0.06	0.4	6	40
Vanadium	0.005	0.08	0.5	8
Zinc	0.006	0.02	0.6	2

Table 1.8 Project MDLs and PQLs
(continued)

	Water (ug/L)		Soil (mg/kg)	
	MDL	PQL	MDL	PQL
TPH - gasoline (5030/8015M)	70	100	0.07	1
TPH - diesel (3520/3550/8100M)	20	1000	0.8	10
TPH - oil (3520/3550/AK103M)	2000	10000	80	100
Chlorinated Pesticides (8080)				
Aldrin	0.008	0.04	0.0003	0.003
alpha-BHC	0.007	0.03	0.0003	0.002
beta-BHC	0.02	0.06	0.0007	0.004
delta-BHC	0.007	0.09	0.0003	0.006
Lindane (gamma-BHC)	0.009	0.04	0.0003	0.003
gamma-Chlordane	0.008	0.1	0.0003	0.009
4,4'-DDD	0.02	0.1	0.0007	0.007
4,4'-DDE	0.01	0.04	0.0004	0.003
4,4'-DDT	0.02	0.1	0.0007	0.008
Dieldrin	0.009	0.02	0.0003	0.01
Endosulfan I	0.01	0.1	0.0004	0.009
Endosulfan II	0.02	0.04	0.0007	0.003
Endosulfan Sulfate	0.02	0.6	0.0007	0.04
Endrin	0.02	0.06	0.0007	0.004
Endrin Aldehyde	0.02	0.2	0.0007	0.02
Heptachlor	0.007	0.03	0.0003	0.002
Heptachlor epoxide	0.02	0.8	0.0007	0.06
Methoxychlor	0.02	1	0.0007	0.1
Toxaphene	0.5	2	0.02	0.2
PCB-1016	0.7	1	0.03	1
PCB-1221	0.9	1	0.03	1
PCB-1232	0.4	1	0.02	1
PCB-1242	0.7	1	0.03	1
PCB-1248	0.4	1	0.02	1
PCB-1254	0.5	1	0.02	1
PCB-1260	0.2	1	0.007	1

Table 1.8 Project MDLs and PQLs
(continued)

	Soil (mg/kg) MDL	PQL
Volatile Organics by GCMS (8240)		
Acetone	0.007	0.1
Benzene	0.0006	0.005
Bromodichloromethane	0.0003	0.005
Bromoform	0.0004	0.005
Bromomethane	0.0009	0.01
2-Butanone (MEK)	0.004	0.1
Carbon disulfide	0.002	0.005
Carbon tetrachloride	0.0007	0.005
Chlorobenzene	0.0004	0.005
Chloromethane	0.0009	0.01
Dibromochloromethane	0.0007	0.005
Chloroethane	0.001	0.01
2-Chloroethylvinylether	0.0009	0.01
Chloroform	0.001	0.005
1,1-Dichloroethane	0.0003	0.005
1,2-Dichloroethane	0.0008	0.005
1,1-Dichloroethene	0.0008	0.005
cis-1,2-Dichloroethene	0.001	0.005
trans-1,2-Dichloroethene	0.0004	0.005
1,2-Dichloropropane	0.0005	0.005
cis-1,3-Dichloropropene	0.0007	0.005
trans-1,3-Dichloropropene	0.0004	0.005
Ethylbenzene	0.0005	0.005
2-Hexanone	0.003	0.05
Methylene chloride	0.0007	0.005
4-Methyl-2-pentanone	0.002	0.05
Styrene	0.0009	0.005
1,1,2,2-Tetrachloroethane	0.0008	0.005
Tetrachloroethene	0.0005	0.005
Toluene	0.0004	0.005
1,1,1-Trichloroethane	0.0006	0.005
1,1,2-Trichloroethane	0.0009	0.005
Trichloroethene	0.0005	0.005
Vinyl acetate	0.001	0.05
Vinyl chloride	0.001	0.01
Xylenes (total)	0.003	0.005

Table 1.8 Project MDLs and PQLs
(continued)

	Water (ug/L)	
	MDL	PQL
Volatile Organics by GC/MS (8260)		
Benzene	0.1	2
Bromobenzene	0.2	5
Bromodichloromethane	0.09	1
Bromoform	0.07	2
Bromomethane	0.1	10
Carbon tetrachloride	0.3	1
Chlorobenzene	0.07	2
Chloromethane	0.3	5
Chlorodibromomethane	0.3	1
Chloroethane	0.1	5
Chloroform	0.1	1
1-Chlorohexane	0.3	5
Dibromomethane	0.1	5
1,2-Dichlorobenzene	0.09	2
1,3-Dichlorobenzene	0.2	3
1,4-Dichlorobenzene	0.2	2
1,1-Dichloroethane	0.08	1
1.2-Dichloroethane	0.3	1
1,1-Dichloroethene	0.06	1
trans-1,2-Dichloroethene	0.1	1
cis-1,2-Dichloroethene	0.5	1
1,2-Dichloropropane	0.4	1
Ethylbenzene	0.09	2
Methylene chloride	0.2	2
Styrene	0.5	5
1.1,2,2-Tetrachloroethane	0.07	1
1,1,1,2-Tetrachloroethane	0.2	5
Tetrachloroethene	0.3	1
Toluene	0.2	2
1,1,1-Trichloroethane	0.3	1
1.1,2-Trichloroethane	0.2	1
Trichloroethene	0.5	1
Trichlorofluoromethane	0.05	1
Vinyl chloride	0.07	2
Xylenes (total)	0.3	2

Table 1.8 Project MDLs and PQLs
(continued)

	Water (ug/L)		Soil (mg/kg)	
	MDL	PQL	MDL	PQL
Base/Neutral/Acid Extractables (8270)				
Acenaphthene	3	10	0.1	0.7
Acenaphthylene	4	10	0.2	0.7
Anthracene	3	10	0.1	0.7
Benzo(a)anthracene	2	10	0.1	0.7
Benzo(b)fluoranthene	2	10	0.1	0.7
Benzo(g,h,i)perylene	2	10	0.1	0.7
Benzo(a)pyrene	2	10	0.1	0.7
Benzyl Alcohol	4	20	0.2	1.3
bis(2-Chloroethoxy)methane	5	10	0.2	0.7
bis(2-Chloroethyl)ether	5	10	0.2	0.7
bis(2-Chloroisopropyl)ether	5	10	0.2	0.7
bis(2-Ethylhexyl)phthalate	3	10	0.1	0.7
4-Bromophenyl phenyl ether	3	10	0.1	0.7
Butyl benzylphthalate	3	10	0.1	0.7
4-Chloroaniline	5	20	0.2	1
2-Chloronaphthalene	6	10	0.2	0.7
4-Chlorophenyl phenyl ether	3	10	0.1	0.7
Chrysene	2	10	0.1	0.7
Dibenz(a,h)anthracene	2	10	0.1	0.7
Dibenzofuran	3	10	0.1	0.7
Di-n-Butylphthalate	3	10	0.1	0.7
1,2-Dichlorobenzene	4	10	0.2	0.7
1,3-Dichlorobenzene	4	10	0.2	0.7
1,4-Dichlorobenzene	4	10	0.2	0.7
3,3'-Dichlorobenzidine	3	20	0.1	1
Diethylphthalate	4	10	0.2	0.7
Dimethylphthalate	4	10	0.2	0.7
2,4-Dinitrotoluene	3	10	0.1	0.7
2,6-Dinitrotoluene	4	10	0.2	0.7
Di-n-octylphthalate	2	10	0.1	0.7
Fluoranthene	3	10	0.1	0.7
Fluorene	3	10	0.1	0.7
Hexachlorobenzene	2	10	0.1	0.7
Hexachlorobutadiene	4	10	0.2	0.7
Hexachlorocyclopentadiene	3	10	0.1	0.7
Hexachloroethane	4	10	0.2	0.7
Indeno(1,2,3-cd)pyrene	4	10	0.2	0.7
Isophorone	5	10	0.2	0.7

Table 1.8 Project MDLs and PQLs
(continued)

	Water (ug/L)		Soil (mg/kg)	
	MDL	PQL	MDL	PQL
Base/Neutral/Acid Extractables (8270) (continued)				
2-Methylnaphthalene	4	10	0.2	0.7
Naphthalene	5	10	0.2	0.7
2-Nitroaniline	4	50	0.2	3
3-Nitroaniline	4	50	0.2	3
4-Nitroaniline	4	50	0.2	3
Nitrobenzene	5	10	0.2	0.7
n-Nitrosodiphenylamine	3	10	0.1	0.7
n-Nitrosodipropylamine	5	10	0.2	0.7
Phenanthrene	3	10	0.1	0.7
Pyrene	3	10	0.1	0.7
1.2,4-Trichlorobenzene	4	10	0.2	0.7
Acid Extractables (8270)				
Benzoic acid	30	50	1	1
4-Chloro-3-methylphenol	4	20	0.2	1
2-Chlorophenol	4	10	0.2	0.3
2.4-Dichlorophenol	4	10	0.2	0.3
2.4-Dimethylphenol	4	10	0.2	0.3
4.6-Dintro-2-methylphenol	5	50	0.2	3.3
2.4-Dinitrophenol	3	50	0.1	3
2-Methylphenol	4	10	0.2	0.3
4-Methylphenol	7	10	0.3	0.3
4-Nitrophenol	5	10	0.2	0.3
4-Nitrophenol	3	50	0.1	1
Pentachlorophenol	3	50	0.1	3
Phenol	3	10	0.1	0.3
2.4.5-Trichlorophenol	4	50	0.2	3
2.4.6-Trichlorophenol	4	10	0.2	0.3

Table 1.8 Project MDLs and PQLs
(continued)

	Water (mg/L) MDL	PQL
TCLP		
INORGANICS:		
Selenium (7740)	0.004	0.005
Mercury (7470)	0.0001	0.001
Metals (6010)		
Arsenic	0.04	0.6
Barium	0.002	0.02
Cadmium	0.002	0.04
Chromium	0.006	0.07
Lead	0.05	0.5
Silver	0.009	0.07

ORGANICS:	Water (ug/L) MDL	PQL
Chlorinated Pesticides (8080)		
Lindane (gamma-BHC)	0.009	0.04
gamma-Chlordane	0.008	0.1
Endrin	0.02	0.06
Heptachlor	0.007	0.03
Heptachlor epoxide	0.02	0.8
Methoxychlor	0.02	1
Toxaphene	0.5	2
Volatile Organics by GCMS (8240)		
Benzene	0.6	5
2-Butanone (MEK)	4	100
Carbon tetrachloride	0.8	5
Chlorobenzene	0.4	5
1,4-Dichlorobenzene	1	5
Chloroform	1	5
1,2-Dichloroethane	0.8	5
1,1-Dichloroethene	0.6	5
Tetrachloroethene	0.5	5
Trichloroethene	0.5	5
Vinyl chloride	1	10

Table 1.8 Project MDLs and PQLs
(continued)

	Water (ug/L) MDL	PQL
TCLP (cont'd)		
Base/Neutral/Acid Extractables (8270)		
2,4-Dinitrotoluene	3	10
Hexachlorobenzene	2	10
Hexachlorobutadiene	4	10
Hexachloroethane	4	10
Nitrobenzene	5	10
Pyridine	10	50
Acid Extractables (8270)		
o-Cresol	3	10
m-Cresol	3	10
p-Cresol	3	10
Pentachlorophenol	3	50
2,4,5-Trichlorophenol	4	50
2,4,6-Trichlorophenol	4	10

1.9 DATA REDUCTION, VALIDATION, AND REPORTING

The deliverables package for this project consists of the Analytical Report with dry weight results, QC report, case narrative, white chain of custody copies and the Electronic Data Transfer (EDT). This section describes the processes by which the laboratory information arrives at this end stage.

1.9.1 Data Reduction

Most of the data produced in the laboratory is generated through the use of dedicated instrumentation with microcomputer interfaces. These PC-based systems receive the original signal from the instrument to which the sample or extract has been submitted. The PC--or, for some larger instruments, a dedicated minicomputer--transforms the raw signal into a quantitative value. An experienced analyst reviews this "candidate" result, either on-screen or on a paper printout. Identifications are verified, quantitative reviews this "candidate" result, either on-screen or on a paper printout. Identifications are verified, quantitative formulas are doublechecked, and final numerical values are acquired.

Data flags are applied at this time to call attention to confirmations, blank contamination or surrogate outliers or dilutions. The flags are entered by leaving a space between the result and the flag.

Whenever a result has been confirmed by second column analysis, the primary column result must have a "C" flag entered next to the result, i.e 0.88 C.

Whenever an analyte of interest is present in the laboratory blank at or above the reporting detection limit the positive sample results must be flagged with a "B." This applies even when the results are orders of magnitude higher than the level found in the blank.

Most of the flags are applied to surrogate results. When the surrogates are out of control, a "Q" flag is entered into the

Whenever an analyte of interest is present in the laboratory blank at or above the reporting detection limit the positive sample results must be flagged with a "B." This applies even when the results are orders of magnitude higher than the level found in the blank.

Most of the flags are applied to surrogate results. When the surrogates are out of control, a "Q" flag is entered into the data base at the time of data entry. If an extractable sample was diluted tenfold or greater, an "NC" flag is used to indicate

that the compound was "Not Calculated" due to the dilution. In rare instances an "NS" flag may be used to indicate that the compound was "Not Spiked."

The analyst then enters calculated results or checks off computer-produced results directly into the computer.

Some instruments are configured to operate independently without computers. For these, the signal is recorded as a strip chart trace, numerical output on a printer strip, or direct reading from a digital or analog dial. In such cases, additional work is required by the analyst to reduce the data to a reportable format. The original signal must be multiplied ba a calibration factor or compared with a standard curve. The aliquot result must be divided by the mass or volume of sample to produce a concentration-based result. Most calculations are performed on scientific calculators; simple programs are used for some. All of these data are recorded in a dedicated bench book for the particular determination in question. Results for single or multiple component tests are hand-entered by the analyst in the assigned book.

Some lab tests, such as titrations or sensory evaluations, are not instrumented. For these, the quantitative result or observation is recorded directly in a bound book by the assigned analyst. Calculations like those described above may be needed; these are recorded in the same book.

For all methods of data reduction, the final analytical value is entered into the laboratory LIMS. Ancillary information, such as analyst name, method number, equipment ID, and so forth, is entered into the computer system.

1.9.2 Data Validation

Data validation at BCA has two principal components. Expert human evaluation is accompanied by automated systems for data checking. After all results for the day are input to the LIMS, a batch process is invoked to produce work approval sheets (WAPS). Printed out overnight, the WAPS display each result as it was entered, and carry a blank space for each value on which the results approver will initial the item. In the process of generating the WAPS, a computer program compares QC results with archived limits for both reagent (LCS) and matrix spikes. These limits are updated in each laboratory on a yearly basis, with none to be greater than those established in EPA methods. Parameters for which there are less than 30 values per year will be evaluated using method-published QC limits. The most recently determined laboratory QC limits for the Glendale laboratory are listed in Table 1.3.

If there are not sufficient QC reported with the analytical batch, or if the reported QC fails the limits, a special report called the Early Warning Report (EWR) is printed for that test. Where warning limits only have been exceeded, the EWR and WAPS both contain results on the samples of interest. Then the assigned approver -- usually the federal team member or resource manager -- may evaluate the data for reporting purposes. If that evaluation leads to a decision to report, the WAPS may be initialled and the process continued. If not, corrective action is taken and the batch is subject to reanalysis. If control limits (more strict than warning limits) are exceeded, the results appear only on the EWR; not on the WAPS. That process forces review of the outlier results, including special manual entry of approval to release any of the records for the batch.

All of the automated review is supplemental to the expert review by the analyst and reviewer. Each analyst reviews his or her own work for consistency and compliance with QC criteria at the time it is entered into the LIMS. The data approvers regularly review run logs, raw data packages, and bench books. These are stamped with a review notice and signed and dated by the reviewer.

Final validation occurs after all results have been approved through the WAPS process. When a report is complete in the data base, another computer program prints it. The hardcopy output is reviewed by a trained, designated final inspector. Under the direction of the Client Manager, this individual verifies the consistency and reasonableness of all results.

1.9.3 Reporting

After the initial report review several other programs are run to begin the careful review of all Jacobs data and preparing the final deliverable. This process is presented in Figure 1.9-1 and listed in the Standard Operating Procedure CS00393, Figure 1.9-2.

The data is then prepared for the final package. The report is checked for QC completeness. If the batches are not complete, the data is set back for review and correction. The order QC report is printed to evaluate any out of control incidences which must be reported on in the case narrative. The data base is updated to remove any unnecessary or unneeded work items. The Batch Supplemental Report is printed to check for correct method numbers, dates or any missing information. The surrogate recoveries are evaluated for potential flagging. The order is then reviewed through the predownload review program. This program checks for potential download errors such as unnecessary work items or the presence of control characters. The report is then downloaded to

Download Procedure

9/2/93

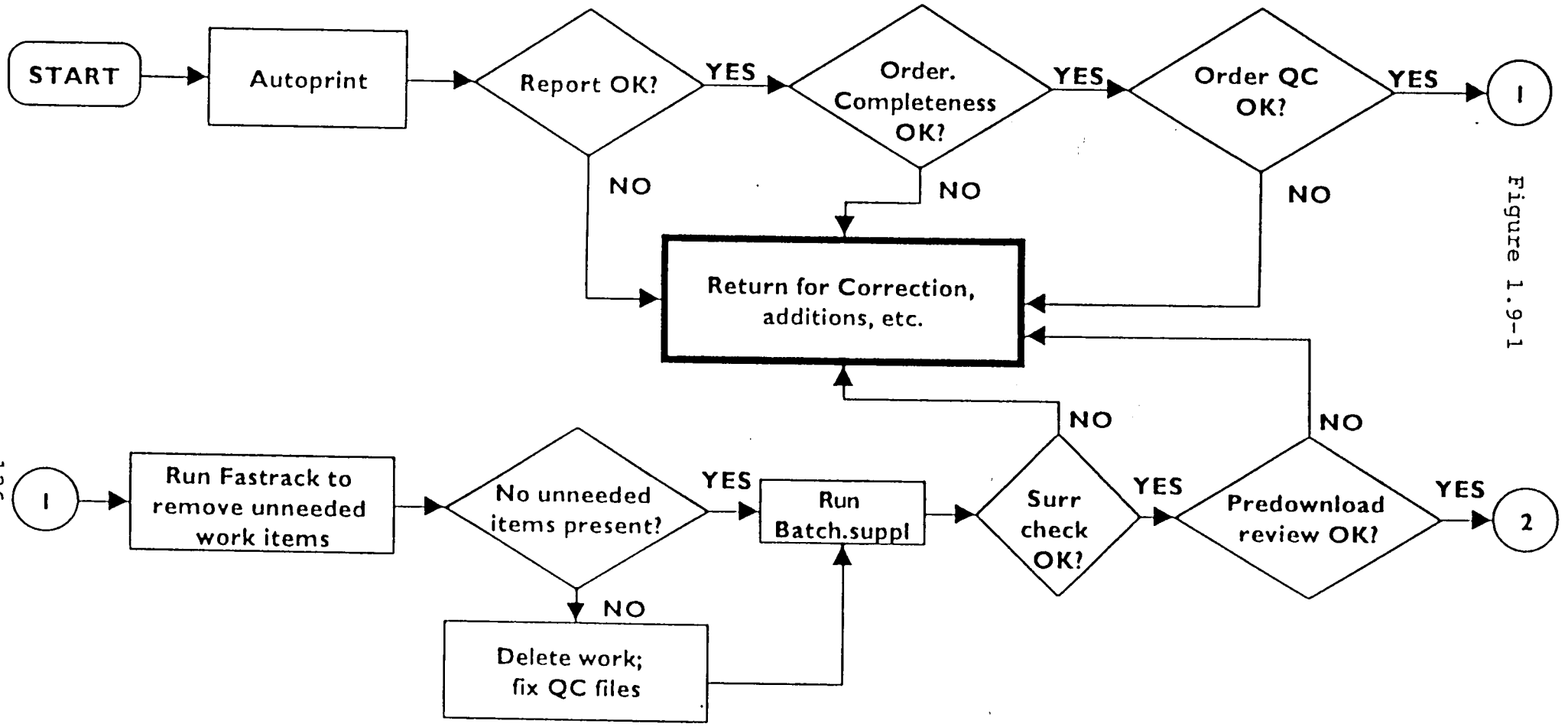


Figure 1.9-1

Figure 1.9-2

DOWNLOAD PRODUCTION

A. Summary

This SOP is to be used for all reports requiring electronic data transfer (EDT) via modem or diskette to insure that the client receives hard copy and diskette that match. The same dry weight conversion program is used for both reporting and downloading the data, ensuring that the analytical results match. The download program collects all of the batch information and places it in a temporary file called XANALYSIS. There is only one XANALYSIS file, so particular care must be given to the review process so that the time spent in the XANALYSIS file will be productive. The review steps in this SOP identify many of the errors that can be corrected prior to the actual data download.

B. Step 1

The report is completed and provided to the reviewer, usually through the autoprint program. The report is reviewed for decimal point, date or data entry errors. Any questions are routed back to the analyst or team member.

C. Step 2

An ORDER.COMPLETENESS (P report is run to be sure that all pertinent information is available for every batch. If it is not, return to the team member or analyst for correction or completion.

D. Step 3

The order QC program is run to review out of control incidences and to document them in the case narrative. The report is reviewed for possible data entry errors such as extra decimal points or wrong dates. Anything with greater than 200 percent recovery or less than 10 percent recovery should be checked with the analyst or team member.

E. Step 4

After it is determined that the order and its QC are complete, any outstanding work items are removed through the

data entry program. The work is selected as a list and deleted as appropriate. The SAMPLES.QC file is adjusted to match the work file deletions.

F. Step 5

The BATCH.SUPL program is run to list the samples and the associated method and instrument numbers. This list is reviewed for completeness and correct method numbers.

G. Step 6

The samples of interest are collected from the samples list (SI) and the surrogate recoveries are reviewed for out of control incidences through the SURR.CHECK program. The surrogates that are out of control must have a Q flag and are included in the case narrative. For samples that are diluted, the NC, Not Calculated, flag is applied. These are also included in the case narrative. Each flag must be on line 31 of the samples file and must be hand entered at this time.

H. Step 7

The PREDOWNLOAD review program is run next. This program checks for method/matrix consistency, reporting detection limit (RDL) violations through the RDL.CHECK program, repeats the SURR.CHECK program and removes control characters that have accidentally been entered. The samples and QC information are listed and can be reviewed for correct units, prep methods, batch numbers, dates and method numbers. Any missing or erroneous data should be corrected at this time, minimizing the amount of time used in the XANALYSIS file.

I. STEP 8

The download program is then run. Each download program is tailored to each client's requirements. The first step is to collect the samples and QC information through the SOBI program. This list may be edited at this time to remove unnecessary QC. The second step may be a listing of the samples and QC involved in the download or it may actually be the download. There is only one download file at this time.

IT IS EXTREMELY IMPORTANT TO BE SURE NO ONE ELSE IS USING THE PROGRAM AT THIS POINT!! YOU MAY OVERWRITE SOMEONE ELSE'S FILE!!

Other steps in the program convert the results to dry weight and remove extra QC such as the theoretical results for spikes and laboratory control standards. Special reporting formats are also put into place during these steps.

One of the most important steps is the error report. The program lists all of the errors found and what the cause might be. These usually include results reported below the RDL and other missing information.

The contents of the XANALYSIS file are printed out and reviewed. Items to look for include prep method numbers, completeness of QC and data, instrument numbers, dates analyzed and detection limits. Any identified corrections must be made in either the SAMPLES or SAMPLES,QC files.

The XANALYSIS file is then copied to the hard drive and then to the diskette.

J. Step 9

To be sure the data reported in the diskette matches what is in the hard copy report, all report information is printed at this time. This includes the dry weight or analytical report, BATCH.SUPL, SURR.CHECK and Order QC.

K. References or Knowledgeable People

This SOP is based upon a 9/2/93 Tier 1 SOP that is available from Linda Geddes or Jim Carter.

Several people have been trained to run downloads. These people include Maria Adriance, Colin Dimock, Linda Geddes, Carol McHale, Sue Snyder and Steve Wong.

If these people are unavailable or can't solve the problem, Kit Wong or Tom Robinson should be contacted.

Reviewed and approved
T. Kirk 10/07/93
Issued _____

provide the electronic deliverable according to the JEMS Laboratory Data Submission Handbook Version 2.1 attached as Appendix A.

At the completion of this SOP, all of the associated reports are immediately reprinted so that they match the electronic deliverable.

A case narrative is prepared to include the following information: condition upon receipt, holding time compliance, surrogate recoveries, batch outliers and method blanks. An example case narrative is presented in Figure 1.9-3.

Finally, the completed report is presented to the Laboratory Director or Manager for final review and signature.

The majority of the samples also require full data packages. This includes all summary forms for calibration standard analyses, method blank summary forms, matrix spike and matrix spike duplicate (MS/MSD) summary forms, blank spike and blank spike duplicate summary forms and QC sample forms. Hard copies of raw data will also be enclosed. The laboratory staff will be following SOP QA00189 presented in Figure 1.9-4 in preparing the packages.

1.9.4 Contract Mangement and Invoicing

1.9.4.1 Contracts

This project will fall under new Jacobs' contracting. The specifics are not known at this time. A delivery order will be issued for the work that will include the tests we are authorized to perform, instructions for delivery of results and instructions for invoicing.

1.9.4.2 Client Contract File

In order to charge the correct prices, a file of contract information is maintained on the BCA LIMS system. The file is set up using information taken from the delivery orders. The file includes contract number for invoicing purposes, prices per determination code, the maximum dollar value, value of the contract to date and the period of performance.

The contract number/project number, prices and expiration date of the contract are automatically added to travellers when the samples are logged in. If the value to date is within 80% of the contract ceiling, a warning message is printed. If the contract ceiling has been reached, an error message prints on the travellers. If a determination code is used that is not in the client contract file, a "c"

Figure 1.9-3

G9309167 Case Narrative

Sample Receipt

All samples were received in good condition and cold at 2°C.

Sample MC-C946505 was held at time of sample receipt the sample was a blank water. The analysis requested on the c-o-c was for organic lead, the sample was a water quality samples for a method not being analyzed for in the soil samples and therefore would be irrelevant to the data being generated by the soil analyses.

Holding Times

All samples were extracted and analyzed within their designated holding times.

Surrogate Recovery

The surrogate Tetachloro-meta-xylene for sample MC-C946501 was below BCA specified control limits and therefore, flagged with the "Q" qualifier. Since the other surrogate was within control, no problems were encountered with the matrix spike or matrix spike duplicate, the data was reported.

Analytical Data

No problems encountered or qualifiers added to the analytical section of this work order.

QC Data

8270 Batch 93210:

The "Q" qualifier was used for Benzoic acid on LCS C3092528*1, since the percent recovery were greater than specified QC limits. It has been the labs experience that certain compounds like Benzoic acid, tend to yield poor calibration stability.
The compound 4-Nitrophenol was also flagged with the "Q" qualifier as the percent recovery was greater than specified QC limits. Per BCA protocol, since the full compound list is spiked, up to three compounds can be out before re-extraction is required.

8080 Batch 93253:

The "Q" qualifier was used for Endrin aldehyde on LCS ID: C3092395*1. The percent recovery was below BCA specified control limits. All other compounds and surrogates are within control limits, therefore the data was reported.

Aluminum Batch 931306:

Due to the aluminum concentration found in this sample (9309165*1), the matrix spike recovery and matrix spike duplicate recovery was not able to be calculated. When the sample result is greater than four times the spike added concentration; the spike added concentration is deemed insignificant since it is diluted out.

Barium Batch 931306:

Due to the barium concentration found in this sample (9309165*1), the matrix spike recovery and matrix spike duplicate recovery was not able to be calculated. When the sample result is greater than four times the spike added concentration; the spike added concentration is deemed insignificant since it is diluted out.

Calcium Batch 931306:

Due to the calcium concentration found in sample (9309165*1), the matrix spike recovery and matrix spike duplicate recovery was not able to be calculated. When the sample result is greater than four times the spike added concentration; the spike added concentration is deemed insignificant since it is diluted out.

Manganese Batch 931306:

Due to the concentration of manganese in sample (9309165*1), the matrix spike recovery and matrix spike duplicate recovery was not able to be calculated. When the sample result is greater than four times the spike added concentration; the spike added concentration is deemed insignificant since it is diluted out.

Iron Batch 931306:

Due to the concentration of iron in sample (9309165*1), the matrix spike recovery and matrix spike duplicate recovery was not able to be calculated. When the sample result is greater than four times the spike added concentration; the spike added concentration is deemed insignificant since it is diluted out.

Magnesium Batch 931306:

Due to the concentration of magnesium in sample (9309165*1), the matrix spike recovery and matrix spike duplicate recovery was not able to be calculated. When the sample result is greater than four times the spike added concentration; the spike added concentration is deemed insignificant since it is diluted out.

Manganese Batch 931324:

The "Q" qualifier was added to the matrix spike duplicate on sample 9309186*21. The percent recovery was greater than specified QC limits. Since the LCS data was acceptable and the RPD's were acceptable, the data was reported.

Method Blanks:

No problems were associated with the method blanks in this order.

S. Snyder 10/27/93

Figure 1.9-4 Data Package SOP

PRODUCING LEVEL III QC DATA PACKAGES

A. Summary

The Level III QC package is intended to comply with the EPA Region IX recommendations for a non-CLP data package. Clients will require the Level III QC when they need to have their data validated. The E&E and ICF documents, developed for EPA Region IX, were used as the source of information for this SOP. The EPA guidelines were "translated" to match the BCA batch QC process. This data package will meet EPA's criteria for validation, as well as fit with BCA's operations.

B. Division of Responsibilities

Client Services/Project Manager Responsibilities

1. Notify Sample Receipt of expected Level III work. Write Work Alert.

2. Notify supervisors/group leaders of Level III QC requirements, including sample receipt.

3. Fill out and distribute check lists to appropriate supervisors.

4. Prepare Table of Contents for Level III QC report.

5. Summarize orders, dates sampled, dates received, dates extracted and dates analyzed. This information can be retrieved using INFO.ACCESS.

6. Obtain copies of analytical reports.

7. Work with the supervisors on the final draft of the case narrative.

8. Final review of entire data package.

Sample Receiving Responsibilities

1. Check for adequate sample on whole bottle extractions. If insufficient sample for MS or MSD, request two LCS's to be run in lieu of spikes.

2. Identify Level III QC report on worksheet notes. The project manager needs to provide: work alert, FIX.FORM with QA instructions, work notes, check lists and individual interaction.

3. Chain-of-custody forms.

4. Interlab chain-of-custody forms.

5. Login for moisture (soils).

Operations Responsibilities

1. Follow specific worknotes on requirements of the project.

2. Compile the raw data.

3. Complete analytical Level III forms including the case narrative form.

4. Check the data for completeness.

5. Submit the raw data, summary sheets and other forms to the project manager.

C. Package Compilation Schedule

1. The Project Manager (PM) writes the Work Alert and talks to Sample Receipt about the work and how to login the samples.

2. The PM distributes the Level III checklists to the supervisors when the samples arrive.

3. Supervisors provide analysts with assignments and pass the appropriate forms along.

4. The analyst completes the analytical forms and the case narrative form during the batch analysis.

5. The raw data, completed analytical forms and case narrative form are turned in to the designated group leader or supervisor for approval.

6. The supervisor/group leader does a completeness check with respect to the enclosed checklists and the case narrative form, then submits the data to the PM for final review, copying, and final assembly.

7. The final draft of the case narrative is written by the supervisor/group leader or PM, as previously arranged.

8. The data is organized by method and by batch, unless

prior arrangements have been made with the client. Each section is divided by colored separators. The final package is reviewed by the QA Coordinator and the PM.

9. The clerical group numbers the pages (as required) and makes three copies.

10. The PM provides the client with one copy, assembled in manila folders, and one copy which is bound. One bound copy will be kept on file by the laboratory.

D. References or Knowledgeable People

The best written reference is either a copy of the ICF guidelines, dated February, 1989 or the E&E guidelines, dated May, 1988. Both of these are on file with the QA Coordinator.

Reviewed and approved
J. Freemeyer 01/29/90
Issued _____

INORGANICS/GENERAL CHEMISTRY AND TRACE METALS CHECKLIST

For each method:

1. SOP/EPA Method. Use the EPA method if no formal SOP exists.

2. MDL summary sheet with supporting documentation (raw data). Note the instance when an MDL study is in progress or scheduled to be completed at a future time.

3. Computer run-log, if ICP metals or 418.1 (IR-Glendale only)

4. Prep, if applicable
   a. Method/SOP
   b. Analysis log including date, log number, sample description, client (optional), analyst, initial wt/vol, final volume
   c. Spiking and LCS solutions: compound concentrations and amounts added
   d. Moisture

5. Summary tables
   a. Blank summary
   b. Duplicate/Matrix Spike summary
   c. LCS summary
   d. ICS (Interference Check Standard) summary for ICP
   e. Acceptance limits for method
   f. Continuing calibration summary table (trace metals)

6. Raw data for each analytical batch
   a. Method blank
   b. LCS
   c. Duplicate
   d. Matrix spike
   e. Matrix modifier should be documented in the notebook.
   f. Environmental samples
   g. Calibration raw data
      1) initial calibration
      2) calibration verification

7. Case narrative, this applies to each sample batch, rather than to each sample. Include explanations for each:
   a. Deviation from the SOP
   b. Rerun
   c. Dilution
   d. Matrix interference
   e. Holding time violations
   f. Were QC criteria met
   g. Were alternate analytical procedures necessary

GC/LC ORGANICS/PESTICIDES, HERBICIDES, GC VOLATILES AND FUELS CHECKLIST

For each method:

1. SOP/EPA Method

2. MDL summary sheet with copies of MDL chromatograms

3. Run-log

4. Prep
   a. Method and SOP
   b. Copies of prep raw data
   c. Spiking, LCS, and Surrogate solutions: compound concentrations and amounts added
   d. Moisture

5. Summary tables
   a. Blank summary
   b. Matrix spike/matrix spike duplicate summary
   c. LCS summary
   d. Surrogate percent recovery summary, if applicable.
   e. Continuing calibration summary
   f. Retention time window summary, (601/8010, 602/8020, 608/8080 and other methods by prior arrangement))
   g. Endrin/DDT degradation summary, if 608/8080
   h. Acceptance limits for method

6. Raw data for each analytical batch, primary and confirmation columns
   a. Method blank chromatograms
   b. LCS chromatograms
   c. Matrix spike chromatograms
   d. Matrix spike duplicate chromatograms
   e. Daily mid-point calibration
   f. OP-series calibration check, if 608/8080
   g. Environmental samples
   h. DDT/Endrin chromatograms, if 608/8080

7. Initial calibration raw data, primary and confirmation columns
   a. Initial calibration
   b. OP-series calibration, if 608/8080

8. Case narrative, this applies to each sample batch, rather than to each sample. Include explanations for each:
   a. Deviation from the SOP
   b. Rerun
   c. dilution
   d. Matrix interference
   e. Holding time violations
   f. Were QC criteria met
   g. Were clean-up procedures required

GC/MS ORGANICS - VOLATILES AND SEMIVOLATILES CHECKLIST

1. SOP

2. MDL Summary sheet with copies of MDL chromatograms

3. Analysis run-log

4. Prep, if applicable (including clean-up procedures)
   a. Method and SOP
   b. Copies of prep raw data
   c. Spiking, LCS, and Surrogate solutions: compound concentrations and amounts added

5. Summary tables
   a. Surrogate percent recovery summary (Form II)
   b. Matrix spike/matrix spike duplicate summary (Form III)
   c. Method blank summary (Form IV)
   d. GC/MS tuning and mass calibration (Form V)
   e. Acceptance limits for each method
   f. Daily calibration (VII)

6. Raw data for each analytical batch
   a. Method blank
   b. LCS
   c. Matrix spike
   d. Matrix spike duplicate
   e. Daily mid-point calibration check
   f. Environmental samples

7. Initial calibration raw data (Form VI)
   a. Initial calibration

8. Case narrative, this applies to each sample batch, rather than to each sample. Include explanations for each:
   a. Deviation from the SOP
   b. Rerun
   c. Dilution
   d. Matrix interference
   e. Holding time violations
   f. Were QC criteria met
   g. Were Clean-up procedures required

LEVEL III CHECKLIST

To: From:

Order: Matrix:

# of Samples: Data Package Due Date:

Analysis: Sample Prep

* Check off the following information and submit to the Project Manager.

Batch: _____ Date_____
(submit one form for each batch)

Copy of Notebook Page(s):
(all pages, reduced to 90 percent)

Including

- O Spike solutions; lot number; amount (conc. and volume)
- O LCS Solutions; lot number; amount (conc. and volume)
- O Surrogate solution; lot number; amount (conc. and volume)
- O Solvent/acid lot number
- O Deviations from SOP.
- O Standard Reference Logbooks

LEVEL III CHECKLIST

To: From:

Order: Matrix:

# of Samples: Data Package Due Date:

Analysis: General Chemistry _____

_____

* Check off the following information and submit to the Project Manager.

Batch: _____ Date_____
(submit one form for each batch)

Summary Form (copy attached)

- O QC Summary Sheet
- O Case Narrative

Raw Data

- O Calibration Standards
- O Instrument Blank (if applicable)
- O Method Blank
- O Samples
- O Duplicate
- O Spike
- O LCS

Other Data

- O Copy of Standard Log (reduce to 90 percent)
- O Copy (all pages) of notebook (reduce to 90 percent)

LEVEL III CHECKLIST

To: From:

Order: Matrix

# of samples: Data Package Due Date:

Analysis: Trace Metals_____

_____

* Check off the following information and submit to the project manager.

Batch: _____ Date_____
(Submit one form for each batch)

Summary form (copy attached)

- O QC summary sheet
- O Case Narrative

Raw Data

- O Calibration Standards
- O Instrument blank (if applicable)
- O Method Blank
- O Samples
- O Duplicate
- O Continuing Calibration
- O Spike (and spiking solutions documentation)
- O LCS (and LCS solution documentation)
- O Run log for ICP

The data packages will be complete if the analytical documentation in notebooks contain:

1. Time of reading, if available
2. Matrix modifier used (if not specified in SOP)
3. Injection volume (GFAA)
4. R value
5. RPD value
6. Rerun and reprep cross-reference (close loops)
7. Hand date/initial each page
8. ICS at start and end of ICP runs
10. Date/time standards were made
11. Case narrative of problems/deviations
12. Corrective action - date initiated

LEVEL III CHECKLIST

To: From:

Order: Matrix:

# of Samples: Data Package Due Date:

Analysis: 601/8010, 602/8020, 608/8080

*Check off the following information and submit to the Project Manager.

Batch: _____ Date_____
(submit one form for each batch)

	Primary Column	Confirmation Column
Summary Forms		
O	DDT-Endrin Deg. (608/8080)	
O	Continuing Calibration	Continuing Calibration
O	Method Blank	Method Blank
O	Surrogate Recoveries	
O	Spike/Duplicate Spike	
O	LCS	
O	Retention Time Summary	Retention Time Summary
O	Case Narrative	
Raw Data		
O	DDT-Endrin Deg. (608/8080)	
O	Continuing Calibration	Continuing Calibration
O	Method Blank	Method Blank
O	Samples	Samples
O	Spike	
O	Duplicate Spike	
O	LCS	
Other Data		
O	Five Point Calibration	Five Point Calibration
O	Copy of Run Log	Copy of Runlog
O	Copy of Standards Log	Copy of Standards Log

Reduce all laboratory notebook pages to 90 percent. Copy both pages from two page layouts. If a dual column system is used for confirmation only one copy of the standard log is necessary.

LEVEL III CHECKLIST

To: From:

Order: Matrix:

# of Samples: Data Package Due Date:

Analysis: Other GC, HPLC, Non-Routine

Determination:

* Check off the following information and submit to the Project Manager.

Batch: _____ Date_____
(submit one form for each batch)

Summary Form (copy attached)

- O QC Summary Sheet
- O Case Narrative

Raw Data

- O Calibration Standards
- O Method Blank
- O Samples
- O Spike
- O Duplicate Spike
- O LCS
- O Continuing Calibration
- O Confirmation Data (if applicable)

Other Data

- O Copy (both pages) of Run Log (reduced to 90 percent)
- O Calibration Curve
- O Copy of Standard Log (reduced to 90 percent)

LEVEL III CHECKLIST

To: From:

Order: Matrix:

# of Samples: Data Package Due Date:

Analysis: 624/8240

*Check off the following information and submit to the Project Manager

Date of Analysis Batch:
(Submit one form for each batch)

Summary Forms (copies attached)

- O Result Sheet for Each Sample
- O Surrogate Recovery
- O Spike/Duplicate
- O Blank
- O Tuning
- O Calibration Curve
- O Continuing Calibration Check
- O IS Areas
- O Case Narrative

Raw Data (in order run)

- O BFB
- O Calibration Check
- O Blank
- O Samples
- O Spike
- O Duplicate Spike
- O LCS

Other Data

- O Five point calibration curve raw data
- O Copy (both pages) of run log (reduced to 90 percent)
- O Copy of Standard Log (reduce to 90 percent)

LEVEL III CHECKLIST

To: From:

Order: Matrix:

# of Samples: Data Package Due Date:

Analysis: 625/8270

*Check off the following information and submit to the Project Manager

Date of Analysis Batch:
(Submit one form for each batch)

Summary Forms (copies attached)

- O Result Sheet for Each Sample
- O Surrogate Recovery
- O Spike/Duplicate
- O Blank
- O Tuning
- O Calibration Curve
- O Continuing Calibration Check
- O IS Areas
- O Case Narrative

Raw Data (in order run)

- O DFTPP
- O Calibration Check
- O Blank
- O Samples
- O Spike
- O Duplicate Spike
- O LCS

Other Data

- O Five point calibration curve raw data
- O Copy (both pages) of run log (reduced to 90 percent)
- O Copy of Standard Log (reduced to 90 percent)

LEVEL III CHECKLIST

To: From:

Order: Matrix:

# of Samples: Data Package Due Date:

Analysis: QC Supplements - SOPs and MDL Package

* Check off the following information and submit to the Project Manager.

1. SOPs for Methods:

   a)
   b)
   c)
   d)
   e)
   f)
   g)

2. MDL Studies (Summary sheets plus raw data) for methods.

   a)
   b)
   c)
   d)
   e)
   f)
   g)

3. Retention Time Windows (raw data plus calculations) for methods.

   a)
   b)
   c)

QUALITY CONTROL SUMMARY SHEET

Parameter: _____

Batch Date: _____

Sample (R1) ID or Log Number: _____

Duplicate (R2) ID or Log Number: _____

Spike (S1) ID or Log Number: _____

Method Blank Result: _____

Sample (R1) Result: _____

Duplicate (R2) Result: _____

RPD: _____

RPD Limits: _____

Conc. Spike Added: _____

Percent Recovery: _____

Recovery Limits: _____

LCS Recovery: _____

LCS Limits: _____

Comments:

LEVEL III CASE NARRATIVE

TO: _____ FROM: _____
Method # _____ BCA SOP # _____
Batch # _____ Sample #s _____
Analyst _____ Date _____ _____
Supervisor _____ Date _____ _____

1. Were there any deviations from the SOP/Method? If so, explain. (Examples: unusual sample size, matrix modifiers, alternate instrument parameters)

2. Were holding times met? Explain failures.

3. Were matrix effects noted? (Examples: high background, interferences, odor, color)

4. Indicate which samples were diluted, how much, and why.

5. Indicate which samples underwent cleanup procedures, why and which procedure was used.

6. Were all QC criteria met? (see QC Summary Sheet) Explain failures.

7. Were reruns required? Why? Indicate sample number(s) and batch number(s) of rerun(s).

8. Model calculations (or SOP reference).

9. Notes. (Examples: instrument problems, broken samples, contamination)

Level III
Surrogate Recovery Summary

Method : _____ Matrix Type : _____

Log No. : _____ Batch No. : _____

	Sample Log No.	Surrogate Recovery	Comments
01			
02			
03			
04			
05			
06			
07			
08			
09			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Surrogate = _____
QC Limits = _____
* = Surrogate outside limits
D = Suggogate diluted out.

Level III
METHOD BLANK SUMMARY

Method: _____

Log No. : _____ Batch NO. : _____

Matrix : (soil/water) _____ Level : (low/med) _____

Date Extracted : _____ Extraction : (5030/3550/3510) _____

Date Analyzed : _____ GC Column ID (1) : _____

Time Analyzed : _____ GC Column ID (2) : _____

Instrument ID : _____

This method blank applies to the following samples:

	SAMPLE LOG NO.	DATE ANALYZED		SAMPLE LOG NO.	DATE ANALYZED
01			02		
03			04		
05			06		
07			08		
09			10		
11			12		
13			14		
15			16		
17			18		
19			20		

COMMENTS : _____

_____

_____

(intentionally blank)

Level III
Pesticide evaluation check for
4,4'-DDT/Endrin breakdown

Log No. : _____ Batch No. : _____

Instrument ID No. : _____

Dates of Analyses : _____ to _____

	DATE ANALYZED	TIME ANALYZED	ENDRIN	4,4'-DDT	COMBINED (1)
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

1 - Combined degradation must be less than 20%

Level III
Retention Time and Continuing Calibration Summary
Method: 608/8080

Instrument ID No. : _____ GC Column ID No. : _____

Calibration Date
FROM : _____
TO : _____

DATE OF ANALYSIS: _____
TIME OF ANALYSIS: _____
STANDARD ID : _____

COMPOUND	RT	RT WINDOW +/- min	STD CONC. (PPB)	RT	CALIB CHECK (PPB)	QC LIMITS (PPB)	%D
alpha-BHC							
beta-BHC							
delta-BHC							
gamma-BHC							
Heptachlor							
Aldrin							
Hept. epoxide							
Endosulfan I							
Dieldrin							
4,4'-DDE							
Endrin							
Endosulfan II							
4,4'-DDD							
Endo. sulfate							
4,4'-DDT							
Methoxychlor							
Endrin ketone							
a. Chlordane							
g. Chlordane							
Toxaphene							

For multicomponent analytes, the single largest peak that is characteristic of the component should be used to establish retention time.
Identification of such analytes is based primarily on pattern recognition.

Level III
Retention Time and Continuing Calibration Summary

Method: _____

Instrument ID No. : _____ GC Column ID No. : _____

	Calibration Date FROM : _____ TO : _____			DATE OF ANALYSIS: _____ TIME OF ANALYSIS: _____ STANDARD ID : _____			
COMPOUND	RT	RT WINDOW +/- min	STD CONC. (PPB)	RT	CALIB CHECK (PPB)	QC LIMITS (PPB)	%D

For multicomponent analytes, the single largest peak that is characteristic of the component should be used to establish retention time.
Identification of such analytes is based primarily on pattern recognition.

is printed on the traveller next to the price. This "c" appears on the login screen as well. A summary of the client contract file can be printed using the P. O. SUMMARY command. There is also a cue-bic menu item available.

1.9.4.3 Chain-of-Custody (COC) Form and BCA Acknowledgement

In addition to recording the transfer of samples, the COC is also BCA's authorization to perform specific tests. Any inconsistencies between sample labels and the COC are discussed with Jacobs Engineering, as described in the sample receiving section of this plan. Resolution of sample receipt problems are documented on the COC forms directly, intialed and dated. After the samples have been successfully logged in, a copy of the traveller and the COC is sent to Jacobs. This serves to confirm the work request.

1.9.4.4 Monitoring Line Item Totals

The maximum amount that BCA is authorized to bill for each analytical test is specified in the delivery order (D.O.). It is BCA's responsibility to ensure that we do not exceed this amount. The BCA Contract Administrator is notified about all incoming project work. The Administrator generates a "Log-In Det Summary Report," which totals the value of work requested for each chemical determination test code.

1.9.4.5 Application and Certificate for Payment (AFP)

All work is billed chronologically in the same order asrequested by Jacobs Engineering. Upon completion of the testing and reporting of the analytical results, i.e. when an entry appears in the MAIL.DATE field of the ORD file, a standard BCA invoice is automatically printed. This invoice is reviewed by BCA's Contract Manager for compliance with authorized tests and prices. Any problems, such as incorrect determination codes and prices, are brought tp the attention of the client services representative and corrected.

The Contract Manager collects 10-20 invoices and prepares an AFP. Instructions for preparing AFPs are given in the delivery order. An AFP includes: Two copies of Attachment A - a line item invoice, BCA standard ivoices and the COC copies stamped "Receiving Report." Each page of the AFP must include the COC numbers in the P.O. column, the delivery order number and the project number. The final AFP for all work under a given delivery order requires a different "Final Release Form." This would apply when the dollar amount is exhausted on a delivery order. All AFPs are submitted to the Jacobs Contracts Administrator.

1.10 INTERNAL QUALITY CONTROL PROCEDURES

Laboratory quality control checks include several procedures to assess laboratory accuracy and precision. Analytical instrument performance is determined by routinely conducting the following checks:

- o Calibration verification
- o Instrument sensitivity checks
- o Daily performance checks

These method-specific control checks have been described in Section 1.7 CALIBRATION PROCEDURES of this document.

1.10.1 Organics Analyses by Gas Chromatography

Specialized quality control procedures for these analyses are typified by those used for pesticides and PCBs by EPA Method 8080. For every batch of 1-20 samples analyzed, another three QC samples--a method blank, a spike, and a spike duplicate--are run. One QC control sample is also analyzed with every batch. The QC control sample results are compared to the previously determined in-house control limits. If the result for a particular parameter does not meet the criteria, the batch may be validated by spike recoveries that are within control limits. Surrogates and internal standards are added to monitor instrument operation and purging or extraction efficiency. These spikes and surrogates and their typical concentration levels are listed in Tables 1.10-1 and 1.10-2.

1.10.2 Organics Analyses by GC/MS

1.10.2.1 Volatile Organics

For every batch of 1-20 samples analyzed, a method blank, a spike, and a spike duplicate are also run. Three surrogates and internal standards are added to each sample in order to monitor purging efficiency and instrument operation. Surrogates and spiking compounds and their typical concentration levels are listed in Tables 1.10-1 and 1.10-2.

1.10.2.2 Semi-volatile Organics

Six surrogate standards are added prior to extraction of the sample in order to monitor the extraction efficiency of the method. A daily sensitivity check is done by adding six internal standards in each sample extract. In addition, three quality control samples: a method blank, a spike and a spike duplicate are analyzed with

Table 1.10-1 LABORATORY SPIKES AND THEIR TYPICAL CONCENTRATIONS

Method	Spiking Compound	Soils mg/kg	Waters mg/L
SW9056	Chloride	NA	2
	Fluoride	NA	1
	Sulfate	NA	4
SW9060	Total Organic Carbon (TOC)	75	7.5
SW7060	Arsenic	5	0.025
SW7421	Lead	4	0.020
SW7740	Selenium	5	0.050
SW7470	Mercury	NA	0.002
SW7471	Mercury	1.25	NA
SW6010	Aluminum	5000	1
	Antimony	300	3
	Arsenic	100	1
	Barium	100	0.5
	Beryllium	1.0	0.1
	Cadmium	10	0.5
	Calcium	5000	50
	Chromium	50	0.2
	Cobalt	50	0.5
	Copper	50	0.5
	Iron	5000	0.3
	Lead	50	3
	Magnesium	5000	50
	Manganese	100	0.05
	Molybdenum	50	3
	Nickel	50	0.5
	Potassium	500	10
	Selenium	100	1
	Silver	50	0.05
	Sodium	500	50
	Thallium	100	3
	Vanadium	50	0.5
	Zinc	50	0.5
SW8015M	Gasoline	10	1.0
SW8100M	Diesel	40	1.0
AK103	Oil	100	2.5

Table 1.10-1 LABORATORY SPIKES AND THEIR TYPICAL CONCENTRATIONS

Method	Spiking Compound	Soils mg/kg	Waters ug/L
SW8080	Aldrin	0.0167	0.5
	DDT	0.0167	0.5
	Dieldrin	0.0167	0.5
	Endrin	0.0167	0.5
	g-BHC	0.0167	0.5
	Heptachlor	0.0167	0.5
	PCB 1260	0.333	10
SW8240	Benzene	0.05	50
	Chlorobenzene	0.05	50
	1,1-Dichloroethene	0.05	50
	Toluene	0.05	50
	Trichloroethene	0.05	50
SW8270	Acenaphthene	1.67	50
	1,4-Dichlorobenzene	1.67	50
	2,4-Dinitrotoluene	1.67	50
	n-Nitrosodipropylamine	1.67	50
	Pyrene	1.67	50
	1,2,4-Trichlorobenzene	1.67	50
	4-Chloro-3-methylphenol	2.50	75
	2-Chlorophenol	2.50	75
	4-Nitrophenol	2.50	75
	Pentachlorophenol	2.50	75
	Phenol	2.50	75

TABLE 1.10-2 LABORATORY SURROGATE COMPOUNDS AND THEIR TYPICAL CONCENTRATIONS FOR ORGANIC ANALYSES

Method	Surrogate	Soils mg/kg	Waters ug/L
SW8015M	a,a,a-Trifluorotoluene	0.03	30
SW8100M	Naphthalene	2.4	0.06 mg/L
AK103	Naphthalene	2.4	0.06 mg/L
SW8080	TCMX	0.0167	0.50
	DCBP	0.0167	0.50
SW846 8240	1,2-Dichloroethane-d4	0.05	50
	Toluene-d8	0.05	50
	4-Bromofluorobenzene	0.05	50
SW846 8270	ACIDS:		
	2-Fluorophenol	2.50	75
	Phenol-d6	2.50	75
	2,4,6-Tribromophenol	2.50	75
	BASE/NEUTRALS:		
	Nitrobenzene-d5	1.67	50
	2-Fluorobiphenyl	1.67	50
	Terphenyl-d14	1.67	50

every batch of 1-20 samples. Surrogates and spiking compounds and their typical concentration levels are listed in Tables 1.10-1 and 1.10-2.

1.10.3 Metals Analyses

Most metals analyses are done by one of three techniques: flame atomic absorption spectrophotometry (FAA), graphite furnace atomic absorption spectrophotometry (GFAA), or inductively coupled argon plasma emission spectrometry (ICP). Available supplementary techniques include cold vapor and hydride generation. All sample digestions follow EPA or Standard Methods prescribed procedures. One method blank for every batch of 1-20 samples is run for each element. Matrix spike and matrix spike duplicate are also run for every batch of 1-20 samples.

When the concentration of the metal being determined exceeds the highest standard, the sample is diluted so it falls within the range of calibration. A daily laboratory control standard is run for all metals. The accuracy of analysis of metals in soils is checked annually by analyzing a National Bureau of Standards reference material such as SRM #1646, an estaurine sediment.

1.10.4 Laboratory QC Samples

1.10.4.1 Method Blanks

Method blanks consist of organic-free or deionized water that is carried through the analytical scheme like a sample. They serve to measure contamination associated with laboratory storage, preparation, or instrumentation. For most analyses, a method blank is analyzed on a daily basis, and at a frequency of one per twenty samples if more than twenty samples are run in a given batch. If the analyte of interest is above the reporting detection limit corrective action as outlined in Section 1.13 should be taken.

1.10.4.2 Travel Blanks and Field Blanks

Travel blanks begin as organic-free reagent water in the laboratory. A sample vial is filled with reagent water and carried with other sample containers to the field and back to the laboratory. Field blanks begin as sample vials which are carried to the sample site and filled with organic-free water at the location. Both blanks identify contamination associated with collection and transportation of the sample.

1.10.4.3 Sample Blanks

Sample blanks are used when characteristics like color or turbidity interfere with a determination. In a spectrophotometric method, for example, the natural absorbance of the sample is measured and subtracted from the absorbance of the developed sample. Sample blanks are run only as necessary.

1.10.4.4 Calibration Blanks

Calibration blanks are prepared with standards to create a calibration curve. They differ from the other standards only by the absence of analyte, and provide the "zero-point" for the curve.

1.10.4.5 Internal Standards

Internal standards are measured amounts of certain compounds added after preparation or extraction of a sample. They are used in an internal standard calibration method to correct sample results suffering from capillary column injection losses, purging losses, or viscosity effects. Internal standard calibration is currently used for volatile organics, chlorinated and organophosphorus pesticides, GC/MS extractables and metals by ICP.

1.10.4.6 Surrogates

Surrogates are measured amounts of certain compounds added before preparation or extraction of a sample. The recovery of a surrogate is measured to determine systematic extraction problems. Surrogates are added to all samples analyzed for chlorinated pesticides, GC/MS extractables and volatiles and GC volatiles. Typical surrogate concentrations are listed in Table 1.10-2.

1.10.4.7 Spikes

Spikes are aliquots of samples to which known amounts of analyte have been added. They are subjected to the sample preparation or extraction procedure and analyzed as samples. The stock solutions used for spiking are purchased or prepared independently of calibration standards. Table 1.10-2 lists typical spike concentrations.

The spike recovery measures the effects of interferences in the sample matrix, and reflects the accuracy of the determination. Spike recoveries are calculated as follows:

$$\%\text{Recovery} = \frac{\text{S-Rav}}{\text{T-Rav}} \times 100$$

where S is the observed concentration of analyte in the spiked sample, Rav is the average determination of the analyte concentration in the original sample, and T is the theoretical concentration of analyte in the spiked sample.

Spikes are prepared and analyzed in every batch of 1-20 samples, and at a frequency of at least one per twentysamples if more than twenty samples are run in a given batch.

Spike recoveries are stored in our data base and are retrievable for statistical analysis. Laboratory control limits are calculated for individual matrix types when twenty data points become available.

1.10.5.8 Duplicates and Duplicate Spikes

Duplicates are additional aliquots of samples subjected to the same preparation and analytical scheme as the original sample. In cases where the analyte concentration is consistently below the detection limit, duplicate spikes are substituted for duplicates. The relative percent difference between duplicates or duplicate spikes measures the precision of a given analysis. Relative percent differences are calculated as follows:

$$\%\text{RPD} = \frac{\text{R1-R2}}{\text{Rav}} \times 100$$

$$= \frac{\text{S1-S2}}{\text{Sav}} \times 100$$

where R1 and R2 are duplicate determinations of the analyte in the sample, S1 and S2 are the observed concentrations of analyte in the spike and its duplicate, Rav is the average determination of the analyte concentration in the original sample and Sav is the average of the observed analyte concentrations in the spike and its duplicate.

Duplicates (or duplicate spikes) are prepared and analyzed at a frequency of at least one per batch or one for every 20 samples.

Relative percent differences are stored in our data base and are retrievable for statistical analysis.

1.10.5.9 Laboratory Control Standards

Laboratory control standards (LCS's or QCCS's) are aliquots of organic-free or deionized water to which known amounts of analyte have been added. They are subjected to the sample preparation or extraction procedure and analyzed as samples. The stock solutions used for LCS's are purchased or prepared independently of calibration standards. The LCS recovery tests the function of analytical methods and equipment.

LCS's are prepared and analyzed in every batch of 1-20 samples and at a frequency of one per twenty samples if more than twenty samples are run in a given batch.

The Early Warning Report requires that an LCS be reported with every batch of 1-20 samples logged in for a particular determination. The true value and recovered concentrationare archived and retrievable for statistical analysis. Laboratory control limits are calculated when twenty data points become available.

1.11 PERFORMANCE AND SYSTEM AUDITS

1.11.1 System Audits

System audits will be performed in accordance with the policies and procedures established by Jacobs' Quality Assurance Unit. All audits will be initiated by the Project Quality Assurance Officer and will consist of periodic reviews to ensure that:

- o The necessary procedures for each step of the project operation plans are established.
- o Standards, procedures, and records are properly maintained and documented.
- o Verification that QC records are adequately filed and maintained to assure protection, retrievability and traceability.

The system audit will consist of observations and documentations of all aspects of the analytical system to assess its overall effectiveness. The auditor will act functionally independent of the program staff. A system audit will be performed at least once per year.

1.11.2 Performance Audits

Performance audits are conducted to quantitatively evaluate the quality of data outputs with respect to the requirements specified in the analytical method. The Project Quality Assurance Officer will be responsible for the identification of tasks to be audited and for appointing an auditor. The performance audit will be performed to:

- o Evaluate the accuracy of data generated during analysis
- o Assure that control standards are being measured at specified intervals
- o Check the status of reference materials

A performance audit will be conducted at least biannually.

1.11.3 Certification Programs

BCA is certified under the following categories:

1. Accreditations

   a. California Department of Health Services (DHS) Environmental Laboratory Accreditation Program (ELAP).

   b. Other States. BCA holds certifications in Arizona, Nevada, Tennessee and Oklahoma.

2. Other government programs

   a. United States Air Force, through audit process by Mitre Corportion.

   b. United States Navy Naval Energy and Environmental Support Activity (NEESA) projects, through Mitre Corporation.

3. Private sector programs

   a. Chemical Waste Management, Inc.

   b. Shell Oil

   c. IBM

   d. Anheuser-Busch

   e. Minnesota Mining and Manufacturing (3M)

   f. Chevron

   g. Hargis and Associates, Inc.

1.11.4 Performance Evaluation Check Samples

BCA participates in the following performance evaluation samples:

1. USEPA semiannual drinking water performance check samples (WS series).

2. USEPA semiannual wastewater performance check samples (WP series).

3. Orange County Environmental Management Agency approval to analyze for metals, inorganics, halogenated pesticides and PCBs.

4. Chemical Waste Management, Inc., hazardous materials testing performance evaluation program.

5. Applied Products Group environmental check sample program.

1.11.5 B C Analytical Comparability Samples

USEPA provides performance evaluation standards for both inorganics and organics. Other performance evaluation standards are purchased from reputable suppliers who certify traceability. Using external sources for control standards insures comparable and accurate results.

Internal performance check samples supplied by APG are used in two programs within each laboratory. Semiannual and quarterly volatile performance evaluation check samples are logged in as normal samples and flow through the laboratory in the same manner as a client's sample. These are the true "system" audit samples. Other check samples are assigned to a specific analysis in the laboratory as part of the training program or if a systematic error is suspected.

1.11.6 Internal Audits

Quarterly audits cover all areas of operation from sample custody and sample management through analysis and data validation to data archival as well as general laboratory quality assurance measures. The QA Group developed an extensive checklist which is used by the Quality Assurance Coordinator during the audit. At the completion of each audit the Quality Assurance Coordinator scores the laboratory and provides a written report detailing areas of concern. The Quality Assurance Coordinator is responsible for developing a written corrective action plan and overseeing its implementation.

1.12 PREVENTIVE MAINTENANCE

Preventive maintenance is a crucial element of the quality assurance program in an analytical laboratory. BCA analysts perform routine preventive maintenance such as the replacement of minor parts, cleaning of exterior components and providing the instruments with a clean, climate controlled environment. Major instruments such as gas chromatographs, atomic absorption spectrophotometers, analytical balances, and GC/MS systems are maintained under commercial service contracts or by qualified in-house service technicians. All instrument maintenance is recorded in the associated instrument logbook for future reference and validation of scheduled maintenance.

Instruments are constantly monitored by the use of daily calibration, sensitivity, and response checks to determine when non-scheduled mainentance is required. In the event that an instrument does fail every effort is made to meet obligations to clients concerning holding times and analysis due dates. In the event that a holding time will be missed, the project manager will notify the Jacobs client contact.

Laboratory support systems such as the deionized water supplies, refrigerators and ovens are also monitored and serviced regularly. In many instances the improper functioning of such basic equipment as a refrigerator is enough to invalidate costly data. BCA's quality assurance program is designed to minimize data loss by monitoring and recording the functioning of these systems, allowing rapid correction of any malfunction before data loss can occur.

1.13 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality Assurance is of vital concern to all levels of management at BCA. A major component of the quality assurance program is the feedback mechanism designed to keep all managers and supervisors aware of quality issues and performance in the laboratory.

1.13.1 Early Warning Report

Resource Managers receive daily reports of all quality control parameters which are outside warning and/or acceptance limits (the Early Warning Report). This allows for prompt corrective action at the bench and immediate flow of information to the client, when appropriate. It is important to note that data cannot be approved and reported to the client until corrective action validates the result. The Quality Assurance Coordinator receives a copy of the Early Warning Report so that confirmation of corrective action can proceed in a timely fashion. At the discretion of the individual resource manager or quality assurance coordinator, quality control data can be retrieved from the computer for any analysis for a specified time period. This historical data can demonstrate trends and is used to revise control limits.

1.13.2 Other Internal Reports

As a supplement to routine quality control reporting, all events which significantly affect the quality assurance program are reported to the Quality Assurance Director who reports to the Business Unit Manager. All audits, certification proceedings, performance evaluations and major corrective action plans are brought to management's attention via this direct link to the Business Unit Manager.

1.13.3 Quality Assurance Reports

In addition to reports to internal management, BCA provides quality assurance reports to clients upon request. Quality Control data such as duplicate and spike results can be routinely reported. More comprehensive quality assurance packages are arranged on a project by project basis, depending on the scope of the project and the data validation requirements of the client. Interested clients should contact the Project Manager to arrange deliverables and discuss the cost of the package.

1.14 LABORATORY SAFETY

Laboratory safety is addressed in a July 17, 1989 document that every employee is required to read and sign a document stating that they have read it. Copies can be provided upon request. This safety program is designed to:

- Provide the management systems and support necessary to achieve and maintain safe and healthful working conditions for all employees.

- Minimize accidents through proactive anticipation and prevention rather than reaction after the fact.

- Provide training for all employees to ensure safety awareness and proper work habits.

- Comply with or exceed the requirements, regulations, and standards imposed on BC Analytical by government agencies.

- Ensure proper storage, use, and disposal of chemicals and other hazardous materials.

- Require adoption of and adherence to all Company safety procedures and practices.

1.15 SAMPLE DISPOSAL

For the Indian Mountain prioject all samples will be disposed by BCA.

1.16 TRAINING

Most BCA employees have a college degree in a science related field. Regardless of their educational background or assigned duties, each employee is processed through a rigorous training program. This training includes detailed safety information about the chemicals to be used. Each employee is required to read the safety manual and sign a document stating that they have read it. Upon hire or change in responsibilities the employee is provided a technical training schedule.

The analyst is required to complete a personal check sample and/or run a Laboratory Control Standard four times to demonstrate the ability to generate acceptable accuracy and precision. A bench level review by the Quality Assurance Coordinator or Resource Manager may be completed. Corrective action and retraining are initiated where appropriate. If the analyst passes this review process, they are declared approved to perform the designated analyses.

APPENDIX A

JACOBS ENGINEERING GROUP INC.

JEMS Laboratory Data Submission Handbook

Version 2.1

30 August 1993

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Revision history

This is version 2.1 of this document. Substantive revisions from the previous version are noted with a vertical bar in the outside margin. Deletions are shown in the body of the document in ~~strike-through~~ text and insertions in double-underscore text. In some cases, for readability, there will only be a single note for an entire section that has been added that is in this distinctive revision format.

Version 1.1

- Trivial typographical errors.
- Incorporating 20 August 1992 memo, *"Modifications and clarifications to JEMS Laboratory Data Submission Handbook."*
- Revision and clarification on *qc_type* field.

Version 1.2

- Widening of *control_num* field. The field title is now "Container Control Number."
- Widening of the *dilution* field, which can now handle dilution up to 999,999.99.
- Revision of the definitions and VVLs for the *lab_qual, lab_qual_o, val_qual* and *val_qual_rc* fields.
- Addition of *val_id* field.
- Removal of IRPIMS-based VVLs from Appendix B. These values are available in a separate report from JEG, or on diskette in Xbase format.
- Addition of "Miscellany" subsection in Section 2 on various data questions which have been raised.
- Better definition of *dcl_flag* field.

Version 2.0

- Further clarifications in text.
- Additional indicators for the Required column in Appendix A (page 11).
- Inclusion of the LDSH version in the README file and diskette label.
- Use "LABQC" as Container Control Number for laboratory QC results.
- If no extraction is done, the appropriate fields in the Data file should be left blank.
- Most "time" fields in the Data file are now required.
- The dilution factor field is now required.
- Inclusion of surrogate spike flag.
- Inclusion of sample matrix field.
- Making the result precision mandatory.
- Addition of Comment file.
- Instructions for handling samples run through multiple analytical batches.
- Modification of *spike_val* field for certain QC.

Version 2.1

- Incorporation of memos *"Typos in LDSH 2.0"* (9 March 1993), *"Clarifications to LDSH 2.0"* (4 May 1993) and *"Change to LDSH 2.0"* (9 July 1993).

- Inclusion of more explanations of different aspect of the data deliverables.
- Use *A-Z* as *qc_type* sequences after *1-9*.
- No new substantive changes.

1. Introduction

The Jacobs Environmental Management System (JEMS) is a relational database system maintained by Jacobs Engineering Group Inc. (JEG) to store, analyze, and report on information on environmental samples for Jacobs clients.

JEMS represents the linkage of location and sample acquisition data with the analytical results of those samples. Location and sample acquisition data are obtained from field personnel directly. Analytical results are provided by laboratories. There are considerable efficiencies resulting from input of analytical results to JEMS in an electronic format:

- ***Reduced data entry time***
- ***Reduced data entry costs***
- ***Reduced data entry errors***

Laboratories providing analytical services to JEG are therefore required to submit their analytical results to JEG in an electronic format compatible with JEMS. The purpose of this *JEMS Laboratory Data Submission Handbook* (LDSH) is to define the file formats and assist laboratories in creating file submissions. To that end, it is organized as follows:

- **Section 1**, this introduction, describes JEMS in general terms.
- **Section 2** describes the requirements for the files to be submitted, including rules on file naming and structure.
- **Section 3** describes the data submission requirements for physically moving the files to JEMS.
- **Appendix A** describes in detail the structure of each of the files to be transmitted.
- **Appendix B** describes the fields in the files in greater detail, indicating formats and valid values to be used. ~~Valid Values to be used in certain of the fields~~.
- **Appendix C** cross-references JEMS data fields to those in the US Air Force Installation Restoration Program Information Management System (IRPIMS) data structure.

Any questions related to creating files should be coordinated through the Jacobs Project Date Manager and directed to the JEMS Customer Manager~~System Administrator~~. Questions and comments regarding this handbook, and proposed additions to the Valid Value Lists, should be submitted in writing to the same party.

Acknowledgments are made to Jim Stanley of the JEG Corporate MIS Department; John Moorman, Jim Powers, Lisa Carlson, and Ron Munsee of the JEG Pasadena Environmental Programs group; Michael Pallesen and Spencer Preston of Egret Technologies; and all others who contributed to this document.

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2. Data requirements

This section provides the format and content specifications for the JEMS files, followed by explicit requirements for the data entry of files.

JEMS data will be submitted in three different file formats:

- The **README file**, identifying the contents of the diskette. There will be only one README file per diskette.
- The **Data file**, containing analytical results. There may be more than one Data file per diskette.
- The **Comment file**, containing comments on tests or results in a corresponding Data file. There can be up to one Comment file per Data file on the diskette.

2.1. The README file

This file contains a set of records identifying the contents of a diskette. It should be named "README," with no extension. A README file must be included on every disk submitted to JEG.

Unlike the Data files, the structure of the README file varies from record to record. The layout of this file is given in Appendix A, page 16.

2.2. Data files

These files contain analytical results. ***Each record in the files identifies a unique analytical result***, including information on the sample and tests which generated the result. This test data must be repeated in each pertinent record (i.e., the test data is ***not normalized***); though this is less efficient in disk space, it provides unequivocal identification between analytical result, test and sample.

The structure for Data files is given in Appendix A on page 14.

2.2.1. Files and samples

Multiple Data files may be submitted on a single diskette. Each one must be listed in the README file, described above.

A Data file may contain results for multiple samples.

The results for a given sample (as identified by a Container Control Number on the Chain of Custody) should be, but need not be, submitted within the same file.

2.2.2. File names

All Data files submitted from a lab for a given project must be uniquely named. Data files must be named in a specific format: "`yymmddss.JEM`" where

`yymmdd` is the date the file is generated, using numeric, zero-padded representations for the year (`yy`), month (`mm`) and day (`dd`).

Note that this is a different date format than that used for data in the Data files.

`ss` is a sequence number, beginning with 01, to allow for multiple files to be generated in a particular day.

`.JEM` is the literal string "JEM", used as an identifying extension for all such Data files submitted to JEMS.

So, for example, the file `92081202.JEM` would be the second (`02`) JEMS Data file (`.JEM`) generated by the lab on 12 August 1992 (`920812`). The first file submitted that day (or the only one,

if only one were generated) would be named `92081201.JEM`.

2.2.3 Resubmitted Data files

If Data files are to be resubmitted with corrections, it is not necessary to resubmit all records in a file. Labs may resubmit just those records which need correction. Labs may, at their discretion, resubmit entire Data files; this is not required, however.

However, a given resubmission file must contain ***only records from one original file***. Resubmitted records from more than one file may not be submitted in the same file.

Files containing resubmitted data must be named as described above in Section 2.2.2. Resubmitted files must be given ***new names*** reflecting the new file generation date. A resubmission file must not be given the same name as the original file which contained the data.

The README file must include a cross-reference between the original Data file and the resubmitted Data file. This cross-reference is accomplished by entering the name of the original submission file in the *data_file_o* field of the record identifying the submission. An example is included with the README file layout on page 16.

The README file should also indicate Data files which have accompanying Comment files. This is done with an asterisk after the name of the Data file.

2.3. Comment files

These files contain comments on analyses or analytical results on a corresponding Data file.

These are meant to be abbreviated ad hoc comments. More extensive comments should be included in the hardcopy report submitted to JEG. Where appropriate, the *lab_qual* and *lab_qual_o* fields of the Data file can be used for standardized comments.

The structure for Comment files is given in Appendix A on page 17.

2.3.1. Files, samples, tests, results and comments

Only one comment line may be entered that applies to a given sample's test as a whole, and only one comment line may be entered that applies to a given sample's test's analytical result. For example:

Sample A is run on test T1 and produces 12 results. The Comment file could have up to 13 lines relating to this data: one for the test as a whole, and one for each result.

Comments are not required for every record in the corresponding Data file. A Comment file must be associated with only one Data file. If there are no comments for the records of a given Data file, no Comment file need be submitted. However, Comment files should be in the same delivery batch as their corresponding Data files (preferably on the same diskette).

A corrective action Comment (*comm_type="C"*) must be submitted where corrective action is taken.

2.3.2. File names

All Comment files submitted from a lab for a given project must be uniquely named, based on their associated Data file. Comment files must be named in a specific format: "`yymmddss.JEC`" where:

`yymmddss` is the same sequence number as the corresponding Data file.

`.JEC` is the literal string "JEC", used as an identifying extension for all such Comment files submitted to JEMS.

So, for example, the file **`92081202.JEC`** would be the Comment file associated with the Data file 92081202.JEM.

2.3.3 Resubmitted comments

If a result record from a Data file is resubmitted, and it had a corresponding comment in the initial

submission, the Comment file record does not need to be resubmitted, unless a change is being made in the comment.

New or changed comments in a Comment file must be submitted with a corresponding resubmission of the Data file result records. In this case, the Comment file with the change would be renamed as the Data file is for resubmission. Following this reasoning, it is clear that a given Comment file resubmission must contain only records from one original Comment file, and that resubmitted records from more than one Comment file may not be combined into a new file.

2.4. General data requirements

Loading ASCII file submissions into JEMS requires absolute adherence to each of the following file, record and field requirements. Contractors are required to follow these instructions. ***Data file submissions with protocol errors will be returned for corrections and resubmission, and will not be considered to have met contractual obligations.***

2.4.1. Files, records and fields

Each JEMS ASCII file is made up of one or more lines of data. Each line of data is equivalent to a single record in the file. Each **record** is made up of distinct fields of information. Each **field** is assigned a specific location in the line. These field positions are defined in Appendix A of this document, starting on page 11. These file specifications shall be followed for entering each record of information in the specified file.

2.4.2. Records must be self-sufficient

A data record must not be dependent on another record or file for data. The data in each record is independent. Actual valid data must be entered in ***each record***. Do not enter data that refers to another record, e.g., entering a record in the Data File that says, "see record number 10 above." or "same as above." Each record must be capable of standing on its own, as if it were stored in its own individual file.

2.4.3. Use the Valid Value Lists

The Valid Value Lists in Appendix B, page 19, provide data which are required to be entered in fields where codes, abbreviations, labels, and names have been assigned. ***Contractors are required to use the Valid Value Lists provided by JEG and must not enter in JEMS file submissions any values not provided by JEG.*** Any questions or problems related to data entry and proposed additions to the valid value lists should be addressed in writing, coordinated through the Project Manager, to the JEMS System Administrator.

Even in cases where a third party is responsible for modifying Valid Value Lists utilized by JEG (e.g., the IRPIMS Help Desk defining IRP VVLs), JEG must be informed ***in writing*** of any modified or new codes obtained by the lab directly from the third party. Where additional valid values are obtained through another client of the laboratory, they should be verified by the lab with the governing issuing agency, and such verification communicated to Jacobs.

2.4.4. Leave out column names and headings

For clarification and illustration, this document sometimes uses the descriptive names of fields or columns. However, ***do not enter column headings or field names in JEMS files.*** This information is not part of the file.

2.4.5. Don't add left margins

Do not make left margins. Every record in every file starts in the farthest left position in the record, ***column 1***. When entering data using a spreadsheet program to build your files, set your left margin as 0, and your right margin at the end position of the last field in the record (e.g., if the last field has start and end positions of 156-157, then the right margin must be 157).

2.4.6. Use spaces, not tabs

Do not enter tabs or use the tab key. Tab characters will be read as data and interfere with accurate loading of the submitted files.

If you have completed entering data within a field, and have not yet reached the end of the field (e.g., you have entered "JACOBS" in a 10-character field), then use the space bar to insert sufficient space characters to reach the beginning of the next field.

2.4.7. Use no blank records

When creating a JEMS file, the first record or row in the file, and every subsequent record or row, must contain valid data. ***No blank or empty rows or records are permitted in JEMS files.***

The only exception to this is that it is permissible to include a single blank or non-data record at the ***end*** of a Data file to denote the end of that file. This is not required, however, and at no time may a blank or non-data record be included in a file anywhere but as the last record.

2.4.8. Do not duplicate records

Each record within a file must be **unique.** Records which have exactly the same data in every field are regarded as duplicate records and should be corrected accordingly.

2.4.9. All fields are required

Enter valid data for every field and only the fields described in the specifications. **Do not add, delete or omit any fields.** JEG requires that no additional or non-requested information be entered in JEMS file submissions. The lab must not delete or omit any JEMS data field. If a field is not indicated as required in the file specifications table, and the information is available, it must be entered. If the information is not available, space characters must be entered in the specified field.

2.4.10. Position data as shown

The exact placement of each character in a record is stated in the file specifications under the column heading "Start-End Positions." Each character occupies one position or space in the record. Start and end position numbers are specified for two reasons:

- To give the size of the required data field: *(end - start + 1)* bytes.
- To give the ***exact character positions where the applicable data must be placed in the file record.***

2.4.11. Single character fields

Single character fields have the same start and end position number. Put the one character of data in that position in the field.

2.5. Software to use to produce these files

Labs may use any software product they wish to produce the defined electronic files, so long as the files match this document's specifications. Anything which will produce ASCII column-delimited files (e.g., Borland dBASE, Lotus 1-2-3) may be used. This specification is concerned solely with the nature of the output.

2.6. Data Issues

This section discusses some specific data questions which have been raised.

2.6.1. Data qualifiers

JEMS currently requires three general classes of data qualifiers be provided by labs.[1] These roughly parallel each other, but each provides uniquely formatted information for Jacobs usage and client deliveries.

[1] Lab validators have their own fields for qualification codes, *val_qual* and *val_qual_rc*.

dcl_level: This field provides a basic "data confidence level" based on the source of the analytical results, distinguishing, for example, between field and lab analysis. See page 20.

lab_qual: This is the most detailed results qualifier, derived from EPA CLP results qualifiers. Non-CLP (lab-idiosyncratic) qualifiers of this sort should be put in the *lab_qual_o* field. See page 21.

parvo: This is a more general results qualifier, based on the Air Force IRP field of the same name. See page 23.

All of these fields are required.

Note that further comments and qualifiers on results can be included in the Comment file.

2.6.2. Tentatively Identified Compounds

Tentatively Identified Compounds (TICs) should be reported electronically only when they can be explicitly related to an existing *analyte* code. For example, on jobs where IRPIMS PARLABELs are being used (*anl_type*=AFI), TICs should only be included in the electronic deliverable for explicit compounds or analytes possessing a valid PARLABEL, not for vague families of compounds. Such groupings or families should be noted, however, in whatever hardcopy result deliverables are provided JEG.

TIC results should be noted using the appropriate codes in *parvq* and *lab_qual*.

2.6.3. Quantitation and detection limits

The text in this section has been moved to Appendix B under the *detect* and *pquant* fields (pages 20 and 23, respectively)

2.6.4. Laboratory QC batches

Lab QC is performed in batches that do not necessarily correlate with particular Jacobs projects or particular deliverables (i.e., a particular deliverable from the lab may partially belong to a lab batch which produces records on another deliverable).

To insure that data can be correlated properly, laboratory QC results from a given analytical batch should be transmitted ***once, and only once, for each Jacobs project number*** being delivered.

Example:

JEG project *proj_num*	**Sample #** *control_num*	**Disk**	**Lab batch** *lab_batch*
01A00100	AB-0000001	1	001
01A00100	AB-0000002	2	001
01A00100	AB-0000003	1	002
58B99900	AX-0000100	3	001
58B99900	AX-0000101	3	002
22A22200	BD-0000025	4	001

Six samples from three different Jacobs projects have ended up in two different lab batches. The results for the samples in the first project are returned in two different disks. The other two projects are on their own disks (since a disk must hold data for only one JEG project). The distribution of the results within multiple files on the disk are not important.

The following is how the lab QC for each batch would be returned:

Disk 1: Batch 001 for 01A00100
Batch 002 for 01A00100

Disk 2: None[2]

Disk 3: Batch 001 for 58B99900
Batch 002 for 58B99900

Disk 4: Batch 001 for 22A22200

Thus, the lab QC results for Batch 001 would be reported in three different disks, but only once for each project.

[2] Batch 001 has already been reported for project 01A00100.

2.6.5. Multiple analytical batch samples

There are occasions in which a given sample may be split into multiple analytical batches for a given test, e.g., if blank contamination is found for certain analytes. The following are guidelines for submitting results data for these analyses:

1. Unless instructed otherwise, laboratories should submit only one analytical result for a particular test on a sample.[3]

   Where a test is run on a sample multiple times in different analytical batches (as identified by the *lab_batch* field in the Data file), only one record per analyte for all of those tests should be submitted.

   For example:

   Sample S is put into Analytical Batch L1 and run through method M, which produces twenty analytical results. Upon review, the lab identifies blank contamination on three of those results, and reruns method M on sample S, giving it Analytical Batch L2.

   The lab should report in the Data file the seventeen non-contaminated records from L1, and the three re-run results from L2.

2. The exception to #1 above is that the results from surrogate spikes should be reported for all applicable batches. To extend the above example:

   There are 4 surrogates for method M. The 4 surrogate results would be reported back for L1 and again for L2.

2.6.6. Laboratory QC data

The information in this section was moved in LDSH 2.1 to Appendix B under *control_num* (page 19) and *spike_val* (page 25).

2.6.7. Significant figures and rounding

The same number of significant figures and rounding methods will be used on both LDSH deliverables and hardcopy deliverables. It is not allowable to report a result of, for example, "0.510" in the hardcopy and "0.5" in the LDSH data.

[3] For gas chromatographic (GC) results, one result for each column reported and a "primary" result should be reported, the records identified through the *pvccode* field.

3. Submitting JEMS files

This section specifies the general requirements for submitting files to JEMS and provides an example of how files would be prepared as the data are generated. Data will be submitted on a labeled diskette. Each diskette will consist of a "README" file identifying the contents of the disk, and one or more analytical Data files, as defined below.

3.1. Disk format requirements

Data must be submitted to JEG on diskette, meeting the following requirements:

- MS-DOS format.
- 3½" size.
- 1.44Mb Double Sided, High Density format.

References below to diskettes include the above requirements.

3.2. External labeling of diskettes

Each diskette will be externally labeled with the following information:

- Laboratory ID
- Project number
- Jacobs charge number
- Date of submission
- The version of the LDSH by which the disk data is formatted.
- List of Data files on diskette (those with Comment files should be flagged with an asterisk)

With the exception of the list of Data files, the format of the label will be identical to that of the README file, as described on pages 3 and 16. For example:

LABXXXXXXX	93061801.JEM
99D00747	93061802.JEM*
JC12345	93061803.JEM
23-JUN-93	93062001.JEM*
2.0	93062301.JEM*
	93062302.JEM

3.3. Transmittal letter

A transmittal letter will accompany each diskette submission, specifically stating the contents of each diskette, per the diskette external labels.

This may be simply be a printout of the README file for each disk.

3.4. Other requirements

All other submission requirements will be made per contractual agreements.

(This page intentionally left blank.)

Appendix A—File layouts

This appendix includes the layouts for the two different files used in JEMS (README and Data files). All files submitted to JEMS must follow these formats.

The file layouts are presented in tables on the following pages with these column headings:

Record Number gives the record that the field is on in the README file. This column is not given in the Data file layout.

Field Name gives a reference name for the JEMS data field. This name is for reference only. ***Do not use these field names or any column headings in files submitted to JEG.***

Start-End Positions states the exact positions to enter the first through last characters of the field. Begin data entry for each field in the start position. If the data entered is shorter than the field width, enter space characters in the remaining positions of the field, including the end position. If the data to be entered is longer than the field width, truncate it to a unique identifier or significant value.

Pg indicates a page number in this manual for more information on the field, including lists of valid values.

Req indicates if data is required in this field through one of the following codes:

- ✔ The field is required and that data ***must*** be submitted by labs for it.
- ✍ The field is to be used only by lab validators.
- ★ The field is required for some records, as described in the Definition column or in Appendix B.
- **B** A blank value is meaningful. Data must be submitted for such a field, but one of the results of that data may be an empty or blank field. Review the VVL for the field for more information.

If a field is not marked as required, ***data must be provided by the lab if the lab has it available.*** Only if the data is not required and the lab does not have it available should a field be left blank.

Fields not marked as required as a general rule may be required by specific projects. Laboratories should consult with Jacobs project personnel for such added requirements.

Format shows the format that the data in the field should follow.

[A*n*] defines an alphanumeric field *n* positions wide All alphabetic characters should be in UPPER CASE ***only.*** It is Jacobs intention to use upper case for all fields defined in this document. Any exceptions will be noted. If the alphanumeric data does not fill the field, it should be left-justified (data starting in the first byte), with spaces padding out the rest of the width. For example, on an "A5" field:

`abc1_` is **wrong** because of the lower case letters.

`_ABC1` is **wrong** because it is not left-justified.

`ABC1_` is **correct.**

[Nn.d] defines a numeric field. The format is defined similarly to that in Xbase languages, describing a field *n* bytes wide total (including the decimal point), with *d* digits after the decimal point. Values extending beyond the number of decimal places must be rounded appropriately. The decimal point is included and must

go in the byte defined (one more from the right than *d* indicates). Undefined digits may be replaced with spaces or zeros. For integer values, with no decimal points or places, *d* should be "0". For example, with "N6.2":

99.999 is **wrong** because too many places are given beyond the decimal point.

99.9__ is **wrong** because the decimal point is not in the fourth byte.

_99.9_ is **correct**.

099.90 is also **correct**.

[D9] defines a date field, in the standard Oracle form dd-mmm-yy using a zero-padded day (dd), the capitalized first three letters of the month name (mmm), and the last two digits of the year (yy), each separated by dashes, taking up a total of nine bytes. The **dashes are required**. E.g., for 5 January, 1993:

01/05/93_ is **wrong** because it does not match the dd-mmm-yy format.

05JAN93__ is **wrong** because the dashes are missing.

05-Jan-93 is **wrong** because it is in mixed case.

5-JAN-93_ is **wrong** because the date must be two digits, zero-padded if necessary.

05-JAN-93 is **correct**.

[T4] defines a time field in the format hhmm, i.e., in hours (hh) and minutes (mm), taking up a total of four bytes. Neither colons nor seconds should be included. Time should be expressed in 24-hour military time format, and in local time for the laboratory. Thus, for 1:12 p.m.,

112_ is **wrong** because the hours must be two digits, zero-padded if necessary.

0112 is **wrong** because the time must be in 24-hour format.

1:12 is **wrong** because no colon should be included (making the field too long).

1312 is **correct**.

Definition gives the full field title, followed by a description of the data to be entered in the field. Further definition for VVL fields can be found in Appendix B, page 19.

The README file layout

For an explanation of this file, see page 3. For an explanation of the column headings, see page 11. Note that each of the first five records has its own layout, and that the sixth record and beyond share the same layout.

Record Number	Field Name	Start-End Positions	Format	Definition
1	lab_id	1-10	A10	**Laboratory ID.** Identifying name or code for laboratory. This is a Valid Value List item; see Appendix B.
2	proj_num	1-8	A8	**JEG Project Number.** Jacobs Engineering project number under which analysis was done, in the format aaaaaaaa. This will be provided to labs by JEG.
3	charge_num	1-7	A7	**JEG Charge Number.** Jacobs Engineering charge number, for internal accounting purposes. This will be provided to labs by JEG.
4	sub_date	1-9	D9	**Data Submission Date.** Date the data is submitted to JEG by the laboratory.
5	ldsh_ver	1-3	N3.1	**LDSH Version.** The version of the LDSH which was used to format this file.
6 , etc.	data_file	1-12	A12	**Data File Name.** Name of a Data file submitted on the diskette. The format of the file name is discussed on page 3.
6, etc.	comment	13-13	A1	**Comment Flag.** If the Data files has a corresponding Comment file, insert an asterisk (*) in this field.
6 , etc.	data_file_o	15-26	A12	**Original Data File Name.** If the Data file in field *data_file* is a corrected resubmission of a previous Data file, this field must contain the name of that previous Data file. Otherwise, this field will contain ASCII space characters.

The following is a sample of what the README file will contain. Each line is a record; note that the fifth record onward are Data file names, and that the ninth record represents a resubmission and includes the requisite cross-reference to the original submission. Note also three Data files which have corresponding Comment files (as indicated by an asterisk).

```
LABXXXXXXX
99D00747
JC12345
05-JAN-93
2.0
93010201.JEM
93010202.JEM*
93010203.JEM*
93010401.JEM* 92122801.JEM
93010501.JEM
93010502.JEM
```

The Data file layout

This file is further explained on page 3. For an explanation of the column headings, see page 11. The Pg column is new, replacing a previous indicator of a VVL list. Note that each record of the file must be laid out as follows.

Field Name	Req	Start-End Positions	Format	Definition	Pg
lab_id	✔	1-10	A10	**Laboratory ID.** Identifying name or code for laboratory.	21
proj_num	✔	11-18	A8	**JEG Project Number.** Jacobs Engineering project number under which analysis was done, in the format aaaaaaaa. This will be provided to labs by JEG.	
surrogate	✔	19-19	A1	**Surrogate Result Flag.** Indicate if the particular analytical result on that record is a surrogate spike compound.	25
matrix	✔	20-20	A1	**Sample Matrix:** Indicate the matrix of the sample producing this result.	22
control_num	✔	21-40	A20	**Container Control Number.** Identifier for the sample provided to lab by JEG. For QC samples synthesized in the lab, put "LABQC" in this field.	19
test_mthd	✔	41-50	A10	**Analytical Method Code.** Coded value representing the method of analysis of the given parameter.	25
lab_snum	✔	51-65	A15	**Laboratory Sample ID.** Identifier assigned to the sample by a lab and included in the reporting of the results.	22
prep_mthd	✔B	64-73	A10	**Preparation Method Code.** Coded value identifying the method used to extract the sample for a particular analysis. Use "NONE" if no prep/extraction was done, or "METHOD" where the prep/extraction method is dictated by the analytical method. ~~Leaving this field blank indicates that no extraction was done.~~	23
lab_extrc_d	✔B	76-84	D9	**Extraction Date.** Date that the extraction or preparation is made from the sample. Leaving this field blank indicates that no extraction was done.	
lab_extrc_t	✔B	85-88	T4	**Extraction Time.** Time that the extraction or preparation was made from the sample, upon completion of the extraction. Leaving this field blank indicates that no extraction was done.	
lab_recvd	✔	89-97	D9	**Lab Received Date.** Date the lab received the sample, or the date that the lab created the analytical QC sample.	
lab_anal_d	✔	98-106	D9	**Analysis Date.** Date the sample or extract is analyzed in the lab.	
lab_anal_t	✔	107-110	T4	**Analysis Time.** Time the sample or extract is analyzed in the lab, upon completion of the analysis. Note that this is a required field as of LDSH 2.0.	
lab_batch	✔	111-122	A12	**Laboratory Batch Number.** The batch designator of an autonomous group of environmental samples and associated QC samples analyzed by a test.	8, 21
units	✔	123-132	A10	**Units of Measure.** Units of measure used to report the parameter value.	25
basis	✔	133-133	A1	**Basis.** For tissue or solid samples, enter whether results are reported on a wet or dry basis.	19
analyte	✔	134-145	A12	**Analyte Code.** Coded number for analyte or parameter, using the coding system defined in the *anl_type* field.	19
value	✔	146-159	N14.4	**Parameter Value.** Actual analytical value for a given parameter (analytical result), reported in units consistent with the *units* field.	

(Continues)

(The Data file layout, cont.)

Field Name	Req	Start-End Positions	Format	Definition	Pg
sigdig	✔	160-160	N1.0	**Parameter Value Significant Digits.** Precision in significant digits of the parameter value. Note that this a required field as of LDSH 2.0.	
detect	★✔ B	161-169	N9.4	**Lab Detection Limit.** Minimum detectable quantity of a parameter based on conditions of the particular result record. Enter space characters for results such as pH and temperature that have no detection limit.	20
detect_sd		170-170	N1.0	**Lab Detection Limit Significant Digits.** Precision in significant digits of *detect* field value. The entry must reflect any dilutions beyond those called for in the analytical method description.	
pquant		171-179	N9.4	**Practical Quantitation Level.** Level above which quantitative results may be obtained with a specific degree of confidence.	23
pquant_sd		180-180	N1.0	**Practical Quantitation Level Significant Digits.** Precision in significant digits of the *pquant* field value.	
spike_val	✔	181-194	N14.4	**Spiked Parameter Value.** The amount of the record's analyte spiked into the sample. . It is required for some lab QC and surrogate spike results.	8
dcl_flag		195-195	A1	**Data Confidence Level.** Flag to indicate data confidence level, based on laboratory process and QC.	6, 20
lab_qual	✔B	196-200	A5	**Lab Result Qualifier.** Coded information concerning the numeric result or the lack of a numeric result.	6, 21
lab_qual_o		201-205	A5	**Lab Qualifier (Other).** Qualifier information using laboratory qualifier codes not in the VVL for *lab_qual.*.	22
val_qual	✔ ✍B	206-210	A5	**Validator Result Qualifier.** Coded information concerning the numeric result or the lack of a numeric result. *Only to be filled in by lab validator.*	26
val_qual_rc	✍	211-215	A5	**Validator Qualifier Reason Code.** Additional qualifier information, particularly the reason. *Only to be filled in by lab validator.*	26
qc_type	★	216-219	A4	**Lab QC Sample Type.** Coded value identifying the QC type of QC samples. Required for all lab QC results only.	24
dilution	✔	220-228	N9.2	**Dilution Factor.** The numeric factor by which the sample was diluted as part of the preparation process. If no dilution is done, then the dilution factor is 1.	20
pvccode	✔	229-230	A2	**Parameter Value Classification Code.** Coded value representing whether the parameter is the primary or confirming result. Use the code "PR" for all results except gas chromatographic (GC) results.	23
parvq	✔	231-232	A2	**Parameter Value Qualifier.** Coded value qualifying the analytical results field (*value*). This field should be filled in every record.	6, 23
parun		233-244	N12.4	**Parameter Value Uncertainty.** The uncertainty of a measured value due to a measuring technique, expressed as plus or minus some value.	
parunprc		245-245	N1.0	**Parameter Value Uncertainty Precision.** Number of significant digits in the *parun* field value.	
anl_type	✔	246-249	A4	**Analyte ID System.** The coding system used for identifying analytes, i.e., what system the *analyte* field is expressed in.	19

(Continues)

(The Data file layout, cont.)

Field Name	Req	Start-End Positions	Format	Definition	Pg
val_id	✓	250-254	A5	**Validator ID.** Identifying name or code for lab validating firm. *Only to be filled in by validator.*	25
climit_min	✓	255-258	N4	**Control Limit (Minimum).** Minimum percent recovery (accuracy criteria) of spikes for this matrix, test method and analyte.	
climit_max	✓	259-262	N4	**Control Limit (Maximum).** Maximum acceptable percent recovery (accuracy criteria) of spikes for this matrix, test method and analyte.	
max_rpd	✓	263-266	N4	**Maximum RPD.** Precision criteria in percent for control limits on spiked analytes on this matrix, test method and analyte.	
instrument	✓	267-286 ~~284~~	A20	**Instrument ID.** Identification code for laboratory instrument used in this analysis.	21
calib_ref	✓	287-306 ~~285-304~~	A20	**Calibration Reference Number.** Reference number to the last calibration made on *instrument*.	19

The Comment file layout

For an explanation of this file, see page 4. For an explanation of the column headings, see page 11. The first ten fields represent a unique key pointing to a specific result record in the corresponding Data file. These fields have the same name as their counterparts in the Data file, and have abbreviated descriptions; you can see the full descriptions starting on page 14.

Comments for an entire particular test can be indicated by wildcards ("*") in the *analyte* and *pvccode* fields. For gas chromatographic (GC) tests, comments will usually need be addressed to the primary result (*pvccode* = "PR") only, though specific comments on particular column results (*pvccode* = "1C" or "2C" etc.) can be provided.

Each record of the file must be laid out as follows.

Field Name	Req	Start-End Positions	Format	Definition	Pg
lab_id	✔	1-10	A10	**Laboratory ID.**	21
proj_num	✔	11-18	A8	**JEG Project Number.**	
control_num	✔	19-38	A20	**Container Control Number.**	19
test_mthd	✔	39-48	A10	**Analytical Method Code.**	25
lab_snum	✔	49-63	A15	**Laboratory Sample ID.**	22
prep_mthd	✔B	64-73	A10	**Preparation Method Code.**	22
lab_batch	✔	74-85	A12	**Laboratory Batch Number.**	21
qc_type	★	86-89	A4	**Lab QC Sample Type.**	24
analyte	✔	90-101	A12	**Analyte Code.** Coded number for analyte or parameter, using the coding system used in the Data file. If an astensk (*) is entered here, the comment applies to the test as a whole and to all resulting analyte records.	19
pvccode	✔	102-103	A2	**Parameter Value Classification Code.** Coded value representing whether the parameter referred to in the Data file is the primary or confirming result. If an astensk (*) is entered here, the comment applies to the test as a whole and to all resulting analyte records.	23
comm_type	✔	104-104	A1	**Comment Type.** Coded letter describing the type of comment this record represents.	19
comment	✔	105-164	A60	**Comment.** Abbreviated comment. Lengthier comments should be included in hardcopy reports. Standardized comments can be included in *lab_qual* or *lab_qual_o* fields of the Data file.	

(This page intentionally left blank.)

Appendix B—Field definitions

This appendix includes additional information on the definition, usage, and valid values for various fields in Appendix A, ordered by field name.

A number of fields have lengthy Valid Value Lists (VVLs), which are available on a separate document. These are indicated with the text [VVL]. ***If other codes are to be used, prior approval must be obtained from JEG.***

analyte

Analyte Code.

[VVL]

This is the coded description of the analytical result material. It should be coded based on the *anl_type* scheme. Non-standard additions to these schemes (e.g., added CAS numbers) must be submitted to JEG in writing and obtain approval prior to their submission.

In the Comment file, an additional value of an asterisk ("*") can be used in this field, to represent that the comment refers to all result records for that specific test.

anl_type

Analyte Type.

Laboratories will be instructed on a given Jacobs project as to the allowable coding scheme(s). Use of any other ID scheme must have prior approval by JEG.

Code	Scheme
CAS	CAS Number
AFI	US Air Force IRPIMS PARLABEL

basis

Basis.

This field represents the basis (wet or dry) for reporting tissue or solid samples. Enter "X" for other results. In general, unless otherwise specified by Jacobs project personnel, solid and tissue samples should be reported on a dry basis.

Note that the *basis* relates to the *matrix* field in the result record, as shown on page 22.

Code	Scheme
D	Solid/tissue sample reported on a dry basis.
W	Solid/tissue sample reported on a wet basis.
X	Other.

calib_ref

Calibration Reference Number.

This field is used to further track down any result problems associated with a particular instrument, as identified in the *instrument* field (page 21). Where no particular number is used by the lab, enter the date of the last calibration. Where the instruments are not calibrated, enter "NA".

comm_type

Comment Type.

This field indicates the type of comment on that record of the Comment file.

Code	Definition
G	General comment (everything that is not one of the others below).
C	Corrective Action.

control_num

Container Control Number (CCN).

(This explanatory text was added to this section in LDSH 2.1.)

This is an for sample container groups submitted to the lab by Jacobs. It can be derived from the sample label or the Chain of Custody. The field should be filled in as follows:

a. For environmental samples submitted by Jacobs to the lab, the CCN is on the container labels and on the Chain of Custody.

b. Where lab QC is derived from an environmental sample (e.g., a matrix spike), that original sample's CCN must be included in the result records for that lab QC.

c. Where lab QC is synthesized by the laboratory (e.g., a lab blank), the word "LABQC" must be put in the *control_num* field.

In summary, the following *control_num* values should be used based on the *qc_type* of the record:

QC type *qc_type*	**Control number** *control_num*
BS/BD: Blank spike/duplicate	"LABQC"
LB: Lab blank	"LABQC"
MS/SD: Matrix spike/duplicate	As in original
LR: Lab replicate	As in original
RM/KD: Reference material/-duplicate	"LABQC"
Other	As provided

dcl_flag

Data Confidence Level.

This field reflects result qualification based on the source of the analytical data. The codes are derived from the *US EPA Data Quality Objectives for Remedial Response Activities* (EPA/540/G-87/003, 3/87; pp. 4-9ff.) descriptors of analytical level, with the addition of two other values to account for uncertain data.

Code	Definition
Q	Questionable origin.
H	Historic data. Origin unknown.
1	Field screening or analysis with portable instruments.
2	Field analysis with more sophisticated instruments or mobile lab.
3	Standard lab methods at an offsite lab.
4	CLP routine analytical services (RAS) at an off-site CLP lab following CLP protocols.
5	Special, non-standard analytic service, including CLP special analytical services (SAS).

See also section 2.6.1, page 6.

detect

Laboratory Detection Limit.

(This further explanatory text was first included in LDSH 2.1.)

This is the minimum detectable quantity of an analyte for the particular lab batch, as influenced by lab conditions, analytical method, or field conditions. The limit should be that which applies to the result in the specific record, and should account for any dilutions done on a sample beyond those normally called for in the analytical method.

It is not required where inapplicable (e.g., for pH or temperature), or for surrogate spike analytes.

Base method detection limits are established for each project based on Jacobs client requirements. Laboratories should contact Jacobs project personnel for specific detection limit requirements.

Where an analyte's *value* is below *detect*, the *lab_qual* field should have a "U" and the *parvo* field an "ND".

dilution

Dilution factor.

(This further explanatory text was first included in LDSH 2.1.)

This field contains the factor by which the sample was diluted beyond that called for in the standard analytical protocol. If, for example, the original sample is 100ml, and enough solvent is added to make the total volume equal to 1000ml, then *dilution* is 10.00. Where no dilution is done beyond the analytical protocol, a dilution factor of 1.0 should be entered.

instrument

Instrument ID.

(This further explanatory text was first included in LDSH 2.1.)

This field contains an instrument number, serial number, or some other means of identifying the particular instrument the test was run on. This is for the purpose of tracking down any result problems associated with a particular instrument. Where the small size, commonality, or disposability of the test instrument (e.g., pH meters, thermometers) do not lend themselves to an instrument ID, enter "NA".

See also the *calib_ref* field on page 19.

lab_batch

Laboratory Batch Number.

This field is used to relate QC data to data from environmental samples. Samples must be identified by a lab batch number (lot control number) to designate a group of samples sharing the same QC data for a test. This group is equivalent to the EPA SW-846 concept of "Analytical Batch":

> *Samples which are analyzed together with the same method sequence and the same lots f reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch should be of similar composition.*[4]

For example, three environmental samples come into the lab, and are run on a particular test, along with a matrix spike and spike duplicate of one sample, and a blank spike. These would be considered a complete laboratory lot and given a common *lab_batch* number.

There is no required convention for numbering lab batches. Any scheme that properly associates analytical results from the same test batch is acceptable. However, note that this number must be unique within a JEG project *(proj_num)*, at the very least. It is not acceptable to repeat this number each day, month, etc., or to have any other field (such as date) necessary for this number to uniquely group a particular set of laboratory/analytical batch results.

See page 8, section 2.6.5, for information on reporting samples run through multiple lab batches.

lab_id

Laboratory ID.

[VVL]

This is a short code for the submitting laboratory.

lab_qual

Laboratory Result Qualifier.

Laboratories should use this field to qualify results using the following codes. More than one code may be placed in this field. Other qualifying codes not on this list should be put in the *lab_qual_o* field. No qualifiers should be included in the *lab_qual* field for analytical results other than organics or inorganics (such as pH or temperature); any qualifiers for such results should also be put in the *lab_qual_o* field. Definition of analytes as organic, inorganic or other may be confirmed with Jacobs project personnel. Note that, though this is a required field, ***the lack of a code in this field is meaningful***, representing an unqualified result.

These definitions are summarized from the *US EPA CLP Statement of Work for Organics Analysis* (OLM01.0-6, 6/91) and the *US EPA CLP Statement of Work for Inorganics Analysis* (ILM01.0), which should be considered the authoritative definitions for the codes in this field.

[4] EPA SW-846 rev 0, Sept. 1986, section 1.1.8.

Code	Definition

Inorganics

B	Reported value was below the Contract Required Detection Limit (CRDL), but greater than or equal to the Instrument Detection Limit (IDL).
E	Estimated, due to interference, e.g., CN, color interference.
M	Duplicate injection precision was not met.
N	Spiked sample recovery was not within control limits.
S	The reported value was determined by the Method of Standard Additions (MSA).
U	The analyte was analyzed for but not detected.
W	Post-digestion spike for Furnace AA analysis was out of control limits, while sample absorbance was less than 50% of spike absorbance.
*	Duplicate analysis was not within control limits.
+	Correlation coefficient of MSA was less than 0.995.
(blank)	Unqualified result.

Note that "S", "W" and "+" are mutually exclusive, and may not occur on the same record.

Organics

A	A TIC is a suspected aldol-condensation product, possibly generated during analysis, e.g., MEK acetone production during TCLP prep.
B	Analyte was found in the associated blank as well as the sample for the record shown. Possible blank contamination. This flag may not be combined with the "U" flag.
C	Pesticide, where the identification was confirmed by GC/MS.
D	Compound was identified at a secondary dilution factor, e.g., after a sample got an "E" qualifier.
J	Estimated value below quantitation limit.
N	Presumptive evidence of a compound. Use for all TICs.
P	Pesticide/Aroclor target analyte, where there is greater than 25% difference for detected concentrations between two GC columns.
U	Compound was analyzed for but not detected. This flag may not be combined with the "B" flag.
(blank)	Unqualified result.

Note that the "U" and "B" qualifiers are mutually exclusive, and may not occur on the same record.

See also section 2.6.1, *"Data qualifiers,"* page 6, and 2.6.2, *"Tentatively Identified Compounds,"* page 7.

lab_qual_o

Lab Qualifier (Other)

This field is used for qualifier codes used by the lab which are not in the VVL for *lab_qual*. Written explanation of these codes must be provided to Jacobs Engineering.

lab_snum

Lab Sample Number

This field is used for the identification code associated by the lab with the sample when received or generated.

This clarification was incorporated as of LDSH 2.1, initially specified in the memo *"Clarifications to LDSH 2.0"* on 4 May 1993.

Laboratory sample numbers, as reported to JEG in the *lab_snum* field of the Data file (page 22), must ***uniquely*** identify a sample ***independent*** of the *qc_type* field, i.e., the *qc_type* field shouldn't be considered part of the key to associate results to a given *lab_snum*. For example:

a. If a field sample (*qc_type* = N1) has a matrix spike sample (*qc_type* = MS1) derived from it, that matrix spike sample must have a different lab sample number than the original field sample.

b. If a matrix spike duplicate (*qc_type* = SD1) is pulled from the sample in (a) as well, it must have a unique lab sample number from both the N1 and MS1 sample.

c. If two QC samples are synthesized by the lab, e.g., a blank spike and a blank spike

duplicate (*qc_type* = BS1 and BD1, respectively), each of these must have a unique lab sample number.

d. If a fraction of a sample is re-run in another lab batch (e.g., after blank contamination is detected), or where multiple GC column results are being detected, it is ***not*** necessary to change the laboratory sample number. The *lab_batch* and *pvccode* fields will uniquely identify the result.

If this uniqueness is not currently part of the laboratory's sample numbering scheme, it is suggested that the *qc_type* field (or a codified version thereof) be appended to the current lab sample number when reported in the *lab_snum* field.

matrix

Sample Matrix

This code indicates the matrix of the sample which has produced this result record.

For laboratory QC, use the actual matrix of the QC sample, not that of the associated sample.

Unless otherwise instructed by Jacobs project personnel, the matrix reported should dictate the *basis* field as indicated (see page 19).

Code	Matrix is...	Basis should be...
W	Water/aqueous	X
S	Solid/soil	D or W
A	Air/gaseous	X
T	Tissue	D or W

parvq

Parameter Value Qualifier.

[VVL]

Note that this field parallels the *lab_qual* field, though with less detail.

See also section 2.6.1, *"Data qualifiers,"* page 6, and 2.6.2, *"Tentatively Identified Compounds,"* page 7.

pquant

Practical Quantitation Level.

(This further explanatory text was first included in LDSH 2.1.)

This is the level above which quantitative results may be obtained with a specific degree of confidence. It should take into account the same variable factors as the *detect* field, and so is applicable to the specific record it is found in.

It is not required where inapplicable (e.g., for pH or temperature), or for surrogate spike analytes.

Quantitation limits are established on the same basis as detection limits. Laboratories should contact project personnel for particulars.

Where *value* is at or above *detect*, but below *pquant*, then the *lab_qual* field should be "J" for organics or "B" for inorganics.

prep_mthd

Preparation Method Code.

[VVL]

Where no preparation or extraction is performed, a *prep_mthd* of "NONE" should be entered. Where the extraction is dictated by the analytical method, a *prep_mthd* of "METHOD" should be included.

pvccode

Parameter Value Classification Code.

Positive gas chromatographic results must be confirmed by testing the same sample on a different GC column. For each analyte subject to confirmation, three records must be provided: the ***first column*** result, the ***second column*** result, and the ***primary*** result (the labs considered opinion of the "true" analyte confirmation). For example, if peaks overlap (coelute) on one column, the lab would report the concentration from the other column as the primary result. If a *third column* is used, it must be reported as well. The primary result will be a duplicate of the first or second column results. When submitting

these three records, they must be distinguished by using the appropriate code.

Where results are non-detects, only the primary result need be submitted.

Code	Name
1C	First column result.
2C	Second column result.
3C	Third column result.
PR	Primary result.
MS	Confirmed by GC/MS Method.

qc_type

Lab QC Sample Type.

This code describes the purpose of the sample. Labs should use these codes to identify QC samples prepared at the lab to evaluate analytical conditions and precision. These lab samples must be uniquely identified, since two or more of the same type may be analyzed at the same time, e.g., LR1 and LR2.

The following further explanation was substantially expanded in LDSH 2.1, as originally communicated in the memo *"Clarifications to LDSH 2.0,"* 4 May 1993. For readability, it is not given in this distinctive revision format.

The QC samples are identified in this field with one of the prefixes given below, and then a single sequential digit or letter (shown as *n* below, representing 1-9, then A-Z) for any samples of the same type prepared on the same day. The sequence number for a particular *qc_type* code must be incremented for each instance of a particular QC type generated by the lab ***for a given Jacobs project on a given day.*** This requirement is independent of any unique assignment of *lab_snum.*

The first nine of a given type of QC for the day should use the sequence "1" through "9". The tenth should use "A" for the sequence, followed by "B", etc.

For example:

Two Jacobs samples for project 99G04700 come in to Lab X. On 5 January a matrix spike is crated from each of these samples. These must be given a qc_type *of "MS1" and "MS2".*

Later that same day, a sample for Jacobs project 01G12300 comes in. A matrix spike is created from this. It is given a qc_type *of "MS1" because it is the first MS created for that project on that day. Still later that same day, another sample for Jacobs project 99G04700 comes in. A matrix spike is created for it. it is given the* qc_type *of "MS3", as it is the third matrix spike for the lab on that project on that date.*

A matrix spike is taken off of that last sample on following day. This one is given a qc_type *of "MS1", as it is the first taken on that project that day.*

We thus end up with the following:

Project number *Proj_num*	**Lab received** *Lab_recvd*	**QC type** *qc_type*
99G04700	05-Jan-94	MS1
99G04700	05-Jan-94	MS2
99G04700	05-Jan-94	MS3
99G04700	06-Jan-94	MS1
01G12300	05-Jan-94	MS1

A blank value in this field indicates that it is not a laboratory QC sample. Thus, though this is a required field, a blank value is acceptable and meaningful.

Code	Name
BS*n*	Blank Spike: A measurement of a known concentration of an analyte of interest to check analytical accuracy.
BD*n*	Blank Spike Duplicate: The second of a pair of blank spike samples to check precision and accuracy of analysis.
RM*n*	Reference Material: Known external reference material with well-established properties used to calibrate apparatus or assess measurement methods.
KD*n*	Known Duplicate: A second analysis of a Reference Material (RM) sample.
LB*n*	Lab Blank: Blank sample to detect contamination of samples in lab.
LR*n*	Lab Replicate: Split of sample to check precision of analysis.

MS*n*	Matrix Spike: A normal sample with a known amount of target analyte added in the lab to check accuracy of analysis.
SD*n*	Matrix Spike Duplicate: The second of a pair of matrix spikes to check precision and accuracy of analysis.

spike_val

Spiked Parameter Value.

(This explanatory text was included here in LDSH 2.1)

This field represents the amount of *analyte (in units)* which was spiked, or added, into this particular sample prior to analysis. The lab should *not* include the amount recovered in this field. Actual quantities for *spike_val* and *value* should be used, rather than percent recoveries. The exceptions is for surrogate spikes, where, if percentages are used, the *spike_val* should be 100 and the *value* should be the percentage recover (with *units* as "PERCENT").

For results which were not spike analytes, a *spike_val* of zero (0.0000) should be used.

The following values, then, should be in *spike_val*, based on the *qc_type* field:

QC type *qc_type*	Spiked value *spike_val*
BS/BD: Blank spike/duplicate	Amount added
LB: Lab blank	"0.0000"
MS/SD: Matrix spike/duplicate	Amount added
LR: Lab replicate	"0.0000"
RM/KD: Reference material-/duplicate	Amount known
Surrogate spike result	Amount added
Other	"0.0000"

surrogate

Surrogate Spike Flag

This field indicates if the analyte for the given analytical result record is a surrogate spike analyte.

Code	Definition
T	The analyte is a surrogate spike for this sample and test.
F	The analyte is not a surrogate spike.

test_mthd

Analytical Test Method Code.

[VVL]

units

Units of Measure.

[VVL]

As a general rule, the following units will be used for reporting analytical results. Exceptions should be clearly documented and approved by Jacobs project personnel.

Sample type	Test type	Units
Water	inorganics, metals	MG/L
Water	organics	UG/L
Water	radioactivity	PCI/L
Water	TCLP	MG/L
Soil/sediment	inorganics, metals	MG/KG
Soil/sediment	organics	UG/KG
Soil/sediment	radioactivity	PCI/KG
Soil/sediment	TCLP	MG/L
Soil Gas	GC, GC/MS	PPB
Soil Gas	OVA, HNu	PPM

val_id

Validator ID.

[VVL]

The value to be used by each validator will be provided by Jacobs Engineering.

val_qual

Validator Result Qualifier.

Validating firms should use these codes to qualify results they are providing. Note that, although this is a required field, a blank value is meaningful, indicating that the result is unqualified.

These definitions are summarized from the *US EPA CLP National Functional Guidelines for Organics Data Review (Draft 12/90, Revised 6/91)* and the *US EPA Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses (7/1/88)*, which should be considered the authoritative definitions. The codes may only be combined as shown.

Further reason codes (or sub-codes) should be stored in the *val_qual_rc* field.

Code	Qualification
U	Material was analyzed for, but not detected above the level in the *value* field. The *value* is either the sample quantitation limit or the sample detection limit.
J	The analyte was positively identified. The *value* is an estimated quantity.
N	The analysis indicates presumptive evidence for a tentative identification of the analyte. *This code is inapplicable for inorganic results.*
NJ	The analysis indicates presumptive evidence for a tentative identification of the analyte. The *value* field holds the estimated quantity. *This code is inapplicable for inorganic results.*
R	The data are unusable. The analyte may or may not be present.
UJ	The material was analyzed for, but not detected above the quantitation limit. The value is an estimate, and may be inaccurate or imprecise.
(blank)	Unqualified result

val_qual_rc

Validator Qualifier Reason Code.

Validators should place reason codes or sub-codes for the codes in *val_qual* in this field. There is no VVL for this field, but all values should be agreed upon by and provided to Jacobs Engineering.

Appendix C—JEMS/IRPIMS cross-reference

This appendix cross-references JEMS data field names to, where applicable, the appropriate Air Force IRPIMS field. The cross-reference is provided to provide more information for labs on field contents and layouts.

Further information on the IRPIMS fields can be found in the IRPIMS DLH.

JEMS field	IRPIMS file	IRPIMS field
analyte	BCHRES	PARLABEL
anl_type	-	-
basis	BCHTEST	BASIS
calib_ref	-	-
comm_type	-	-
comment	-	-
climit_min	-	-
climit_max	-	-
control_num	-	-
dcl_flag	-	-
detect	BCHRES	LABDL
detect_sd	BCHRES	LABDLPRC
dilution	-	-
instrument	-	-
lab_anal_d	BCHTEST	ANADATE
lab_anal_t	BCHTEST	ANATIME
lab_batch	BCHSAMP	LABLOTCTL
lab_extrc_d	BCHTEST	EXTDATE
lab_extrc_t	BCHTEST	EXTTIME
lab_id	BCHTEST	LABCODE
lab_qual	-	-
lab_qual_o	-	-
lab_recvd	-	-
lab_snum	BCHTEST	LABSAMPID
matrix	-	-
max_rpd	-	-
parun	BCHRES	PARUN
parunprc	BCHRES	PARUNPRC
parvq	BCHRES	PARVQ
pquant	BCHRES	PQLEVEL
pquant_sd	BCHRES	PQLEVELPRC
prep_mthd	BCHTEST	EXMCODE
proj_num	-	-
pvccode	BCHTEST	PVCCODE
qc_type	BCHSAMP	SACODE
sigdig	BCHRES	PARPRC
spike_val	BCHRES	EXPECTED
surrogate	-	-
test_mthd	BCHTEST	ANMCODE
units	BCHRES	UTMCODE
val_id	-	-
val_qual	-	-
val_qual_rc	-	-
value	BCHRES	PARVAL

BC Analytical Laboratory

Diesel-Range Organics

Analytical Standard Operating Procedure

Recycled

DIESEL 3510/3550 ANALYSIS

A. Summary

This procedure describes the method used to determine organic compounds that have low volatility such as diesel fuel, oils, and hydraulic fluids in aqueous, soil and sediment samples by gas chromatography. It can also determine the carbon range and characterization.

The sample is extracted with methylene chloride and then injected into a gas chromatograph equipped with a megabore column, splitless injector and flame ionization detector.

B. Safety

1. Analyst should use gloves when handling samples or standards.
2. Safety glasses should be worn.
3. Standards and samples should be prepared in the hood.
4. Methylene chloride is a suspected carcinogen and should be used under a hood. A respirator should be worn.

C. Apparatus

1. Varian 3400 or equivalent gas chromatograph equipped with:
   a. Flame ionization detector
   b. Varian 8000 series autosampler, or equivalent
   c. Splitless injector
2. Column (J & W Scientific, 30 m x 0.25 mm ID DB-5 column, 0.25 u film thickness, or equivalent).
3. Autosampler vials, 1.5-mL.
4. Hamilton syringes: 10-uL, 100-uL, 500-uL, 2500-uL.
5. Top-loading balance.

6. Ultrasonic cell Disruptor

7. Kuderna-Danish (K-D) apparatus

8. Hot water bath or heating block, temperature controlled.

D. Reagents

1. Neat diesel fuel, two sources

2. Methylene chloride (E.M. Science, Chromatography grade)

3. Anhydrous sodium sulfate.

4. Compressed air, high purity

5. Compressed hydrogen, high purity

6. Compressed helium, high purity

7. Naphthalene (Baker analyzed, Reagent grade)

8. Standard stock solution, 10000-ppm diesel: Weigh out 0.10 g of the neat diesel into 10-mL volumetric flasks. Dilute to the mark with methylene chloride. Mix well. Prepare fresh every year.

9. Surrogate stock solution, 10000-ppm naphthalene: Weigh 0.25 g of naphthalene into a 25-mL volumetric flask; dilute to the mark with methylene chloride; mix well. Prepare fresh every year.

10. Working surrogate solution, 100-ppm naphthalene: dilute surrogate stock solution 1:100 in methylene chloride. Prepare fresh every three months.

11. Laboratory control standard (LCS) stock: repeat step 8 above with a separate source of diesel fuel. Prepare fresh every three months.

12. Working calibration standards (prepare fresh every three months.)

    a. Prepare five concentration levels of diesel at 50, 100, 200, 300, 400, and 500 ppm by diluting the standard stock solution with methylene chloride.

    b. Prepare five levels of naphthalene at 4, 8, 12, 16, and 20 ppm by diluting the standard surrogate solution with $MeCl_2$.

13. Calibration check solution: Dilute the diesel stock standard to 200 ppm. Add 12 ppm of naphthalene. Prepare

fresh every three months.

14. Carbon range standards: prepare mix of C5 to C36 at 100 ppm from neat mixtures of C5-C8, C7-C10, C10-C16, C18-C24, and C24-C36. Prepare a separate 100 ppm solution of C10-C16 only.

E. Procedure

1. Notebook Preparation:

   a. Enter the date, batch number, the instrument number and the analyst's initials in the header.

   b. Prepare columns for log-number, sample description, client name, sample weight, final volume and comments.

   c. Enter the log numbers, sample descriptions, and client codes in the appropriate columns.

   d. Prepare the runlog by entering the date and analyst's initials in the header. Enter the log number of each sample to be run, the dilution (if any) and the data file name (the chromatogram number) in the appropriate columns of the runlog.

2. Soil Preparation:

   a. Open the sample and discard the top 2 inches of soil if it is a brass core.

   b. Weigh out 25 grams of sample into a 500 ml beaker.

   c. Record the sample weight in the prep notebook.

   d. For matrix spikes, weigh out additional portions of sample and add 100 uL of the LCS stock solution directly into the soil.

   e. For the method blank and LCS, weigh 25 grams of DI water. Add 100 uL of LCS stock soultion to the LCS.

   f. Add 600 uL of working surrogate solution to all samples and QC solutions.

   g. Add 75 mL of methylene chloride.

   h. Place beaker onto sonicator platform with Disruptor horn about a 1/2 inch below surface of the solvent, but above the sediment layer.

   i. Sonicate for three minutes, while the output control knob is set at 10, the mode switch set on pulse and the percent-duty cycle knob is set at 50%.

j. Decant the liquid onto a drying column containing about 5 cm of dry sodium sulfate. Collect the dried extract in a K-D concentrator setup.

k. Repeat the extract process two more times. Rinse the drying column with 50-75 ml of methylene chloride after the final extract is dryed.

l. Place a snyder column onto the K-D apparatus and cook down the extract to 5 ml final volume on the heating block (80-90 C).

3. Aqueous Sample Preparation (for continuous extraction method, skip to step j):

a. Place one liter of liquid sample into the 2-liter separatory funnel.

b. For matrix spikes use one liter of liquid samples from extra client supplied bottles. Add 100 uL of LCS stock solution.

c. For the LCS and method blank, use one liter of DI water. Add 100 uL of LCS stock solution to the LCS.

d. Add 600 uL of working surrogate solution to all samples.

e. Add 75 mL of methylene chloride to separatory funnel.

f. Shake vigorously for two minutes.

g. Allow to stand until layers separate (10 min) then collect organic phase in a flask.

h. Repeat solvent extraction two more times, combining all three extracts.

i. Decant the liquid onto a drying column containing about 5 cm of dry sodium sulfate. Collect the dried extract in a K-D concentrator setup. Rinse the drying column with 50-75 mL of methylene chloride. Attach a snyder column onto the K-D apparatus and cook down the extract to 5 mL final volume on the heating block at 80-90^{o}C. Proceed with analysis section 4.

j. If using continuous extraction, add 225 mL of $MeCl_2$ to a 250 or 500 mL round bottom flask attached to a continuous extractor.

k. Pour one liter of liquid sample into the continuous extractor vessel from the top.

l. Perform steps b through d above.

m. Set extraction time for 18 hours.

n. After 18 hours, collect extract into the round bottom flask by tilting the continuous exractor.

o. Finish extraction by following step i above.

4. Sample Analysis:

a. A methylene chloride wash should be run to check the instrument for contamination.

b. Initially calibrate the instrument by injecting the five calibration standards.

c. Run the calibration check standard.

d. If the calibration check standard meets the criteria in section F, load the autosampler with the analytical batch.

e. A typical batch sequence is:
   1. method blank
   2. half of sample extracts
   3. spike
   4. spike duplicate
   5. remainder of sample extracts
   6. LCS

f. A methylene chloride wash should be run after the LCS.

g. After the batch has run calculate spike, surrogate, and LCS recoveries and record them on the chromatograms.

5. Instrument conditions:

a. Initial oven temp = 45 C, initial hold = 4 min

b. Ramping rate = 20 C/min, final temp = 300 C, final hold = 8.25 min

c. Detector temp = 350 C

d. Injector temp = 250 C

e. FID range = 12

f. Autosampler injection time = 0.03 min

g. Splitless injection time = 0.20 min

h. Injection vol = 2 ul

6. Carbon Range Determination:

   a. Analyze 100 ppm C5-C36 carbon range standard and 100 ppm C10-C16 to determine retention times for carbon ranges.

   b. Repeat carbon range determination whenever the retention time of the naphthalene peak shifts by more than 0.25 minutes.

F. Quality Control

1. The calibration curve must have a correlation coefficient of at least 0.995.

2. The concentration of the daily calibration check must be within 15% of the expected value. If not, rerun the calibration check. If it fails again the instrument must be recalibrated.

3. A matrix spike, matrix spike duplicate and LCS must be run once per batch.

4. The LCS recovery must fall between the current control limits.

5. The percent recovery of the matrix spikes should fall between current control limits. If not, check the LCS. If the LCS is within the control limits, the results can be reported.

6. A reagent (method) blank must be run with each batch. The observed contamination level must be below the reported detection limit or the batch must be repreped.

G. Calculations and Data Review

$$\text{Response Factor} = \frac{\text{Concentration of standard}}{\text{Area count of standard}}$$

$$\text{Concentration of aqueous(mg/L)} = \frac{As \times RF \times Ve}{Vs}$$

$$\text{Concentration soil(mg/kg)} = \frac{As \times RF \times Ve}{Ws}$$

where:

As = Area count of the sample
RF = Response factor
Ve = Volume of the methylene chloride extract
Vs = Volume of the aque. sample
Ws = Weight of the soil sample

Carbon range:

Carbon range is determined by comparing with the retention time of alkanes standard.

Characterization:

Characterization is done by matching the pattern with various type of fuels such as gasoline, diesel, and jet fuel.

H. Troubleshooting

1. Low spike recovery

   Check the surrogate recovery. If the surrogate recovery is also low, check for leaks and re-run the sample.

2. Excessive cross-contamination

   a. Bake column at 320 degrees C for at least one hour and then run several methylene chloride washes.

   b. Replace the glass insert and cut the column at the injector end.

I. Interferences

1. Any compound whose response to FID detector will interfere with fuel analysis.

J. References

1. Personal communication, Technical Servies Dept., Chevron Research, Richmond, CA

2. Test Methods for Evalulating Solid Waste, Volume 1B, USEPA, Third Edition, November 1986, Method 8015.

Reviewed and approved
T. Kirk 05/14/93
Issued _____

BC Analytical Laboratory
Gasoline-Range Organics
Analytical Standard Operating Procedures

Recycled

VOLATILE PETROLEUM HYDROCARBONS

A. Summary

This method describes the preparation and analysis of water and soil samples for volatile compounds, such as gasoline, that have boiling points below 200°C. Diesel and other mid-weight products have poor purging efficiencies and can best be analyzed by other gas chromatographic methods.

Soil samples with low expected contamination are slurried with water and loaded directly on the purge and trap instrument. Likewise, water samples are not extracted but placed directly into the purge and trap instrument. Soil samples with high levels of contamination are micro-extracted with methanol, and this extract is diluted with water and loaded on the purge and trap instrument.

Samples are heated from 25°C to 60°C and purged with an inert gas, such that the volatile components are transferred to the vapor phase and adsorbed on a sorbent trap. The trap is then rapidly heated and backflushed with inert gas, transferring the components into the gas chromatograph. Components are separated on a capillary column and analyzed with PID and FID detectors. The results are calculated on a PC-based data system.

B. Safety

1. Gloves should be worn when handling reagents, standards and samples.

2. Respirators or fume hoods should be used when preparing standards.

3. Safety glasses should be worn at all times.

4. Care must be taken not to allow a build-up of hydrogen gas in a gas chromatograph oven since an explosion could result.

5. All gas cylinders must be secured with a chain at all times.

6. Refrigerators/freezers should be rendered spark free.

C. Apparatus

1. Instrumentation and Equipment
(equivalent equipment may be substituted)

a. HP 5890A GC, supplies and tools

b. DB-5 Columns, 30m x 0.53mm ID 5 micron film thickness

c. Tekmar ALS 2016

d. Tekmar LSC 2000

e. 25mL Purge vessels

f. HP 5890A FID or FID/OI PID in tandem

g. OI 4430 PID

h. PE Nelson 900 series interface

i. 12" Tenax Trap, 1/8" ID

j. IBM-Compatible 386 Microcomputer with monitor and printer

k. Milli-Q water (purification) system or equivalent

l. Balance: Analytical capable of accurately weighing 0.0001g and a top-leading balance capable of weighing 0.01g.

2. Supplies

a. Microsyringes: 10uL, 50uL, 100uL, 500uL, and 100uL 1000uL, gas tight, with fixed or removable needles.

b. Syringe: 10mL, gas-tight

c. Volatile Organic Analysis (VOA) vials, 40mL, 10mL, 3.7mL, and 1.7mL with teflon-lined septa screw caps.

d. Glass bottle: 125mL amber with screw cap and teflon-lined septa.

e. Volumetric flasks: 1 Liter with ground glass stoppers.

f. Stainless steel spatula.

g. Pipettes: glass, calibrated to deliver 2mL, 3mL, 5 mL, and 10mL.

h. Pipettes, adjustable, with disposable tips, 100uL and

1000uL. The disposable tips must be shown to contain no interferences prior to use.

i. Disposable pipets: Pasteur

j. Water purging/purification flasks, 1-2 liters.

D. Reagents

1. Compressed hydrogen, helium, and nitrogen in cylinders at 99.999% purity. Zero Grade Air--breathing quality.

2. Methanol: GC grade or equivalent

3. Reagent water: Distilled water filtered and purified by an appropriate system, then purged for one hour by an uncontaminated inert gas, such as nitrogen or helium.

4. Gasoline: Store securely sealed in a glass vial.

5. Purgeable aromatics (EPA 8020) standard 200 ug/mL in methanol, in 1mL sealed glass ampules.

6. Pure benzene, analysis grade, 98% or more.

7. Pure toluene, analysis grade, 98% or more.

8. Pure Ethylbenzene, analysis grade, 98% or more

9. Pure m-Xylene, analysis grade, 98% or more

10. Pure p-xylene, analysis grade,, 98% or more

11. 1,4-Bromofluorobenzene

12. a,a,a-Trifluorotoluene

E. Standards (Prepared from reagents listed above.)

1. Gasoline Stock Standard (50,000 ug/mL in methanol)

2. Gasoline Working Calibration Standard (4000 ug/ml in methanol, prepared from Gasoline Stock Standard)

3. BTEX Working Calibration Standard (200 ug/mL of each component in methanol)

4. BTEX Stock Spiking Solution (1000 ug/mL of each BTEX component in methanol)

5. Working Laboratory Control Standard (Prepared from BTEX Stock Spiking Solution. 20 ug/mL for each BTEX component.)

6. Internal Standard Solution (50 ug/ml of 1,4-bromofluorobenzene in methanol)

7. 8020 Surrogate Solution (200 ug/mL of a,a,a-Trifluorotoluene in methanol)

F. Procedure

1. Preparing the Purge Vessels and Instrumentation

   a. Rinse purge vessels three times with deionized water, dry in oven, and cool.

   b. Bake GC at 240°C for 30 minutes.

   c. Bake trap for 15 minutes to remove possible contaminants.

2. General Procedure for Loading of Water Samples, Soil Extracts, and Standards

   a. Rinse a 5mL-10mL gas-tight syringe three times with purge water.

   b. For blanks, LCS's and extracted soil samples, refill the syringe with the purge water and adjust volume to 5mL. Introduce some air into the syringe to allow ample room for introduction of sample or standard, and surrogate so as to avoid expulsion of any syringe contents. Add the appropriate amounts of internal standard and surrogate extract or standard with a gas-tight syringe. Transfer syringe contents to purge vessel. Normal volume of soil sample extract used is 100uL. If the sample is highly concentrated use a smaller amount down to 2ul. If 2uL still yields a result that is over range, dilute the soil extract before reanalysis.

   c. For undiluted aqueous samples, pour sample directly into syringe barrel, replace plunger, adjust volume to 5mL, add internal standard and surrogate, and transfer to purge vessel.

   d. For diluted aqueous samples, if the sample volume to be used is 1mL or less, add enough water to the syringe such that the total volume will be 5mL after the sample aliquot is added. Then add the sample aliquot to the syringe. Internal standard and surrogate solution is then added to the syringe prior to transfering to the purge vessel. If the dilution factor will be $\geq$20, serial dilutions must be made prior to purge vessel introduction. Internal standard and surrogates must also be added.

3. General Procedure for Loading Soil Slurry Samples

   a. Rinse a 5mL gas-tight syringe three times with purge water.

   b. Fill the syringe with purge water and adjust the volume to 5.0mL. Introduce some air into the syringe to allow ample room for the introduction of internal standard and surrogate without the expulsion of any syringe contents. Add the appropriate amount of internal standard and surrogate with a gas-tight syringe.

   c. Remove the cap from the sample tube or jar and discard the top 1 1/2-2 inches of sample. Quickly weigh out 4.8 to 5.2 g of sample into a purge vessel. Add the purge water and internal standard and surrogate from the syringe to the purge vessel, and place the vessel on the autosampler. Lower the purge needle to the soil/water interface.

4. Instrument Calibration

   The instrument is calibrated with five point curves from separate analyses of dilutions of the BTEX and Gasoline Working Calibration Standards. Concentrations should span the working range of the instrument. The BTEX range is 5-100 ug/L and the gasoline range is 250-4000 ug/L. The correlation coefficient should be greater than or equal to 0.995 to proceed. This calibration is checked daily and must be within +/- 15 percent to analyze samples. If the +/- 15 percent is not met, the instrument must be recalibrated.

5. Dilution of Samples

   All samples are analyzed in such a way as to provide the client with the lowest practical detection limit. Dilutions may be necessary, however, for samples which contain high levels of contaminants or interferences. Aqueous samples are diluted to the appropriate level with purge water. Soil samples may be slurried using less than the usual 5g of sample. Using less than 1g of sample is not recommended. Soils may be extracted with methanol and the extract diluted with purge water if more dilution is necessary.

6. Extraction of Soil Samples

   a. Place 4.8 - 5.2 g of soil sample into a 40mL VOA vial and weigh to nearest 0.1g.

   b. Add 10.0mL of methanol with a glass pipet.

c. Cap vial and shake for two minutes.

d. Record client code, sample description written on sample container, sample weight, date, batch number and final volume.

7. Sample Analysis

a. In general, analyze water samples before soil samples, and samples of known low concentration before those known to be of higher concentration.

b. Start a run with a midpoint standard to verify the initial calibration, then a water method blank or extraction method blank, the samples or sample extracts, matrix QC and finally an LCS.

c. Prior to analysis, enter the correct sample log number, batch number, extraction date, and dilution factor into the method sequence file of the computer. If possible, include the batch number and extraction date as well.

d. Sample run times and conditions may need adjustment for variations in instrumentation, so the following should only be used as a guideline.

Autosampler conditions:

Sample temperature (^{o}C)	35
Sample preheat (min)	4
Purge temperature (^{o}C)	60
Purge time (min)	11
Dry purge time (min)	4
Desorb preheat (^{o}C)	175
Desorb teperature (^{o}C)	180
Desorb time (min)	4
Bake temperature (^{o}C)	225
Bake time (min)	12
Purge flow (mL/min)	30
Purge pressure (psi)	20
Valve temperature (^{o}C)	100
Line temperature (^{o}C)	100

GC conditions:

		A
Initial temperature (^{o}C)	40	
Initial hold time (min)	5	
Rate (^{o}C/min)	6	10
Final temperature (^{o}C)	100	250
Final hold time (min)	0	0
Injector temperature	180	

Detector temperature	250
Column flow rate (mL/min)	10 (He)
Make-up gas (mL/min)	30 (H2)
PID sweep gas (mL/min)	25 (H2)
FID air (mL/min)	300

G. Quality Control

1. Water and Soil Slurry Method Blanks

   a. Analyze a method blank for every analytical batch. The blank consists of reagent water spiked with 5 uL of internal standard solution and 2 uL of surrogate solution. Use 5mL of water for aqueous batches and for soil slurry batches.

   b. A method blank is acceptable if all components measured are below 3 times the reporting detection limits for the sample matrix. If the blank exceeds this limit, the source of contamination should be identified and appropriate corrective action documented. This may include re-running the batch and/or flagging the data.

   c. Refer to the method blank SOP.

2. Soil Extraction Method Blanks

   a. Prepare an extraction method blank by spiking 5mL of reagent water with 100uL of the methanol used to extract the soil samples, and adding 5uL of internal standard and 2uL of surrogate solution.

   b. Analyze one method blank for every batch of soil samples extracted.

   c. The method of determining acceptability and the corrective action plan are analogous to those specified for water and soil slurry method blanks.

   d. Refer to the method blank SOP.

3. Laboratory Control Standard (LCS)

   a. Prepare the LCS by spiking 5mL of reagent water (5mL for soil slurry batches) with an appropriate amount of the LCS solution.

   b. Run LCS's at a frequency of one per analytical batch.

   c. Determine LCS acceptability limits by computing the

average and standard deviation for ≥20 LCS results. Multiply the standard deviation by a factor of two to determine the warning limits about the average value. Multiply the standard deviation by a factor of three to determine the control limits about the average value.

d. LCS values are acceptable if they fall within control limits. If any LCS value falls outside of control limits, run another LCS. If the LCS fails, make fresh LCS solution and rerun. Document all corrective action on the appropriate chromatogram and in the log book.

4. Duplicate Spikes

Water Samples

a. Spike duplicate aliquots of a water sample in the same manner that reagent water is spiked to make an LCS.

b. Prepare one set of duplicate spikes for each analytical batch. If there is insufficient sample, two LCS' are prepared for the prep batch.

c. Determine limits of acceptability for both spike recovery and precision in the same manner as LCS recovery acceptability limits were determined.

d. If spike recoveries are outside of control limits first check the internal standard (I.S.) recovery. If the I.S. recovery lies outside of control limits, rerun the spike. Document appropriately on the spike sample chromatogram and in the log book.

e. If precision data lies outside of control limits, first check the I.S. recovery and rerun any sample for which the I.S. recovery lies outside of control limits.

f. If the I.S. recovery is good and the problem persists, check the gas-tight syringes and then respike two new duplicate aliquots of sample, taking care that the sample is thoroughly homogenized. If precision data still falls outside of control limits, assume matrix problems and document in an operations note.

Soil Slurry Samples

a. Weigh 5.0 +/- 0.2g of soil into each of three purge vessels. If the soil is in a core, discard the first

1/2 inch or so. If the sample has a high clay content, homogenization may be needed, taking care to mimimize loss of volatiles.

b. Spike two of the soil aliquots with an appropriate amount of the Working Laboratory Control Standard solution directly onto the soil. These are samples -S1 and -S2. Do not spike the third aliquot of soil; this is sample -R1.

c. Complete the sample loading procedure as described above (F.3., General Prcedure for Loading Soil Slurry Samples).

d. Prepare one set of duplicate spikes for each analytical batch. If there is insufficient sample for duplicate spikes, prepare two LCS' for the prep batch.

e. Determine acceptability and perform corrective action in the same manner as for water samples.

Soil Extracts

a. Weigh 5.00 to 5.50g of soil in each of three VOA vials, following the sample guidelines in a above.

b. Spike two of the soil aliquots with an appropriate amount of Working Laboratory Control Standard solution directly onto the soil. These are samples -S1 and -S2. Do not spike the third aliquot of soil; this is sample -R1.

c. Complete the extraction process as described above (F6, Extraction of Soil Samples).

d. Prepare one set of duplicate spikes for each analytical batch. Unless two LCS's are prepared for the prep batch.

e. Determine acceptability and perform corrective action in the same manner as for water samples.

5. Internal Standards

a. Add internal standard to every analytical run.

b. Determine control limits from the values obtained during the calibration of the instrument and/or the daily midpoint calibration check. The internal standard areas counts should be 50-200% of either the mean of the calibration or the daily midpoint.

c. If I.S. recovery is below the lower control limit

for any sample, rerun the sample after checking that all connections leading to and from the purge vessel are sufficiently tight. If the I.S. recovery is still too low after rerunning the sample on the same autosampler port, check for leaks in the system. A purge tube or fitting may need replacement. If I.S. recoveries are systematically low or high, make fresh I.S. solution. Some soil matrices may cause low I.S., surrogate and/or matrix spike recoveries.

6. Surrogates

   a. Add surrogate to every analytical run.

   b. Compare results against historical control limits. Recalculate result and re-analyze if still out. Document that this was done in the log book.

7. Confirmation

   Benzene, toluene, ethylbenzene and xylene are major components of gasoline. Therefore, when gasoline is detected in a sample, the presence of BTEX is automatically confirmed. When BTEX is observed in a sample without the presence of gasoline or if the presence of BTEX is in any manner questionable, it must be confirmed by either EPA method 8020 or 8240 within the holding time of 14 days.

H. Calculations and Data Review:

1. Sample Calculations

   a. For BTEX

$$\frac{AC}{RF} \times \frac{\text{Purge Volume}}{\text{Sample Volume or Weight}} \times df = \text{concentration}$$

   b. For Gasoline

$$(AC - BA) \times RF \times \frac{\text{Purge Volume}}{\text{Sample Volume or Weight}} \times df = \text{concentration}$$

   where:

   AC is Area Count. For BTEX, AC is the area of the single peak of interest on the PID chromatogram. For Total Hydrocarbons, AC is the total area of the FID chromatogram where a gasoline matrix is identified.

   BA is the total area of the method blank FID chromatogram.

RF is the Response Factor as calculated from the calibration curve of the analyte of interest. This RF is determined by calculating the average response of each compound based upon concentration and the Internal Standard areas. The Internal Standard method is used for BTEX and the External Standard method is used for gasoline.

Purge Volume is the total volume in the purge vessel. Usually 5 mL.

Sample Volume is the actual amount of sample which has been added to the purge vessel. For aqueous samples this volume is nominally 5 or 10mL, for soil slurries 5g, and for soil extracts 100ul of 5g extracted to 10mL (or 0.2g).

df is Dilution Factor. This factor represents how much the sample was diluted from the nominal sample volume and is the same number which will be entered as the dilution factor result on the final report.

2. Calibration curve selection.

For BTEX on the PID channel, accept the calibration curves if the r value is greater than or equal to > 0.995.

For gasoline, accept the calibration curve if r is greater than or equal to 0.995.

3. Retention time windows

Determine the retention time (RT) window from the calibration data for BTEX and internal standard (I.S.) Calculate the average (RT) and the standard deviation (s). Calculate the RT window as 3s.

For example for o-xylene,

RT = 8.668 min
S = 0.007 min
3s = 0.02 min

Therefore, the retention time window is 8.67$\pm$ 0.02 min.

4. Internal Standard

Use a constant concentration of internal standard in all samples, standards and blank. Calculate the average and the standard deviation (S.D.) of the concentration by using the computer-calculated

average response factor (ARF). Multiply S.D. by two to determine the warning limits for I.S. recovery; multiply S.D. by three to establish the control limits.

5. Surrogate recovery calculations

Determine the percent recovery by dividing the amount seen by the theoretical value. Compare against historical limits, and take corrective action if necessary.

6. LCS Recovery Calculations
Determine the percent recoveries for each BTEX component by dividing the amounts measured by the theoretical values. Compare against historical limits, and take corrective action if necessary. This corrective action might include re-running the LCS or preparing new LCS material. If the LCS continues to be out of control, the batch must be re-analyzed after the problem is identified and corrected.

7. Reagent and Method Blanks

Blank values are reported as calculated and are not subtracted from the sample results.

8. Spike Recovery Calculations

a. Since water samples are spiked in the same manner as reagent water is spike to create an LCS, the theoretical value and spike recoveries are calculated in similar fashion.

R1 + V = T, where

R1 = measured concentration of unspiked sample

V = concentration of spike added.

T = Theoretical value of the spike sample

The recovery is calculated by

$$\% \text{ Rec} = \frac{S - R1}{V}$$

where S = measured concentration of spiked sample

b. Calculate the recovery for spiked soil samples in similar fashion.

9. Significant Figures

Use a maximum of two significant figures to report all results. Refer to the laboratory SOP on significant figures.

10. Interferences

Interferences most commonly occur for toluene and xylenes. To best eliminate them, use clean, sparge vessels, and, if neccessary purge all sparge vessels for three minutes before loading samples. Also, use top quality reagents and standards.

J. References

1. Test Methods for Evaluating Solid Waste, Volume 1B, USEPA SW-846, Third Edition, November 1986.

2. Leaking Underground Fuel Tank (LUFT) Field Manual, State Water Resources Control Board, State of California, Sacramento, CA, May, 1988.

Reviewed and approved
Y. Yang 05/20/92
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APPENDIX B

Data Validation Activities and Required Documents

Data Validation

Data validation activities will typically consist of data review, data evaluation, and data qualification.

Data review will involve reviewing the data package for conformity to the appropriate laboratory protocols (SW-846 Methods), project-specific Quality Assurance Plans, and AFCEE Handbook to support the IRP Statement of Work. Data review will also incorporate evaluation of QC requirements and mathematical and transcription errors. Nonconformances will be noted both on the appropriate worksheets and in the final data validation report.

Using the results of the data review, the data will be evaluated to determine the relevance and impact of any non-conformances. The results of the data evaluation specifying data quality and qualification are summarized as a written report. Qualifiers will be added to copies of the reporting forms and also entered on the electronic data deliverable, if provided.

The following sections summarize the elements of data validation as well as the laboratory data completeness requirements. Receipt of complete data packages incorporating all documentation specified will facilitate efficient, accurate, and comprehensive data validation.

The information summarized in the following sections will be used to review, evaluate, and qualify the data:

SW-846 METHOD 6010 - METALS ANALYSIS BY ICP

Data Validation Element	Requirement Evaluated During Data Validation	Required Documentation
Holding Times	Holding times are evaluated for all samples.	Field Chain-of-Custody Record and Form 14.
Sample Preparation	Appropriate SW-846 methods are evaluated.	Digestion logs indicating SW-846 method used.
Sample Preservation	Sample preservation criteria are evaluated for all samples.	Field Chain-of-Custody Record for all samples showing temperature upon receipt. Digestion logs reporting sample pH for all aqueous samples.
Calibration	Verify ICP has been calibrated with one blank and three standards.	Instrument printout of all calibrations and true concentration of standards.
Instrument Check Standard (ICV, CCV)	All ICV and CCV %Rs are evaluated.	Form 2 reporting all ICV and CCV %Rs and raw data.
Calibration Blank (ICB, CCB)	Verify that an ICB is analyzed immediately following the ICV and CCBs are analyzed every 10 samples immediately following the CCV and at the end of every analytical run.	Form 3 reporting all ICB and CCB results (including negative blank results) and raw data.
Quality Control Sample (QCS)	Verify that one QCS is analyzed per analytical run. All QCS %Rs are evaluated.	Summary report reporting all QCS %Rs.
Method Blank	Method blanks are evaluated for all analytes.	All associated digestion logs and Form 3 reporting all method blank results.
Interference Check Standard	All ICS %Rs are evaluated.	Form 4s.
Matrix Spike (MS)	Verify that one matrix spike is analyzed per batch or one per 20 samples whichever is more frequent (per matrix type), for all analytes. All MS %Rs are evaluated.	Form 5 for all associated matrix spike recoveries and instrument raw data.

Data Validation Element	Requirement Evaluated During Data Validation	Required Documentation
Matrix Spike Duplicate (MSD)	Verify that one MSD is analyzed per batch per matrix type or per 20 client samples, whichever is more frequent. All MSD RPDs are evaluated.	Summary Report reporting all matrix spike duplicate %Rs and all %RPDs and instrument raw data.
Laboratory Control Sample (LCS)	Verify that one LCS is analyzed per digestion batch for all analytes and analyzed in duplicate to calculate RPD. All LCS %Rs and RPDs are evaluated.	Form 7 and all associated digestion logs.
Serial Dilution	All serial dilution %Ds are evaluated.	Form 9 with all serial dilution results and %Ds reported.
Laboratory Duplicate	Laboratory duplicate RPDs are evaluated for all analytes.	Form 5 reporting all duplicate RPDs.

SW-846 METHOD 7000 SERIES FOR GFAA AND CVAA

Data Validation Element	Requirement Evaluated During Data Validation	Required Documentation
Holding Times	Holding times are evaluated for all samples.	Field Chain-of-Custody Record and Form 14.
Sample Preparation	Appropriate SW-846 methods are evaluated.	Digestion Logs indicating SW-846 method used.
Sample Preservation	Sample preservation criteria are evaluated for all samples.	Field Chain-of-Custody Record for all samples showing temperature upon receipt. Digestion logs reporting sample pH for all aqueous samples.
Calibration	Verify the CVAA for Hg was calibrated with one blank and five standards. Verify that the GFAA was calibrated with one blank and three standards.	Instrument printout of all calibrations and true concentration of standards.
Instrument Check Standard (ICV, CCV)	All ICV and CCV %Rs are evaluated.	Form 2 reporting all ICV and CCV %Rs and raw data.
Calibration Blank (ICB, CCB)	Verify that an ICB is analyzed immediately following the ICV. CCBs are analyzed every 10 samples immediately following the CCV and at the end of every analytical run.	Form 3 reporting all ICB and CCB results (including negative blank results) and instrument raw data.
Quality Control Sample (QCS)	Verify that QCS is analyzed per analytical run. All QCS %Rs are evaluated.	Summary report reporting all QCS %Rs.
Method Blank	Method blanks are evaluated for all analytes.	All associated digestion logs and Form 3 reporting all method blank results.
Matrix Spike (MS)	Verify that one matrix spike is analyzed per batch or one per 20 samples whichever is more frequent (per matrix type), for all analytes.	Form 5 for all associated matrix spike recoveries and instrument raw data.

Data Validation Element	Requirement Evaluated During Data Validation	Required Documentation
Matrix Spike Duplicate (MSD)	Verify that one MSD is analyzed per batch per matrix type or per 20 client samples, whichever is more frequent. All MSD RPDs are evaluated.	Summary Report reporting all matrix spike duplicate %Rs and all %RPDs and instrument raw data.
Laboratory Control Sample (LCS)	Verify that one LCS is analyzed per digestion batch for all analytes and analyzed in duplicate to calculate RPD. All LCS %Rs and RPDs are evaluated.	Form 7 and all associated digestion logs.
Serial Dilution	Verify that a serial dilution was performed on at least one sample per batch (except for mercury).	Raw data.
Post-digestion Spike	Spike recovery for one sample per batch must be within 85-115%R. If outside control limits, MSA must be performed on all samples in analytical batch. -- or -- If SOW GFAA scheme is used: A post-digestion spike is performed on all samples in the batch.	Raw data and Form 8s if MSA is performed.
Method of Standard Addition (MSA)	Verify that the MSA correlation coefficient is greater than 0.995.	Form 8.
Duplicate Injection	Duplicate injections are evaluated for every sample analyzed by GFAA.	Raw data.
Laboratory Duplicate	Laboratory duplicate RPDs are evaluated for all analytes.	Form 5 reporting all duplicate RPDs.

GC/MS METHODS 8240, 8260, AND 8270

Data Validation Element	Requirement Evaluated During Data Validation	Required Documentation
Holding Times	Holding times are evaluated for all samples.	Chain-of-Custody Record, Form 1 or equivalent or Form 4 or equivalent, raw data, and extraction logs (for extraction date).
Tune	Tune is verified for every I-CAL and C-CAL.	Form 5 or equivalent and raw GC/MS tune data.
Initial Calibration	All %RSDs and average RRFs are evaluated for each initial calibration.	Form 6 or equivalent, standard concentrations, and raw data.
Continuing Calibration	All %Ds and RRFs are evaluated for each 12-hour period.	Form 7 or equivalent, standard concentration, and raw data.
Method Blank	The method blank for each 12-hour period is evaluated.	Form 1 or equivalent, Form 4 or equivalent, raw data, and run log.
Surrogates	The percent recoveries for all samples and blanks are evaluated.	Form 2 or equivalent, raw data, and surrogate concentration.
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	The MS/MSD for each analytical batch is evaluated.	Form 1 or equivalent for MS and MSD, Form 3 or equivalent, spike concentration, and chromatograms and quantitation reports.
Internal Standard	Areas and retention times for each internal standard for all samples and blanks are evaluated.	Form 8 or equivalent, sample raw data, and standard raw data.
Laboratory Control Sample (LCS)	The LCS recorvies for each analytical batch are evaluated.	Form 1 or equivalent, %R summary form, spike concentration, and chromatograms and quantitation reports.
Compound Identification	All positive results are verified.	Form 1 or equivalent, sample and reference mass spectra, and raw data.

Data Validation Element	Requirement Evaluated During Data Validation	Required Documentation
Compound Quantitation	Verify that calculations are correct and performed in accordance with the method. Transcriptions from the raw data to the summary forms are verified.	Form 1 or equivalent, Form 6 or equivalent, Form 7 or equivalent, sample raw data, standard raw data, extraction logs, run logs, and example calculations.

GC 8000 SERIES METHODS

Data Validation Element	Requirement Evaluated During Data Validation	Required Documentation
Holding Times	Holding times are evaluated for all samples.	Chain-of-Custody Record, Form 1 or equivalent or Form 4 or equivalent, raw data, and extraction logs (for extraction date).
Initial Calibration	All %RSDs for each initial calibration are evaluated.	Form 8D (or 6) or equivalent, Form 8E or equivalent, Form 9 or equivalent, standard concentrations, raw data, and injection volume.
Continuing Calibration	The continuing calibration %Ds and analytical sequence are verified. (Continuing calibration is required after every 10 sample analyses and at the end of the analytical sequence.)	Form 9 or equivalent, Form 8E or equivalent or run logs (for analytical sequence), standard concentration, raw data, and injection volume.
Method Blank	The method blank carried through each stage of sample preparation and measurement is evaluated extraction batch.	Form 1 or equivalent, Form 4 or equivalent, raw data, and run log.
Surrogates	The percent recoveries for all samples and blanks are evaluated.	Form 2 or equivalent, raw data, and surrogate concentration.
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	The MS/MSD for each analytical batch is evaluated.	Form 1 or equivalent for MS and MSD, Form 3 or equivalent, spike concentration, and raw data.
Laboratory Control Sample (LCS)	The LCS recoveries for each analytical batch are evaluated.	Form 1 or equivalent, %R summary form, spike concentration, and chromatograms and quantitation reports.
Compound Identification	Retention time windows from both columns are evaluated. All positive results are verified.	Form 1 or equivalent, Form 9 or equivalent Form 10 or equivalent (retention time windows), and raw data.

Data Validation Element	Requirement Evaluated During Data Validation	Required Documentation
Compound Quantitation	Verify that calculations are correct and performed in accordance with the method. Transcriptions from the raw data to the summary forms are verified.	Form 1 or equivalent, calibration standard concentrations, raw data, extraction logs, run logs, and example calculations.

APPENDIX C
Field Forms

JE JACOBS ENGINEERING GROUP INC.
600 SEVENTEENTH STREET, SUITE 1100N DENVER, COLORADO 80202
TELEPHONE (303) 595 - 8855 FAX (303) 595 - 8857

CHAIN OF CUSTODY RECORD

USE A BALLPOINT PEN, BLACK INK, AND PRESS FIRMLY. INSTRUCTIONS ARE ON THE BACK

PROJECT NAME:

PROJECT NUMBER:

WBS CODE:

SUBCONTRACT / D.O. No.

LABORATORY NAME & ADDRESS:

SAMPLE NUMBER	COLLECTION DATE	COLLECTION TIME	SAMPLER'S INITIALS	NUMBER OF CONTAINERS	CONTAINER SIZE AND TYPE	PRESERVATIVE	MATRIX CODE	ANALYSES REQUESTED	QC	CONDITION ON RECEIPT

COMMENTS:

COLLECTED & RELEASED BY	DATE / /	TIME :	TURNAROUND TIME		
RECEIVED BY	DATE / /	TIME :	RELINQUISHED BY	DATE / /	TIME :
RECORD RETURNED BY	DATE / /	TIME :			
			SHIPPING NUMBER:		

DISTRIBUTION: WHITE - PROJECT FILE / CANARY - LAB RECEIPT / PINK - DATA MANAGEMENT / GOLDENROD - FIELD

INFORMATION IN THIS SECTION

FOR JACOBS USE ONLY

LOCATION	SAMPLE TYPE	DEPTH (FT.)	QC CODE

SAMPLING COMMENTS:

FORM-12.CDR 07-10-92

RECORD OF PHOTOGRAPHS
INDIAN MOUNTAIN LRRS
PROJECT NUMBER 05G46200

Film Type _____ Roll No. _____
ASA Number _____

Photo No.	Date	Time	Photographer	Weather Conditions	Location	Description of Photograph
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						

_____
Signature of Photographer

ChemTel FAX : 1-813-979-4620
Confirmation: 1-800-255-3924

Date: _____

Time: _____

SHIPPING NOTIFICATION
Jacobs Engineering Group Inc.
Denver, CO
Project: Indian Mountain LRRS
Denver (303) 595-8855

ChemTel:

The following shipment has been made:

From: Indian Mountain LRRS, Alaska

To/From: Warbelows Air Ventures
Indian Mountain/Fairbanks, AK
Airbill No.: _____

Alaska Air Lines
Fairbanks/Anchorage, AK

To/From: Jacobs Representative
Anchorage, AK
FedEx Airbill No.: _____

To: BCA Representative
Glendale, CA
(818) 247-5737

CONTENTS

The shipment consists of groundwater, surface water, soil, and sediment samples. The liquid samples contain a **small** amount of acid added as a preservative to achieve a pH of 2.0 or less. Soil and sediment samples are not preserved. The acids used are:

Hydrochloric Nitric Sulfuric

The samples may also contain **trace** amounts of the following compounds:

Unless noted below, concentrations of the solvents are expected to be less than 10 mg/L (ppm) and fuel compounds are expected to be less than 0.1 mg/L (ppm). Pesticide concentrations are expected to be less than 200 *u*g/kg (ppb) and may be present in most samples.

NOTES _____
_____

PACKING/QUANTITIES

_____ High impact plastic coolers, secured with shipping tape.

_____ Total liters of water samples in 1-liter glass, 1-liter plastic, and 40-ml glass containers. Containers are sealed in "ziploc" bags and bubble-wrap (if glass), and packed with WET ICE in absorbant. Coolers have a plastic liner to inhibit leakage.

JE

JACOBS ENGINEERING GROUP INC.
DENVER, CO (303) 595-8855

DAILY REGISTER

PROJECT NO: 05G46200
PROJECT NAME: Indian Mountain
PLACE:_____
DATE(S):_____

	NAME	TITLE	COMPANY	ONSITE LOCATION
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

INDIAN MOUNTAIN LRRS
PROJECT NUMBER 05G46200
WATER LEVEL ELEVATIONS

Well Number	Date	Initials	Water Level (Top of Casing)	Top of Casing Elevation	Land Surface to Water Level	Water Level Elevation

GROUNDWATER SAMPLING DATA SHEET

Project Name: Indian Mountain LRRS
Site ID: _____
Project Number: 05G46200
Date: _____ Start Time: _____ Finish Time: _____
Sampled By: _____

Well Number: _____
Well Type: (i.e., Monitor, Extraction) _____
Well Material: (i.e., PVC, St. Steel) _____
Well Integrity _____
HNU Reading: _____

WELL PURGING

PURGE VOLUME

Borehole Radius (in feet) = _____ inches/12 inches per foot = _____
Total depth of borehole (in feet BTOC) = _____
Water Level Depth (in feet BTOC) = _____
Casing Radius (in feet) = _____ inches/12 inches per foot = _____
Total depth of casing (in feet BTOC) = _____
Number of well volumes to be purged (# Vols.) = _____

PURGE METHOD

_____ Bailer – Type: _____
Pump Type:
_____ Submersible _____ Centrifugal _____ Bladder
_____ Other – Type: _____
Immiscible Phase Detection: ___Yes ___No __LNAPL __DNAPL
Depth to top (ft.) _____ Depth to bottom (ft.) _____
Thickness (ft.) _____

PURGE VOLUME CALCULATION

Borehole Volume (gallons) = 3.14 X (_____)² X (_____ – _____) X 7.48 gallons/ft³
Borehole radius (ft.) Total Depth of Borehole (ft.) Water Level (ft.)
= _____ gallons

Casing Volume (gallons) = 3.14 X (_____)² X (_____ – _____) X 7.48 gallons/ft³
Casing radius (ft.) Total Depth of Casing (ft.) Water Level (ft.)
= _____ gallons

Total Purge Volume = (_____ – _____) X 0.45 + _____ x _____ = _____ gallons
Borehole Volume (gal.) Casing Volume (gal.) Casing Volume (gal.) # volumes Tot. Purge Volume

PURGE TIME

_____ Start _____ Stop _____ Elapsed

PURGE RATE

Initial _____ gpm

ACTUAL PURGE VOLUME

_____ gallons

FIELD PARAMETER MEASUREMENT

Minutes Since Pumping Began	Volume Purged	pH	Cond. (umhos/cm)	T ___ °C ___ °F	Turbidity (ntu)	Other

Minutes Since Pumping Began	Volume Purged	pH	Cond. (umhos/cm)	T ___ °C ___ °F	Turbidity (ntu)	Other

Meter IDs Horiba: Pump: Others:
Observations During Purging (Well Conditions, Color, Odor): _____
Discharge Water Disposal: Sanitary Sewer ___ Storm Sewer ___ Drum ___ (No._____) Other: _____

WELL SAMPLING

SAMPLING METHOD

____Bailer – Type: _____
____Submersible ____Centrifugal ____Bladder: Pump No. _____
____Grab – Type: _____
____Other – Type: _____

SAMPLING DISTRIBUTION Sample Date: _____ Start Time: _____ Finish Time: _____

Sample No.	Volume/Cont.	Analysis Requested	Preservatives	Lab ID	Comments

QUALITY CONTROL SAMPLES

Duplicate Samples

Original Sample No.	Dup. Sample No.

Blank Samples

Type	Sample No.

Other Samples

Type	Sample No.

Field QC By: _____ Date: _____

(sym)af\indn–mtn\gwrec 02–Jun–94

SURFACE SOIL SAMPLING FIELD DATA FORM

PROJECT NAME: INDIAN MOUNTAIN LRRS

PROJECT NUMBER: 05G46200

SITE ID: _____

SAMPLE ID: _____

DATE: _____ START TIME: _____ FINISH TIME: _____

WEATHER: _____

FIELD SAMPLING TEAM:

↑ N

_____

_____

_____

SAMPLING LOCATION:

_____

_____

COMPOSITE: YES/NO COMPOSITE DESCRIPTION: _____

DEPTH OF SAMPLING INTERVAL: _____ VOLUME COLLECTED: _____

HEADSPACE READINGS: _____

DESCRIPTION OF SOIL MATERIALS:

MOISTURE CONTENT: _____

COLOR: _____

USCS CODE: _____

OTHER : _____

FIELD TEST KIT SCREENING RESULTS:

TPH: _____ PCB: _____

DATE AND TIME OF
TEST KIT SCREENING _____

COMPLETED BY:

_____

PRINT NAME SIGNATURE DATE

CHECKED BY:

_____

PRINT NAME SIGNATURE DATE

(win) \wp\af\indn-mtn\fsursosa 06/02/94

Lithologic Borehole Log
Indian Mountain LRRS - Project Number 05G46200

Sheet _____ of _____

Date Started _____ Date Finished _____

↑ N

Borehole Number _____ Drilling Contr _____
Borehole Diameter _____ Driller _____
Depth of Final Sample _____ Drill Rig _____
Total Drill Depth _____ Drill Method _____
GW Depth _____ Geologist _____
Completion Method _____ Sample Method _____
Hammer Wt/Drop _____

Weather
Other Personnel Present

Depth In Feet	Sample Interval	Sample ID	Time Collected	% Rec.	HNU Reading	Blows Per 6"	Moisture Content	USCS Code	Color	Graphic Log	Description
0											
5											
10											
15											
20											
25											
30											

(win) \wp\a\Nndn-mtn\t-LborL.doc 06/02/94

Field QC by _____ Date _____

MONITORING WELL DEVELOPMENT DATA SHEET

Project Name: Indian Mountain LRRS
Site ID: _____
Project Number: 05G46200
Date: _____ Start Time: _____ Finish Time: _____
Sampled By: _____

Well Number: _____
Well Type: (i.e., Monitor, Extraction) _____
Well Material: (I.e., PVC, St. Steel) _____
Well Integrity _____
HNU Reading: _____

WELL PURGING

PURGE VOLUME

Borehole Radius (in feet) = _____ inches/12 inches per foot = _____
Total depth of borehole (in feet BTOC) = _____
Water Level Depth (in feet BTOC) = _____
Casing Radius (in feet) = _____ inches/12 inches per foot = _____
Total depth of casing (in feet BTOC) = _____
Number of well volumes to be purged (# Vols.) = _____

PURGE METHOD

_____ Bailer – Type: _____
Pump Type:
_____ Submersible _____ Centrifugal _____ Bladder
_____ Other – Type: _____
Immiscible Phase Detection: ___Yes ___No ___LNAPL ___DNAPL
Depth to top (ft.) _____ Depth to bottom (ft.) _____
Thickness (ft.) _____

PURGE VOLUME CALCULATION

Borehole Volume (gallons) = 3.14 X (_____)² X (_____ – _____) X 7.48 X _____
Borehole radius (ft.) Total Depth of Borehole (ft.) Water Level (ft.) gallons/ft.³ # Vols.
= _____ gallons

Casing Volume (gallons) = 3.14 X (_____)² X (_____ – _____) X 7.48 X _____
Casing radius (ft.) Total Depth of Casing (ft.) Water Level (ft.) gallons/ft.³ # Vols.
= _____ gallons

Total Purge Volume = (_____ – _____) X 0.45 + _____ = _____ gallons
Borehole Volume (gal.) Casing Volume (gal.) Casing Volume (gal.) Tot. Purge Volume

PURGE TIME

_____ Start _____ Stop _____ Elapsed

PURGE RATE

Initial _____ gpm

ACTUAL PURGE VOLUME

_____ gallons

FIELD PARAMETER MEASUREMENT

Minutes Since Pumping Began	Volume Purged	pH	Conduct. (umhos/cm)	T ___ °C ___ °F	Turbidity (ntu)	Salinity	Dissolved Oxygen	TPH	Alkalinity	Redox Potential	Other Observations

Meter IDs Horiba: Pump: Other:

Observations During Purging (Well Conditions, Color, Odor): _____

Water Levels/Rate of Recovery

Time:	Depth:	Time:	Depth:	Time:	Depth:

Imhoff Cone Data

Time Filled	Time Stirred:	Time Measured:	Settlement (mg/L):

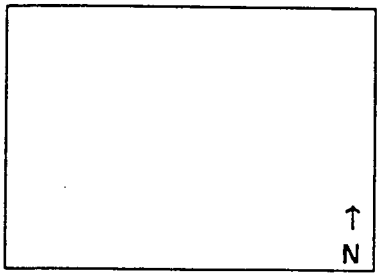
JACOBS ENGINEERING GROUP INC.

(sym)sbrown\ind\mwdev

Indian Mountain LRRS
Project Number 05G46200
SOIL GAS FIELD DATA FORM

SITE INFORMATION:

Upper Camp/Lower Camp
Source/Area Sample ID: _____
Sample Collection Date: _____ Time: _____
Sample Type: Soil Gas / Duplicate / Equipment Blank
Completion Method: _____



Distance and bearing between known point and a sample location:

Weatherconditions:_____

Field Sampling Team:

_____

Was probe decontaminated prior to use?.....Y / N

Surface description/comments (eg. staining, debris, vegetation):

_____

_____

DRIVE DATA:

Target depth: _____ feet below ground surface (bgs)

Refusal?..... Y / N
refusal depth: _____ ft bgs
Offset attempted?..... Y / N
offset refusal?..... Y / N
offset refusal depth: _____ ft bgs
Site abandoned due to refusal <..... Y / N

Drive Comments:

_____

_____

PRE-SAMPLE PURGE DATA:

Purge Volume Calculation.
Casing Volume (mLs) = 3.14 X ( )^2 X ( ) X 28316 (ml/ft^3) = ____ ml
casing radius (ft) total length of casing (ft)

Purge Data		
time (minutes)	**flow rate (ml/min)**	**Purge Volume (ml)**

Indian Mountain LRRS
Project Number 05G46200
SOIL GAS FIELD DATA FORM
(Page 2 of 2)

Purge Comments:

_____

_____

Field Sampling Results:

HNu_____

Landtec _____

Sampling Comments:

_____

_____

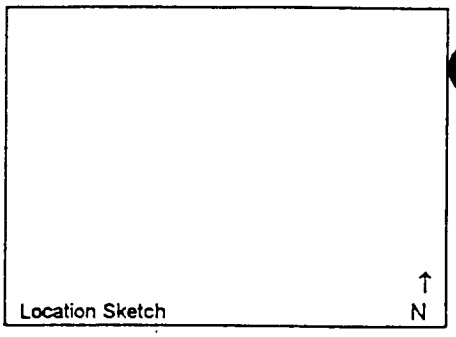
Completed By:

_____	_____	_____
Print Name	Signature	Date

Checked By:

_____	_____	_____
Print Name	Signature	Date

SURFACE WATER SAMPLING FIELD DATA FORM



PROJECT NAME: Indian Mountain LRRS PROJECT NUMBER: 05G46200

LOCATION: Upper/Lower-Source/Area SAMPLE NUMBER: _____

SAMPLE COLLECTION DATE: _____ SAMPLE COLLECTION TIME: _____

SAMPLE RS: _____

SAMPLE TYPE: _____ DISPOSITION: _____

QC TYPE (check): REAL: ____ MS: ____ MSD: ____ LR: ____ DUP: ____ RNS: ____

SAMPLE IS A: GRAB: _____ DEPTH-INTEGRATED COMPOSITE: _____

SAMPLING TECHNIQUE: BUCKET: ____ BEAKER/DIPPER: ____ IMMERSION: ____

SAMPLED FROM: SHORE: ____ WADED: ____ BRIDGE: ____

SAMPLING LOCATION: STREAM: ____ POND: ____ PUDDLE: ____ DITCH: ____

POOL: ____ SEEP: ____ CREEK: ____ OTHER: ____

WEATHER CONDITIONS: _____

FIELD ANALYTICAL PARAMETERS:

Sample No.	Air Temp (°C)	Water Temp (°C)	Dissolved Oxygen (ppm)	pH	Salinity (ppm)	Specific Conduct. (ms/cm)	Alkalinity (mg/l)

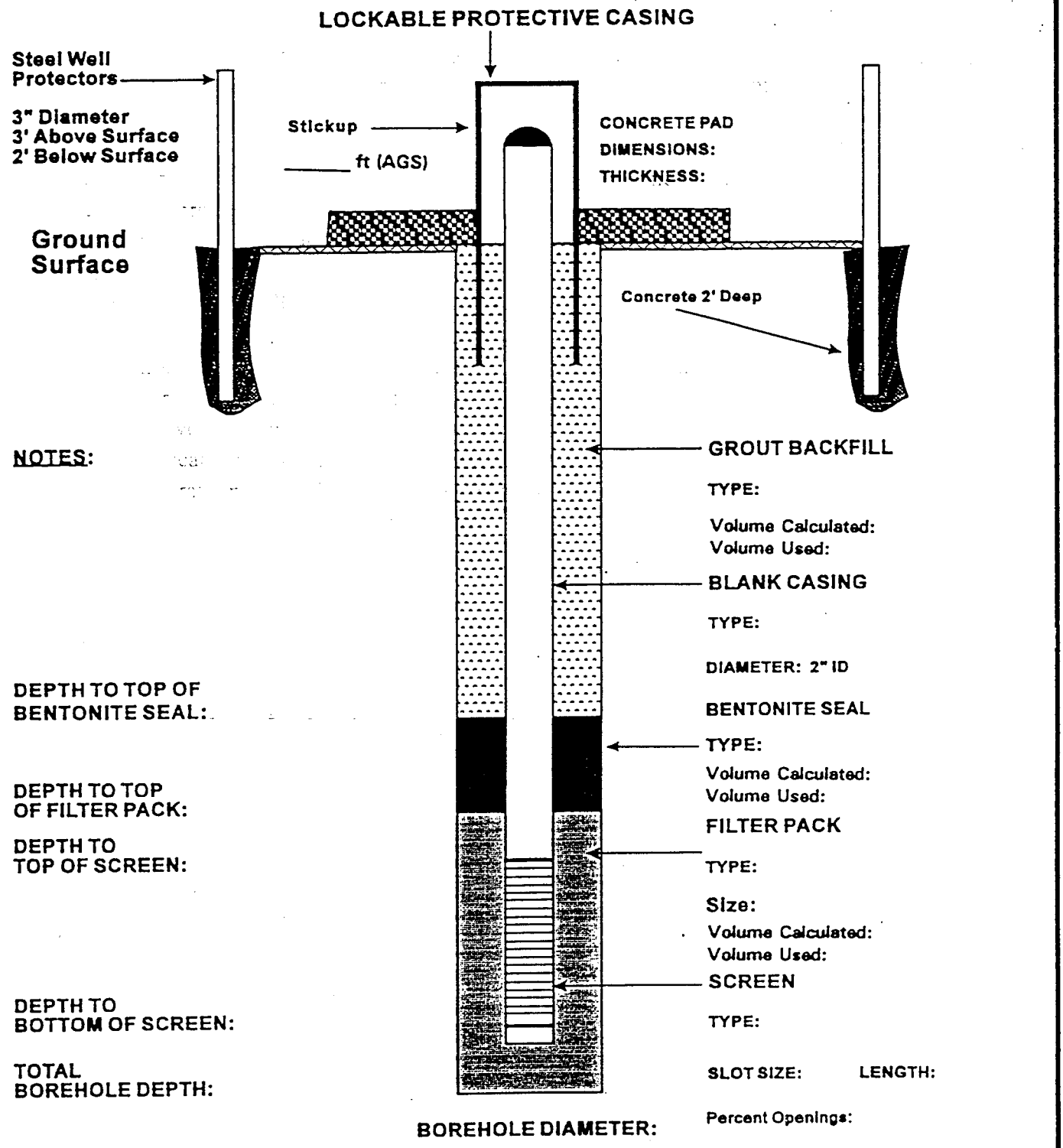
COMMENTS: _____

_____

Completed By: _____ Date: _____
Print Name Signature

Checked By: _____ Date: _____
Print Name Signature

(win)af\indn-mtn\swsform



JE

JACOBS ENGINEERING GROUP INC

MONITORING WELL _____ COMPLETION DIAGRAM

PROJECT: _____ DRILLING CONTRACTOR: _____

DATE INSTALLED: _____ DRILLING METHOD: _____

FIELD REPRESENTATIVE: _____ DRILL RIG AND SIZE: _____

WP\OFFICE\mwmst2b.CDR 05/11/94

APPENDIX D

Instrument Operation Manuals

OPEN CHANNEL

PROFILING HANDBOOK

JANUARY 1989

REV 1 MAY 1990

Marsh-McBirney, Inc
4539 Metropolitan Court
Frederick, MD 21701

800-368-2723
TWX 710-828-0083

OPEN CHANNEL PROFILING

Preface

This handbook contains the instructions on hov to measure the velocity profile and calculate the flov of open channels. The velocity profile is measured using a hand held velocity meter. Flov is calculated with the continuity equation ($Q = \bar{U} \times A$) where Q is flov, $\bar{U}$ is mean velocity and A is cross-sectional area.

Section I describes mean velocity, cross-sectional area, site selection, profiling and methods of determining the mean velocity. Section II describes methods of calculating the instantaneous flov rate. Section III is a case study with the MMI Model 201 being used to determine $\bar{U}$.

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.2 .4 .8 Method ---------- 1-4
.4 Method ---------- 1-4
2-D Method ---------- 1-5
VPT Method ---------- 1-5
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Calculating Flow

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Calculating Flow in Rectangular Channels ---------- 2-5
Calculating Flow in Rivers and Streams ---------- 2-7

SECTION III
A Profiling Example Using The MMI Model 201

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Collecting Field Data ---------- 3-1
.2 .4 .8 Method ---------- 3-3
.4 Method ---------- 3-3
0.9 x Vmax Method ---------- 3-4
2-D Method ---------- 3-4
VPT Method ---------- 3-4
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% of Deviation ---------- 3-5

MEAN VELOCITY ($\bar{U}$) DEFINITION

A particle of water near the conduit wall will not move as fast as a particle toward the center. To understand this, we need to look at the molecules of moving liquids. The first layer of molecules stick to the wall of the conduit. The next layer will move by sliding across the first layer. This happens throughout the flow with each successive layer moving at a faster velocity. The change in velocity is greater near the conduit wall than it is toward the center. If velocity measurements of each layer could be taken, a velocity profile similar to the one in Figure 1-1 would be produced. Notice that the velocity decreases near the surface because of surface effects. Since most flows fit this profile, this is called the typical profile. There are however, situations which will cause other profile shapes and, it is usually more difficult to calculate flow with these shapes.

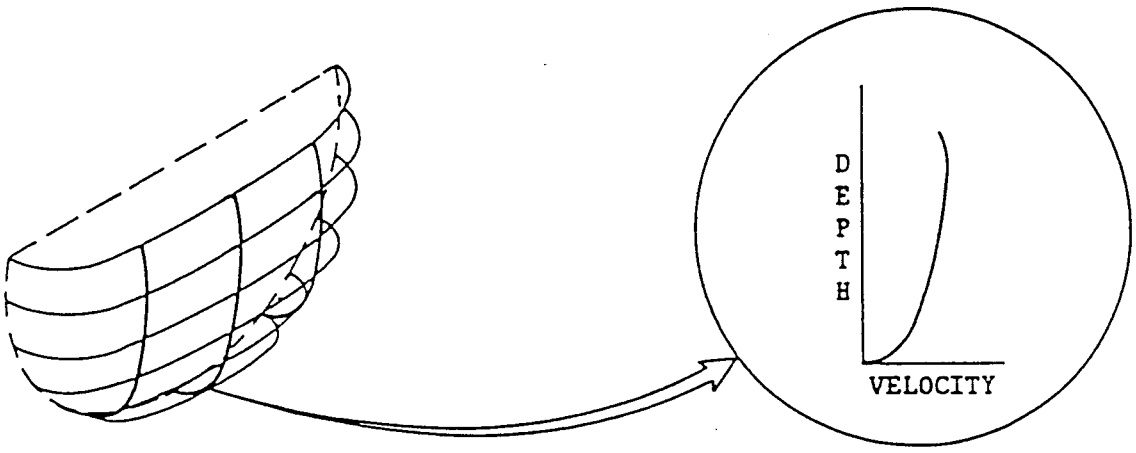


Figure 1-1. Typical Profile

To calculate flow, an average or mean of all the varying velocities must be determined. Since it is not practical to measure the velocity of each layer of molecules, methods have been developed with which a mean velocity ($\bar{U}$) can be determined from velocity measurements taken at various positions in the flow.

CROSS-SECTIONAL AREA

The cross-sectional area of the flow is determined from a level measurement and the channel shape. It is important that the mean velocity measurement and the level measurement is done at the same location in the channel.

SITE SELECTION

A site that produces the typical profile shape will give the most accurate results. In a majority of the cases, problem sites can be identified by a visual inspection. Site inspection guidelines are as follows:

* The channel should have as much straight run as possible. Where the length of straight run is limited, the length upstream from the profile should be twice the downstream length.

* The channel should be free of flow disturbances. Look for protruding pipe joints, sudden changes in diameter, contributing sidestreams, outgoing sidestreams, or obstructions. Clean any rocks, sediment, or other debris that might be on the bottom of the pipe.

* The flow should be free of swirls, eddies, vortices, backward flow, or dead zones. Be careful of areas that have visible swirls on the surface.

* Avoid areas immediately downstream from sharp bends or obstructions.

* Avoid converging or diverging flow (approach to a flume) and vertical drops.

* Avoid areas immediately downstream from a sluice gate or where the channel empties into a body of stationary water.

CHOOSING THE METHOD

All profiling methods can be used in a site that produces a typical profile and has sufficient level to measure three point velocities. If you cannot avoid sites with nontypical profiles or low flows, the following guidelines will help in choosing a method that will give the best results.

Low flows - In flows of less than two inches, the 0.9 x Vmax method is recommended.

Rapidly Changing Flows - A flow that is changing more than 10% in three minutes or less can be classified as rapidly changing. The 0.9 x Vmax or 0.4 methods take the least amount of time. However, these methods usually require a typical profile shape for accurate results.

[NOTE]

Check the level several times during the profiling procedure. If the level has changed but, is less than 10%, average the level measurements and use the average in the flow calculation.

Asymmetrical flow - There will be a difference of 30% or more between the right and left side velocities in asymmetrical flow. The 2-D method is recommended.

Vertical drop (outfalls) - The 2-D method is recommended for outfalls. Remember to measure the level on the same plane as the velocity profile. Outfalls should be avoided wherever possible.

Nontypical profile shape - If you suspect a profile shape may not be typical, use the 2-D method.

Choosing the method will become easier as you gain experience.

PROFILING CHECKS

For best possible results, you should:

* Check the inside diameter of the conduit. Also measure the horizontal and vertical diameters. If there is a difference, then average the diameters.

* Check for symmetry of flow.

* Check level several times during the procedure.

* Check the invert for rocks, sediment, and other debris.

CALCULATING $\bar{U}$
0.9 x Vmax Method

* Take a series of point velocity measurements throughout the entire flow.

* Identify the fastest velocity. In most cases, this is usually located in the center just beneath the surface.

* Multiply the fastest velocity by 0.9 for $\bar{U}$.

CALCULATING $\bar{U}$
.2, .4, .8 of Depth Method

* Measure depth of flow (Page 1-6).

* Locate positions on the centerline by:

  .2 x depth
  .4 x depth
  .8 x depth

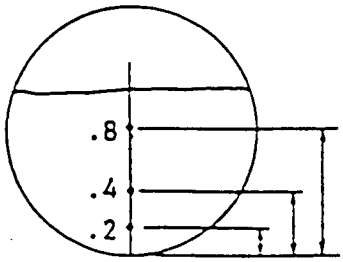


Figure 1-2. (.2 .4 .8) Velocity Positions

* At .2, .4, and .8 positions, measure and record the point velocities (Figure 1-2).

[NOTE]

In manmade channels, measure the .2, .4, and .8 positions from the bottom.

* Average .2 and .8 velocities.

* Average the .4 velocity with the .2 and .8 average for $\bar{U}$.

CALCULATING $\bar{U}$
.4 Method

A simplified version of the .2, .4, .8 method is to measure the velocity at the .4 position and use this as $\bar{U}$. This method is probably the least accurate because it uses only one data point and assumes that a typical profile exists. This is also called the 60% of depth method.

Calculating $\bar{U}$
2-D Method

* Locate the center line of the flow.

* Take at least seven velocity measurements at different depths along the centerline.

* Locate vertical velocity lines (VVL) halfway between the centerline and the side walls of the conduit. This is measured at the widest part of the flow.

* Take velocity readings at different depths on the VVL. The distance between these depths should be the same as those on the centerline.

* Take final point velocity readings at the right and left corners of the flow.

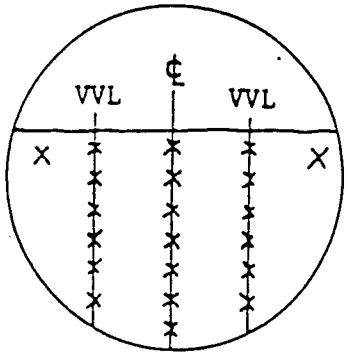


Figure 1-3. 2-D Velocity Positions

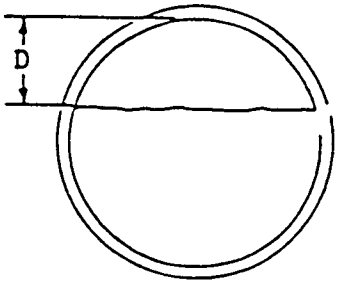
* Check the data for any outliers. If a best fit curve of the velocity profile were plotted, an outlier would lie outside the best fit curve region. See Figure 3-1 on Page 3-2.

* Average all measurements except outliers for $\bar{U}$. Remember to include the corner measurements.

CALCULATING $\bar{U}$
VPT Method

The velocity profiling technique (VPT) was first described by N. T. Debevoise and R. B. Fernandez in the November 1984 issue of the WPCF Journal. With this method, a series of point velocity measurements are taken at different depths along the centerline of the flow. These measurements along with level are input into a VPT computer program which calculates and flow. The program and a detailed description of this method is available from HMI.

MEASURING LEVEL
Circular Conduits



* Measure the inside diameter of the conduit.
* Measure distance D (Figure 1-4).
* Subtract D from the inside diameter of the conduit for the depth of flow. This eliminates the problem of the ruler interfering with the liquid.

Figure 1-4 Level Measurement

[NOTE]

The level measurement and the velocity profile must be on the same plane for proper application of the continuity equation.

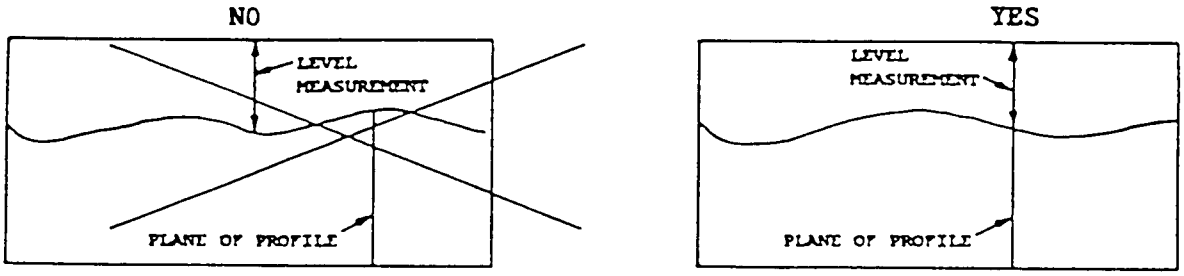


Figure 1-5. Location of Level Measurement

SECTION II CALCULATING FLOW

CIRCULAR CONDUITS

To calculate flow in circular conduits you need:

* The mean velocity $\bar{U}$ from Section I.

* The depth of flow at the time of profile.

* The inside diameter of the conduit.

Calculate level/diameter ratio by:

$$L \div D = L/D$$

Where:

L is depth of flow in inches at time of profile.

D is inside diameter in inches.

L/D is level/diameter ratio.

Identify K from:

Table II on Page 2-4.

Where:

K is flow unit multiplier.

Find the appropriate L/D ratio in the L/D column and move to the right to the K in the appropriate units column.

Calculate D^2 by:

$$(\text{Diameter Inches} \div 12)^2$$

Where:

D^2 is diameter squared in feet. This matches the velocity unit of feet/sec.

Calculate flow by:

$$K \times D^2 \times \bar{U} = \text{flow}$$

Example:

What is the flow in millions of gallons per day of a 10 inch diameter conduit with a 6 inch level? The $\bar{U}$ has been calculated to be 1.5 ft/sec.

Calculate level/diameter ratio L/D:

Level ratio L/D = 6 inches/10 inches = 0.6

Identify K:

K = 0.6 → 0.3180 from Table II

Calculate D^2:

$D^2 = (10in \div 12)^2 = (0.83\ ft)^2 = 0.6889\ ft^2$

Calculate flow:

$K \times D^2 \times \bar{U} = MGD$

$0.3180 \times 0.6889\ ft^2 \times 1.5\ ft/sec = 0.328\ MGD$

TABLE I
Inch to Feet Conversion

IN.	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
FT.	0.04	0.08	0.12	0.17	0.21	0.25	0.29	0.33
IN.	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
FT.	0.37	0.42	0.46	0.50	0.54	0.58	0.62	0.67
IN.	8.50	9.00	9.50	10.0	10.5	11.0	11.5	12.0
FT.	0.71	0.75	0.79	0.83	0.87	0.92	0.96	1.00

Table II Flow Unit Multiplier

L/D	K (flow unit multiplier)					
	MGD	GPM	CFS	CMM	CMD	LPM
.01	.0009	.5966	.0013	.0023	3.2522	2.2585
.02	.0024	1.6824	.0037	.0063	9.1709	6.3687
.03	.0044	3.0814	.0069	.0117	16.7986	11.6644
.04	.0068	4.7296	.0105	.0179	25.7811	17.9036
.05	.0095	6.5894	.0147	.0249	35.9190	24.9438
.06	.0124	8.6351	.0192	.0327	47.0701	32.6876
.07	.0156	10.8475	.0242	.0411	59.1295	41.0621
.08	.0190	13.2113	.0294	.0500	72.0148	50.0103
.09	.0226	15.7143	.0350	.0595	85.6585	59.4851
.10	.0264	18.3460	.0409	.0694	100.0039	69.4471
.11	.0304	21.0975	.0470	.0799	115.0022	79.8627
.12	.0345	23.9609	.0534	.0907	130.6108	90.7020
.13	.0388	26.9294	.0600	.1019	146.7919	101.9388
.14	.0432	29.9967	.0668	.1135	163.5116	113.5497
.15	.0477	33.1571	.0739	.1255	180.7393	125.5134
.16	.0524	36.4056	.0811	.1378	198.4467	137.8102
.17	.0572	39.7374	.0885	.1504	216.6081	150.4223
.18	.0621	43.1480	.0961	.1633	235.1995	163.3330
.19	.0672	46.6334	.1039	.1765	254.1985	176.5267
.20	.0723	50.1898	.1118	.1900	273.5844	189.9892
.21	.0775	53.8135	.1199	.2037	293.3373	203.7064
.22	.0828	57.5012	.1281	.2177	313.4387	217.6657
.23	.0882	61.2496	.1365	.2319	333.8710	231.8548
.24	.0937	65.0555	.1449	.2463	354.6172	246.2619
.25	.0992	68.9161	.1535	.2609	375.6613	260.8759
.26	.1049	72.8286	.1623	.2757	396.9880	275.6861
.27	.1106	76.7901	.1711	.2907	418.5825	290.9823
.28	.1163	80.7982	.1800	.3059	440.4305	305.8545
.29	.1222	84.8503	.1890	.3212	462.5182	321.1932
.30	.1281	88.9439	.1982	.3367	484.8325	336.3892
.31	.1340	93.0767	.2074	.3523	507.3605	352.3337
.32	.1400	97.2464	.2167	.3681	530.0894	368.1176
.33	.1461	101.4507	.2260	.3840	553.0071	384.0327
.34	.1522	105.6875	.2355	.4001	576.1017	400.0706
.35	.1583	109.9546	.2450	.4162	599.3618	416.2234
.36	.1645	114.2500	.2545	.4325	622.7757	432.4831
.37	.1707	118.5715	.2642	.4488	646.3325	448.8419
.38	.1770	122.9172	.2739	.4653	670.0208	465.2922
.39	.1833	127.2851	.2836	.4818	693.8301	481.8265
.40	.1896	131.6733	.2934	.4984	717.7501	498.4375
.41	.1960	136.0797	.3032	.5151	741.7607	515.1178
.42	.2023	140.5026	.3130	.5319	765.8788	531.8603
.43	.2087	144.9400	.3229	.5487	790.0673	548.6578
.44	.2151	149.3902	.3328	.5655	814.3250	565.5034
.45	.2215	153.8512	.3428	.5824	838.6420	582.3902
.46	.2280	158.3212	.3527	.5993	863.0080	599.3111
.47	.2344	162.7985	.3627	.6163	887.4133	616.2592
.48	.2409	167.2811	.3727	.6332	911.8480	633.2277
.49	.2473	171.7673	.3827	.6502	936.3024	650.2100
.50	.2538	176.2553	.3927	.6672	960.7664	667.1989

Table II Continued

L/D	K (flow unit multiplier)					
	MGD	GPM	CFS	CMM	CMD	LPM
.51	.2603	180.7433	.4027	.6842	985.2306	684.1879
.52	.2667	185.2295	.4127	.7012	1009.6850	701.1701
.53	.2732	189.7121	.4227	.7181	1043.1200	718.1385
.54	.2796	194.1894	.4327	.7351	1058.5250	735.0869
.55	.2861	198.6594	.4426	.7520	1082.8910	752.0076
.56	.2925	203.1204	.4526	.7689	1107.1080	768.8945
.57	.2989	207.5706	.4635	.7857	1131.4660	785.7401
.58	.3053	212.0080	.4724	.8025	1155.6540	802.5377
.59	.3117	216.4309	.4822	.8193	1179.7630	819.2801
.60	.3180	220.8374	.4920	.8360	1203.7830	835.9605
.61	.3243	225.2255	.5018	.8526	1227.7030	852.5715
.62	.3306	229.5934	.5115	.8691	1251.5120	869.1057
.63	.3369	233.9392	.5212	.8856	1275.2010	885.5560
.64	.3431	238.2607	.5308	.9019	1298.7580	901.9149
.65	.3493	242.5560	.5404	.9182	1322.1710	918.1745
.66	.3554	246.8232	.5499	.9343	1345.4320	934.3275
.67	.3615	251.0600	.5594	.9504	1368.5260	950.3654
.68	.3676	255.2643	.5687	.9663	1391.4440	966.2805
.69	.3736	259.4340	.5780	.9821	1414.1730	982.0645
.70	.3795	263.5668	.5872	.9977	1436.7010	997.7090
.71	.3854	267.6604	.5963	1.0132	1459.0150	1013.2050
.72	.3913	271.7125	.6054	1.0285	1481.1030	1028.5440
.73	.3970	275.7206	.6143	1.0437	1502.9510	1043.7160
.74	.4027	279.6822	.6231	1.0579	1524.5460	1058.7120
.75	.4084	283.5946	.6319	1.0735	1545.8720	1073.5220
.76	.4139	287.4553	.6405	1.0881	1566.9170	1088.1370
.77	.4194	291.2612	.6489	1.1025	1587.6630	1102.5440
.78	.4248	295.0096	.6573	1.1167	1608.0950	1116.7330
.79	.4301	298.6972	.6655	1.1307	1628.1970	1130.6920
.80	.4353	302.3210	.6736	1.1444	1647.9500	1144.4090
.81	.4405	305.8774	.6815	1.1579	1667.3360	1157.8720
.82	.4455	309.3629	.6893	1.1711	1686.3350	1171.0660
.83	.4505	312.7735	.6969	1.1840	1704.9260	1183.9760
.84	.4552	316.1053	.7043	1.1966	1723.0680	1196.5890
.85	.4599	319.3538	.7115	1.2089	1740.7950	1208.8860
.86	.4644	322.5143	.7186	1.2208	1758.0230	1220.8490
.87	.4688	325.5815	.7254	1.2325	1774.7430	1232.4600
.88	.4731	328.5500	.7320	1.2437	1790.9240	1243.6970
.89	.4772	331.4135	.7384	1.2545	1806.5330	1254.5360
.90	.4812	334.1650	.7445	1.2650	1821.5310	1264.9520
.91	.4850	336.7967	.7504	1.2749	1835.8760	1274.9140
.92	.4886	339.2997	.7560	1.2844	1849.5200	1284.3890
.93	.4920	341.6636	.7612	1.2933	1862.4060	1293.3370
.94	.4952	343.8759	.7662	1.3017	1874.4650	1301.7120
.95	.4981	345.9216	.7707	1.3095	1885.6160	1309.4560
.96	.5008	347.7815	.7749	1.3165	1895.7540	1316.4960
.97	.5032	349.4297	.7785	1.3277	1904.7390	1322.7350
.98	.5052	350.8287	.7816	1.3280	1912.3650	1328.0310
.99	.5068	351.9145	.7841	1.3321	1918.2840	1332.1410
1.00	.5076	352.5112	.7854	1.3344	1921.5360	1334.4000

CALCULATING FLOW
Rectangular Channels

Flow in rectangular channels is calculated by the following:

* Determine $\overline{U}$ with the .2 .4 .8 method as described on Page 1-4. For channel widths of six feet or larger, use the .2 .6 .8 method as described on Page 2-6 for rivers and streams. Velocity units must be in ft/sec.

* Calculate the cross-sectional area in ft^2 by:

  [(Depth of Flow)in ÷ 12] x [(Channel Width)in ÷ 12]

* Calculate flow by:

  $\overline{U}$ x (Cross-sectional Area)

The result should be a flow rate in ft^3/sec. You can convert this to other flow units with the flow unit conversion multipliers in Table III on page 2-8.

Example:

What is the flow in a channel 24 inches wide with a 10 inch flow?

Solution:

* Velocity measured at .2 = 1.5 ft/sec
  .4 = 1.7 ft/sec
  .8 = 1.8 ft/sec

* (1.5 + 1.8) ÷ 2 = 1.65 ft/sec

* $\overline{U}$ = (1.65 + 1.7) ÷ 2 = 1.67 ft/sec

* From Table I on Page 2-2, 10 in = 0.83 ft

* Area = 0.83 ft x 2 ft = 1.66 ft^2

* Flow = 1.67 ft^2/sec x 1.66 ft = 2.77 ft^3/sec

From Table III on Page 2-8.

.64632 x 2.77ft^3/sec = 1.7903 MGD

* Divide the width of the channel into a number of equal segments with a distance d (Figure 2-1). The more segments you use the better the result. If the difference in mean velocity between two adjacent segments is greater than 10%, the segments should be smaller.

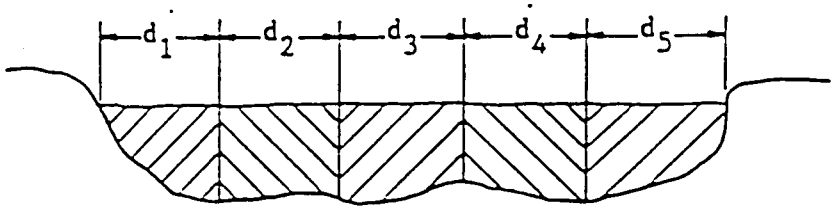


Figure 2-1. Segment Distance

* Locate the center line for each segment at 1/2 d (Figure 2-2).

* Calculate .2 .6 .8 velocity positions by:

  .2 x Depth
  .6 x Depth
  .8 x Depth

* Measure the velocity at the .2, .6, and .8 positions.

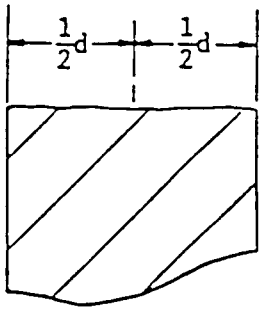


Figure 2-2. Segment Centerline

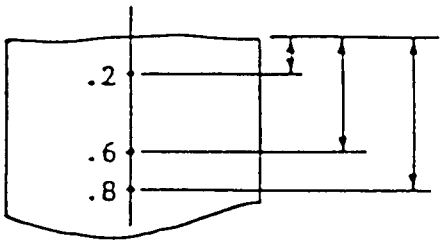


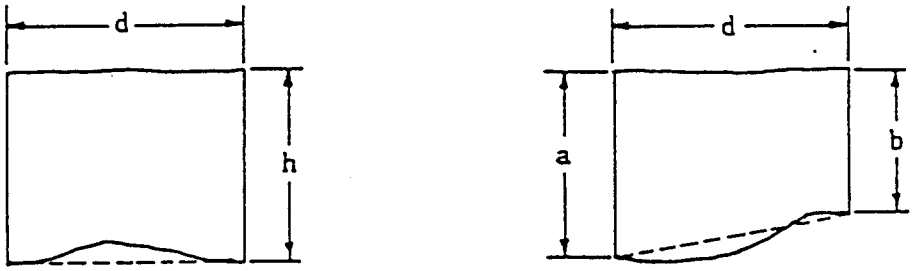
Figure 2-3. Velocity Positions

[NOTE]

The .2, .6, and .8, positions for rivers and streams are measured from the surface. All depth and velocity measurements must be on the same plane.

* Average the .2 and .8 velocities.

* Average the .6 velocity with the average of the .2 and .8 velocities for $\bar{U}$.



Rectangle
d x h = A

Trapezoid
[(a + b) ÷ 2] x d = A

Figure 2-4. Segment Area

* Calculate the flow of each segment by: (Segment Area) x $\bar{U}$.

* Sum the flow of the segments for total flow.

FLOW UNIT CONVERSION

TABLE III
Flow Unit Conversion Factor

NEW UNITS

EXISTING UNITS	CFS	MGD	GPM	CMD	CMM
CFS	1	0.64632	448.831	2446.576	1.69901
MGD	1.54723	1	694.44	3785.412	2.62876
GPM	0.002228	0.00144	1	5.45099	0.0037854
CMD	0.000408	0.0002642	0.18345	1	0.0006944
CMM	0.5885	0.380408	264.172	1440	1

In the Table III, the left column is the existing unit of flow and the top row is the new unit of flow. To change flow units, locate

the existing units in the left column and move to the right under the appropriate new unit. The number at this intersection is the conversion factor. Multiply the existing flow by this factor to determine new units.

Example:

Convert 20 ft^3/sec (CFS) to millions of gallons per day (MGD).

Solution:

From Table III, conversion factor = 0.64632

20 ft^3/sec x 0.64632 = 12.9264 MGD

Flow Units

MGD - Millions of Gallons per Day
GPM - Gallons per Minute
CFS - Cubic Feet per Second
CMM - Cubic Meters per Minute
CMD - Cubic Meters per Day
LPM - Liters per Minute

SECTION III A PROFILING EXAMPLE USING THE MMI MODEL 201

This section illustrates how to collect and analyze data from circular conduits and achieve the best possible accuracy. The data shown in this section is actual field data that was collected with a MMI model 201 in a normal flow.

[NOTE]

A 2-D profile is used to collect the field data since this method provides the most point velocity measurements. A centerline profile is plotted and a best fit curve is drawn. This permits all profiling methods described in Section I to be utilized with one set of velocity measurements.

Collecting Field Data With the Model 201 2-D Method

We start the 2-D profile on the vertical center line at the invert or bottom of the conduit. The first velocity measurement with the model 201 is 0.75 inches or 1.9 cm from the invert. This is because the electrodes, which measure the point velocity, are 0.75 inches from the bottom of the sensor. If the sensor is moved up 0.25 inches for second velocity measurement, this will put the electrodes one inch from the invert. The sensor can then be moved at even inch or half inch-increments. Five to ten velocity measurements between the bottom and the surface are recommended. After the vertical centerline is profiled, the level is measured and recorded.

Next the right and left vertical velocity lines are profiled and recorded. Then the right and left corner velocity measurements are taken and recorded. Finally the level is measured and recorded. We nov have the necessary data to calculate flow.

[NOTE]

If there is a sudden drop in velocity at any position, check the sensor for debris.

FIELD DATA

CONDUIT DIAMETER = 24.25 INCHES

POSITION AS MEASURED FROM THE INVERT	CENTERLINE FT/SEC	RIGHT VVL FT/SEC	LEFT VVL FT/SEC
0.75	5.2	5.2	4.9
1.0	5.4	5.5	5.2
2.0	5.4	5.5	5.5
3.0	4.3	5.5	5.5
4.0	5.5	5.1	5.2
5.0	5.4	4.2	4.8
6.0	5.2	4.0	4.2
6.5	4.0	—	—

LEVEL DURING PROFILE
7 INCHES
6 7/8 INCHES
7 1/8 INCHES

RIGHT CORNER = 4.0 FT/SEC
LEFT CORNER = 4.8 FT/SEC

AVERAGE LEVEL = 7 INCHES

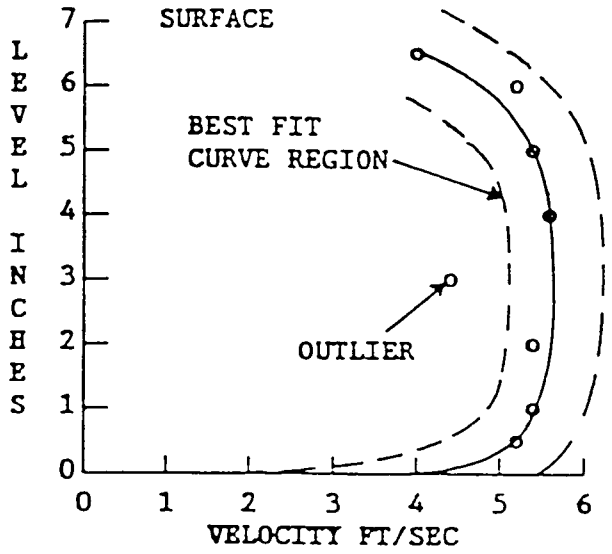


Figure 3-1. Best Fit Curve

[NOTE]

The 4.3 ft/sec velocity at the 3 inch position is outside the best fit curve region and is ignored. This is called an outlier.

.2 .4 .8 METHOD

Position	Velocity from curve
.2 x 7" = 1.4"	5.4 ft/sec
.4 x 7" = 2.8"	5.5 ft/sec
.8 x 7" = 5.6"	5.35 ft/sec

(5.4 + 5.35) ÷ 2 = 5.37 ft/sec

$\bar{U}$ = (5.37 + 5.5) ÷ 2 = 5.4 ft/sec

.4 METHOD

The velocity from the curve at the .4 position = 5.5 ft/sec. $\bar{U}$ = 5.5 ft/sec.

0.9 x Vmax METHOD

From the curve Vmax = 5.5 ft/sec.

Calculate $\bar{U}$ by:

0.9 x 5.5 = 4.95 ft/sec = $\bar{U}$

2-D METHOD

Average all velocity measurements. Remember to include the two corner measurements and discard any outliers.

$\bar{U}$ from 2-D average = 5.0 ft/sec

VPT METHOD

This method requires a computer program from MMI. If you have this program, enter the velocity measurements from the center line profile. Discard any outliers.

$\bar{U}$ from VPT program = 5.32 ft/sec

AVERAGE $\bar{U}$

An overall $\bar{U}$ can be calculated by averaging the values from the different methods.

$(5.4 + 5.5 + 4.95 + 5.0 + 5.32) \div 5 = 5.23$ ft/sec

Average $\bar{U} = 5.2$ ft/sec

[NOTE]

If the profile is not symmetrical, then the results from the .9 x Vmax and 2-D methods may vary greatly from the VPT, .2 .4 .8 and .4 methods.

% OF DEVIATION

Now we calculate the % of deviation between the average $\bar{U}$ of 5.2 ft/sec and the high and low $\bar{U}$.

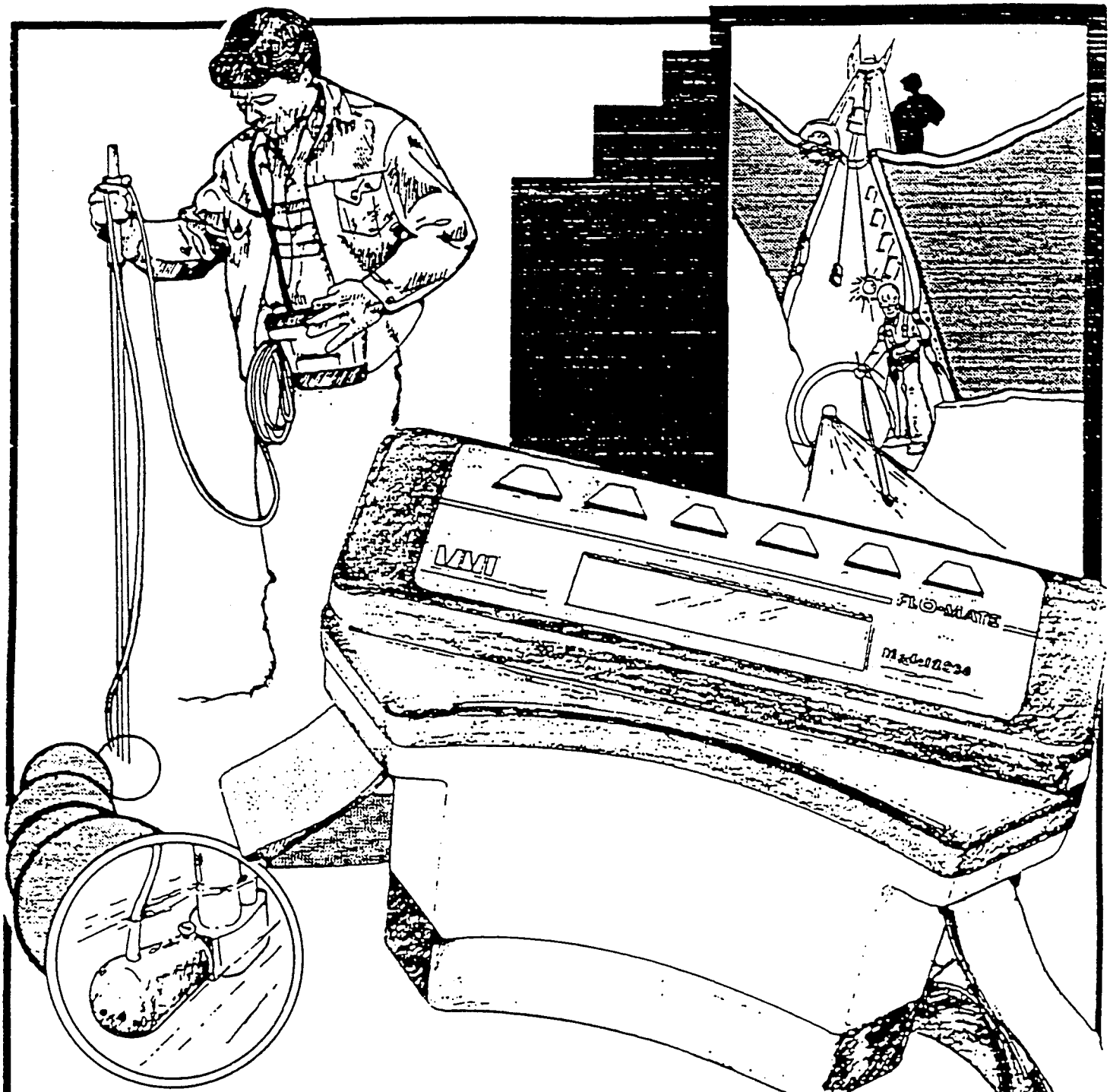
High $\bar{U}$ from .2 .4 .8 method = 5.5 ft/sec

$$\% \text{ deviation} = \frac{(5.5 - 5.2)}{5.2} \times 100 = 5.76\%$$

Low $\bar{U}$ from 2-D method = 4.8%

$$\% \text{ deviation} = \frac{(5.2 - 4.8)}{5.2} \times 100 = 7.7\%$$

Since no method deviates greater then 10% from the average $\bar{U}$, all values are valid.



MARSH-McBIRNEY, INC.

FLO-MATE™

MODEL 2000 PORTABLE WATER FLOWMETER
INSTRUCTION MANUAL

MMI MODEL 2000 FLO-MATE PORTABLE WATER FLOWMETER INSTRUCTION MANUAL

December 1990

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PN 105000301

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SPECIFICATIONS

VELOCITY MEASUREMENT

Method: Electromagnetic

Zero Stability: ± 0.05 ft/sec

Accuracy: ± 2% of reading + zero stability

Range: -0.5 to +19.99 ft/sec (-0.15 m/sec to 6 m/sec)

POWER REQUIREMENTS

Batteries: Two D Cells
Battery Life:

Alkaline: 20 continuous hours (wet sensor)

Nicad: 13 continuous hours (wet sensor)

External Supply (Optional)

Supply Current

Sensor Wet: 300 mA, 3 V

Sensor Dry: 100 mA, 3 V

WATER RESISTANCE

Submersible: One foot for 30 seconds

OUTPUTS

Display: 3-1/2 digit

Signal Output (Optional)

Analog: 0.1 V per 1 ft/sec or 1 m/sec

Full Scale: 2 V

MATERIALS

Sensor: Polyurethane

Cable: Polyurethane jacket

Electronic Case: High impact molded plastic

WEIGHT

With Sensor and 20' of Cable: 3 lb 9 oz

Without Sensor: 2 lb 10 oz

ENVIRONMENTAL

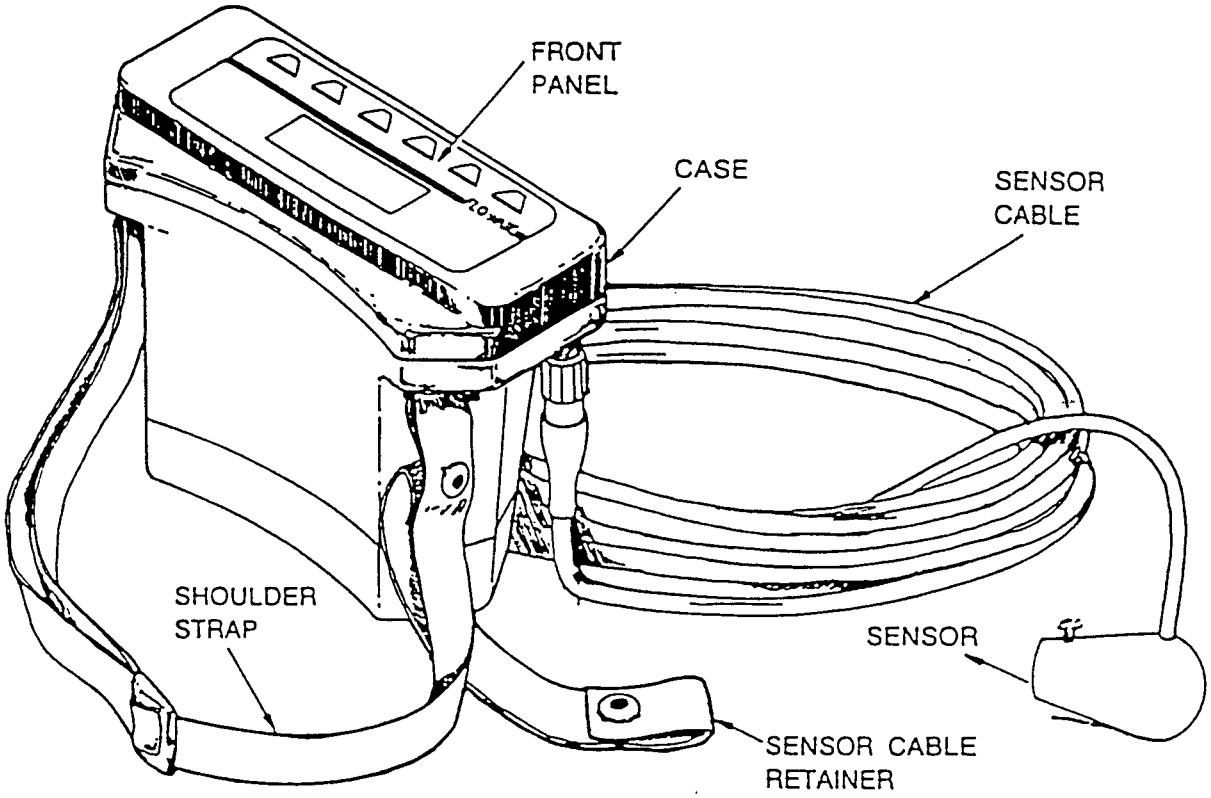
Sensor: 32° F to 160° F (0° C to 65° C)

Electronics: 32° F to 122° F (0° C to 50° C)

GENERAL DESCRIPTION

The Marsh-McBirney Model 2000 Flo-Mate is a portable flowmeter designed for use in both the field and laboratory. The unit measures velocity in one direction from an electromagnetic sensor placed in a conductive liquid such as water. The velocity measurement is displayed on a digital display as feet per second (ft/s) or meters per second (m/s).

A water-tight case protects the electronics from wet weather and accidential submersions. The unit is powered by two D-size batteries in the bottom of the case. A shoulder strap and 20 feet of sensor cable are standard. Excess sensor cable is coiled and secured to the shoulder strap by the sensor cable retainer.

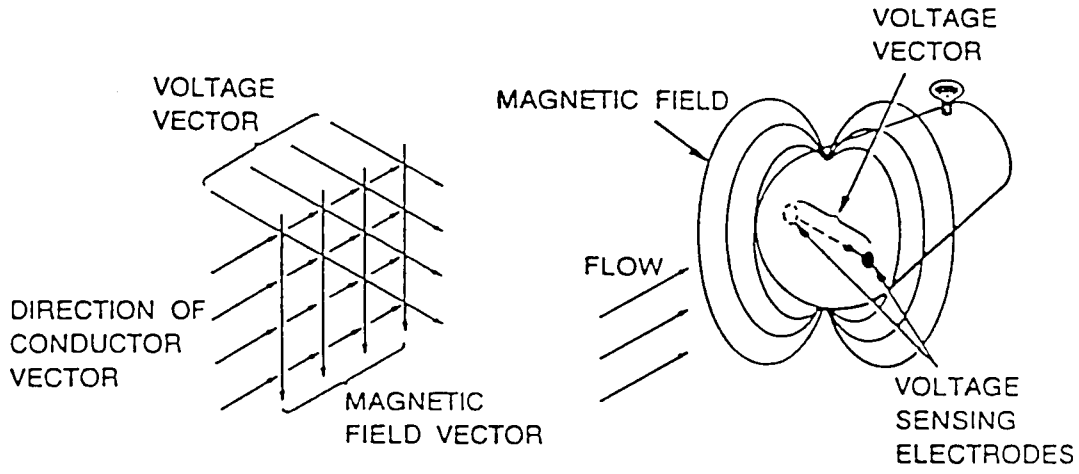


THEORY OF OPERATION

The Flo-Mate measures flow using the Faraday Principle: as a conductor moves through and cuts the lines of magnetic flux, a voltage is produced. The magnitude of the generated voltage is directly proportional to the velocity at which the conductor moves through the magnetic field.

When the flow approaches the sensor from directly in front, then the direction of the flow, the magnetic field, and the sensed voltage are mutually perpendicular to each other. Hence, the voltage output will represent the velocity of the flow at the electrodes.

The sensor is equipped with an electromagnetic coil that produces the magnetic field. A pair of carbon electrodes measure the voltage produced by the velocity of the conductor, which in this case is the flowing liquid. The measured voltage is processed by the electronics and output as a linear measurement of velocity.



Design Features

The Model 2000 design features are as follows:

* Lightweight (3 lb 9 oz with sensor and 20 ft of cable), water resistant, and rugged. The case is made of a high impact molded material which protects the electronics from wet environments and accidental submersions.

* Digital filtering. The sensor electronics uses digital filtering. This does a better job than analog filtering in rejecting electrical noise that may be present in the flow.

* Noise flag. If electrical noise is detected, a noise flag is displayed. Any readings displayed while the noise flag is on will be accurate. If the noise level is too high to measure velocity accurately, the display will blank out.

* Conductivity lost detection. A conductivity lost flag is displayed and the velocity readings are blanked out when conductivity lost is detected. Conductivity lost is usually caused by the sensor being out of the water.

* Dry sensor power down. The unit stops driving the sensor five seconds after conductivity lost is detected. This results in a 66% reduction in power consumption, which conserves battery life.

* Automatic shut off. After five minutes of conductivity lost, the unit will shut itself off thus conserving battery life.

* Low battery flag. A low battery flag is displayed when the batteries need to be replaced.

* Display clear function. The display clear function clears the display and restarts the filtering.

* Data storage and recall ability. There are 19 memory locations in which to store velocity measurements.

* Unit of measurement selection. The meter can be switched between English (ft/s) and metric (m/s) units of measurement.

* Selectable filtering modes for display output. Fluid dynamics near the sensor electrodes may cause slightly noisy readings. The output can be stabilized by averaging the velocities over a fixed time period or by a software algorithm that mimics an RC time constant.

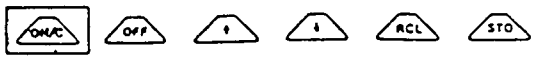
OPERATION

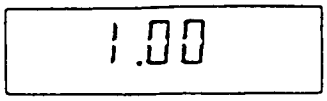
The Model 2000 has two operating modes: real-time and recall. In the real-time operating mode, realtime velocities from the sensor are displayed. In the recall operating mode, velocities from memory are displayed.

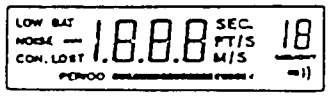
Real-Time Operating Mode

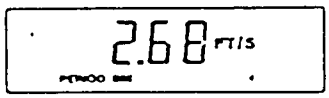
The unit will always power up in the real-time operating mode. From the real-time mode you can change the filter value, store readings in memory, turn the beeper on or off, alternate between feet per second (ft/s) and meters per second (m/s), alternate between fixed point averaging and time constant filtering, and switch to the recall operating mode.

Display ON Sequence:









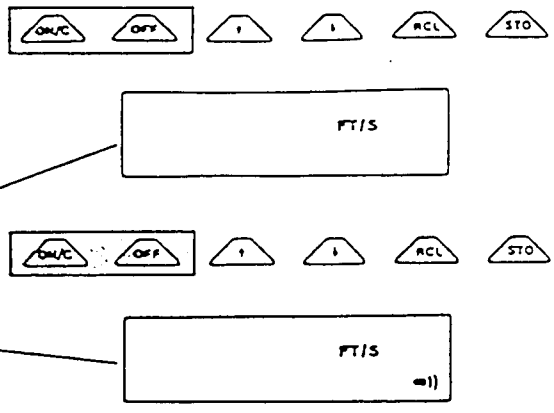
When the unit is turned ON, the display output sequence is as follows:

* Software version number. This is the Model 2000 operating software that was burned into the electronics at the factory.
* Display segment test. The unit will light all display segments.
* Velocity output. The first few readings are not filtered; however, they are accurate.

Units of Measurement/Beeper:

The Model 2000 can output velocity in ft/s or m/s. Press down on the ON/C and OFF keys simultaneously to cycle between:

* ft/s no beeper
* m/s no beeper
* ft/s with beeper
* m/s with beeper



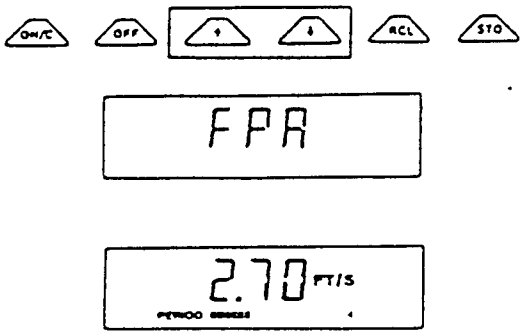
The beeper sounds when a key is pressed.

Fixed Point Average/Time Constant Filtering:

The fluid dynamics around the sensor electrodes may cause the readings to bounce around. To stablize the readings, the output to the display is dampened. The display can be dampened by Fixed Point Averaging (FPA) or by time constant filtering (rC).

Fixed Point Averaging is an average of velocities over a fixed period of time. Time constant filtering is a software algorithm that mimics an RC analog circuit. Press the ↑ and ↓ keys simultaneously to alternate between the FPA and rC displays.

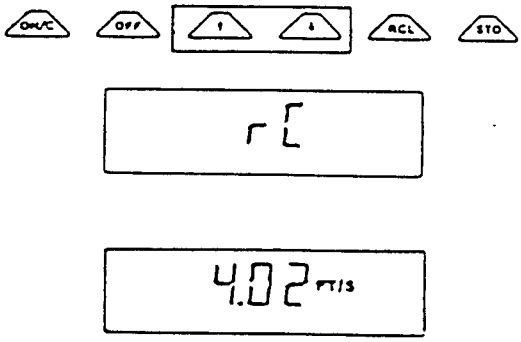
FPA:



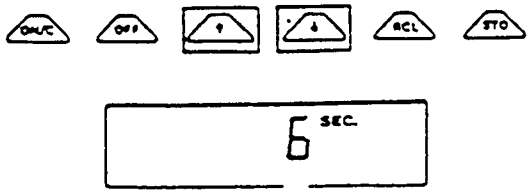
The display will show the letters FPA when you first switch to the FPA display. Except for the first period, the display is updated at the end of each averaging period. For example, if the FPA is set to 10 seconds, the display is updated once every ten seconds. The FPA display will have a horizontal time bar under the velocity output. The time bar provides an indication as to the amount of time left until the display is updated.

rC:

The display will show the letters rC when you first switch to the time constant mode. The display will start with unfiltered full scale velocities. These readings are accurate but may bounce around slightly. As the filtering takes effect, the readings will settle out. It takes five time constants to get to maximum filtering. There is no time bar on the rC display because the display is continually updated.



FPA/rC Time:



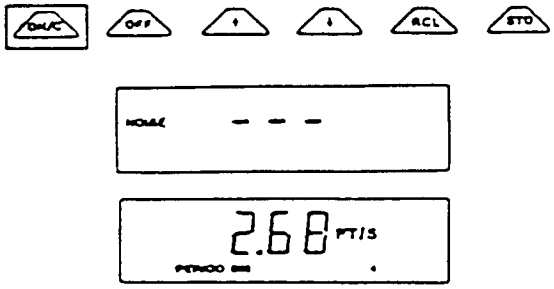
The FPA and rC time is specified in seconds. The ↑ key increments time and the ↓ key decrements time. The display will show the FPA/rC length in seconds. After you have reached the desired setting, wait and the display will automatically switch to velocity.

Comment:

Limits are 1 - 120 seconds for FPA and 2 - 30 seconds for rC.

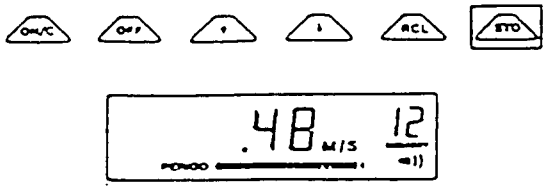
Changing FPA and rC time restarts the filtering.

Clearing The Display:



The clear funciton will clear the display and restart the filtering. To clear the display, press the ON/C key. The display will blank out for a second and then restart to output velocity readings.

Storing Velocity Readings:



There are 19 memory locations in which velocity readings can be stored. To store a reading, press the STO key when the desired velocity is displayed. The unit will store the reading and automatically increment to the next empty location. The memory location shown on the display is where the present reading will be stored. No memory locations are shown until after the first reading has been stored.

Comment:

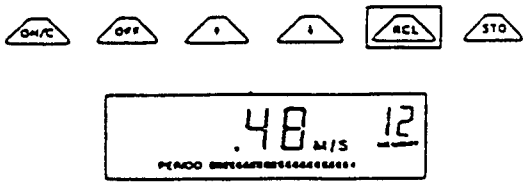
Except for the beeper symbol, the STO function will store the display as you see it.

Turning the unit off or changing batteries does not affect the memory.

If you want to measure a prior location again, you need to switch to the recall mode with the RCL key. Go back to the prior location with the ↑ key. Switch to the real-time mode with the RCL key; and

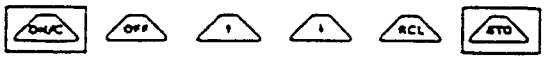
when you get a good velocity reading store it with the STO key. The reading is stored, and the unit advances to the next empty memory location.

Recall Operating Mode



The recall operating mode outputs the velocity readings that have been stored in memory. The recall mode is indicated by a blinking memory location number and always starts at location one. To switch to the recall mode, press the RCL key. The memory location and the velocity stored in that location is shown on the display. Increment and decrement through the locations with the ↑ and ↓ keys respectively. With the exception of the first empty location, only the locations that have stored readings can be recalled.

To clear memory, press the ON/C and STO keys simultaneously while the unit is in the real-time mode. You cannot clear memory from the recall mode.



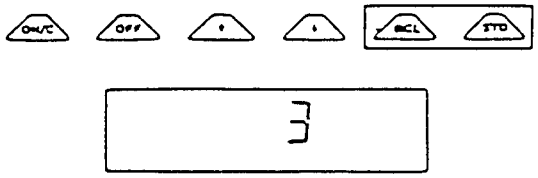
ZERO ADJUST

Zero Check:

First clean the sensor (Page 10) because a thin film of oil on the electrodes can cause noisy readings. Then place the sensor in a five gallon plastic bucket of water. Keep it at least three inches away from the sides and bottom of the bucket. To make sure the water is not moving, wait 10 or 15 minutes after you have positioned the sensor before taking any zero readings. Use a filter value of 5 seconds. Zero stability is ± 0.05 ft/sec.

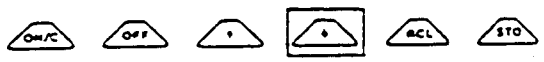
Zero Adjust:

* Position the sensor as described in the zero check procedure.
* To initiate the zero start sequence, press the STO and RCL keys at the same time. You will see a number 3 on the display.
* Decrement to zero with the ↓ key and press the STO and RCL keys a second time.



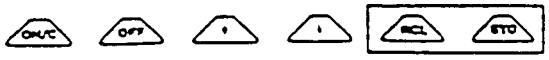
Comment:

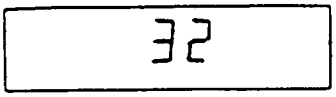
If you do not press the ↓ key within one second from the time you see 3 on the display, the unit will display Err 3. Turn the unit OFF and back ON. Press STO and RCL keys to re-initate zero start sequence.





* The number 32 will be displayed.





* The unit will decrement itself to zero and turn off. The unit is now zeroed.

ERRORS

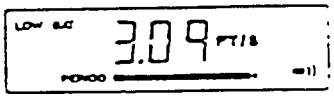
The purpose of displaying errors is to alert the user of possible problems with either the unit or application. Errors can be displayed as messages or numerical codes. There are three error messages and five numerical codes.

Comment:

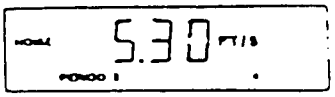
With the exception of Err 2, error codes freeze the display. Turn the unit OFF then back ON to clear the display. If after corrective action the error still exists, call the factory.

Error Messages:

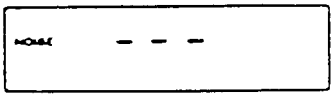
Low Bat — Indicates low batteries. Replace the batteries.



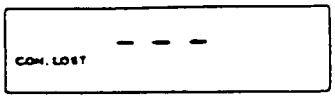
Noise — Indicates electrical noise is present in the flow. The noise flag usually comes on for a few seconds right after the sensor is placed in the water. This is normal.



If the noise level is to high to get accurate readings, the screen will blank out.

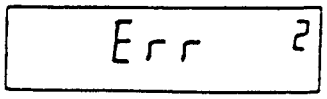


Con Lost — Indicates sensor electrodes are out of the water or have become coated with oil or grease. After minutes, the unit will turn itself OFF. If the electrodes are coated, clean the sensor (Page 10).



Error Codes:

Error #1 Problem with sensor drive circuit. Check sensor disconnect.



Error #2 Memory full error. Memory must be cleared before another reading can be stored.

Error #3 Incorrect zero adjust start sequence. Reinitiate zero start sequence.

Error #4 Zero offset is greater than the zero adjust range. Turn the unit OFF then back ON. If error is still displayed, unit needs servicing.

Error #5 Conductivity lost or noise detected during zero adjust. Usually caused by the sensor being out of the water.

KEY SUMMARY

One Key Function

ON/C - Turns Unit ON. Clears the display and restarts the meter.

OFF - Turns Unit OFF.

↑ - Increments FPA, TC, and Memory Location.

↓ - Decrements FPA, TC, and Memory Location.

RCL - Alternates Between Recall and Real-Time Operating Modes.

STO - Stores Values In Memory.

Two Key Function

ON/C + OFF - Change Units, Turns Beeper ON/OFF.

↑ + ↓ - Alternates Between FPA and rC Filtering.

ON/C + STO - Clears Memory. Meter must be in the Real-Time Operating Mode.

RCL + STO - Initiates zero adjust sequence. Zero stability is ± 0.05 ft/sec.

MAINTENANCE

Routine maintenance of the unit is confined to cleaning the sensor and changing the batteries.

Cleaning The Sensor:

Nonconductive coatings (oil and grease) can cause noisy readings or conductivity test errors. Clean the sensor with soap and water. If a problem still persists, clean the electrodes with a very fine grit (600) sandpaper. Do not use hydrocarbon solvents.

Changing Batteries:

A low battery flag is displayed when low batteries are detected. The amount of time the batteries will last after the flag is displayed can vary from 5 hours (alkaline) to 15 minutes (nicads).

The battery compartment (Figure 1) is located in the bottom of the meter. To change the batteries, unscrew the three captive screws on the bottom cover. Remove cover and replace the batteries (two D size). Reinstall the bottom cover.

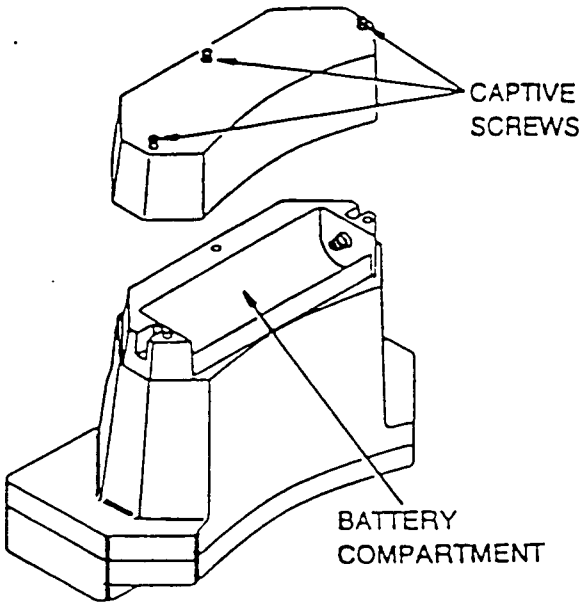


Figure 1. Battery Compartment

OPTIONS

Sensor Disconnect:

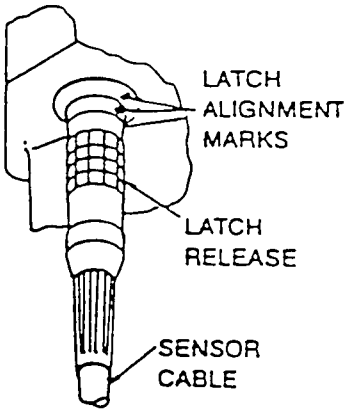


Figure 2. Sensor Disconnect

The sensor cable can be disconnected from the flowmeter with the sensor disconnect option. To disconnect the sensor, pull the latch release (Figure 2) toward the sensor cable.

To connect the cable, align the latch alignment marks and the push connector together.

Comment:

If you change sensors, check the zero (Page 7).

Power In Signal Out Connector:

Except for being smaller in size, the power in signal out connector operates the same as the sensor disconnect. The connector is shipped with a short cable attached.



Figure 3. Power In Signal Out Connector

[CAUTION]

To prevent damage to the unit, remove nonrechargeable batteries when the AC power adapter is connected.

A well isolated AC power adapter serves as a battery charger and external power source. The unit is powered by 2 D-Size nicad rechargeable batteries which take about 8 hours to charge. Power requirements are 300 mA, 3 V for wet sensor; 100 mA, 3 V for dry sensor.

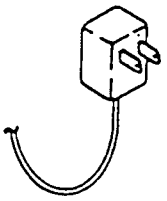


Figure 4. AC Power Adapter

The signal can be output to external recording devices. Output signal is 0.1 V = 1 ft/sec or 0.1 V = 1 m/sec. Maximum scale is 2 volts.

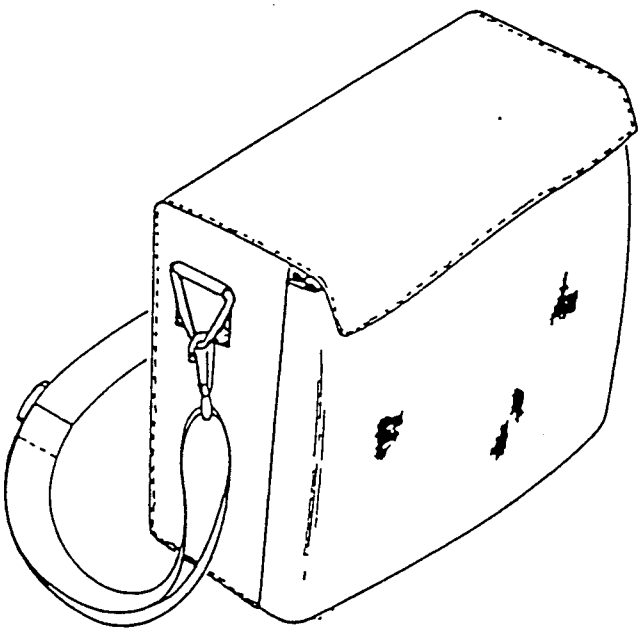


Figure 5. Soft Carrying Case

Carrying Case:

The carrying case for the Model 2000 is a padded nylon case with two compartments and a shoulder strap. The back compartment is for the meter, and the front compartment is for the sensor and cable. The sensor compartment is made of nylon mesh which lets air circulate through the compartment.

SENSORS

The Model 2000 can be configured with an open channel velocity sensor, a one inch full pipe velocity sensor, or a two inch full pipe velocity sensor. The open channel velocity sensor is the standard configuration.

Open Channel Velocity Sensor:

The front of the open channel velocity sensor is round with three electrodes. A mounting hole is in back, and a thumbscrew is on top (Figure 6). The front of the sensor must be pointed upstream and the electrodes must be in contact with the flow to get good readings.

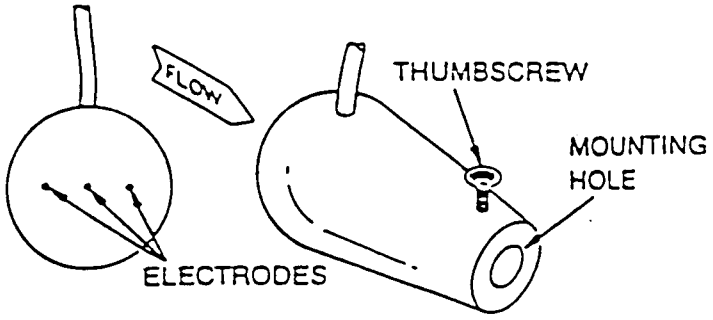


Figure 6. Open Channel Velocity Sensor

Comment:

The electrodes on all sensors must be kept free from nonconductive coatings such oil and grease.

The open channel velocity sensor shape produces a cosine response which greatly reduces errors due to sensor positioning. For example, if the front of the sensor is pointed away from the flow at a 10° angle, the cosine of 10° is 0.98480. This is only 1.5% lower than the actual velocity.

Full Pipe Velocity Sensor:

The Model 2000 can be configured with either a one inch full pipe velocity sensor or a two inch full pipe velocity sensor. The installation instructions for the full pipe sensors are contained in the manuals titled "One Inch Full Pipe Sensor Installation" and "Two Inch Full Pipe Sensor Installation. The sensor disconnect is required when the unit is configured with a full pipe sensor.

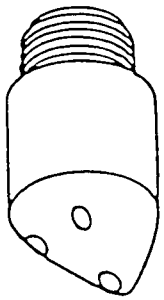


Figure 7. Full Pipe Velocity Sensor

Sensor Mounting Configurations

Universal Sensor Mount:

The sensor can be attached to different size poles with the universal sensor mount (Figure 8). Mounting instructions are as follows:

* Insert the mounting shaft on the universal mount into the hole at the back of the sensor. The thumbscrew needs to be seated in the groove, so make sure the shaft is completely inserted into the hole.

* Hand tighten the thumbscrew.

* Slide a pole one inch or less in diameter through the clamp and tighten.

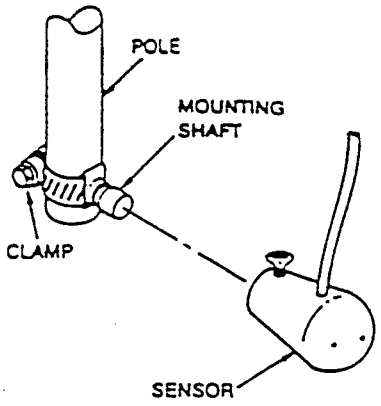


Figure 8. Universal Sensor Mount

[CAUTION]

Do not over tighten the thumbscrew on the sensor. Excessive force on the thumbscrew could damage the sensor.

Standard Wading Rod:

Both the metric and English standard wading rods have a base, a bottom section, a double end hanger, and three intermediate sections (Figure 9). Each intermediate section is two feet in length (English), or one half meter in length (metric). The bottom section is shorter; but when it is screwed to the base, the overall length is equal to the intermediate sections. Each section is divided into 0.10 foot (single marks), 0.50 foot (double marks) and 1.0 foot (triple marks) increments (English), or 5 cm (single marks) and 10 cm (double marks) increments (metric).

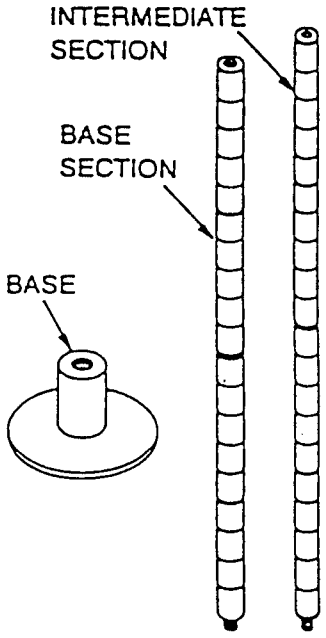


Figure 9. Standard Wading Rod

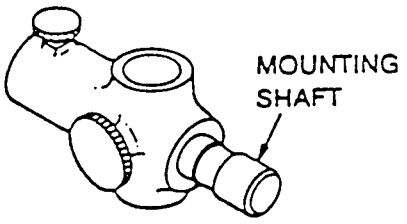


Figure 10. Double End Hanger

Double End Hanger:

The sensor is mounted to the standard wading rod with a double end hanger (Figure 10). Slide the wading rod through the hole in the hanger and hand tighten the lockng screw on the side. Insert the mounting shaft on the hanger into the hole in back of the sensor. Then hand tighten the thumbscrew on top of the sensor. The thumbscrew must be seated in the groove on the shaft, so make sure the mounting shaft is completely inserted into the hole on the sensor.

Suspension Cable:

The suspension cable (Figure 11) makes it possible for the sensor to be lowered into the water from boats or bridges. To attach the sensor to the suspension cable, insert the mounting shaft on the sensor mount into the hole at the back of the sensor. The thumbscrew needs to be seated in the groove on the shaft, so make sure the shaft is completely inserted into the hole. Hand tighten the thumbscrew.

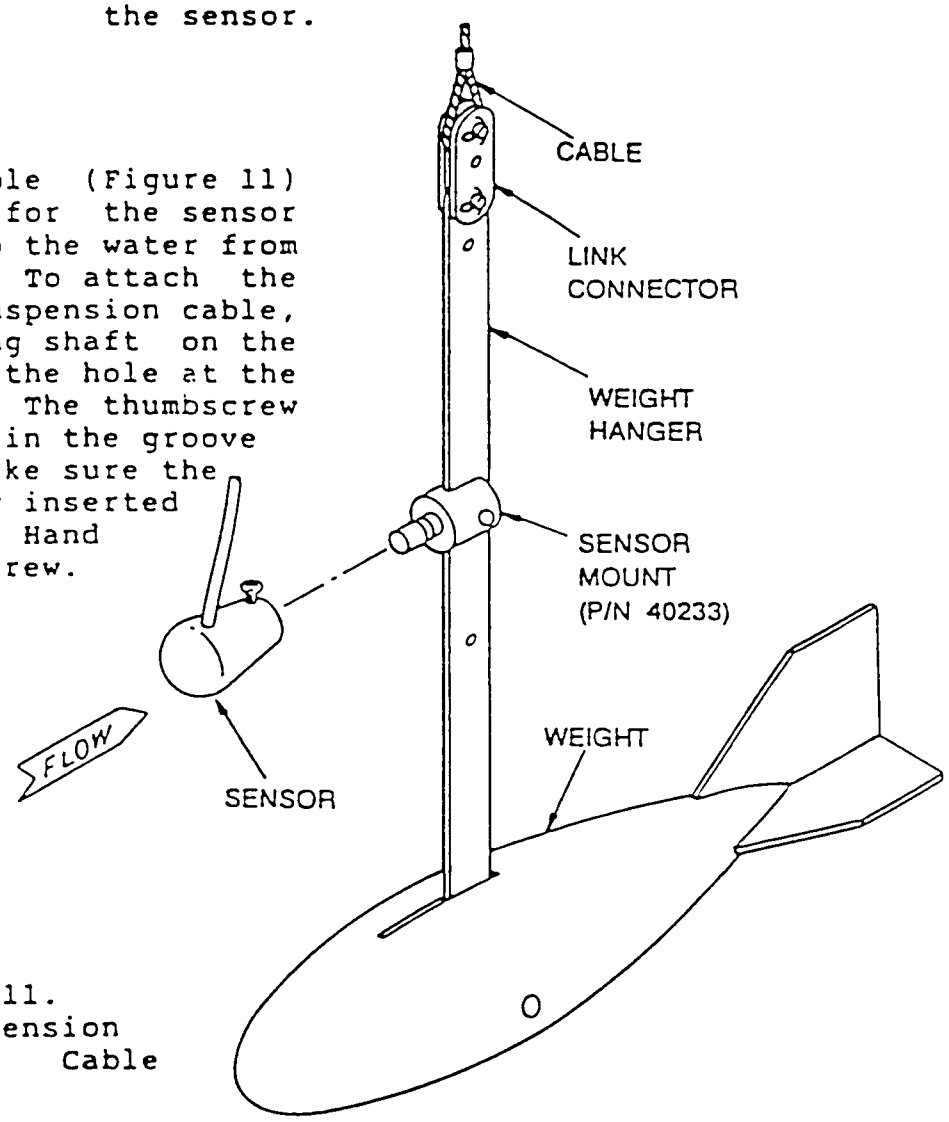


Figure 11. Suspension Cable

MMI PROFILING ROD

The purpose of the MMI profiling rod is to conveniently position the sensor electrodes at specific locations in the flow. The profiling rod is made up of a depth scale rod and a profiling gauge. The depth scale rod has a bottom and top section. Each section is two feet in length and marked off in inch increments. Every half foot is indicated by a double mark and every foot is indicated by a triple mark.

The profiling gauge is made up of a locking collar and sensor mount. Insert the mounting shaft on the sensor mount into the hole in the back of the sensor and hand tighten the thumbscrew on the sensor. The thumbscrew must be in the groove on the mounting shaft.

The top of the locking collar is used to position the sensor electrodes. Start by sliding the profiling gauge to its lowest position. In this position, the sensor electrodes are 3/4" from the bottom, the first mark above the locking collar is the first inch mark, the second mark is the second inch mark, and so on. Now the distance above the bottom can be measured by using the inch marks and the top of the locking collar.

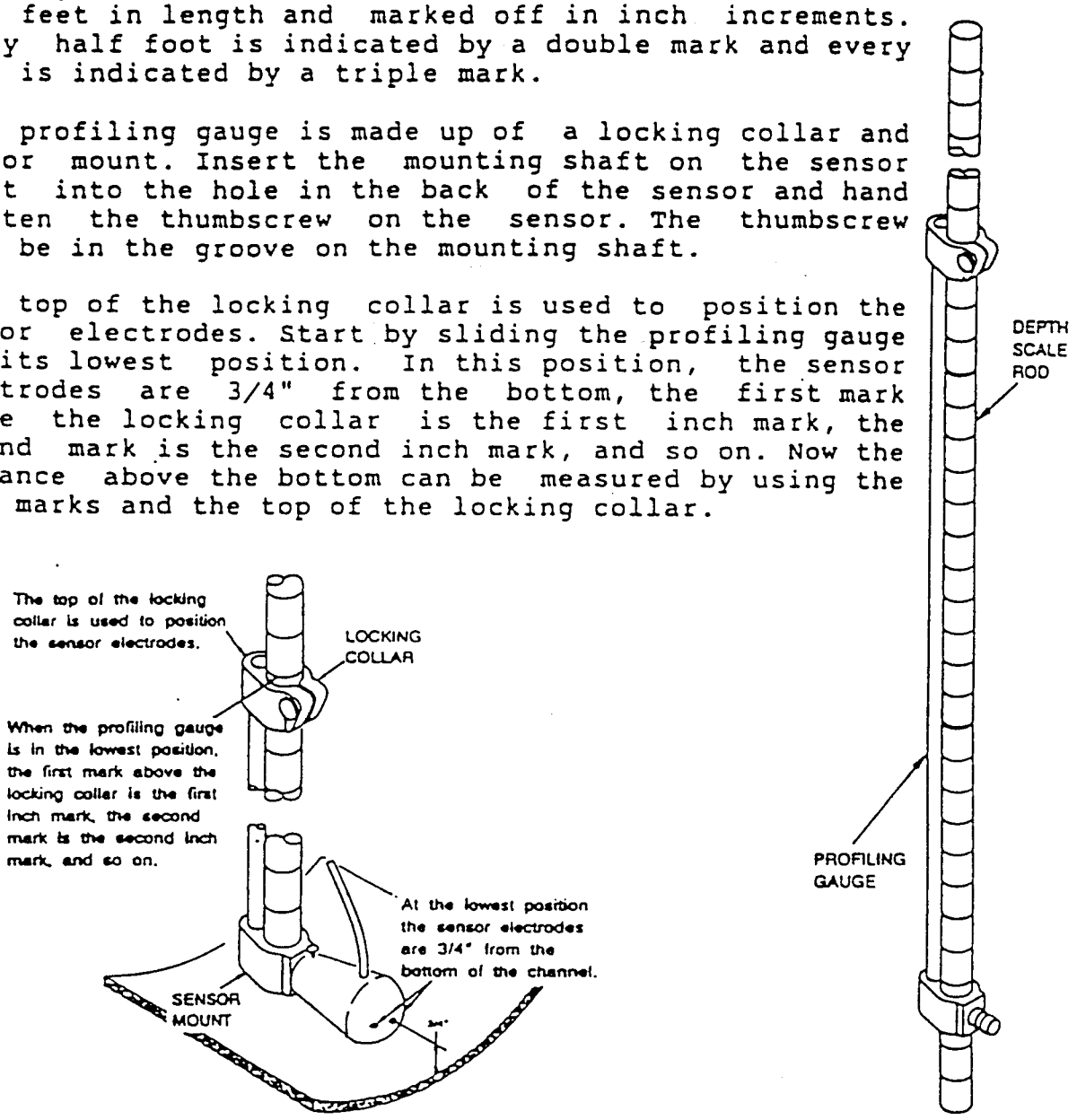


Figure 12. MMI Profiling Rod

The swivel sensor mount can be used in places where you need to get up the pipe or in places where there is not enough room to permit proper use of the profiling gauge.

Slide the swivel mount onto the depth scale rod and hand tighten the locking screw. Insert the mounting shaft into the hole in back of the sensor and hand tighten the thumbscrew on the sensor. The thumbscrew must be seated in the groove on the mounting shaft. Position the sensor at the desired angle and tighten the swivel screw.

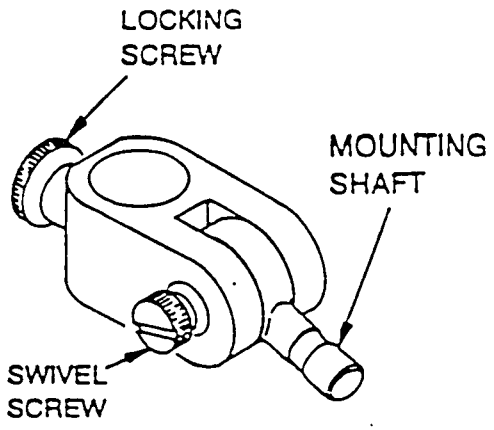


Figure 13. Swivel Mount

Top-Setting Wading Rod:

Two accepted methods for determining mean velocities of flows are as follows:

1. Measure the velocity at 60% of the depth (from the top) and use this as the mean.

2. Measure the velocity at 20% and 80% of the depth (from the top). Use the average of these velocities as the mean.

The purpose of the top setting wading rod (Figure 14) is to conveniently set the sensor at 20%, 60%, or 80% of total depth. The total depth can be measured with the depth gauge rod. Each single mark represents 0.10 foot, each double mark represents 0.50 foot, and each triple mark represents 1.00 foot.

To set the sensor at 60% of the depth, line up the foot scale on the sliding rod with the tenth scale to the top of the depth gauge rod. If, for example, the total depth is 2.7 feet, then line up the 2 on the foot scale with the 7 on the tenth scale.

To set the sensor at 20% of the depth, multiply the total depth by two and repeat the above procedure. In the above example this would be 5.4 feet. Line up the 5 on the foot scale with 4 on the tenth scale.

To set the sensor at 80% of the depth, divide the total depth by two and repeat the above procedure. In the above example, this would be 1.33 feet. Line the 1 on the foot scale with 0.33 on the tenth scale.

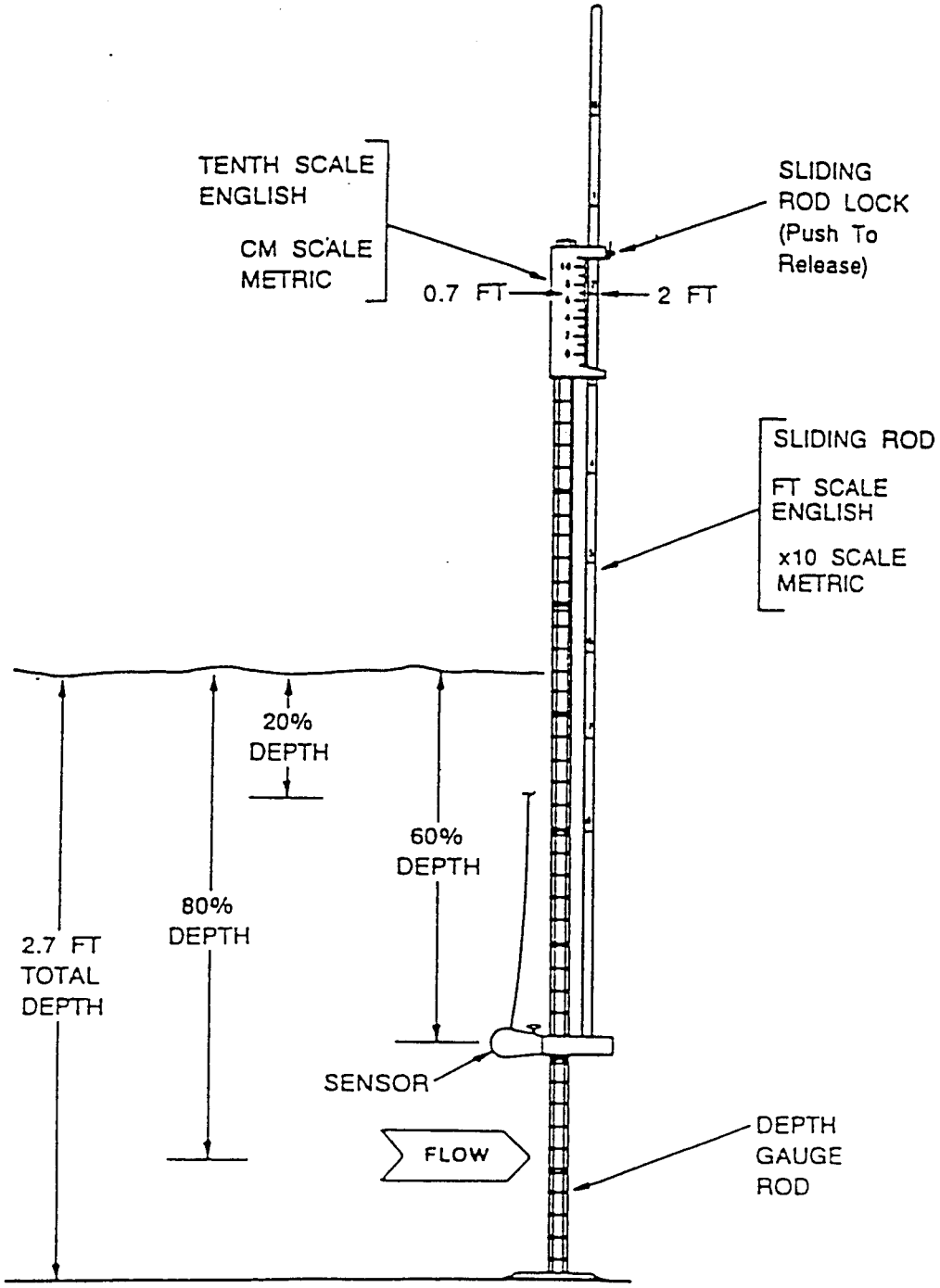


Figure 14. Top-Setting Wading Rod

MSA

Model 360/361
Instrument Manual

HAZCO Services, Inc.

MODEL 360 CARBON MONOXIDE, COMBUSTIBLE GAS & OXYGEN ALARM OR MODEL 361 HYDROGEN SULFIDE, COMBUSTIBLE GAS & OXYGEN ALARM

instruction manual

IMPORTANT WARNING

THIS MANUAL MUST BE CAREFULLY READ BY ALL INDIVIDUALS WHO HAVE OR WILL HAVE THE RESPONSIBILITY FOR INSTALLING, USING, OR SERVICING THE PRODUCT. Like any piece of complex equipment, the MODEL 360 CARBON MONOXIDE, COMBUSTIBLE GAS AND OXYGEN ALARM OR MODEL 361 HYDROGEN SULFIDE, COMBUSTIBLE GAS AND OXYGEN ALARM will perform as designed only if it is installed, used and serviced in accordance with the manufacturer's instructions. OTHERWISE IT COULD FAIL TO PERFORM AS DESIGNED AND PERSONS WHO RELY ON THIS PRODUCT FOR THEIR SAFETY COULD SUSTAIN SEVERE BODILY INJURY OR DEATH.

The warranties made by Mine Safety Appliances Company with respect to the product are voided if the product is not installed, used and serviced in accordance with the instructions in this manual. Please protect yourself and your employees by following them. We encourage our customers to write or call for a demonstration of this equipment prior to use or for any additional information relative to use or repairs.

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Manufactured by
MINE SAFETY APPLIANCES COMPANY
PITTSBURGH, PENNSYLVANIA, U.S.A. 15230

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CAUTIONS AND WARNINGS

1. The toxic sensors used in the Model 360 or 361 are designed to detect carbon monoxide or hydrogen sulfide, respectively. These two toxic gases may be present in work areas. Other toxic gases and vapors may also be present in work areas which cannot be detected by the Model 360 or 361. Every work area should be appraised by someone trained in hazard control to make sure that the correct instrument is chosen and to determine whether other instruments or methods should be used in addition to the Model 360 or 361 to prevent possible exposures to other toxic gases.

2. The toxic gas sensors will exhibit cross-sensitivities to several other gases (NOTE: See Section 6 for cross-sensitivity tables).

3. Handle the toxic sensor carefully; it is a sealed unit which contains an acid electrolyte. If electrolyte is leaking from the sensor, exercise caution so that the electrolyte does not contact skin, eyes or clothing, thus avoiding acid burns. If contact occurs, rinse the area immediately with a large quantity of water. In case of contact with eyes, immediately flush eyes with plenty of clean water for at least 15 minutes and contact a physician.

4. The combustible gas sensor of the Model 360 or 361 is designed to measure combustible gas or vapor content in air. It will not indicate the combustible gas content in an inert gas background, furnace stack or in other atmospheres with less than 10% oxygen. Further, these instruments should not be used where the oxygen concentration exceeds that of fresh air (oxygen enriched atmospheres) because the extra oxygen makes any combustible mix easier to ignite and, thus, more dangerous.

5. Certain materials such as silicone, silicates and organic lead compounds tend to poison the combustible gas sensor, thereby causing erroneously low readings. Calibration checks should be made frequently if such materials are suspected to be present in the tested atmosphere. (NOTE: See Uses and Limitations, Section 1 - OPERATION for more detailed information.)

6. The combustible gas sensor detects only combustible gases and vapors in air. It will not indicate the presence of combustible airborne mists or dusts such as lubricating oils, coal dust or grain dust.

7. Combustible gases will burn or explode only when the fuel/air mixtures are within certain proportions. The minimum concentration of a particular combustible gas in air which will burn and continue to burn when ignited is defined as the lower explosive limit (LEL). The maximum concentration that can be ignited is defined as the upper explosive limit (UEL). In some references, the terms used are lower and upper flammable limits (LFL and UFL). See Uses and Limitations, Section 1 - OPERATION.

8. Before each day's usage (every 8 hours), sensitivity must be tested on a known concentration of each of the gases for which the instrument is calibrated. The indication must be equal to or higher than the actual concentration.

9. The oxygen sensor of the Model 360 or 361 detects the partial pressure of the oxygen in the sample. High or low pressure samples will give erroneous oxygen percent (%) readings. For atmospheric sampling at higher or lower altitudes, the instrument oxygen meter should be calibrated at the elevation where sampling is to take place.

10. Acid gases, such as carbon dioxide will shorten the service life of the oxygen sensor.

11. Depending on the actual MSA part number ordered, the oxygen and toxic gas sensors may be packaged separately in sealed containers. They must be installed before the Model 360 or 361 can be used.

12. Sampling lines will increase the response time of the instrument. For example: a 50-foot sample line will increase the initial response time of the Model 360 or 361 to approximately 30 seconds and the final response to approximately 3 minutes.

13. Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair instrument performance. Repair or alteration of the Model 360 or 361 Alarm, beyond the scope of these maintenance instructions or by anyone other than a certified MSA serviceman, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain severe bodily injury or death.
    WARNING: Any substitution of components may impair intrinsic safety.

14. Proper readings are obtained only when the battery has a sufficient level of charge.
    a. Upon receiving a new Model 360 or 361, it is recommended that the battery be charged for at least 14 hours.

    b. After each day of use the battery should be charged for a minimum of 14 hours.

    c. Recharging must be done in a non-hazardous location to prevent the potential ignition of combustible atmospheres.

d. Do not operate the Model 360 or 361 while the battery is being charged.

e. As a regular monthly maintenance item for optimum battery service, the Model 360 or 361 battery should be charged for 16 hours. Then run the instrument for 8 hours and fully charge the battery for 24 to 36 hours.

15. The sample inlet filter should be examined each time the Model 360 or 361 is recharged. If the filter element appears to be coated with dust or dirt, it should be washed, dried and reinserted or a new element substituted. Make sure that the inlet seal O-ring in the inlet filter cap is properly seated. If O-ring is damaged or missing, the O-ring must be replaced before using the Model 360 or 361 with any sampling accessories.

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SECTION 1
OPERATION

GENERAL SPECIFICATIONS

Performance Characteristics

- ACCURACY:
  - All Ranges: ±1 digit for digital display characteristic
  - Combustible Gas: ±3% LEL up to 50% of full-scale; ±5% LEL, 50% to 100% of full-scale
  - Oxygen: ±0.8% O_2, 0% to 10% oxygen; ±0.3% O_2, 10% to 25% oxygen
  - Toxic Gas: When calibrated with 300 ppm CO or 40 ppm H_2S calibration gas at temperature of use:
  - Model 360: ±10 ppm CO or ±10% of reading (whichever is greater)
  - Model 361: ±2 ppm H_2S or ±10% of reading (whichever is greater)

- RANGES:
  - Toxic Gas:
    - Model 360: 0 to 500 ppm CO;
    - Model 361: 0 to 50 ppm H_2S
  - Combustible Gas: 0 to 100% LEL measurement; 60% LEL maximum alarm set point
  - Oxygen: 0 to 25% O_2

- RESPONSE TIME:
  - Combustible Gas: 15 seconds to 90% of final reading
  - Oxygen: 20 seconds to 90% of final reading
  - Toxic Gas:
    - Model 360: < 5 sec. to alarm on 300 ppm CO when alarm setpoint is 50 ppm
    - Model 361: < 3 sec. to alarm on 40 ppm H_2S when alarm setpoint is 10 ppm

- OPERATING HUMIDITY RANGE:
  10 to 90% RH; (NOTE: Long-term exposures to extreme limits of humidity will reduce the life of the toxic gas sensor.)

  OPERATING TEMPERATURE RANGE:
  Combustible Gas: 0° to 104°F (-18° to 40°C)
  Oxygen: 32° to 104°F (0° to 40°C)
  0° to 104°F (-18° to 40°C) if calibrated at temperature of use
  Toxic Gas: Maximum temperature compensation error with dynamic changes in temperature from 32°F (0°C) to 104°F (40°C) when calibrated at 68°F (20°C)
  Model 360: ± 5% of Full Scale
  Model 361: ± 10% of Full Scale

- STORAGE TEMPERATURE RANGE: 32° to 104°F

- ALARMS: High Oxygen, Low Oxygen, High Combustible Gas and High Toxic Gas Alarms (all adjustable); Off-scale, LEL Latching and Low Battery Alarms (not adjustable)

Operating Characteristics

- POWER SUPPLY: Rechargeable, sealed, 4.0-volt lead-acid battery pack

- OPERATING TIME: A minimum of 8 hours with fully charged battery

- READOUT: LCD with individual descriptors for range identification & alarms:
  - SCAN Mode: The LCD digital display automatically and sequentially switches to each of the three sensors for approximately 7 seconds per sensor

(NOTE: All three alarm circuits are continuously monitored, regardless of display readout)

- MANUAL Mode: The LCD digital display is connected to one of the three sensors manually selected by a push button control (NOTE: All three alarm circuits are continuously monitored, regardless of display readout)

- SAMPLE FLOW RATE: Approximately 1.5 liters per minute

Physical Characteristics

- CASE CONSTRUCTION: Aluminum

- DIMENSIONS AND WEIGHT: 10 x 7 x 3-3/4 in.; 7-1/2 lbs.

- ACCESSORIES: Sample lines up to 50 feet long, sample line liquid trap, probe tubes, 120 and 240 VAC battery chargers, carrying harness, and calibration kits are available

- SERIAL NUMBER: Located on nameplate inside of lid

INTRODUCTION

Prior to testing potentially dangerous atmospheres with the MSA Model 360 or 361 Toxic Gas, Combustible Gas and Oxygen Alarm, the user must be familiar with all sections of this Instruction Manual.

The Model 360 or 361 is a hand-carried, battery-operated instrument (Figures 1A, 1B and 2). It is designed to sample atmospheres for carbon monoxide concentration (Model 360), hydrogen sulfide concentration (Model 361), combustible gases or vapors, oxygen content, and to warn the user when predetermined concentrations are reached.

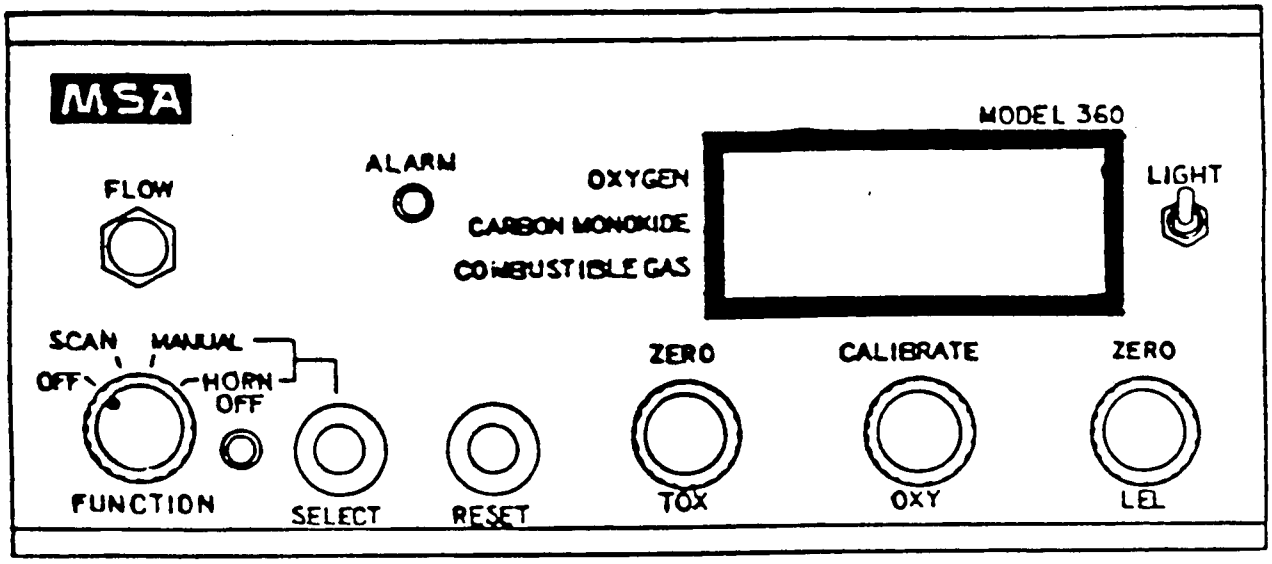


Figure 1A. Model 360 Control Panel

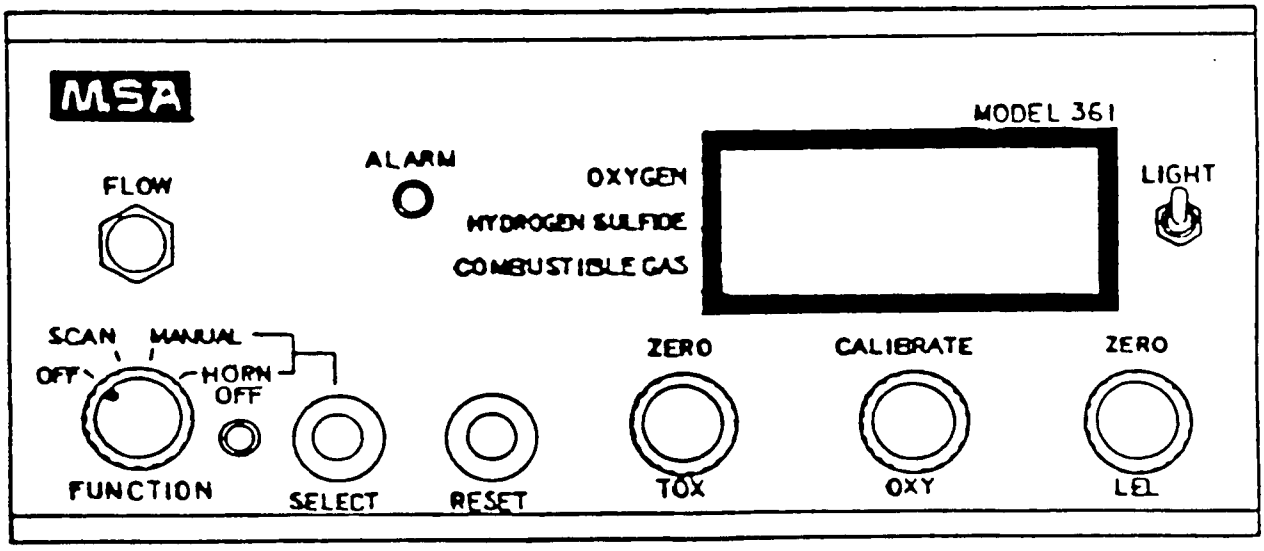


Figure 1B. Model 361 Control Panel

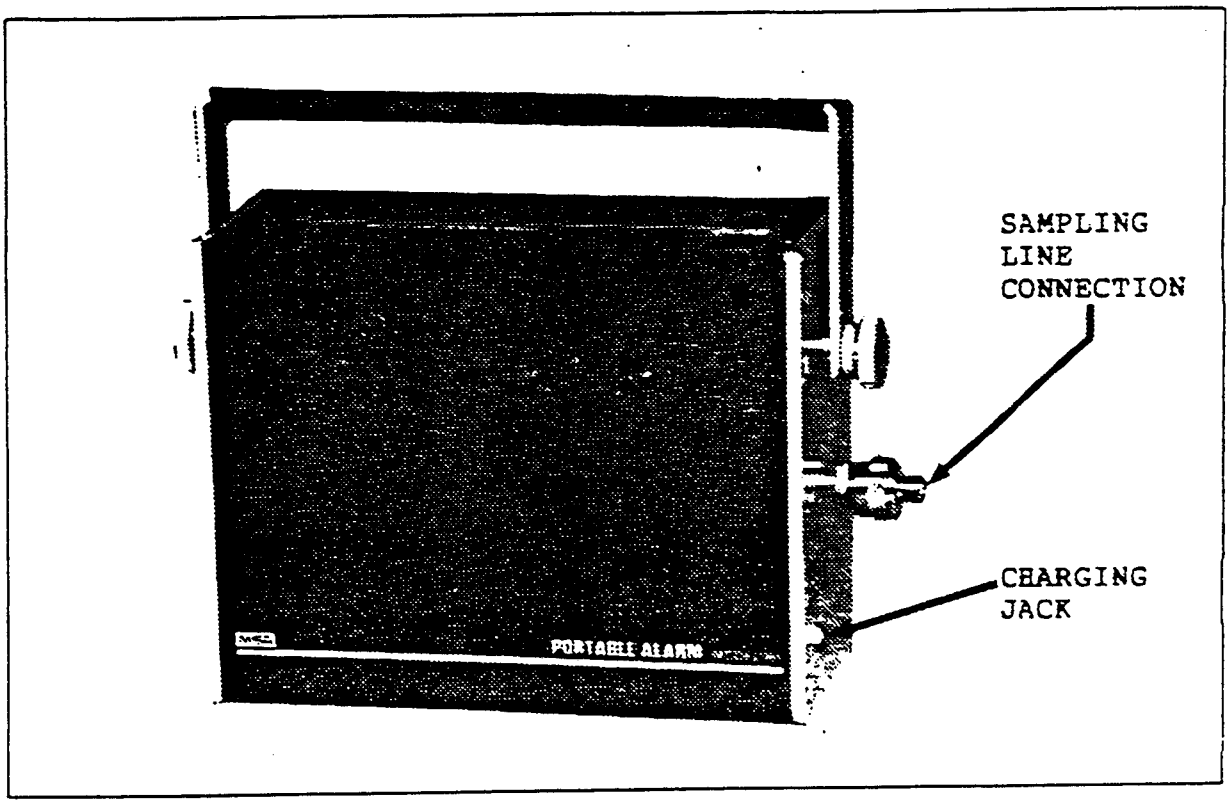


Figure 2. Sample Line/Probe Connection and Battery Charging Jack

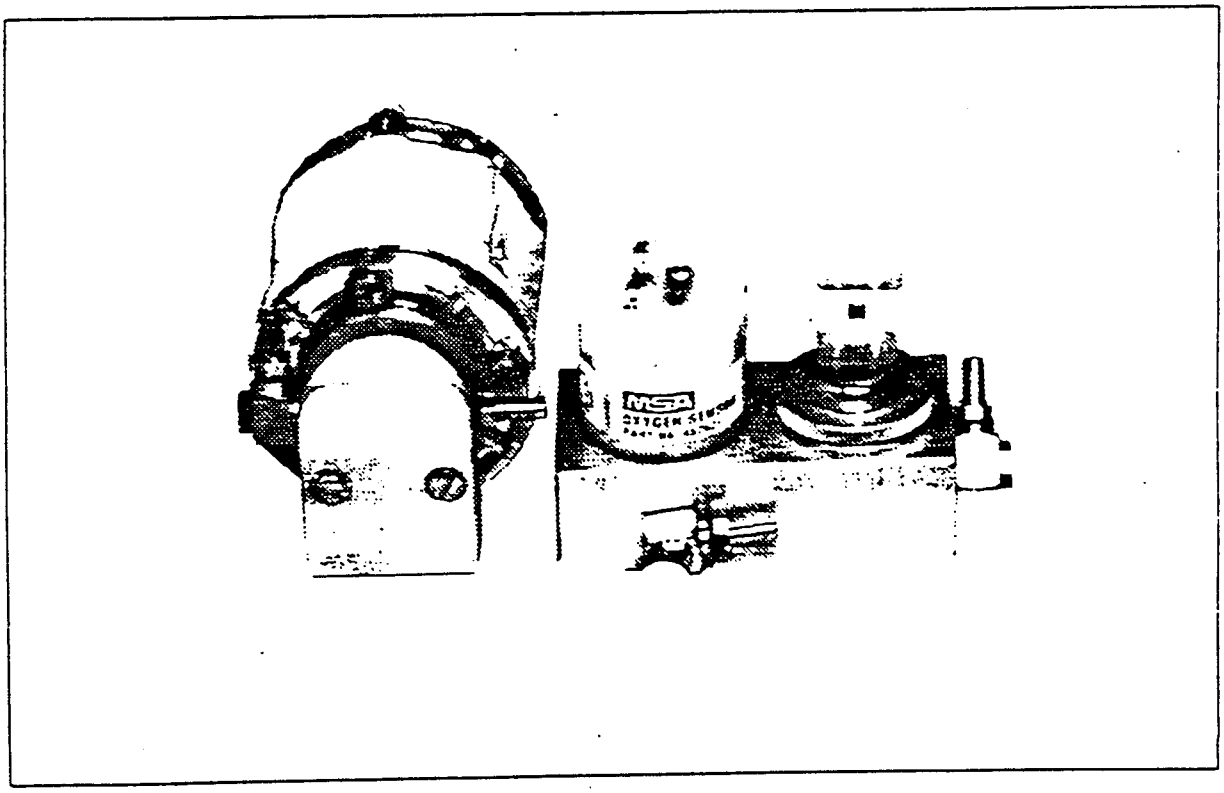


Figure 3. Manifold Blocks

Major features of the Model 360 or 361 are ease of operation and reliability; the integrated circuit electronics and rugged components provide a tough, compact instrument.

The Model 360 or 361 houses three separate sensors and uses a common flow system. The zero and calibration controls have "lift-to-adjust" knobs to prevent any accidental change in adjustments.

A small pump pulls the atmospheric sample through a filter and pushes it through the flow indicator and the manifold blocks in which the toxic gas, combustible gas and oxygen sensors are mounted (Figure 3). The flow is then exhausted to the side of the case. The approximate flow rate is 1.5 liters per minute.

The Model 360 or 361 is powered by a rechargeable, 4.0-volt lead-acid battery pack (Figure 5) sealed in a plastic case. Recharging requires only connecting the instrument to the charger. (NOTE: 120-volt and 240-volt versions are available.) A fully charged battery provides a minimum of 8 hours continuous non-alarm operation at normal temperatures.

USES AND LIMITATIONS

The MSA Model 360 or 361 Alarm provides an efficient and reliable method of testing atmospheres for: the presence of carbon monoxide (Model 360) or hydrogen sulfide (Model 361); combustible gases or vapors which may pose a potential flammability hazard; and sufficient oxygen content for life support. Common examples of such locations are manholes, storage tanks, tank cars, confined spaces, pumping stations, etc.

It is important that the instrument response be appraised by someone trained or experienced in properly interpreting the instrument readings with respect to particular conditions, on-going operations and safe practices. For example, an

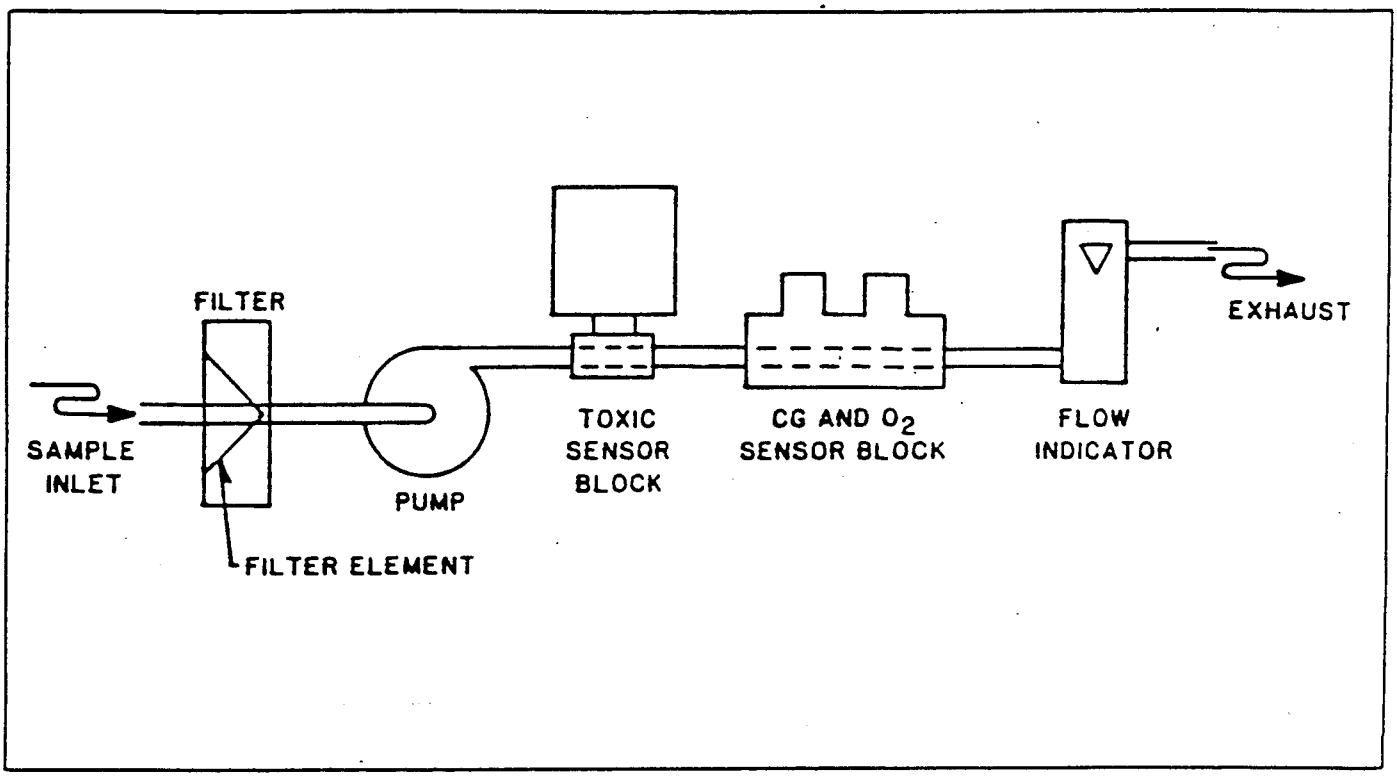


Figure 4. Flow Diagram

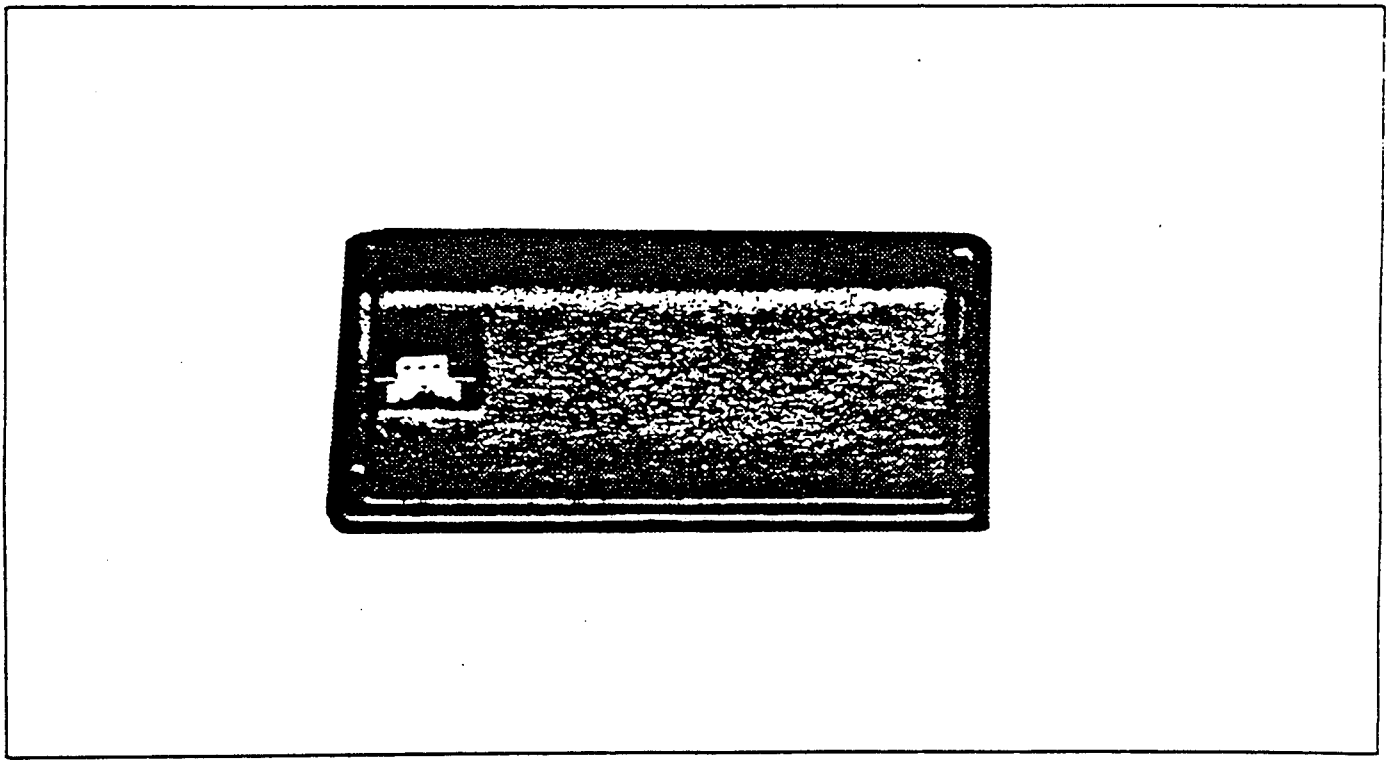


Figure 5. Battery Pack

atmosphere that shows no flammability hazard can still be toxic to workmen. Also, if there is less than 10% oxygen, the instrument may not give an accurate combustible gas reading. Further, a tank or vessel which is safe before work is initiated may be rendered unsafe by changing conditions or work activities, such as by causing a temperature increase, or by stirring or handling bottom sludge in petroleum tanks.

The toxic sensors used in the Model 360 or 361 are designed to detect carbon monoxide and hydrogen sulfide, respectively. These two toxic gases may be present in work areas. Other toxic gases and vapors which cannot be detected by the Model 360 or 361 may also be present in work areas. It is important that every work area be appraised by someone trained in hazard control to make sure that the correct instrument is chosen and to determine whether other instruments or methods should be used in addition to the Model 360 or 361 to prevent possible exposures to other toxic gases.

Combustible gases will burn or explode only when the fuel/air mixtures are within certain proportions. The minimum concentration of a particular combustible gas in air which will burn when ignited is defined as the lower explosive limit (LEL). The maximum concentration that can be ignited is defined as the upper explosive limit (UEL). In some references, the terms used are lower and upper flammable limits (LFL and UFL).

Certain materials in the sampled atmosphere affect the catalytic material on the combustible gas sensor and may cause the indicator to respond incorrectly. Included are organic lead compounds used in leaded gasoline and silicon compounds in the form of silanes, silicones and silicates (often found in hydraulic fluids). Some of these materials rapidly "poison" the detector pelement so that it will malfunction. When such materials are even suspected to be in the atmosphere being

tested, the instrument calibration must be checked before and after each series of tests.

The combustible gas sensor of these instruments is normally calibrated on pentane as being representative of the flammability characteristics of most commonly encountered combustible gases. The meter scale is calibrated from 0% to 100% LEL which corresponds to actual volume concentrations of 0% to approximately 1.5% pentane. Even though the instrument responds to any combustible gas/air mixture below the flammable range, it provides accurate measurement only of the specific gas for which it has been calibrated. For response to other combustibles, see Section 6. The responses to these combustibles may be more or less sensitive than pentane. Calibration for combustibles other than pentane may be obtained through special order. The conversion factors in Section 6 may only be used with a Model 360 or 361 calibrated on pentane.

The combustible measurement is dependent upon catalytic combustion of the flammable gas in combination with the oxygen in the air. Conditions can exist in a closed space where not enough oxygen remains to provide a correct combustible gas reading (approximately 10% oxygen or less).

(NOTE: This low oxygen level is far below what is required for human life.)

In these instances, the % oxygen reading is most important. A low oxygen concentration in an enclosed atmosphere indicates that: (1) some other gas has displaced much of the air, or (2) some process has consumed much of the available oxygen. Upon initially opening and probing an enclosed area, move the probe into the area slowly while watching the readout to provide the earliest possible indication of a potentially dangerous condition.

The oxygen sensor responds to the partial pressures of oxygen in the atmosphere being tested. For this reason, changes in the atmospheric or sample pressure will change the oxygen reading. Calibration should be checked and adjusted in fresh air at the elevation where the instrument is to be used.

The oxygen sensor is temperature compensated in the range of 32° to 104°F (0° to 40°C). Use down to 0°F is possible when calibrated at the temperature of use and if more sampling time is allowed for slower sensor response (approximately 3 minutes without sample line). The life of the oxygen sensor is reduced by exposure to carbon dioxide. The sensor life will be reduced to 2 days in 100% carbon dioxide, 50 days in 5%, and 100 days in 1%. The effect is cumulative; therefore, all tests of atmospheres containing excess concentrations of carbon dioxide should be stopped as soon as a constant reading is obtained. Flush the flow system with fresh air (20.8% oxygen) as soon as possible. Slow recovery to the air calibration point after exposure to high carbon dioxide is to be expected.
Evacuate all personnel from the area if the Model 360 or 361 toxic gas, combustible gas or oxygen alarm indicates the possibility of a hazardous condition.

The battery must have a sufficient charge level for the indicator to function properly. The descriptor BATT will appear in the readout when the battery voltage is too low. In addition, when operating in the ON position, the audible alarm activates when the battery voltage drops to a low level, thus indicating that recharging is necessary. The battery should be performance-checked on a monthly basis. (NOTE: See Section 3, MAINTENANCE.)

Accessory Items

The following accessory items are available for use with the Model 360 or 361 Combustible Gas, Oxygen and Toxic Alarm. See Section 5, PARTS LIST for their respective part numbers.

SAMPLE LINES: Special synthetic rubber lines which have minimal gas absorption characteristics are available in 5, 10, 15, 25, 35, and 50-foot lengths

SAMPLE PROBES: 3-foot, hollow brass probe; 3-foot hollow plastic probe for use in areas where contact with hazardous voltages is possible; a 4-foot, solid end probe to prevent liquid pickup from wet tank bottoms; and a 20-inch plastic probe sized to fit in many carrying cases.

LINE TRAP ASSEMBLY: Helps prevent liquids from being drawn into the instrument

CALIBRATION EQUIPMENT: Consists of calibration gases, a flow regulator, and an adapter hose

CARRYING HARNESS: Neck and waist straps to hold the Model 360/361 in place while climbing, etc.

INITIAL OXYGEN AND TOXIC SENSOR INSTALLATION

The oxygen and toxic sensors may be packaged separately and must be installed in the Model 360 or 361 prior to placing the instrument into service. Once installed, the sensors should be left in place until the end of their useful lives.

Sensor Installation

1. Remove the carrying handle by loosening both knurled screws and spreading the handle beyond the collars. Lift handle from screw shafts.

2. Remove the left side of the case (the end with the threaded inlet fitting) by removing the four mounting screws. Allowing left side to remain attached to the top panel (via tubing and

charge jack wires) slowly slide the top panel from the case until the plastic connectors for the battery and speaker are accessible. Disconnect these connectors. (NOTE: Hold the case lid to prevent it from falling off case; set lid aside.)

3. Slide the top panel completely off the remainder of the case.

4. Open the protective bag containing the oxygen sensor and install the O-ring onto the threaded end of the sensor.

5. Firmly screw the sensor into the manifold by hand so as to compress the O-ring and thereby prevent sample flow leakage.

6. Push the connectors onto the two terminals at the top of the sensor [NOTE: Connect the gray wire to the positive (+) terminal and the yellow wire to the negative (-) terminal.]

7. Open the protective bag containing the toxic sensor and install the O-ring into the threaded end of the sensor.

8. Remove toxic sensor manifold from chassis by removing the 2 screws from the back of the chassis.

9. Remove plastic cap and packaging material and discard. Make sure the sintered metal disc is in place in the manifold.

10. Firmly screw the sensor onto the manifold by hand so as to compress the O-ring and thereby prevent sample flow leakage.

11. Reinstall the flowblock onto the chassis and connect the mating electrical connectors.

12. Reassemble the case by sliding the top panel back into position and reconnect the speaker and battery pack. (NOTE: The top and case fit together by two dove-tail type tongue and grooves. Be sure to align both carefully before sliding the

panel onto the instrument. The panel should slide on easily; if resistance occurs, the tongue and grooves are positioned incorrectly.) While sliding the panel, make sure that the tubing is not pinched.

13. Place the case side in position and install the lid hinge pins into each side. Make sure the tubing is not pinched.

14. Install the mounting screws. (NOTE: Insert all four screws loosely before tightening any one of them.)

15. Reattach the handle.

16. See Troubleshooting Guidelines and Oxygen and Toxic Calibration in Section 3, MAINTENANCE for instructions on leak testing the sample flow system and adjusting the oxygen calibration.

BATTERY CONNECTION

The battery pack has been disconnected to prevent battery discharge during storage and shipment. Before using:

1. Remove handle and speaker panel.

2. Slide battery pack 2-3 inches from instrument and connect the plug to the pack outlet.

3. Slide battery pack back into instrument.

4. Reinstall speaker panel and handle.

5. Connect charger and charge for 14 hours before calibration or use.

WARNING

Failure to charge battery pack for 14 hours may not allow time for the toxic sensor to stabilize after the unpowered storage.

Whereas this instrument was fully calibrated before packing, the instrument's calibration must be checked before using, after unpowered storage. See Section 4, "Calibration" for complete calibration information.

OPERATING INSTRUCTIONS

The Model 360 or 361 oxygen calibration and toxic and combustible zero checks must be made in fresh air or with the inlet end of the sampling line in fresh air.

1. Turn the FUNCTION control to the HORN OFF position; the HORN OFF indicator will light and the descriptor % LEL will show in the readout.

2. Set the readout to zero (00) by adjusting the LEL ZERO control (NOTE: this must be done within 30 seconds of turning ON to prevent the possibility of activating the off-scale, LEL latching alarm).

3. Press the SELECT button firmly to obtain % OXY on the readout; then set the readout to 20.8% by adjusting the OXY CALIBRATE control.

4. Press the SELECT button firmly to obtain PPM TOX on the readout; then set the readout to zero (00) by adjusting the TOX ZERO control.

5. Press the RESET button.

6. Turn the FUNCTION control to MANUAL for continuous readout of any one gas or to SCAN for automatic scanning of the three gas readings. (NOTE: All alarm functions operate in either position.)

7. Momentarily place a finger over the sample inlet fitting or the end of the sample line, if one is used. Observe that the FLOW indicator float drops, indicating no flow. If it does not, check the flow system and sample line for leaks.

8. The instrument is ready for sampling. Move it to the area for sampling or place the end of the sampling line at the point where the sample is to be taken.

WARNING

If an alarm condition is indicated by an ALARM or OVER sign in the readout or a pulsing horn, evacuate personnel from the area and notify the safety officer or fire department.

A low battery condition is indicated by a BATT sign in the readout or by a steady horn; remove the Model 360 or 361 and recharge in a nonhazardous area to prevent potential ignition of combustible atmospheres.

SECTION 2
THEORY OF OPERATION

INTRODUCTION

A block diagram of the MSA Model 360 or 361 is provided in Figure 6. The Model 360 or 361 toxic gas, combustible gas and oxygen sensors operate simultaneously. Each sensing circuit is equipped with an individual, visual alarm descriptor. There is a common, pulsating audible alarm. One position of the FUNCTION switch enables the audible alarm to be turned off, if so desired. The alarm descriptors will remain on until the concentration returns to within the alarm setpoints, and the reset button is depressed.

A low-battery alarm will activate the BATT descriptor in the display and a continuous, steady-sounding audible alarm. This steady sound indicates that the Model 360 or 361 must be removed from service and charged in a nonhazardous area.

WARNING

Exposure of the combustible gas sensor to a concentration high enough to cause the readout to indicate a reading greater than 100% LEL will cause the readout to latch. When latched, the LEL readout will be blank and the descriptors for OVER and LEL ALARM will appear. This latching circuit is a warning that the gas concentration has exceeded the LEL and that all personnel must be evacuated from the area.

This latching circuit can be reset by removing the Model 360 or 361 to an area known to be free of combustible gas (fresh air) and turning off the instrument. The Model 360 or 361 can then be turned on and rezeroed in fresh air. This latch circuit does not operate during the first 30 seconds after turning on the instrument, thus providing sufficient time for sensor warm-up and rezeroing.

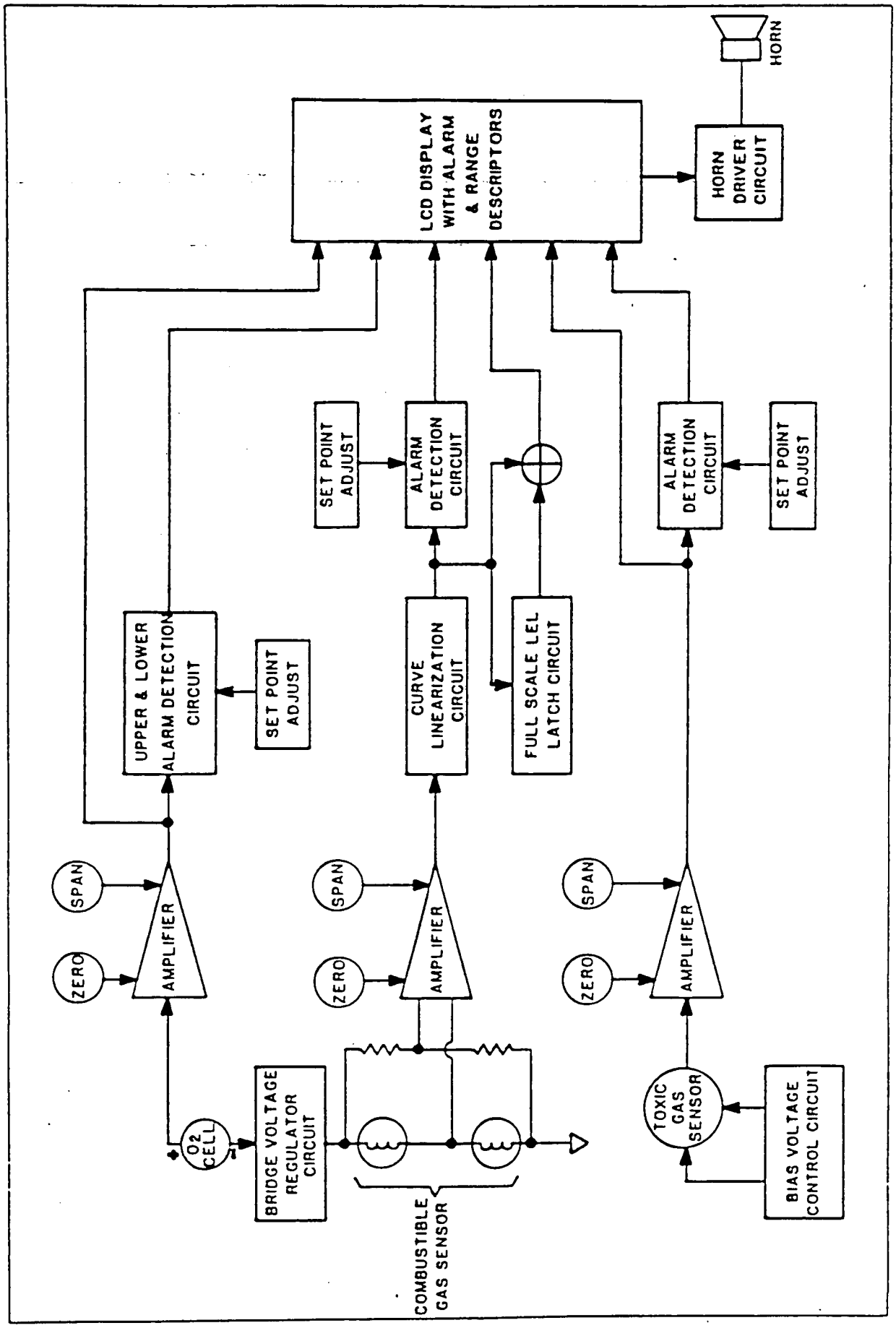


Figure 6. Block Diagram

TOXIC GAS SENSOR

The toxic gas sensor used in both the Model 360 and 361 is a membrane-sealed electrochemical cell. The cell requires an external voltage source to function and produces a current output that is proportional to the amount of CO or H_2S present. The CO or H_2S diffuses through the front membrane of the cell and is oxidized at the working electrode. Current flows through the liquid electrolyte (acid solution) to the counter/reference electrode where oxygen reduction occurs. The amount of current produced for a concentration of CO or H_2S is dependent on the voltage across the working and reference electrodes as well as the electrode materials and the electrolyte. The choice of the particular noble metal electrodes and the setting of the cell voltage optimizes the sensor for the detection of CO or H_2S.

The current from the cell is fed to a current to voltage converter. This voltage signal is applied to an amplifier which drives the toxic gas readout and provides an input for an alarm comparator circuit.

COMBUSTIBLE GAS SENSOR

The flammable properties of combustible gases are used as the basis of detection. The sensor consists of a pair of pelletized filaments called "Pelements™" arranged in an electrically balanced bridge circuit. The detector pelement is treated with a catalyst that causes the combustible gases to combine with oxygen at much lower temperatures than would be required for normal burning. The inactive compensator pelement is also exposed to the sample flow and acts to offset any electrical changes caused by flow conditions, sample temperature, pressure and/or humidity.

Combustible gases in the sample combine with oxygen in the air at the surface of the catalyzed detector pelement. Heat is liberated by this chemical reaction, thus increasing the temperature of the pelement and causing an associated increase in

the pelement electrical resistance.

Increased resistance of the detector pelement unbalances the bridge circuit, causing a voltage change at the mid-point connection between the detector pelement and the compensating pelement. This voltage signal is applied to an amplifier which drives the combustible gas readout and provides an input for an alarm comparator circuit.

OXYGEN SENSOR

The oxygen sensor is a galvanic type cell containing gold and lead electrodes in a potassium hydroxide solution. The cell is sealed with a membrane which allows oxygen to diffuse into the active area. The current generated by the cell is proportional to the oxygen partial pressure in the atmospheric sample passing over the face of the membrane. The generated current passes through a resistance to provide a voltage input signal for an amplifier. The output of the amplifier drives the oxygen readout and also serves as an input to the alarm comparator circuit.

SECTION 3

MAINTENANCE

BATTERY PACK CHARGING

The primary maintenance item of the Model 360 or 361 is the rechargeable, 4.0-volt lead-acid battery (Figure 7). Upon receiving a new Model 360 or 361, the battery pack must be fully charged, per the following procedure. Using the appropriate battery charger [120 VAC (Part No. 631664) or 240 VAC (Part No. 631712)] insert charger plug into charge jack (Figure 2).

CAUTION

Use only the chargers specified above to charge the instrument; otherwise, damage to the battery pack and/or the instrument circuitry may result.

The POWER ON lamp indicates that the charger is receiving power from the 120 or 240 VAC line. The FAST CHARGE lamp indicates that the battery voltage is low and that the charger has automatically switched to the higher charge rate. When the battery is approximately 95% charged, the charger will change to the trickle charge rate and the FAST CHARGE lamp will be extinguished. Recommended charging time is 16 hours. The battery pack may be left on charge for longer periods without damage.

WARNING

Do not charge the battery pack in areas that may contain a flammable mixture of combustible gases, vapors, mists or dust and air; otherwise, an explosion may occur since a source of ignition exists during charging. The battery pack may not supply full power capacity after repeated partial use between chargings; therefore, it is recommended that

the battery pack be "exercised" at least once per month by operating the fully charged Model 360 or 361 for 8 hours and then recharging. The battery pack should be charged after each day of use (or prior to use if the instrument has not been operated for 30 days).

Extended Operation

External Charging Adapter (Part No. 477153) can be used to charge a depleted battery while it is removed from the instrument. Use of this adapter permits extended operation by enabling the user to install a second, back-up battery into the instrument while externally charging the depleted battery.

The Model 360 or 361 Alarm maintains a bias potential on the toxic gas electrochemical cell whenever battery power is available. Any time that the battery power is not available, this bias potential is removed from the toxic gas cell. This specifically includes:

1) The first receipt of the instrument (when the battery is disconnected)

2) Any time the battery is changed

3) Periods of extended storage (when the battery may be removed or depleted)

At such times, the toxic gas cell response will be affected. Symptoms of this condition include zero drift and, in extreme cases, poor response to gas.

The time required to restabilize the cell depends on the condition of the cell and the length of time it went without bias. As a general rule, most cells will stabilize after bias is

applied for 16 to 24 hours. When the interruption in bias is short, such as in changing a batte_, pack, the cell will normally restabilize within a few minutes.

In all cases where the stability of the cell is in doubt, perform zero drift check and a calibration or span check.

BATTERY PACK REPLACEMENT

When the rechargeable, 4.0-volt lead-acid battery pack no longer responds to recharging or no longer "holds" a charge, the pack should be replaced according to the following procedure (Figure 7):

1. Loosen the knurled screws holding the handle and remove handle.

2. Looking at the front panel of the instrument, remove the right (audible alarm side) panel by unscrewing the 4 side panel screws.

3. Gently pull the side panel loose and tilt the instrument to help slide out the battery case. Disconnect the molded nylon plug from the battery case. (NOTE: Do not disconnect the alarm speaker.)

4. Install the new battery by reversing steps 1 through 3 above.

SAMPLE INLET FILTER/FILTER ELEMENT

The sample inlet filter should be examined each time the Model 360 or 361 is recharged (Figure 8). If the filter element appears to be coated with dust or dirt, it should be washed, dried and re-inserted or a new element substituted. If a new element is installed, also install a new filter o-ring. Make sure the inlet seal O-ring in the inlet filter cap is properly seated. If the O-ring is damaged or missing, replace it before using the Model 360 or 361 with any sampling accessories.

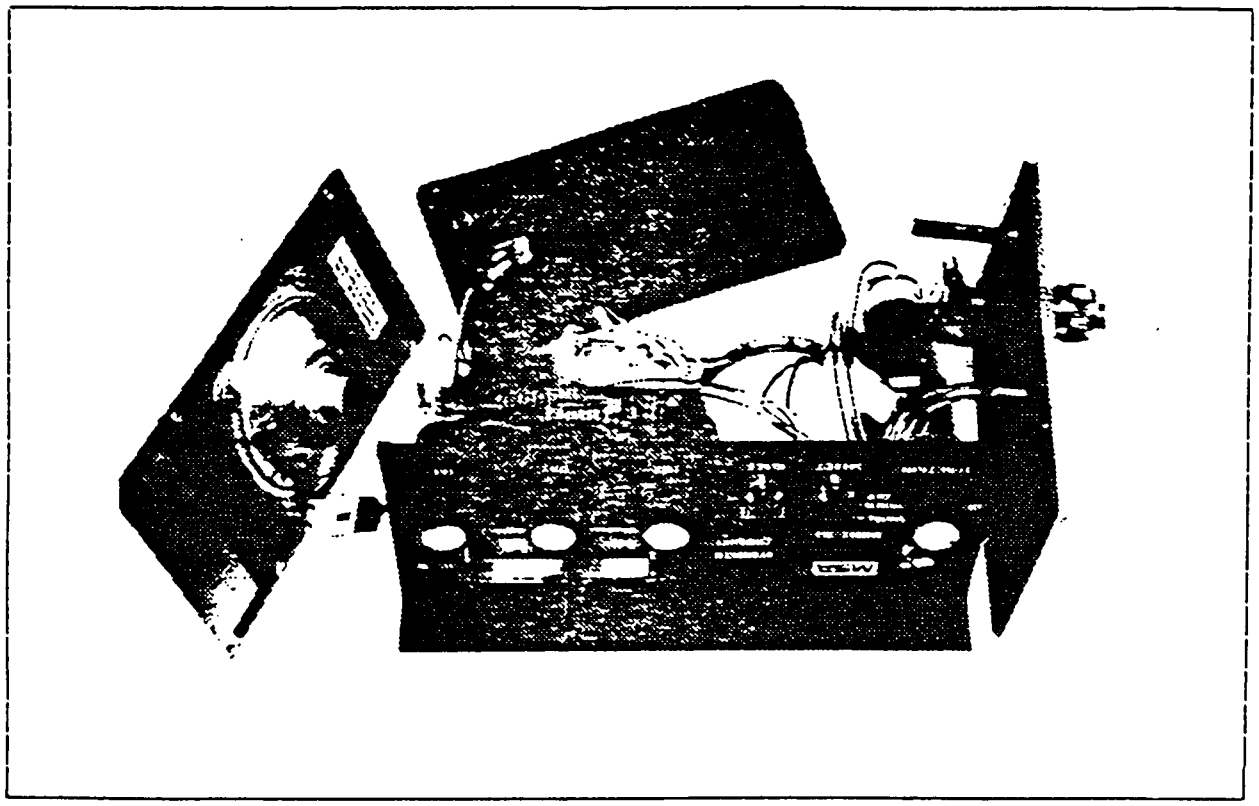


Figure 7. Disassembly Showing Battery Pack

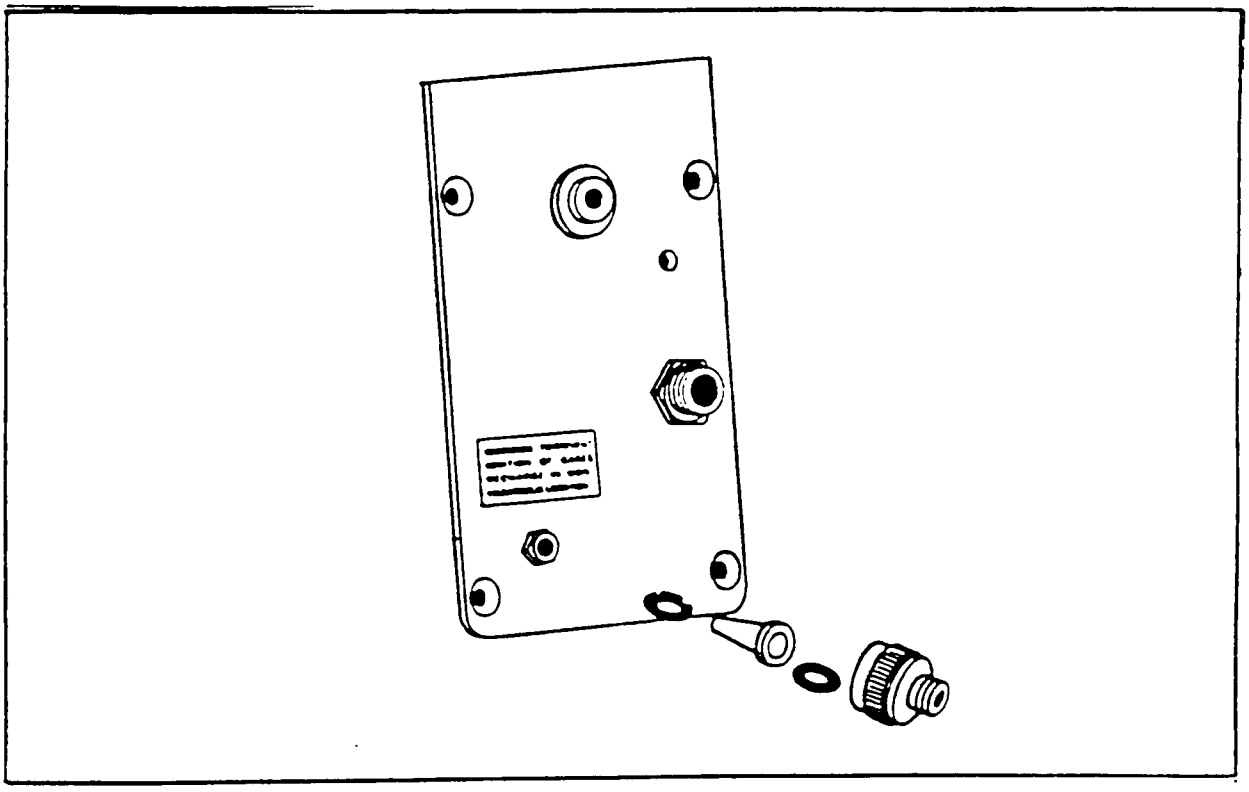


Figure 8. Disassembly Showing Sample Inlet Filter

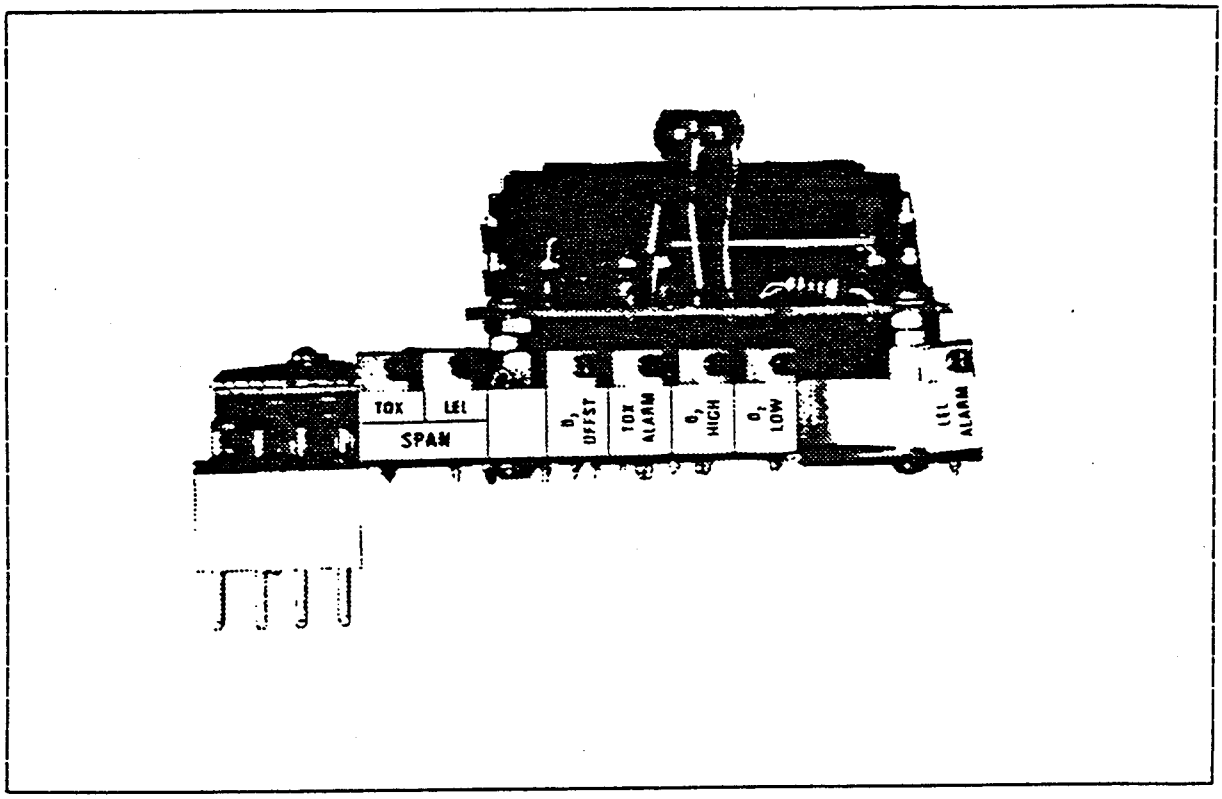


Figure 9. Printed Circuit Board Adjustments

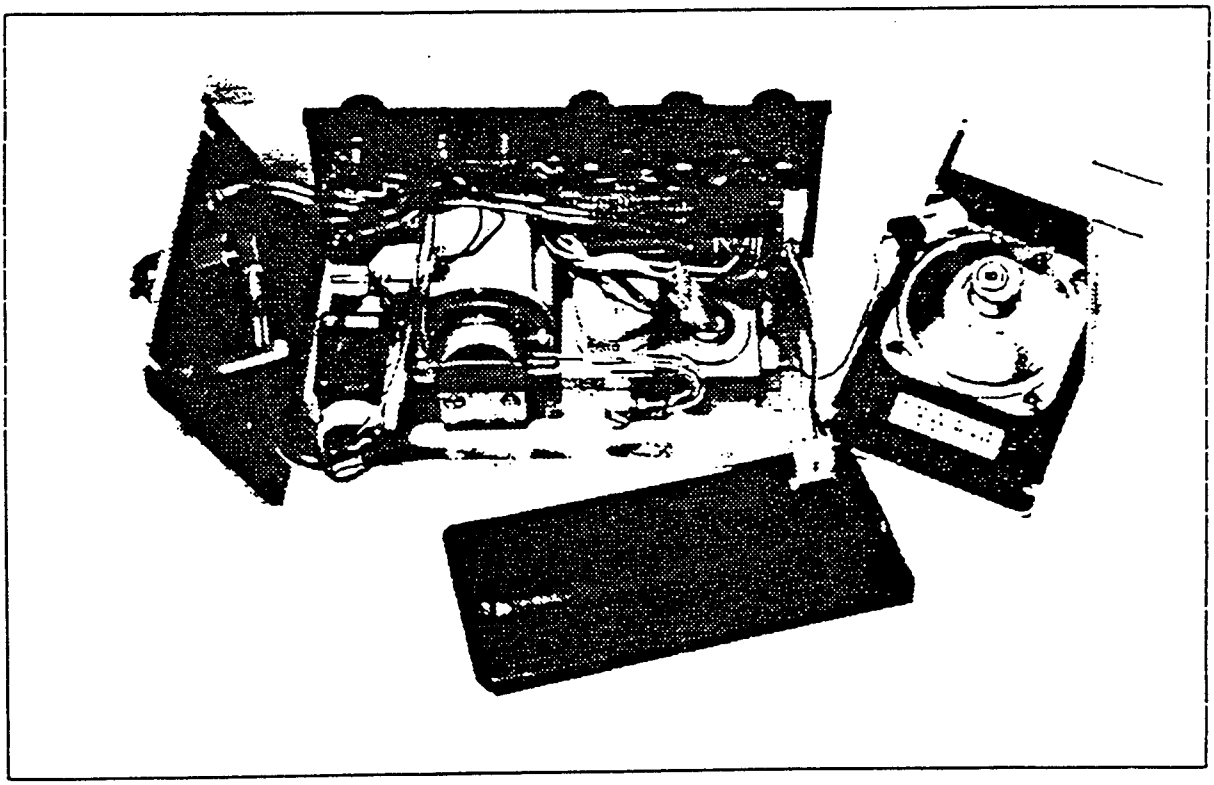


Figure 10. Disassembly Photo

PRINTED CIRCUIT BOARD ADJUSTMENT

The printed circuit board contains seven adjustment pots (Figure 9):

Toxic Gas Adjustments

TOX

ALARM: Model 360 -- The Carbon Monoxide Gas Alarm Point Adjustment (factory-set at 50 ppm)

Model 361 -- The Hydrogen Sulfide Gas Alarm Point Adjustment (factory-set at 10 ppm)

TOX

SPAN: After zeroing, the TOX SPAN is adjusted by sampling calibration gas and adjusting the readout accordingly

Combustible Gas Adjustments

LEL

ALARM: The Combustible Gas Alarm Point Adjustment (factory-set at 25% LEL; maximum setting is 60% LEL)

LEL

SPAN: After zeroing, the Span is adjusted by sampling calibration check gas and adjusting the readout accordingly

Oxygen Adjustments

O_2

HIGH: The Oxygen High Alarm Point adjustment (factory-set at 23%)

O_2

LOW: The Oxygen Low Alarm Point Adjustment (factory-set at 19.5% oxygen)

O_2

OFFSET: The Oxygen Offset controls the zero reading of the oxygen meter. The leads to the oxygen cell must be disconnected and shorted together, and the front panel OXY CALIBRATE knob turned fully clockwise. The % oxygen meter should indicate zero; adjust the O_2 OFFSET, if necessary.

TROUBLESHOOTING GUIDELINES

Difficulties with the Model 360 or 361 can be localized by sis-assembling instrument and performing the following tests (Figure 10):

1. Disconnect any accessories attached to the side of the instrument case.

2. Loosen knurled screws holding the handle and remove handle.

3. Remove both sides of case by removing the two sets of four screws. Remove instrument lid and set aside. Slowly draw the sides away from the case as far as the connecting wires allow.

4. Disconnect molded nylon plugs from the battery and speaker.

5. Slide the battery out of the case.

6. All of the remaining components and wiring are bolted to the top panel of the case; this panel can be removed as a unit by simply sliding the assembly from the extruded sides of case.

7. For troubleshooting purposes, the battery (and speaker, if desired) can be reconnected after the instrument is removed from the case.

CELL BIAS SWITCH

Set the DIP switch on the main circuit board assembly according to Table 3-1.

Table 3-1. Setting the DIP Switch

Instrument	DIP Switch on Main Circuit Board					
Model	1	2	3	4	5	6
360	Off	Off	On	Off	Off	On
361	On	On	On	Off	Off	On

FLOW SYSTEM

A leak in the flow system is indicated if the flow indicator does not drop when the inlet is blocked. If a leak is indicated, remove the inlet filter cap and filter element and place a finger over the filter chamber opening. If the float then drops, the O-rings in the inlet cap or on the filter element should be replaced.

If the flow indicator does not drop when the filter chamber opening is blocked, inspect the condition of the pump assembly, tubing, barbed hose fitting (and it's O-ring) and the flow indicator.

A blockage in the flow system is indicated when the float does not rise in the panel indicator. Remove any sampling line and, if this does not allow the flow to resume, examine the sample inlet filter for blockage or dirt. Clean or replace the filter element if necessary. If the flow is not restored by either of these procedures, the pump assembly should be inspected and/or replaced.

PUMP ASSEMBLY REPLACEMENT

The pump and motor are capable of 1000 hours of sampling. After this time period has lapsed, the motor may fail to start or may run erratically. The pump assembly should be replaced if the panel-mounted flow indicator indicates no flow when the instrument is turned on and the BATT check does not show in the display. Replace pump assembly by performing the following procedure:

1. Unsolder the leads from the motor.

2. Remove the two screws from the back of the chassis.

3. Withdraw the pump assembly and remove the plastic tubing.

4. Connect the plastic tubing to the new pump.

5. Attach the new pump assembly to the chassis with the two screws.

6. Solder the pump power leads to the motor terminals.

   a. Solder the yellow wire to the positive (+) terminal of the motor.

   b. Solder the green and orange wires to the negative (-) terminal of the motor.

7. Check for leaks in the flow system (NOTE: See Step 7 of Operating Instructions, Section 1 - OPERATION).

8. Reassemble the instrument.

TOXIC CELL REPLACEMENT

The toxic cell should perform for approximately 1 year without maintenance. Eventually however, it will lose sensitivity and will not span correctly.

At this time, the cell should be replaced by performing the following procedure:

1. Remove the toxic cell and manifold from chassis by removing the two screws from the back of the chassis.

2. Disconnect the mating electrical connector.

3. Unscrew the toxic cell from the manifold. Make sure that the sintered metal disc remains in place in the manifold.

WARNING

Handle the sensor carefully; it is a sealed unit which contains an acid electrolyte. If electrolyte is leaking from the sensor, exercise caution so that the electrolyte does not contact skin, eyes or clothing, thus avoiding acid burns. If contact occurs, rinse the area immediately with a large quantity of water. In case of contact with eyes, immediately flush eyes with plenty of clean water for at least 15 minutes and call a physician.

4. Open the protective bag containing the toxic sensor and install the O-ring into the threaded end of the sensor.

5. Firmly screw the sensor into the manifold by hand so as to compress the O-ring and thereby prevent sample flow leakage.

6. Reinstall the flow block onto the chassis and connect the mating electrical connector.

7. Check for leaks in the flow system. (NOTE: See Step 7 of Operating Instructions, Section 1 - OPERATION.)

8. Reassemble the instrument.

9. Check calibration (NOTE: See Section 4, CALIBRATION).

COMBUSTIBLE GAS SENSOR REPLACEMENT

Before each day's use, check the combustible gas indicating portion of the Model 360 or 361 for operating accuracy with a known gas-air mixture and adjust as necessary. (NOTE: See Section 5, PARTS LIST for available MSA calibration equipment.) If proper calibration cannot be obtained and/or the combustible gas readout cannot be zeroed, the sensor diffusion head should be

replaced and the instrument recalibrated by performing the following procedure:

1. Unplug the nylon connector from the sensing head.

2. Unscrew the retaining ring holding the diffusion head to the manifold by turning the retaining ring counterclockwise. Remove the diffusion head and O-ring.

3. Position the replacement diffusion head and a new O-ring (supplied with the replacement diffusion head) in the manifold.

4. Install the diffusion head in the manifold with the retaining ring. Use enough finger pressure on the retaining ring to compress the O-ring.

5. Connect the nylon sensing head plug.

6. Check for leaks in the flow system (NOTE: See step 7 of Operating Instructions in Section 1, OPERATION).

7. Reassemble the instrument.

8. Check calibration (See Section 4, CALIBRATION).

OXYGEN CELL REPLACEMENT

The oxygen cell should perform for approximately 1 year without maintenance. Eventually, however, it will lose sensitivity. When it does, the readout can no longer be set to 20.8% with the OXY CALIBRATE knob when sampling fresh air. At this time, the cell should be replaced by performing the following procedure:

1. Disconnect the gray [positive (+)] and the yellow [negative (-)] leads from the oxygen cell.

2. Turn the oxygen cell counterclockwise to remove it and its O-ring from the manifold.

3. Open the protective bag containing the oxygen cell and install the O-ring onto the threaded end of the cell.

4. Firmly screw the cell into the manifold by hand in order to compress the O-ring and thereby prevent sample flow leakage.

5. Connect the gray lead to the positive terminal and the yellow lead to the negative terminal.

6. Check for leaks in the flow system (See Step 7 of Operating Instructions in Section 1, OPERATION).

7. Reassemble the instrument.

8. Check calibration (NOTE: See Section 4, CALIBRATION).

ORDERING REPLACEMENT PARTS

The Section 5, PARTS LIST itemizes common replacement assemblies and components associated with the MSA Model 360 or 361 Toxic Gas, Combustible Gas, and Oxygen Alarm. To obtain a replacement part, specify the description and MSA part number of each item and address the order or inquiry to your nearest MSA branch district office by calling toll-free 1-800-MSA-2222 or to:

Mine Safety Appliances Company
Portable Instruments Sales Department
P.O. Box 426
Pittsburgh, PA 15230

If service other than that outlined is necessary, the Model 360 or 361 should be returned to your nearest MSA branch district office or to:

Mine Safety Appliances Company
Repair Department
Walden Road
Mars, PA 16046

WARNING

Use only genuine MSA replacement parts when performing any maintenance procedures provided in this manual. Failure to do so may seriously impair instrument performance. Repair or alteration of the Model 360 or Model 361 Alarm, beyond the scope of these maintenance instructions or by anyone other than a certified MSA serviceman, could cause the product to fail to perform as designed and persons who rely on this product for their safety could sustain severe bodily injury or death.

SECTION 4
CALIBRATION

Before calibration of the Model 360 or Model 361 can be checked, the instrument must be in operating condition (NOTE: See Operating Instructions in Section 1, OPERATION). Optional calibration equipment is shown in Figure 11. Calibration check adjustment is made as follows:

MODEL 360 CALIBRATION (USING THE MODEL R CALIBRATION CHECK KIT)

1. Attach the flow control to the 0.75% pentane/15% oxygen calibration gas tank.

2. Connect the adapter-hose to the flow control.

3. Open the flow control valve.

4. Connect the adapter-hose fitting to the inlet of the instrument; within 30 seconds, the LEL readout should stabilize and indicate between 47 and 55%. If the indication is not in the correct range, remove the right end of the indicator and adjust the LEL SPAN control to obtain 50%.

5. Verify the oxygen reading; it should be between 13 and 17%.

6. Disconnect the adapter-hose fitting from the instrument.

7. Close the flow control valve.

8. Remove the flow control from the calibration gas tank.

9. Attach the flow control to the 300 ppm carbon monoxide calibration gas tank.

10. Open the flow control valve.

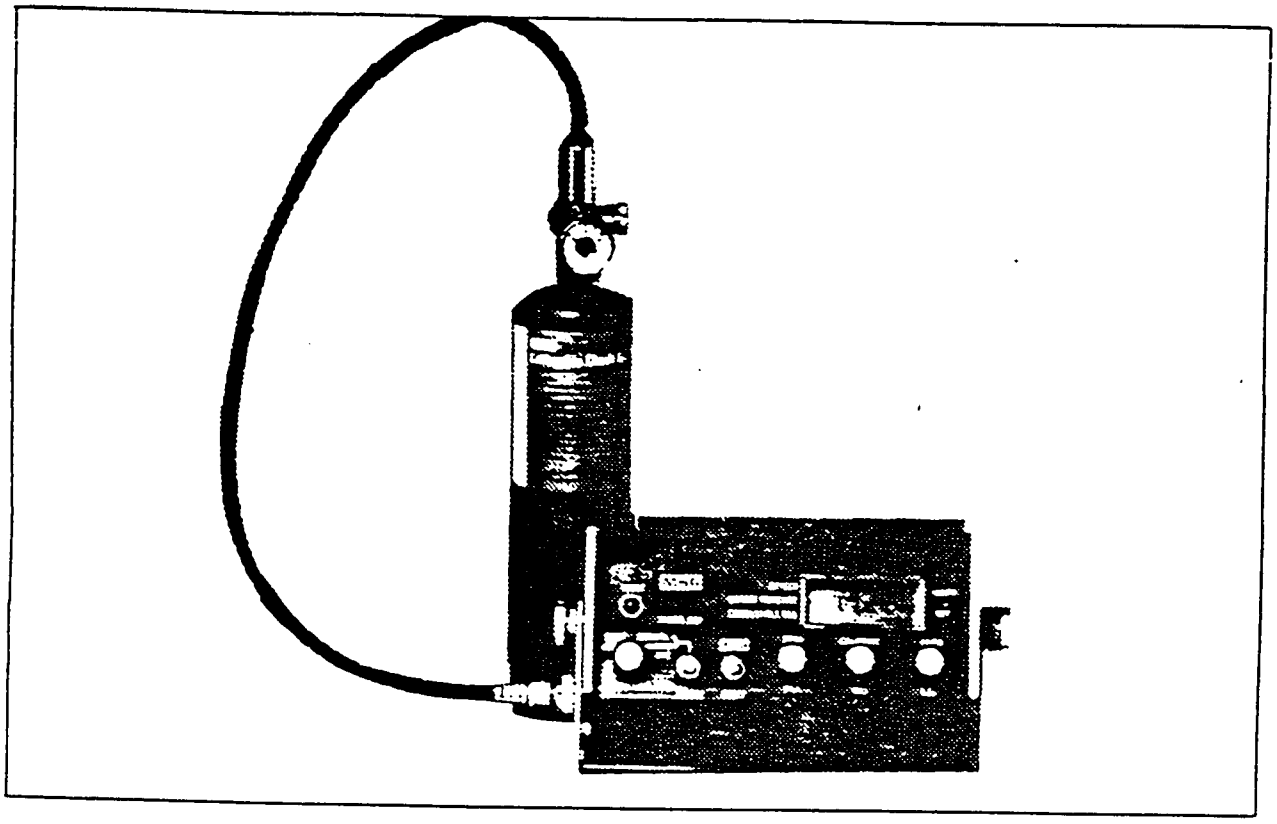


Figure 11. Model 360 or 361 with Calibration Equipment

11. Connect the adapter-hose fitting to the inlet of the instrument; after approximately 2 minutes, the TOX readout should stabilize and indicate between 275 and 325 ppm. If the indication is not in the correct range, remove the right end of the indicator and adjust the TOX SPAN control to obtain 300ppm.

12. Disconnect the adapter-hose fitting from the instrument.

13. Close the flow control valve.

14. Remove the adapter-hose from the flow control.

15. Remove the flow control from the calibration gas tank.

MODEL 361 CALIBRATION
(USING MODEL RP CALIBRATION CHECK KIT, FIGURE 11)

1. Attach the flow control to the .75% pentane/15% oxygen calibration gas tank.

2. Connect the adapter-hose to the flow control.

3. Open the flow control valve.

4. Connect the adapter-hose fitting to the inlet of the instrument; within 30 seconds, the LEL meter should stabilize and indicate between 47 and 55%. If the indication is not in the correct range, remove the right end of the indicator and adjust the LEL SPAN control to obtain 50%

5. Verify the oxygen reading; it should be between 13 and 17%.

6. Disconnect the adapter-hose fitting from the instrument.

7. Close the flow control valve.

8. Remove the flow control from the calibration gas tank.

9. Attach the flow control to the 10 ppm hydrogen sulfide calibration gas tank (40 ppm gas may be used; the choice of H_2S calibration gas will depend upon concentrations anticipated in the workplace).

10. Open the flow control valve.

11. Connect the adapter-hose fitting to the inlet of the instrument; after approximately 1 minute, the TOX readout should stabilize and indicate between 7 to 13 ppm (35 to 45 ppm for 40 ppm H_2S). If the indication is not in the correct range, remove the right end of the indicator and adjust the TOX SPAN control to obtain 10 ppm (40 ppm for 40 ppm H_2S).

12. Disconnect the adapter-hose fitting from the instrument.

13. Close the flow control valve.

14. Remove the adapter-hose from the flow control.

15. Remove the flow control from the calibration gas tank.

CAUTION

Calibration gas tank contents are under pressure. Do not use oil, grease or flammable solvents on the flow control or the calibration gas tank. Do not store calibration gas tank near heat or fire, nor in rooms used for habitation. Do not throw in fire, incinerate or puncture. Keep out of the reach of children. It is illegal and hazardous to refill this tank. Do not attach any gas tank other than MSA calibration tanks to the flow control.

SECTION 5

PARTS LIST

Component/Assembly	Part No.
Model 360 Carbon Monoxide, Combustible Gas and Oxygen Alarm	476151
Model 361 Hydrogen Sulfide, Combustible Gas and Oxygen Alarm	476152
5-Foot Synthetic Rubber Sampling Line w/Couplings	11354
10-Foot Synthetic Rubber Sampling Line w/Couplings	11955
15-Foot Synthetic Rubber Sampling Line w/Couplings	11912
25-Foot Synthetic Rubber Sampling Line w/Couplings	11913
50-Foot Synthetic Rubber Sampling Line w/Couplings	11958
3-Foot Hollow Brass Probe Tube	11961
3-Foot Plastic Probe Tube	73743
4-Foot Solid Brass Probe Rod	11960
Line Trap Assembly	74814
Oxygen Sensor	457621
Pump Assembly	476086
Carrying Harness	457754
Diffusion Head, with O-ring	449917
O-Ring (for Diffusion Head)	67283
Carbon Monoxide Sensor for Model 360, with O-Ring	472077
Hydrogen Sulfide Sensor for Model 361, with O-Ring	478840
O-Ring (for Toxic Sensors)	62740
Disc (Porous)	472301
Battery Pack	476144
Battery Charger, 120 Volt	631664
Battery Charger, 240 Volt	631712
Sample Inlet Filter Element Replacement Kit	469995
Inlet Seal (O-ring)	632152
Printed Circuit Board	476750

PARTS LIST (CONT.)

Component/Assembly	Part No.
MODEL 360 Calibration	
(Using Model R Calibration Check Kit)	
Flow Control, 1.5 L/m	459948
Gas Cylinder, 0.75% Pentane/15% oxygen	476304
Gas Cylinder, 300 ppm Carbon Monoxide	461769
Adapter-Hose	449401
MODEL 361 Calibration	
(Using Model RP Calibration Check Kit)	
Flow Control, 1.5 L/m	467896
Gas Cylinder, 0.75% Pentane/15% Oxygen	478192
Gas Cylinder, 40 ppm Hydrogen Sulfide	467897
Gas Cylinder, 10 ppm Hydrogen Sulfide	467898
Adapter-Hose	449401
Instruction Manual, Model 360/361	476473

SECTION 6
RESPONSE INFORMATION

Table 6-1. Model 360 CO Response to Interferants

INTERFERANT	INTERFERANT CONCENTRATION (PPM)	SENSOR RESPONSE (PPM)
Ammonia	100	-4
Benzene	17.7	0
Carbon Dioxide	5000	-4
Carbon Disulfide	14.5	2
Carbon Monoxide	100	100
Chlorine	5	0
Dimethyl Sulfide	4.5	2
Ethylene	50	100
Freon 12	1000	-2
Hexane	500	-2
Hydrogen	500	70
Hydrogen Cyanide	42	30
Hydrogen Sulfide	40	170
Isopropanol	50	40
Mercaptan		
Ethyl	4.4	6
Methyl	5	7
Methane	50,000	-3
Methanol	50	130
Nitric Oxide	100	260
Nitrogen Dioxide	100	80
Sulfur Dioxide	150	30

Table 6-2. Model 361 H_2S Response to Interferants

INTERFERANT	INTERFERANT CONCENTRATION (PPM)	SENSOR RESPONSE (PPM)
Ammonia	100	0
Benzene	17.7	0
Carbon Dioxide	5000	0
Carbon Disulfide	14.5	0
Carbon Monoxide	100	0
Chlorine	5	0
Dimethyl Sulfide	4.5	0
Ethylene	50	0
Freon 12	1000	0
Hexane	500	0
Hydrogen	500	1
Hydrogen Cyanide	42	0
Hydrogen Sulfide	40	40
Isopropanol	50	0
Mercaptan		
Ethyl	44	3
Methyl	5	5
Methane	50,000	0
Methanol	50	0
Nitric Oxide	100	2
Nitrogen Dioxide	100	-8
Sulfur Dioxide	150	5

SECTION 7

CONVERSION FACTORS

CHEMICAL	CONVERSION FACTOR
Acetone	1.0
Acetylene	0.8
Benzene	1.1
Iso-Butane	1.0
n-Butane	1.0
Butadiene	0.8
Butene-1	1.0
Carbon Monoxide	0.6
Ethane	0.7
Ethyl Acetate	1.1
Ethyl Alcohol	1.0
Ethylene	0.8
Ethylene Oxide	0.9
Ethyl Ether	1.1
Gasoline	1.0
Heptane	1.1
Hexane	1.3
Hydrogen	0.6
Methane	0.6
Methyl Alcohol	0.7
Methyl Ethyl Ketone	1.6
Pentane	1.0
Propane	0.9
Propylene	1.0
Propylene Oxide	1.0
Iso Propyl Alcohol	1.1
Tetrahydrofuran	0.8
Toluene	1.2

EXAMPLE:
When a Model 360 or Model 361, calibrated on Pentane, is used to test for propane, the conversion factor is 0.9. If the meter reads 50% LEL, the true propane concentration is:

(50% x 0.9) OR 45% LEL

The curves presented in this manual are typical of a Model 360 or Model 361 calibrated on Pentane. The response of a particular Model 360 or Model 361 may be higher or lower than the stated response. For this reason an accuracy tolerance of $\pm$25% should be applied in the interpretation of any meter response.

Instruction Manual

Model MAC-51B
Magnetic and Cable Locator

Manufactured By
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Important Notice

Schonstedt believes the statements contained herein to be accurate and reliable. But their accuracy, reliability, or completeness is not guaranteed.

Schonstedt's only obligation shall be to repair or replace any instrument proved to be defective within one year of purchase. Schonstedt shall not be responsible for any injury to persons or property, direct or consequential, arising from the use of any instrument.

Section I
General

Introduction

The MAC-51B Magnetic and Cable Locator is a light-weight, dual-mode instrument designed for detecting buried iron and steel objects and tracing underground cables and pipes. The system consists of two major units: a transmitter and a dual-function receiver. Both units use alkaline C-cell batteries that provide up to 100 hours of operation.

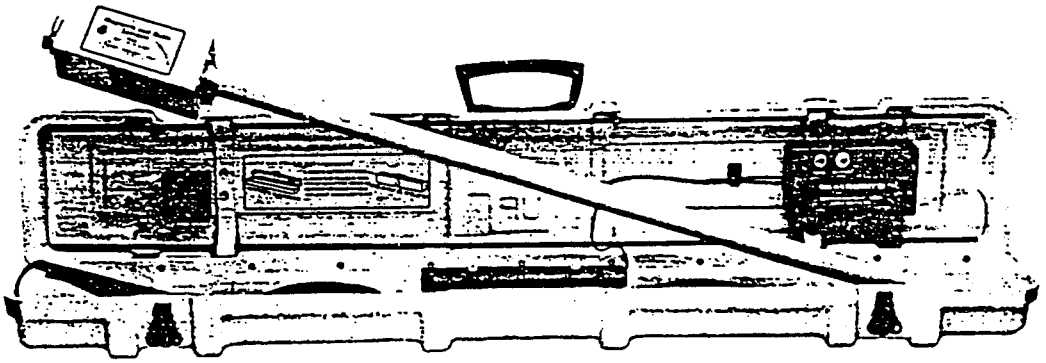


Figure 1-1. MAC-51B Magnetic and Cable Locator

Cable Locator Mode

When used in the cable locator mode, the transmitter generates a distinctive ac signal which is applied to the cable or pipe. The receiver is used to detect and trace the signal as it travels along the cable/pipe. A siren-like tone from the receiver is easily identified as the tracing signal. The approximate depth of an underground cable can be determined using the 45° null-point triangulation method. Operation of the MAC-51B in the cable locator mode is explained in Sections IV and V.

Magnetic Locator Mode

The receiver is the only unit required for operation in the magnetic mode. Set the receiver M/C function switch to "M", adjust the sensitivity control, and you have the best magnetic locator available. Operation of the magnetic locator mode is explained in Sections II and III.

Switching from cable locator mode to magnetic locator mode while tracing a cable is a unique method for unscrambling ground clutter. Gas and water pipes in the immediate vicinity of a cable can emit parasitic signals that distort the identification null. In the magnetic mode cast-iron water pipes and gas lines can be identified quickly and even classified as to type by the conventional spacing of joints, which provide the strongest signals.

Standard Accessories

Basic accessories supplied with the MAC-51B include a headphone jack, a spare batteries holder and a conductive cable assembly with ground stake. An inductive signal clamp, mini transmitter and headphones are available as options.

Optional Inductive Signal Clamp

This option increases the versatility of the MAC-51B by providing a convenient method of selectively applying the trace signal to cables or conductors covered with nonmetallic insulation.

It applies a strong trace signal to only the conductor that it is clamped around. This positive identification allows a specific cable to be traced even when located in congested areas containing cables, water and gas lines or other conductors that may emit lower level parasitic trace signals.

Operation is simple and easy. Plug the clamp lead into the transmitter accessory jack and close the clamp around the cable. No ground connection is required. Hook-up can be made to all standard metallic cable types up to three inches in diameter.

Optional Mini Transmitter

The Model MT-1 is a miniature solid-state transmitter (3 in. × 1 in.) used in combination with a MAC-51B receiver to trace nonmetallic pipes, pinpoint obstructions, and locate concrete septic tanks.

As the MT-1 (Mole) is pushed through a buried nonmetallic pipe, it emits a signal that can be detected at depths up to 18 feet by using the MAC-51B receiver.

The Mole has a concave surface so it can be taped to a plumber's snake, and a ¼-inch tapped hole for end mounting.

One AAA penlight alkaline battery provides up to 30 hours of operation. The battery cap also serves as the On/Off switch. Power is turned off by rotating the battery cap counterclockwise until the battery moves when the MT-1 is shaken.

MAC-51B SPECIFICATIONS

TRANSMITTER

Operating Voltage	12 Volts (eight alkaline C-Cell batteries)
Battery Life	75 hours intermittent operation at 70°F
Output Frequency	82.5 kHz modulated at 382 Hz, pulsed at 4.8 Hz (inductive or conductive)
Audio Indicator	2.58 kHz pulsed at 4.8 Hz
Weight	Approximately 5.5 lb. (2.5 kg.)
Operating Temperature	−13°F to 140°F (−25°C to 60°C)
Overall Size	43.5 in. × 7 in. × 5 in. (110.5 cm. × 17.8 cm. × 12.7 cm.)

RECEIVER

Operating Voltage	6 Volts (4 alkaline C-Cell batteries)
Battery Life	100 hours intermittent operation at 70°F
Output Frequency	Approximately 40 Hz idling tone from speaker. Frequency of pulsing tone increases (or decreases) with signal intensity.
Weight	Approximately 3 lb. (1.36 kg.)
Operating Temperature	−13°F to 140°F (−25°C to 60°C)
Overall Length	42.3 in. (107.4 cm.)
Waterproof Length	34.5 in. (87.6 cm.)
Nominal Sensor Spacing	20 in. (50.8 cm.)

(Specifications subject to change without notice)

Section II
Magnetic Locator Operation

Theory of Operation

In the magnetic locator mode, the MAC-51B receiver responds when the magnetic field strength at the two sensors, which are 20 inches apart, is different. This response consists of a change in the idling frequency of the signal emitted from the speaker.

Figure 2-1 illustrates an application of the locator in which it is used to detect an iron marker of the type used for property line identification. The magnetic field of the marker is stronger at sensor A than it is at sensor B. As a result, the frequency of the signal on the speaker is higher than the 40 Hz idling frequency which exists when the field strength is the same at both sensors.

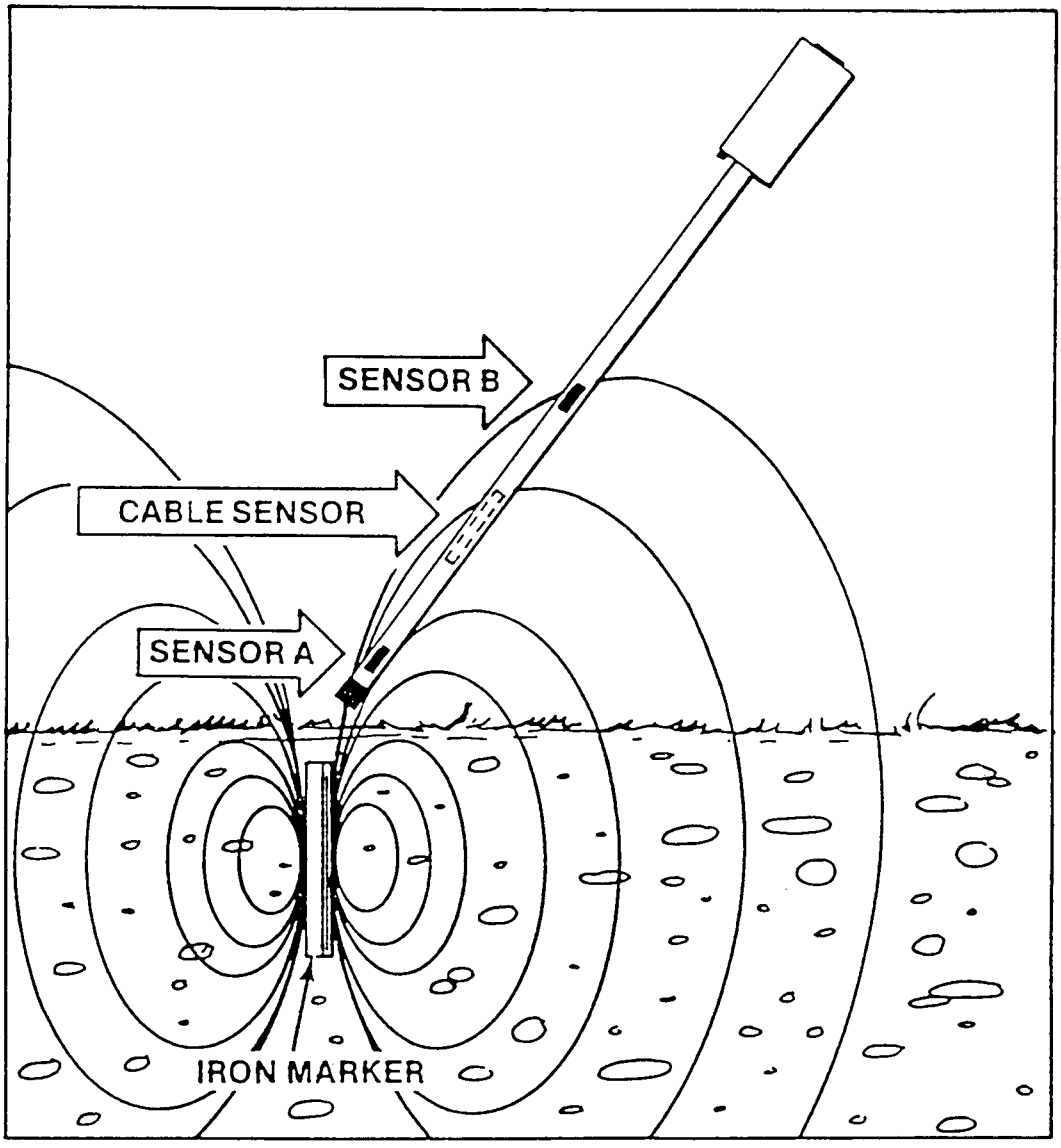


Figure 2-1. Detecting Magnetic Field of an Iron Marker

Function Selection, Turn-On and Initial Sensitivity Setting

Set the M/C Function switch to M and adjust the ON/OFF-Sensitivity control for mid-position as shown in Figure 2-2. With the knob in this position, the sensitivity is set for what is referred to as the Normal Range.

In most areas the locator can be oriented in any direction without producing a significant change in the frequency of the tone from its idling rate. However, in some areas where magnetic disturbances are encountered from nearby structures, rocks, sand or trash, the control should be adjusted for lower sensitivity as illustrated in Figure 2-3.

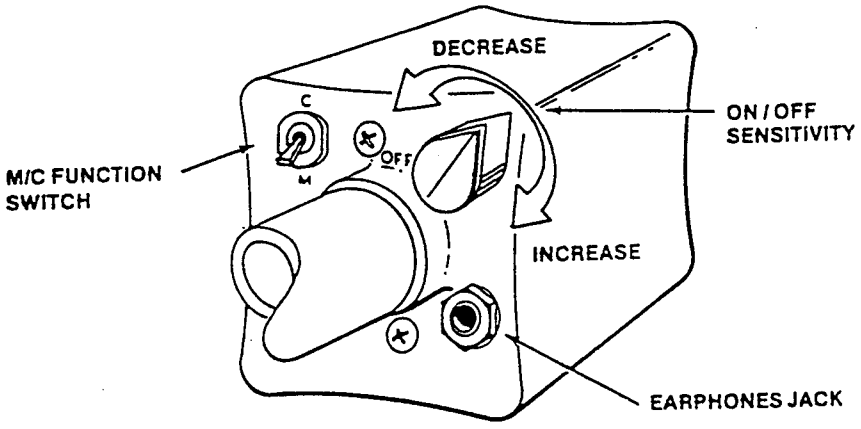


Figure 2-2. Sensitivity Set for Normal Range

Low Sensitivity Operation

Unwanted background signals due to nearby magnetic objects may require that the effective range of the locator be reduced. This is accomplished by turning the sensitivity knob in a counter-clockwise direction. Reduced range is useful for pinpointing the location of a strongly magnetized marker.

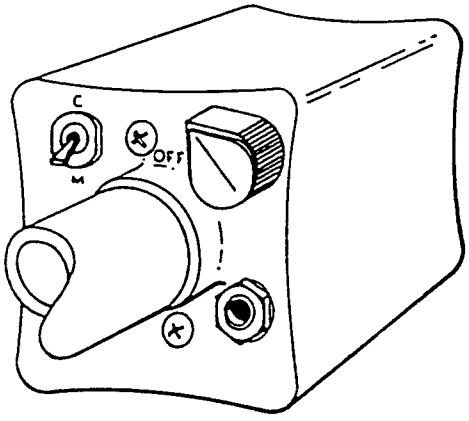


Figure 2-3. Sensitivity Set for Low Range

High Sensitivity Operation

The sensitivity of the locator is increased by turning the sensitivity knob in a clockwise direction. A high sensitivity setting imposes some constraints on operating methods. The locator tone will vary in frequency depending on the instrument's orientation relative to the Earth's magnetic field.

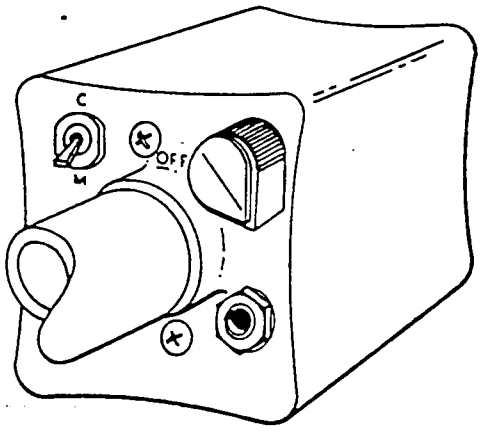


Figure 2-4. Sensitivity Set for High Range

Search Procedure

Set the sensitivity control for normal operation and hold the locator just below the large end as illustrated in Figure 2-5. Because the upper sensor is located near the area where the locator is usually held, wrist watches may produce unwanted changes in the signal frequency. Therefore, a watch worn on the the wrist of the hand holding the locator should be removed. Avoid bringing the locator close to your shoes, since they might contain magnetic material.

To obtain maximum area coverage, the locator should be swept from side-to-side with the small end of the instrument kept close to the ground. A higher frequency tone from the speaker will be heard when the locator is within range of an iron or steel object.



When using a high sensitivity setting, avoid turning the locator about its long axis. This may produce tonal variations in the output signal because of sensor misalignment.

The presence of a ferromagnetic object will be indicated by a change in the tone of the output frequency.

Figure 2-5. Searching with the Locator

Section III
Magnetic Locator Application Notes

Basic Signal Patterns

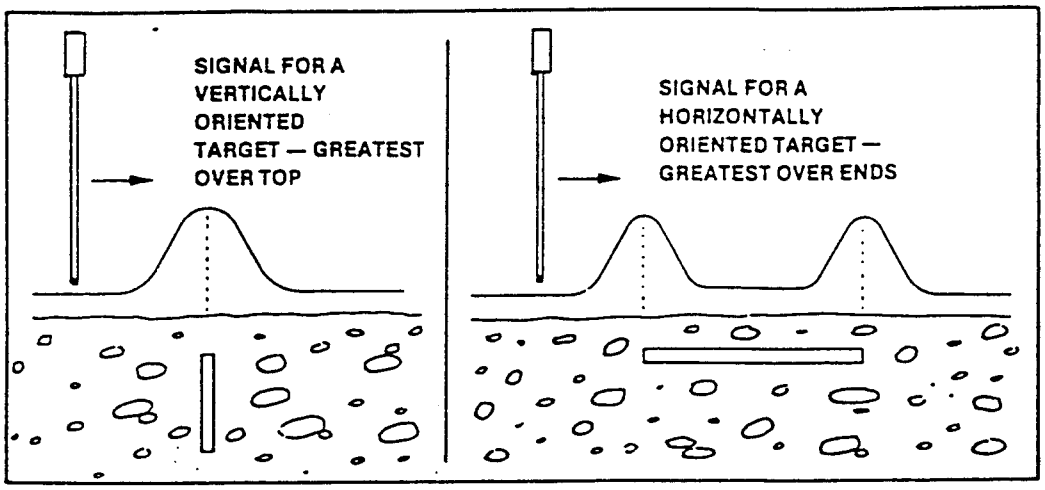


Figure 3-1. Signals from Vertical and Horizontal Targets

After you have detected the presence of a target, hold the locator vertically and move it back and forth in an "X" pattern. The peak signal occurs directly over a vertical target, and over the ends of a horizontal target.

The "X" pattern is ideal for pinpointing small objects. A 1-1/4-inch PK nail buried up to 8 inches can be located so precisely with this technique that it can be uncovered using a 1/2-inch star drill.

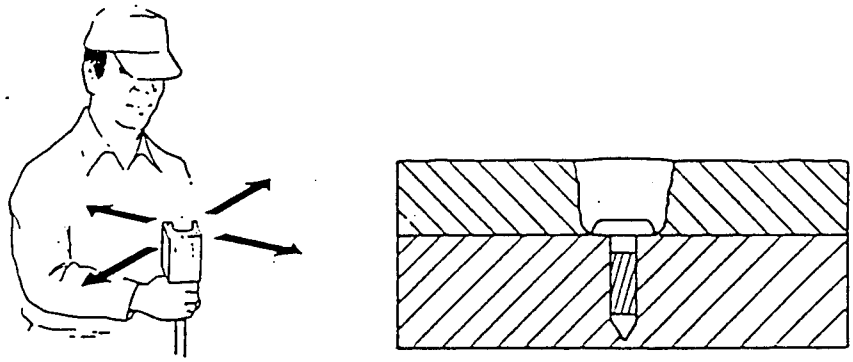


Figure 3-2. "X" Pattern Provides Precision Locating

If you find more then one signal in the vicinity of a target, just raise the locator several inches higher. Any signal that disappears when the locator is raised is probably not coming from the actual target. The signal from a rusty bolt or other small item will decrease much faster with distance than the signal from a larger target such as a corner marker. An 18-inch length of ¾-inch pipe can be located at depths up to 7 feet.

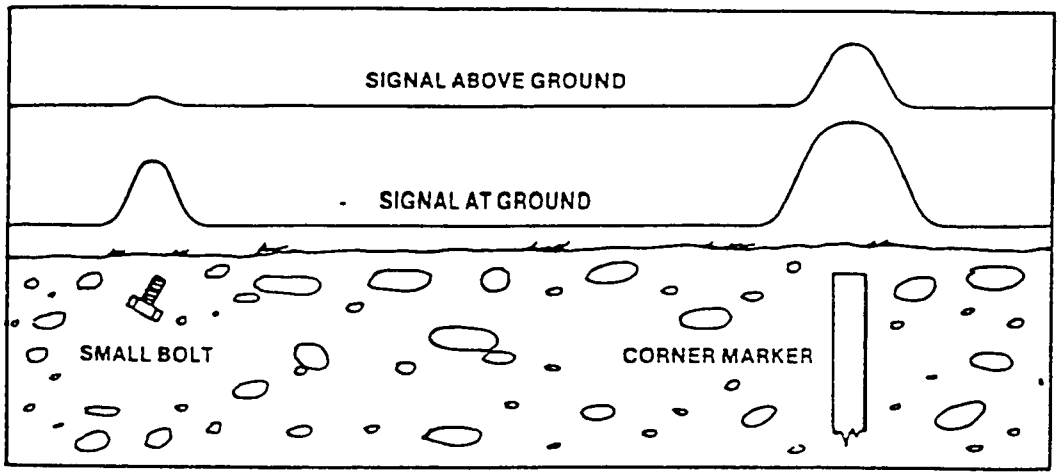


Figure 3-3. Raising the Locator Eliminates Unwanted Signals

Strongly Magnetized Markers

A strongly magnetized marker at or near the surface may provide location information that is misleading.

The heavy line in Figure 3-4 represents the variation in tone frequency when the locator is moved over the marker. When moving the instrument from A to B, the frequency of the tone increases and then suddenly decreases at B. From just beyond B the frequency of the tone increases sharply, becomes very high directly over the marker and decreases just before reaching C. From C to D the pattern is the reverse of that from A to B. It is obvious that the locator must enter the B-C region. Otherwise the marker might be assumed to be between A and B or C and D.

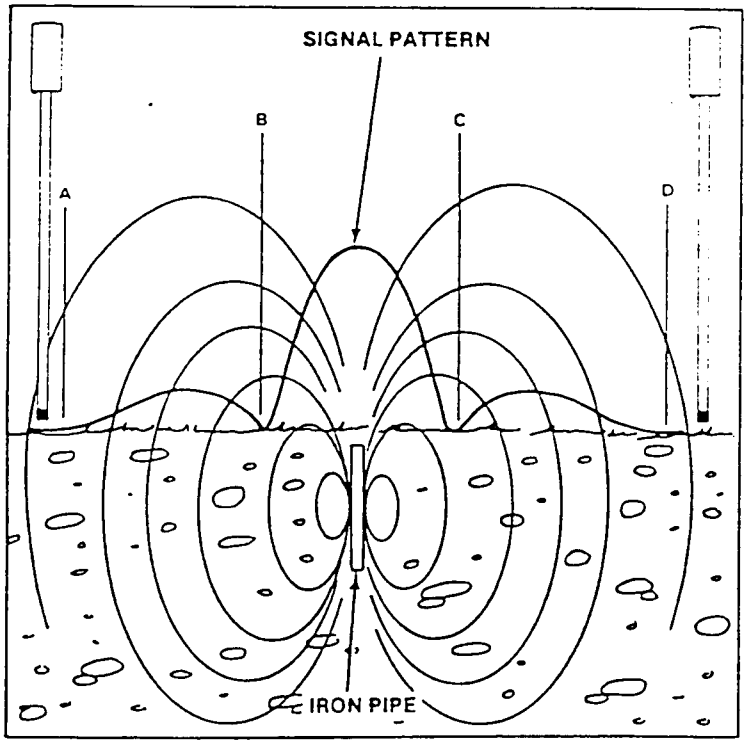


Figure 3-4. Signal Pattern From a Strongly Magnetized Marker

This phenomenon is explained by the fact that the locator is sensitive to the magnetic field components parallel to its long axis. At points B and C the field is perpendicular to the locator so no high frequency is produced at these points.

Locating Manholes, Septic Tanks and Water Wells

The magnetic field is strongest at the edge of a shallow manhole cover. Turn the sensitivity down all the way and you can easily trace the edge of covers near the surface. Locating depth ranges up to 8 feet.

The great length of a well casing provides a strong field at the surface that makes it easy to locate casings buried up to 15 feet deep.

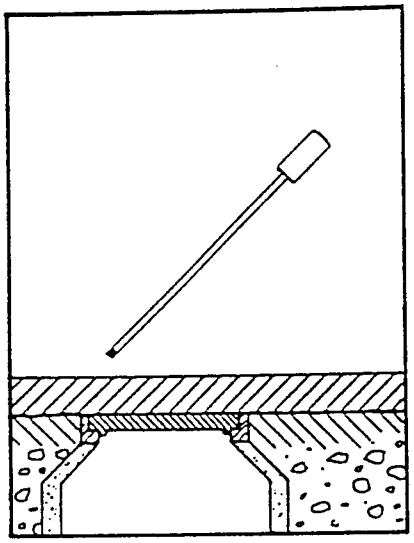


Figure 3-5. Locating Manhole Covers

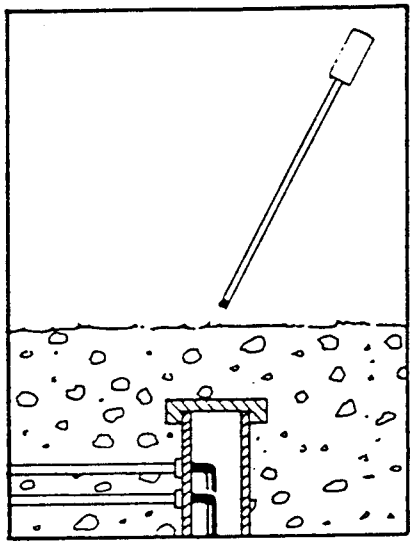


Figure 3-6. Locating Water Well Casings

The MAC-51B receiver can be used to precisely locate the metal handles or reinforcing bars on septic tank covers at depths up to 4 feet.

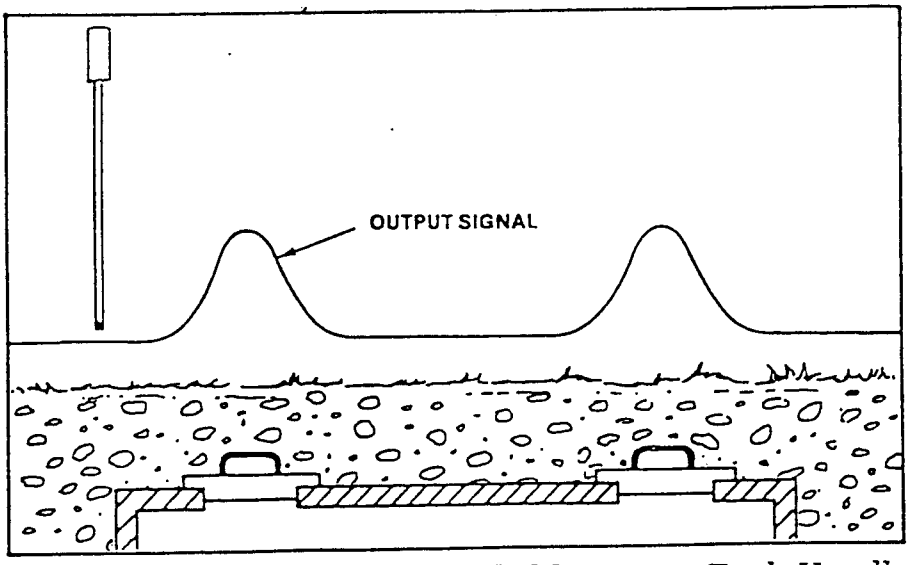


Figure 3-7. Signal Pattern Provided by Septic Tank Handles

Locating Objects under Snow or Water and Tracing Barbed Wire

The locator can be used in flooded areas—just keep the electronic unit out of the water.

Snow poses no problem. Thrust the locator into the snow as deep as necessary to locate the target.

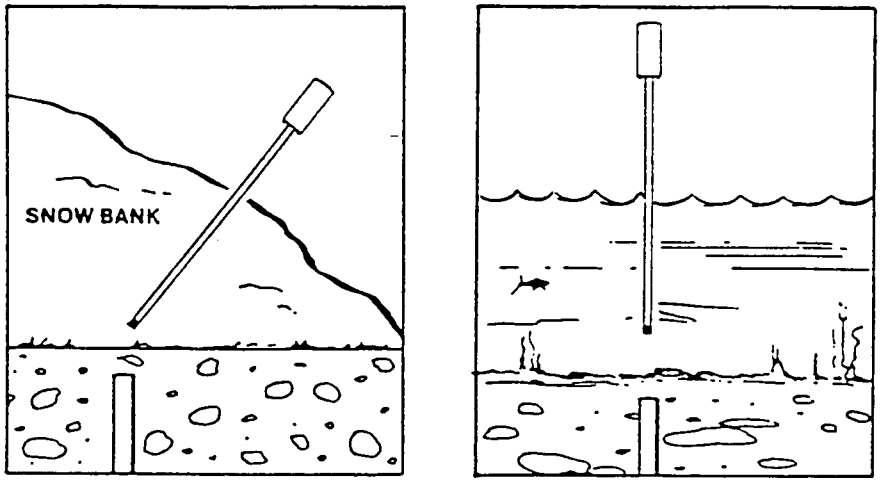


Figure 3-8. Locating Objects under Snow or Water

You can often trace barbed wire (from old fence lines) buried just beneath the surface. Even if the wire is only a trail of rust, it can still be detected near the surface. Tip the locator a little lower than usual—but not parallel with the ground.

First, examine trees for bench marks and bits of embedded barbed wire. Then hold the locator parallel with the direction of the wire.

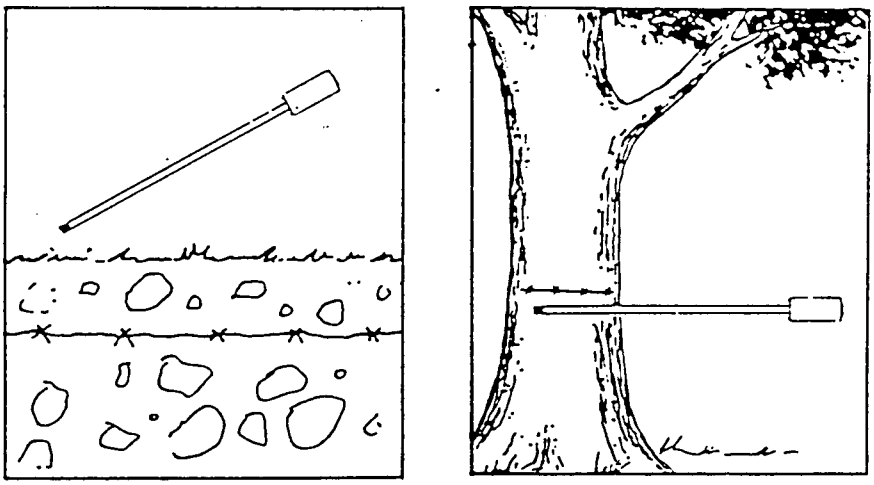


Figure 3-9. Tracing Barbed Wire from Old Fence Lines

Searching Areas Along a Chain Link Fence

Searching in the vicinity of a chain link fence requires a reduced sensitivity setting and also some control over the orientation of the locator. As illustrated in Figure 3-10, position the locator horizontally with its long axis perpendicular to the fence. This ensures that the upper sensor is kept away from the fence.

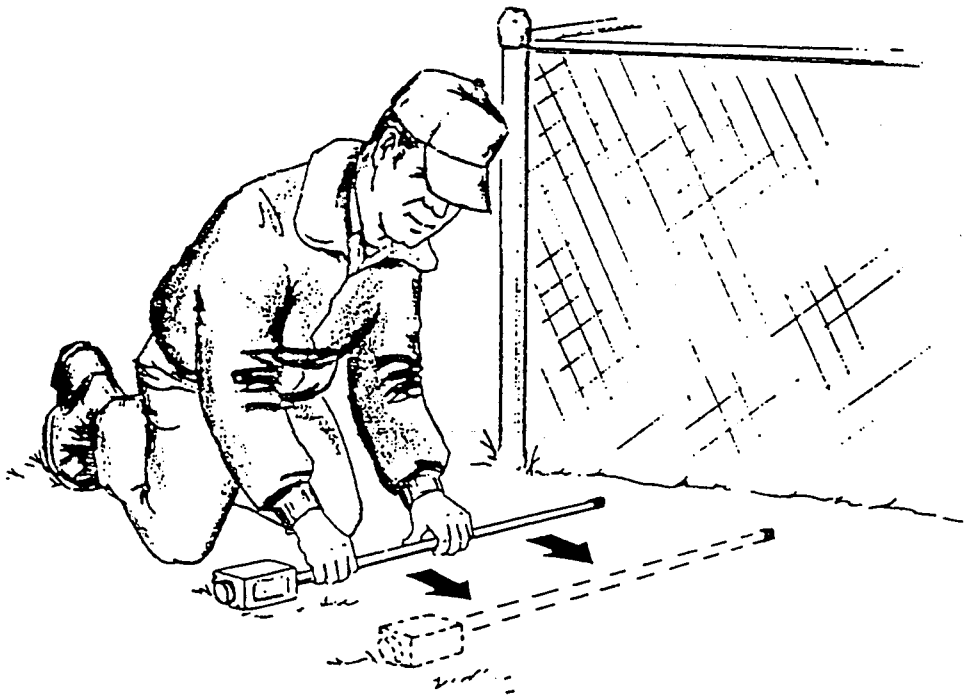


Figure 3-10. Searching in the Vicinity of a Chain Link Fence

Perform the search by moving along the fence, keeping the end a constant distance from the fence. When a point 1-5/8 inches from the end of the locator is directly over the stake, the signal will drop abruptly as shown in Figure 3-11. Any variation in the position of the locator will produce an abrupt rise in the frequency of the tone.

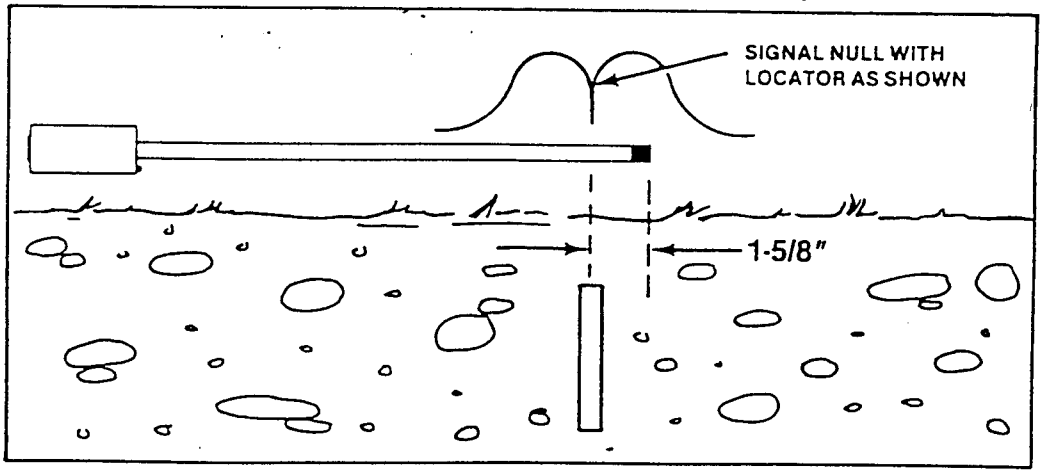


Figure 3-11. Placement of Locator While Searching Along a Chain Link Fence

Locating Valve Boxes

Both the valve and its casing, when iron, provide strong magnetic fields which make them easy to locate. Plastic enclosures containing magnets are easily located at depths of 6 feet or more.

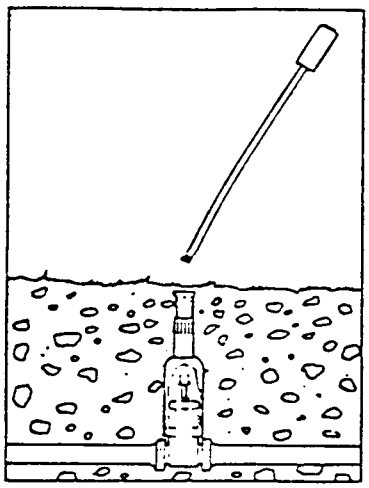


Figure 3-12. Locating Valve Boxes and Casings

Locating Cast-Iron Pipes

As illustrated in Figure 3-13, cast-iron pipes produce the strongest magnetic signals at their joints.

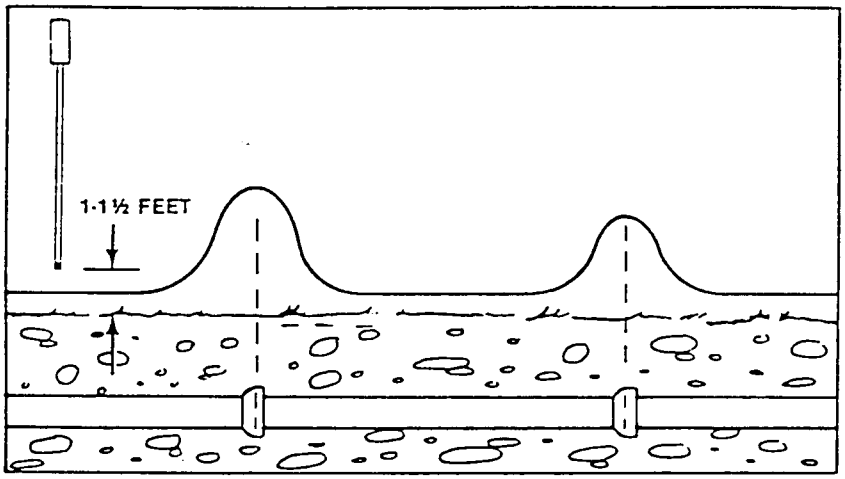


Figure 3-13. Signal Pattern Provided by Cast-Iron Pipes

The initial search should be performed as follows:

1. Adjust the sensitivity level for maximum.
2. Hold the locator vertically approximately 1 to 1-1/2 feet above the surface.
3. Walk along without turning or tilting the locator.
4. Mark the locations where the maximum signal levels occur.
5. Return to an area of maximum signal strength and hold the locator several inches above the surface. The sensitivity will probably have to be reduced during this second pass. Four-inch pipes can be located at depths up to 8 feet.

Locating Steel Drums

As shown in Figure 3-14, the MAC-51B's signal pattern will vary depending on the vertical or horizontal orientation of the drum and also how deep it is buried. A fifty-five gallon drum can be located at depths up to 8 feet.

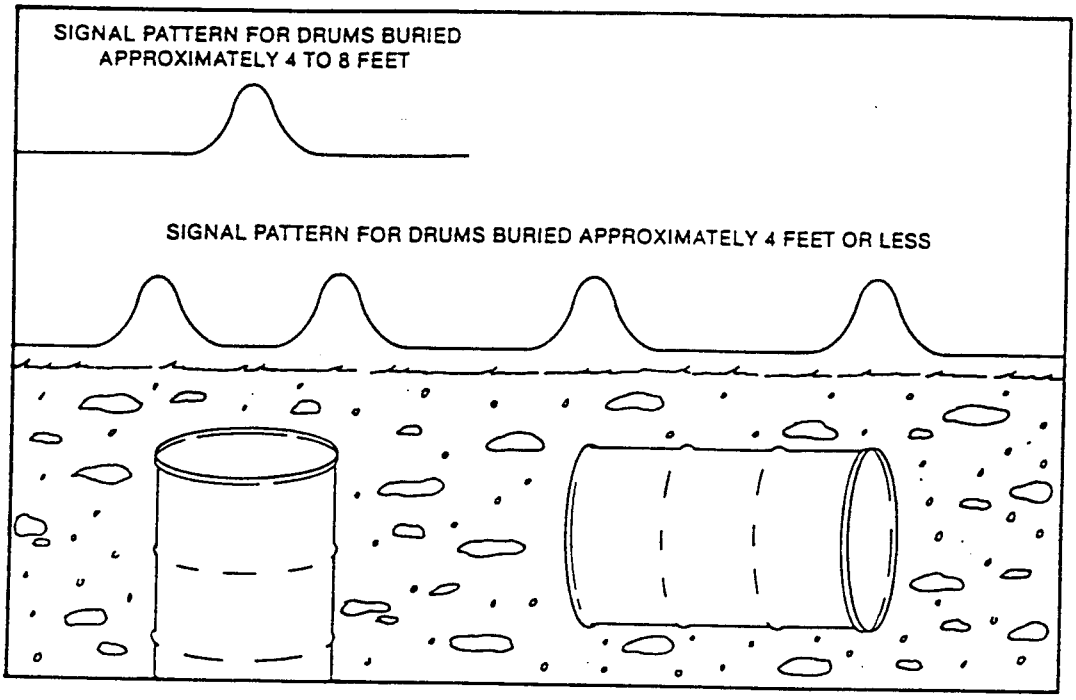


Figure 3-14. Signal Pattern Provided by Steel Drums

Additional Applications

1. The military and many local and state police departments use the MAC-51B to detect buried ordnance and discarded weapons.
2. People drilling in an area where hazardous materials might be encountered use the MAC-51B to search the area prior to drilling. Other Schonstedt gradiometers are available that can be lowered down the hole for periodic checks as drilling progresses.

Other Notes

1. A burbling sound indicates the presence of an energized power line.
2. The instrument will not detect nonmagnetic materials such as gold, silver, copper, brass and aluminum.

Section IV
Cable Locator Operation

Theory of Operation

In the cable locator mode, the receiver must be used in combination with the transmitter which is housed in the carrying case.

As illustrated in Figure 4-1, the transmitter is placed over and in line with the target cable/pipe. An alternating current induced into the cable/pipe produces a signal that is detected with the receiver. The transmitter emits a steady beeping sound to indicate that it is operating, and the receiver emits a siren-like sound that is easily identified as the induced tracing signal.

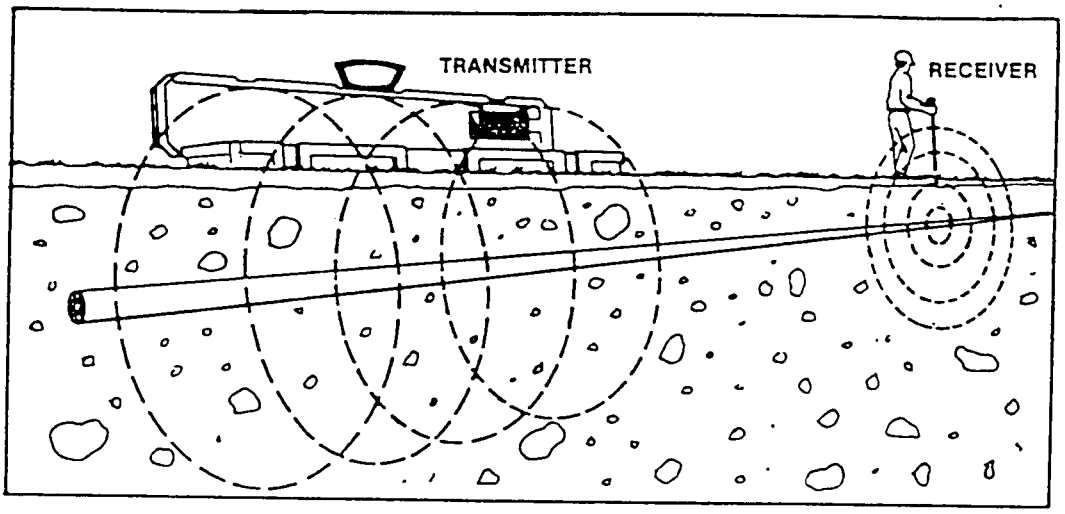


Figure 4-1. Transmitter and Receiver Placement

The tracing current generates an alternating circumferential field around the cable. This alternating field induces a signal into the receiver's sensor. As the receiver is moved back and forth across the cable in a search pattern, the pitch of the audio output from the receiver increases and decreases.

The heavy line in Figure 4-2 represents the increase and decrease in pitch of the audio signal as the receiver is moved back and forth over an energized cable. Moving from A to D causes the pitch to increase to a maximum at B and decrease to a minimum directly over the target. At C the pitch again increases and then decreases at D.

The MAC-51B can be used to trace any long conductive element such as an anode string or metalized warning tape as well as cable and pipe.

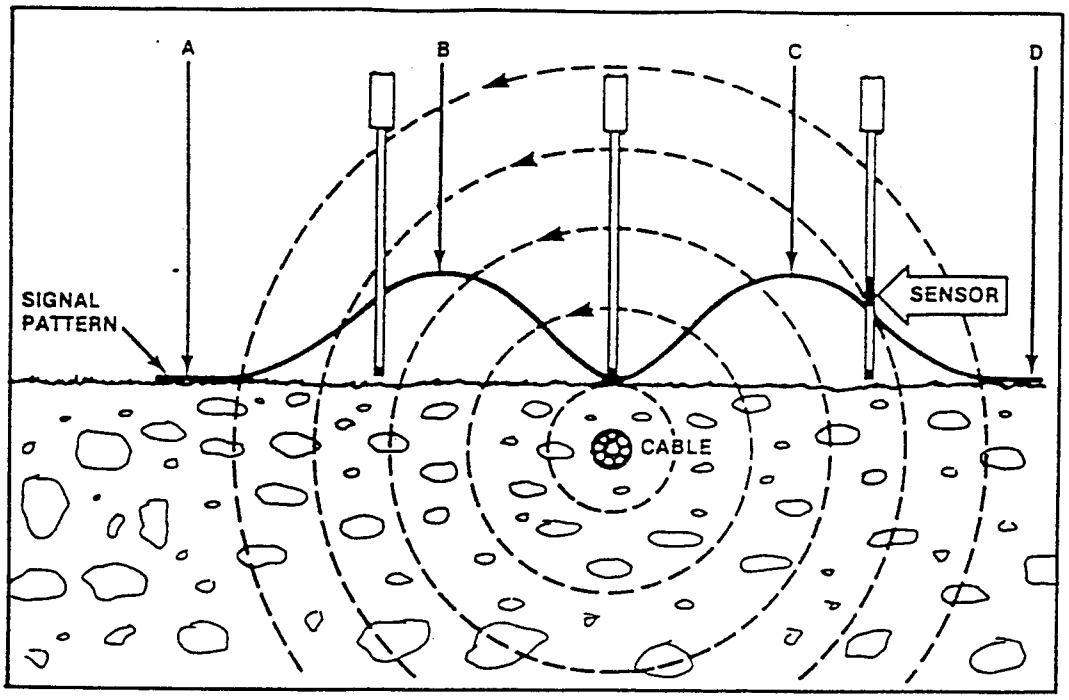


Figure 4-2. Signal Pattern from a Tracing Signal

NOTE
For convenience, all targets will be referred to as lines throughout Sections IV and V.

Transmitter, Turn-On and Battery Check

Set the ON/OFF switch to ON and listen for a steady beeping sound. If a beeping is not heard, the batteries must be replaced as described on page 6-3.

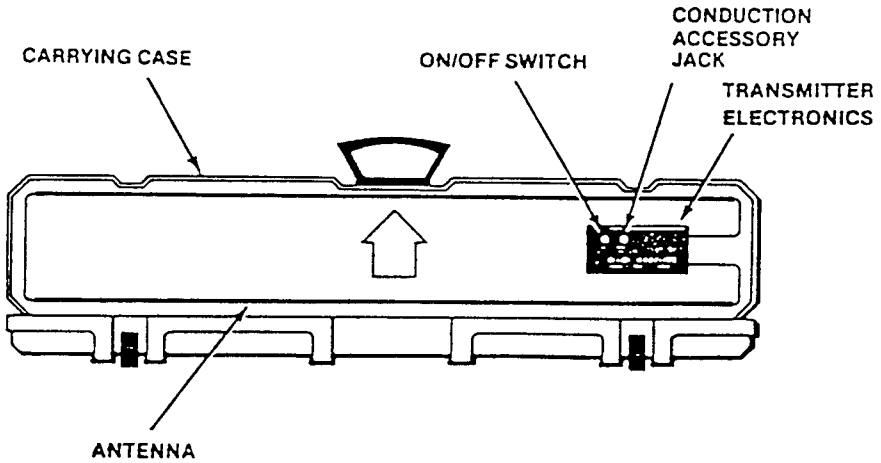


Figure 4-3. Transmitter Controls

Transmitter, Inductive Mode

The most common line excitation mode is inductive. With the cover open and the arrow pointing up, place the transmitter over the line as illustrated in Figure 4-4. The cover must be pointing up. Turn the transmitter ON/OFF switch to ON and you will hear a steady beeping sound. If not, replace the batteries.

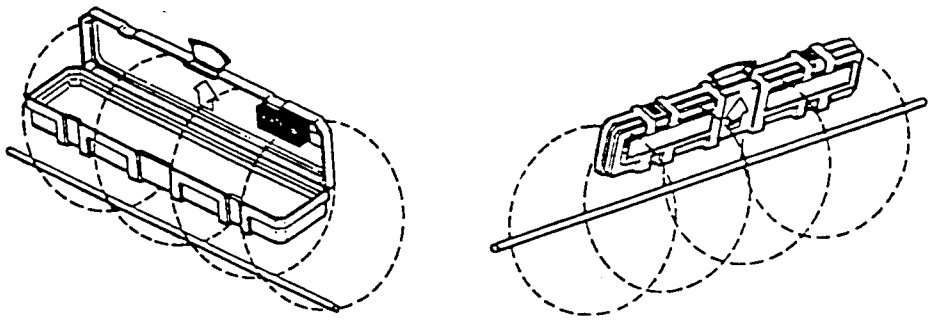


Figure 4-4. Transmitter Operating Positions

Transmitter, Conductive Mode

If an exposed section of a target gas or water pipe is accessible, the tracing signal can be applied directly to the target line.

Plug the conductive cable assembly into the transmitter accessory jack and turn the power switch to ON. (Inserting the plug automatically disables the inductive transmitter and applies exciting current to the cable clips.) Connect one cable clip to a conductive portion of the line. Drive the ground stake into the soil off to the side of the line and attach the other clip to the stake. A good electrical contact between the clips, the line, and the ground stake is very important.

WARNING

Clipping to power lines is dangerous and should not be done. Insulation on the clip is not designed to protect against power line voltages.

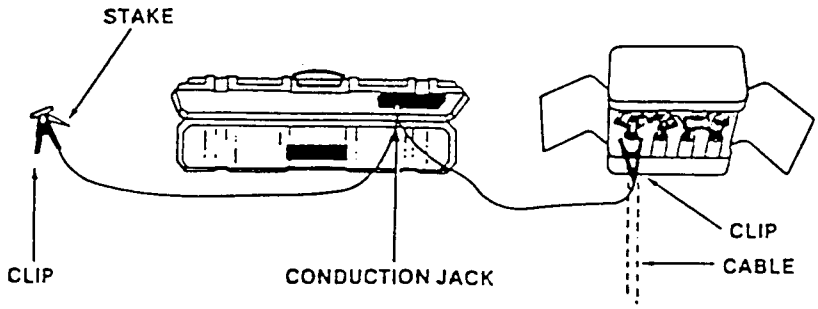


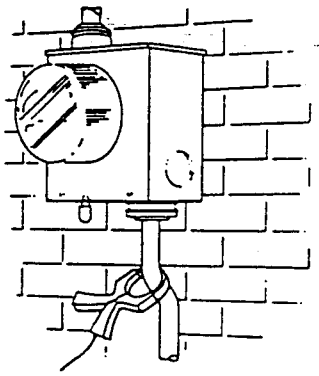
Figure 4-5. Transmitter Hookup for Conductive Operation

Transmitter, Inductive Signal Clamp Mode

The inductive signal clamp (optional) provides a convenient method of applying the tracing signal to electrical cables covered with nonmetalic insulation. Plug the clamp lead into the transmitter accessory jack, turn on the transmitter and close the clamp around the cable. No ground connection is required. It can be applied to cables up to three inches in diameter.

WARNING

Clamping around any power line involves hazard. Exercise caution. Under no circumstances clamp around high tension lines (lines carrying greater than 220 V). High tension voltage can jump to the operator through the insulation and down the wire.



Receiver, Function Selection and Turn-On

Set the M/C switch to C and adjust the ON/OFF-Sensitivity control for mid-position as shown in Figure 4-7. The volume level is preset. If the receiver is turned on when located within 15 feet of the transmitter, the receiver's speaker will emit a siren-like sound indicating that the receiver is picking up the tracing signal directly from the transmitter through the air.

The sensitivity will have to be increased as the distance between the receiver and transmitter increases.

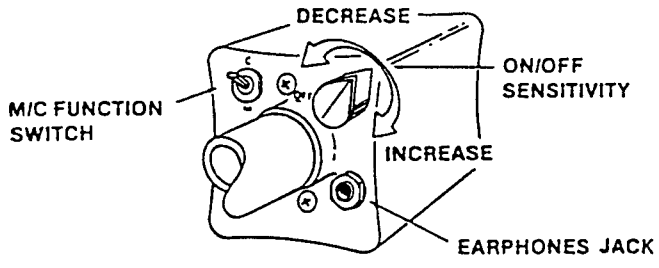


Figure 4-7. Sensitivity Set for Normal Range

Receiver, Sensitivity Settings

The right sensitivity level must be used to obtain a proper null. A null is the audio signature that lets the operator know when he is positioned directly over the target line. If the sensitivity level is set too low, the null between the two signal peaks (highest audio pitch) will cover too large an area, making it difficult to trace the line. If the sensitivity is set too high, the null will be too short and not heard. Setting the sensitivity to get the null width as illustrated by the medium sensitivity curve in Figure 4-8 is the secret to successful tracing.

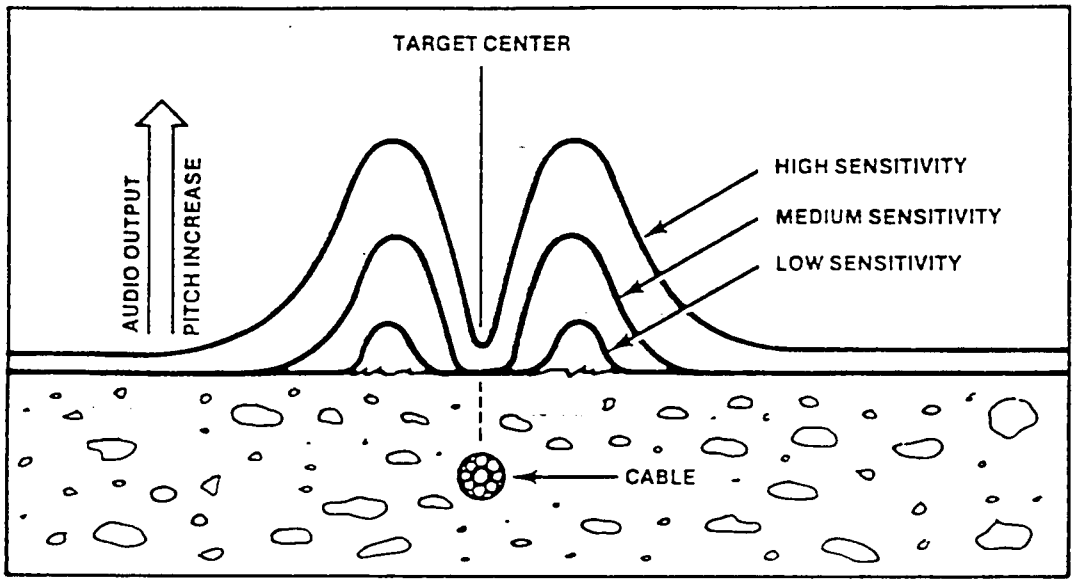


Figure 4-8. Null Shape Versus Sensitivity Setting

Tracing, Inductive Mode

Position the transmitter over the target line and turn the power switch to ON. A steady beeping will be heard that indicates the transmitter is operational. Move approximately 30 feet away from the transmitter along the suspected target line before turning on the receiver. This will ensure that the receiver is not receiving the signal through the air directly from the transmitter. Set the receiver function switch to C and adjust the sensitivity control to obtain a medium pitch signal. Hold the receiver just below the large end as illustrated in Figure 4-9.

NOTE

Do not swing the receiver. The null appears over the target only when the receiver is held in a vertical position. If it is held at an angle, the null will not indicate the true location of the target line.

Holding it in a vertical position with the sensor end close to the ground, move it back and forth across the line. Readjust the sensitivity until a sharp null (minimum pitch) is obtained. The null occurs directly over the line. As you move away from the transmitter the sensitivity level will have to be increased.

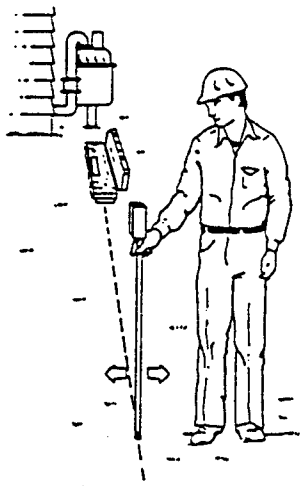


Figure 4-9. Inductive Mode Tracing

Tracing, Conductive Mode

In this mode the transmitter is physically connected to an exposed conductive section of the target line using the conductive cable assembly and the ground stake. After the two clips are connected to the line and to the ground stake (good electrical contacts are essential), the procedure for using the transmitter and the receiver is the same as for the inductive mode except that tracing can be started right next to the transmitter.

WARNING

Clipping to power lines is dangerous and should not be done. Insulation on the clip is not designed to protect against power line voltages.

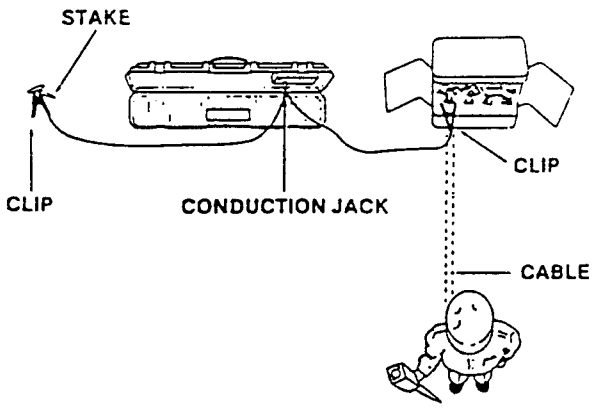


Figure 4-10. Conductive Mode Tracing

Section V
Cable Locator Application Notes

Inductive Coupling

Induction is the easiest and quickest way of applying the tracing signal to a conductor and provides a signal strong enough to trace most lines. Induction does not require access to an exposed section of the line which very often is not available. However, an induced signal is not as strong as a conductively applied signal and will fade quickly as distance from the transmitter increases when electrically poor or leaky conductors such as gas and water pipes are being traced. Any time a tracing signal is induced on a target line, the same signal will be induced on nearby utility lines which may cause some confusion when trying to identify the null.

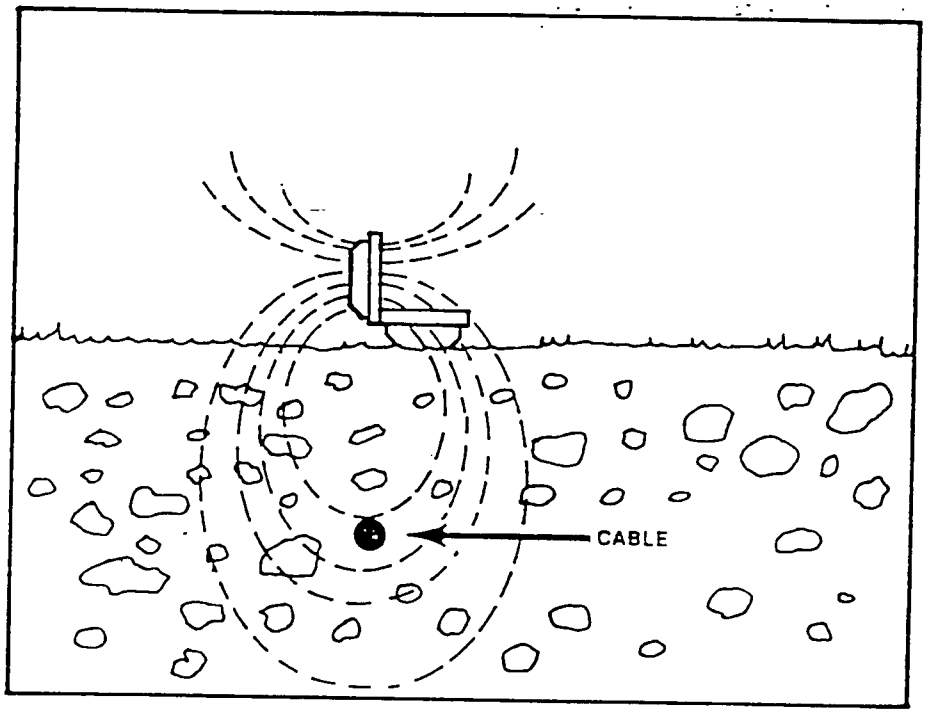


Figure 5-1. Inductive Coupling Setup

Conductive Coupling

This is the most reliable way of applying the tracing signal. A good electrical contact between the clip and the conductive portion of the target line is essential. If necessary, use a file to clean off rust or paint to ensure a good electrical connection. Electrical contact must also be made to the ground using the supplied stake. For the best results, drive the stake into the ground as far off to the side of the line as the connecting cable will permit. (See Figure 5-2)

WARNING

Clipping to power lines is dangerous and should not be done. Insulation on the clip is not designed to protect against power line voltages.

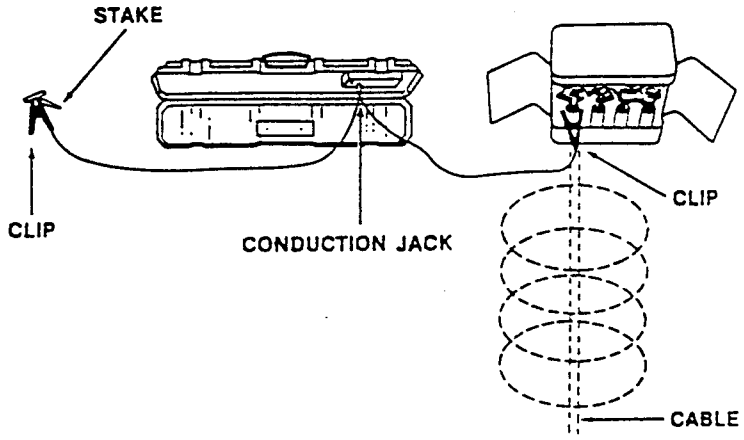


Figure 5-2. Conductive Coupling Setup

Dealing with Clutter Signals

When operating in the inductive mode, an effective method of reducing interference caused by parasitic signals from an adjacent line is to find a second spot on the line that has a good clean null (equal strength lobes on both sides). Move the transmitter to this spot. Confirm that this is the target line by back-tracking with the receiver to the first site of the transmitter and checking for a null. This procedure of leapfrogging the transmitter is also the standard method for extending the tracing range on electrically poor or leaky lines.

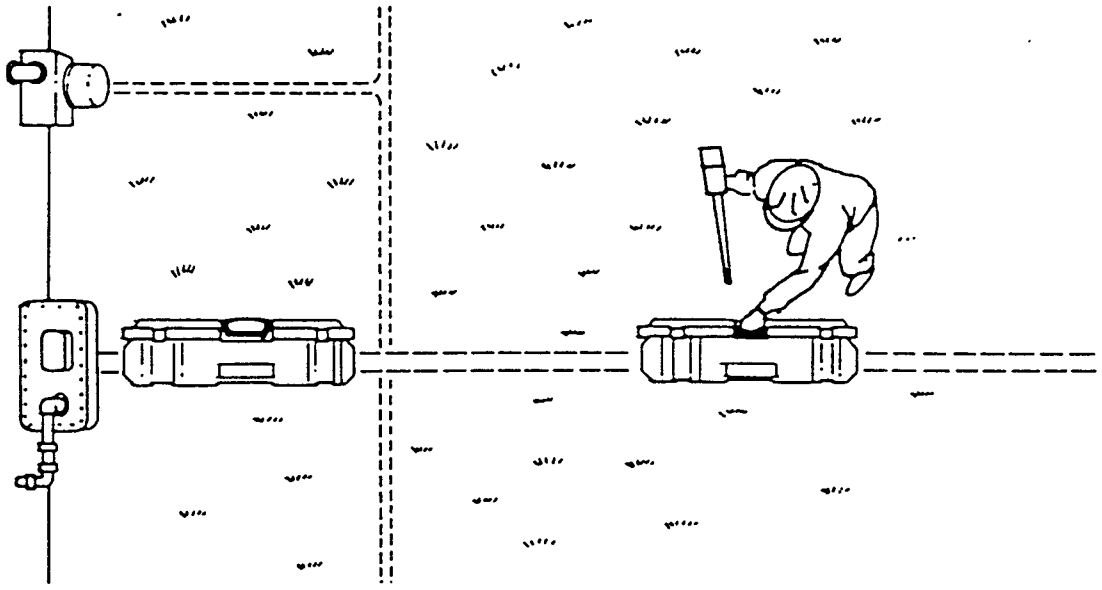


Figure 5-3. Repositioning Transmitter to Reduce Interference

Single-Lobe Identification

A second line parallel to the line being traced will emit a parasitic signal but at a reduced strength. Interaction of these signals results in unequal side lobes, which cause a large null off to one side of the target line as indicated by signal pattern curve A in Figure 5-4. To accurately trace a line under this condition will require practice. An alternate method is to hold the receiver in a horizontal position perpendicular to the line and listen for a single high pitch audio signal that occurs directly over the line as indicated by signal pattern B.

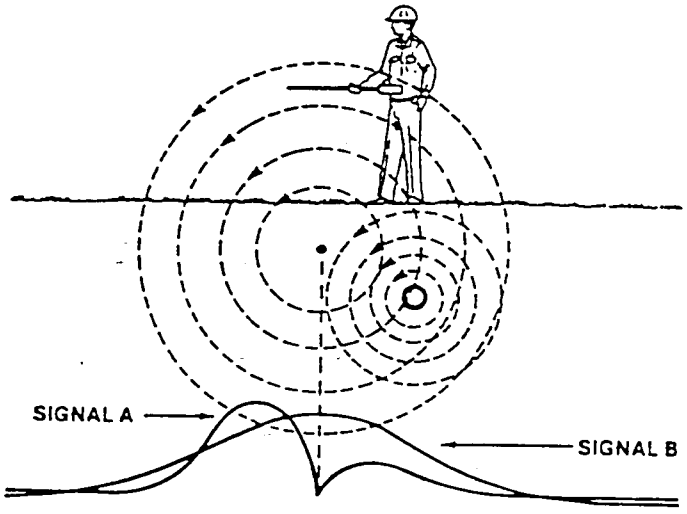


Figure 5-4. Single Lobe Identification Technique

Bends and Junctions

A variation of the two-line, single-lobe identification problem just described occurs when the line being traced has a bend or junction. As the receiver is brought near a bend or junction, the tracing signal becomes difficult to interpret. When this occurs, walk a 20-foot circle around the spot where the signal becomes confusing to detect the null that will indicate the line's new direction. However, to be certain that it is the new direction and not a junction, complete the circle to check for a second null that will indicate if the line has a branch.

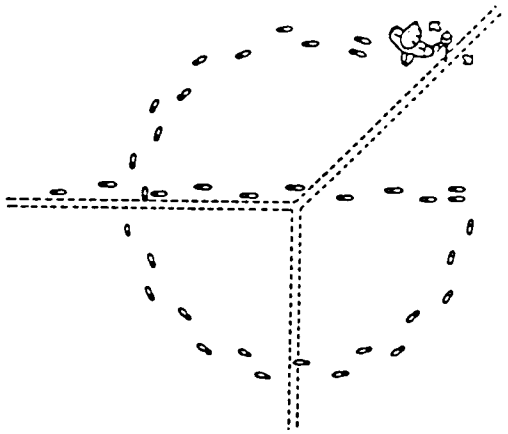


Figure 5-5. Identification of Bends and Junctions

Signal Spreading

Target lines that are poorly insulated from ground such as gas pipes, water pipes and anode strings may cause signal spreading to occur over long distances from the transmitter, even when using the conductive mode. This condition is prevalent when ground water is present. The signal also spreads to nearby lines and into the soil itself. When this situation is encountered, the transmitter must be moved closer to the section of the line to be traced and the conductive mode used if possible.

Signal spreading can also occur even when lines are well insulated. The tracing signal can travel into buildings via the ground or the shield of a line and transfer to the shields of other lines leaving the building. Signal spreading can be minimized by placing the transmitter as far as possible from the building.

Magnetic Locator Function

The MAC-51B has a unique feature designed to help the operator unscramble underground clutter. It is the option of switching to the magnetic mode for a second indication of what category of targets are in the immediate vicinity. In this mode cast-iron water and gas pipes can be readily identified and even classified as to type by the conventional spacing of joints. Power mains and some 60 Hz service drops can also be identified by a burbling sound that peaks when the receiver is directly over the power line. As the operator becomes more familiar with the MAC-51B System, switching between the M and C functions when clutter is encountered will become an invaluable tracing aid.

Isolators and Signal Path Continuity

The tracer current must travel in a closed loop. When it leaves the line being traced, it loops back, one way or another, to the beginning of the line. If the current cannot complete its loop the locating system will not operate. The operator should be aware of this system requirement when tracing lines that have electrical isolators installed.

Electrical isolators are sometimes placed in a gas line at the meter to provide an electrically open circuit which stops the flow of galvanic current and reduces corrosion. To inductively excite this type of line by placing the transmitter close to the meter, a shorting wire must be placed on the pipe to bypass the isolator. This allows the tracer current to return to the pipe through the earth ground of the building. An alternate method is to move the transmitter down the line a few yards away from the building to a point where the gas pipe riser provides a current return path.

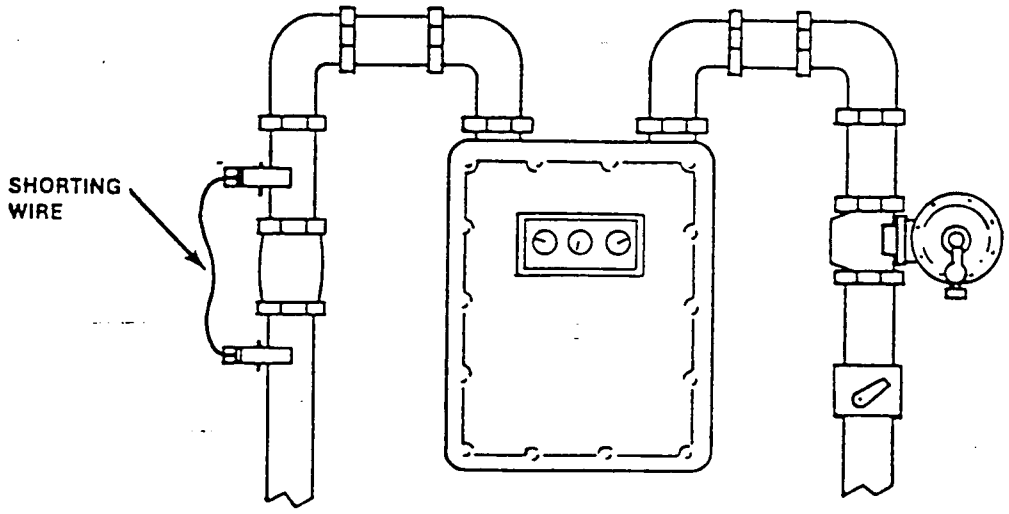


Figure 5-6. Gas Line Isolator Bypassed with Shorting Wire

Isolators and Inductive Excitation

Electrical isolation sometimes occurs inadvertently on phone cables entering a pedestal because the cable's shield is not grounded. In most jurisdictions, grounding the shield inside the pedestal is not required unless the cable shares a trench with power cables. If there is no ground wire, it is recommended that a wire and clips, as shown in Figure 5-7, be connected from the cable shield to the pedestal before using the inductive mode to excite the target cable. This will greatly improve the strength of the inducted tracing signal.

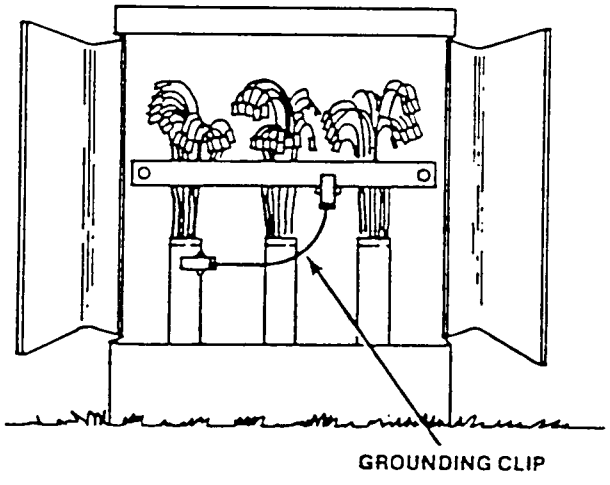


Figure 5-7. Pedestal with Grounding Clip Installed

Isolators and Conductive Excitation

When using the conductive mode to trace a phone cable from a pedestal, electrical isolation of the shield is an advantage. If a ground wire is providing a good path from the shield to earth ground through the pedestal, the trace current will use it to complete the return loop to the transmitter grounding stake instead of going down the target line. So if there is a ground wire in place, disconnect it from the pedestal before connecting the conductive cable clip to the shield to ensure that a strong tracer current is applied to the cable.

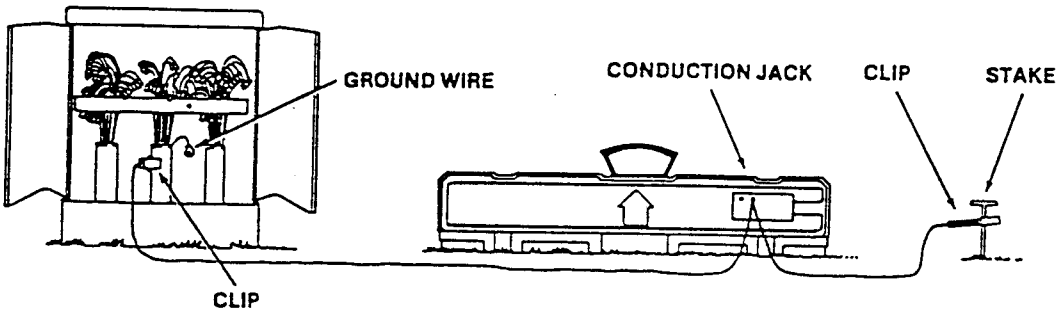


Figure 5-8. Pedestal with Groundwire Removed

Determining Target Depth by Triangulation

The receiver can be used in the traditional triangulation method to determine the approximate depth of a target as illustrated in Figure 5-9. However, when using this method it is necessary to take into account the fact that the center of the cable-sensor is located 11 inches up the receiver tube from the black tip.

When the position of the target has been determined by the null, mark the spot (#1) on the ground. Hold the receiver tip on the ground at this spot, slant the instrument at a 45° angle and slowly move directly back, to one side, from the target until a second null is obtained. Now mark a spot (#2) on the ground that is directly below a point 11 inches up the receiver tube from the black tip. Measure the distance between spot # 1 and spot #2. This measurement indicates the approximate depth of the target.

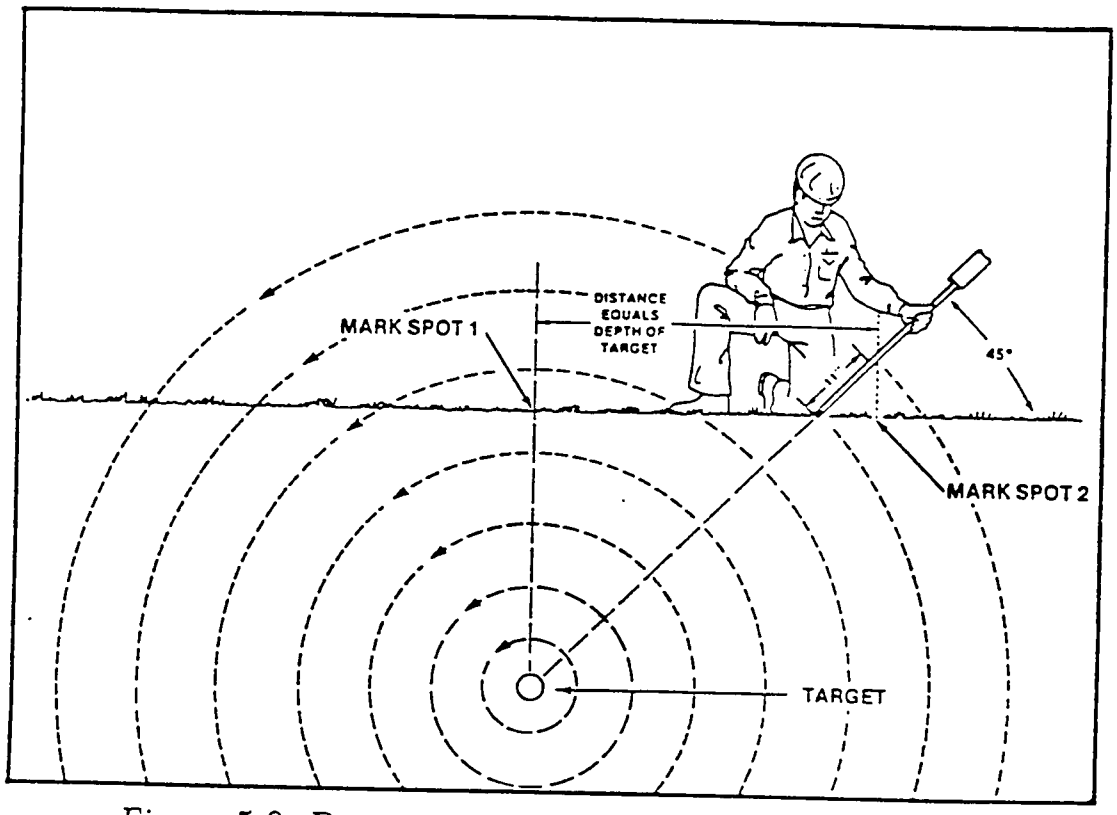


Figure 5-9. Determining Approximate Depth of Target

NOTE

Depth readings should be taken on both sides of the line at a spot where the lobes have the same signal strength. This procedure will help reduce any error in depth estimation caused by a distorted tracing signal due to interference.

Section VI
Maintenance

The MAC-51B system is built to give trouble-free operation. Normally, maintenance is limited to the occasional replacement of batteries. In the event that a malfunction does occur, refer to the appropriate trouble-shooting guide on page 6-4. They list a few possible problems that can generally be corrected in the field so that you will be able to continue using the locator without interruption.

Replacement of Receiver Batteries

The receiver is powered by four C-cell batteries carried in a battery holder illustrated in the exploded view of the electronic assembly. Access to the batteries is obtained by removing the two knurled nuts and sliding off the cover.

The four batteries are connected in series. The proper polarities for the batteries are shown on the battery holder. **Batteries must be removed and installed as shown in Figure 6-2.**

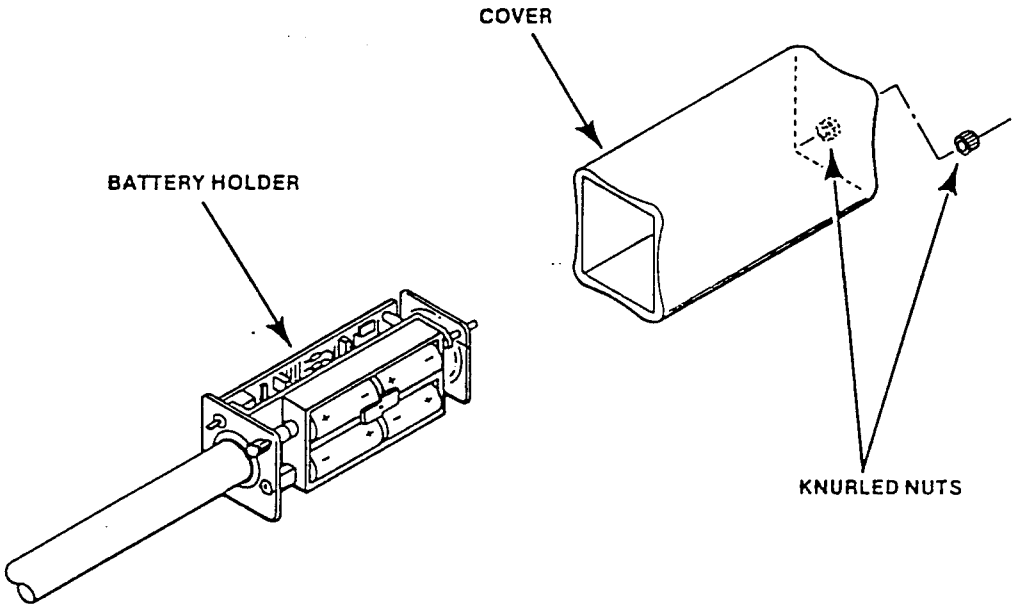
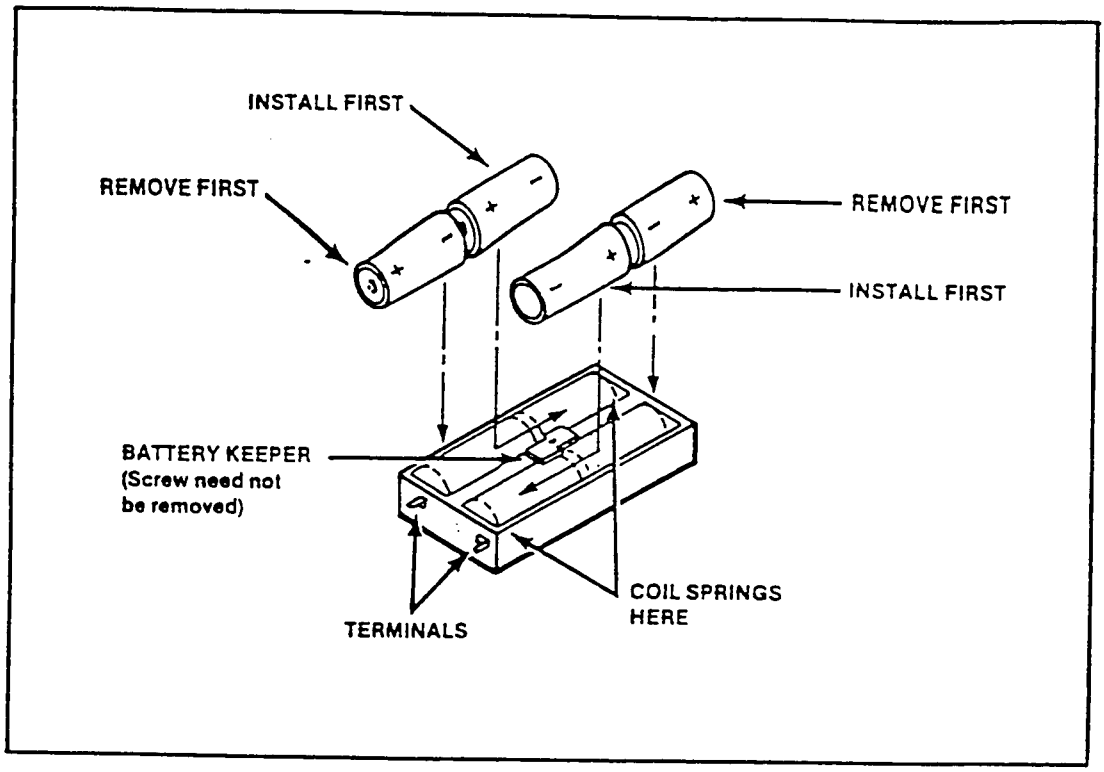


Figure 6-1. Exploded View of Receiver Electronic Unit



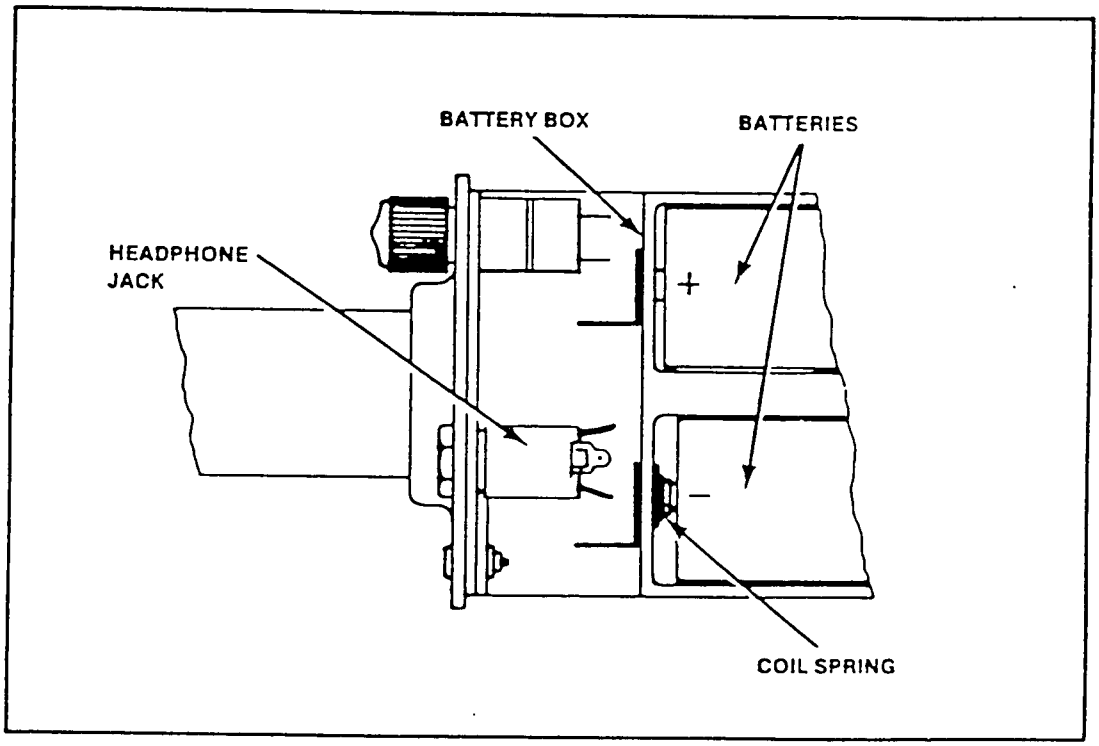


Figure 6-2. Replacement of Receiver Batteries

Replacement of Transmitter Batteries

The transmitter is powered by eight alkaline C-cell batteries located in a battery holder. Access to the batteries, as illustrated in Figure 6-3, is obtained by removing the two knurled nuts, the battery holder cover, and the spare battery holder. The eight batteries are connected in series. The proper polarities for the batteries, their removal, and installation sequence are indicated below. **Batteries must be removed and installed in the order shown.**

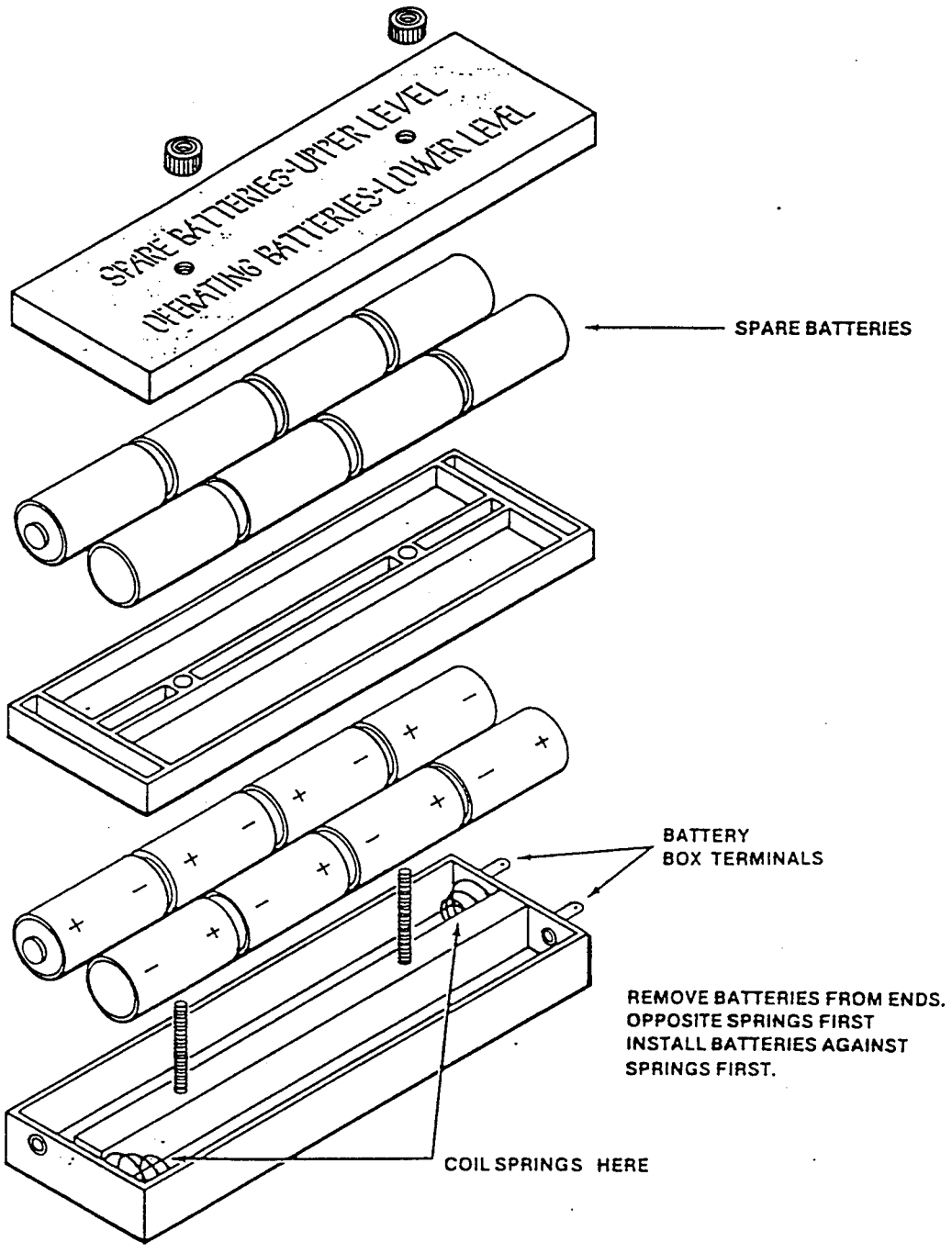


Figure 6-3. Replacement of Transmitter Batteries

RECEIVER TROUBLESHOOTING GUIDE

Symptom	Possible Cause	How to Check	How to Fix
Dead	Dead Batteries. Batteries not making contact. Broken Wires.	Replace. Check for contact corrosion. Visually inspect.	Replace. Clean Contacts. Resolder.
Intermittent	Batteries not making good contact.	Check for corrosion.	Clean Contacts.
No sound	Speaker terminals shorted to cover.	Visual.	Bend terminals.

TRANSMITTER TROUBLESHOOTING GUIDE

Sympton	Possible Cause	How to Check	How to Fix
No Sound	Dead Batteries. Batteries not making contact. Broken wires.	Replace. Check for contact corrosion. Visually inspect.	Replace. Clean Contacts. Resolder.
Intermittent Sound	Batteries not making contact.	Check for corrosion.	Clean contacts.

SERVICE INFORMATION

If your locator needs service, please return it to the factory along with the following information: Name, Address, Where Purchased, Date and Description of Trouble(s). A telephone estimate will be provided prior to service work being done. See shipping information on Page 6-7.

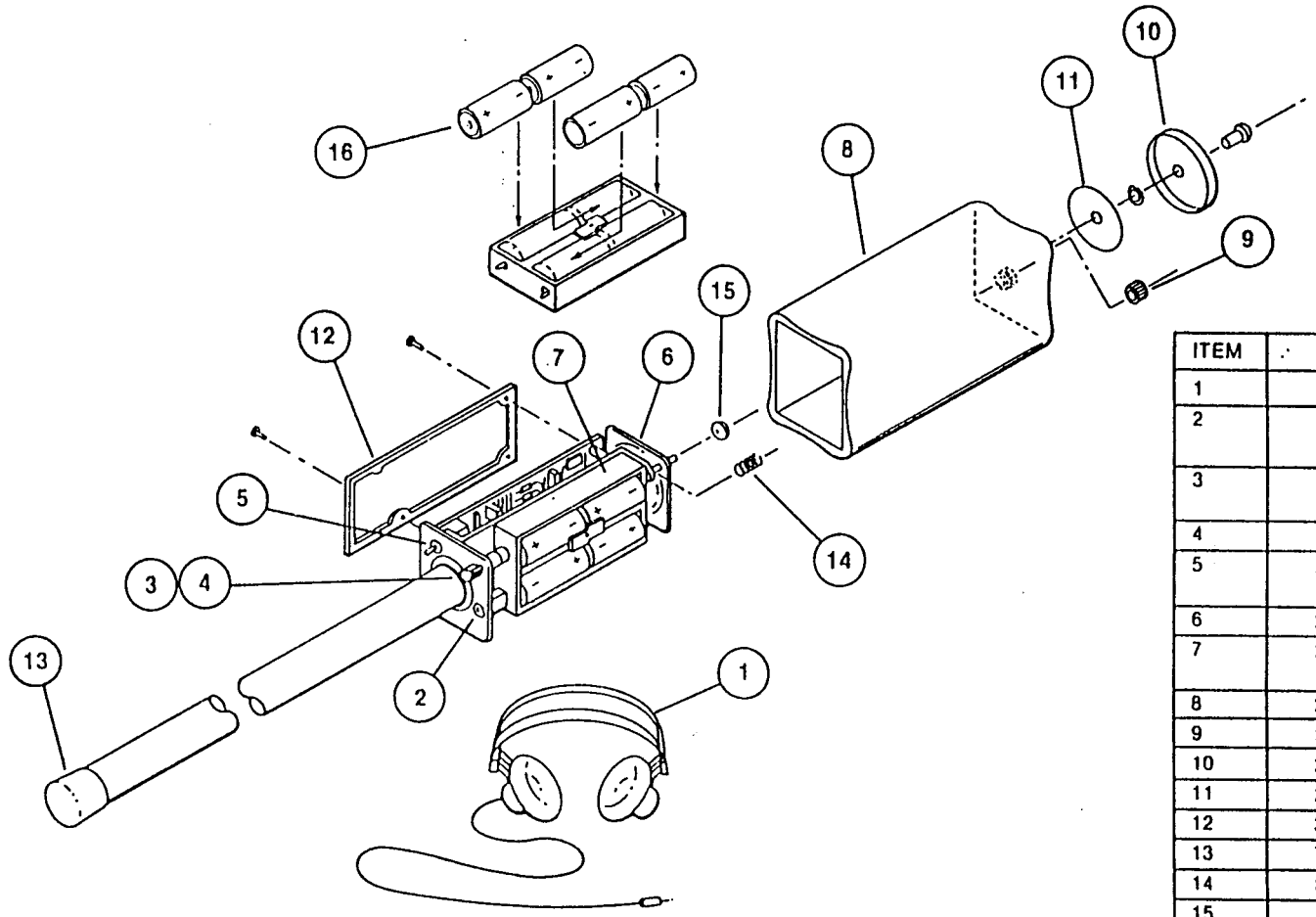
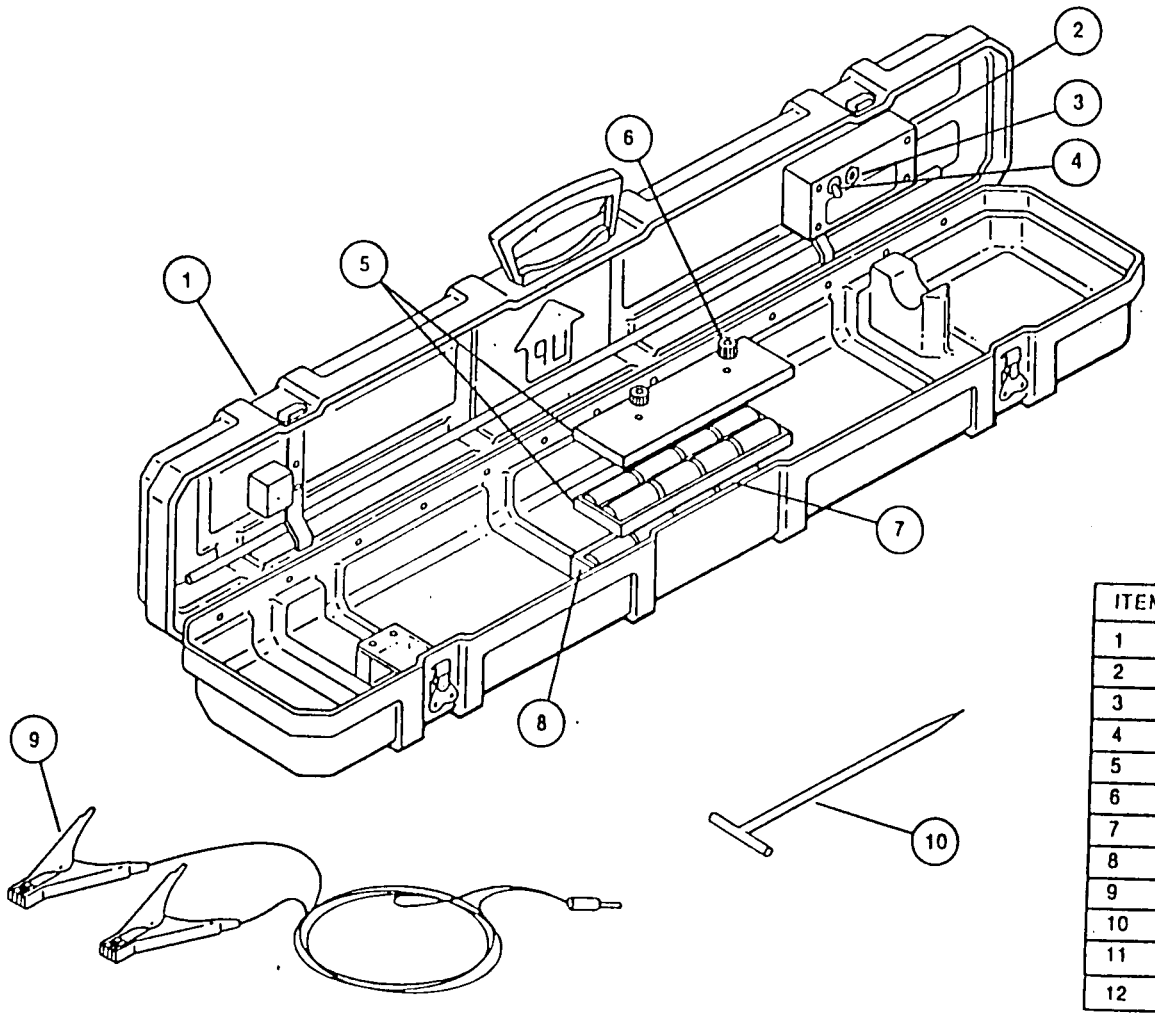
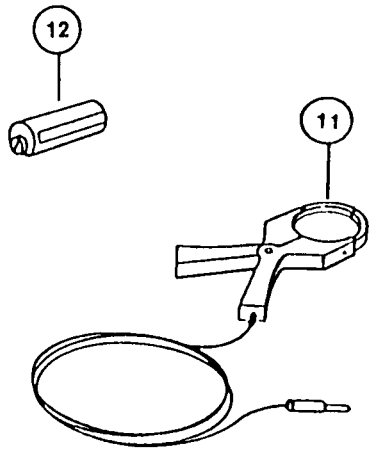


Figure 6-4. MAC-51B Receiver Repair Parts

ITEM	PART NO.	DESCRIPTION
1	H30006	HEADSET*
2	207245	PHONE JACK J10012 WITH WIRES
3	207179	SENSITIVITY CONTROL S35065 WITH WIRES
4	K20011	KNOB
5	207269 B55004	OPTION SWITCH BUSHING BUSHING EXTENDER
6	206003	SPEAKER MOD.
7	207173	BATT. HOLDER AND CHASSIS ASSY.
8	207271	COVER
9	K20021	KNURLED NUT (2 REQ'D)
10	207215	CAP
11	202006	SCREEN
12	301655	PROTECTOR
13	T60003	TIP
14	S56002	SPRING (2 REQ'D)
15	R40016	"O" RING (2 REQ'D)
16	B11009	BATTERY ("C" SIZE, 4 REQ'D)

*OPTIONAL





ITEM	PART NO.	DESCRIPTION
1	500321	CASE
2	301725	ELECTRONICS BOX
3	J10009	JACK
4	S35030	SWITCH
5	207242	BATTERY HOLDER
6	205252	KNURLED NUT 2 REQ'D
7	B11009	BATTERY C TYPE, 4 REQ'D
8	301729	BATTERY CASE
9	301781	CONDUCTIVE CLAMP
10	207200	GROUND SPIKE
11	301646	CLIP*
12	MT-1	MINI TRANSMITTER(MOLE)*

*OPTIONAL

Figure 6-5. MAC-51B Transmitter Repair Parts

LIMITED WARRANTY

The Schonstedt Instrument Company (Schonstedt) warrants each product of its manufacture to be free from defects in material and workmanship subject to the following terms and conditions. The warranty is effective for one year after shipment by Schonstedt to the original purchaser.

Our obligation under the warranty is limited to servicing or adjusting any product returned to the factory for this purpose and to replacing any defective part thereof. Such product must be returned by the original purchaser, transportation charges prepaid, with proof in writing, to our satisfaction, of the defect. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. Prior to repair in this instance, a cost estimate will be submitted. Service or shipping information will be furnished upon notification of the difficulty encountered. Model and serial numbers must be supplied by user. Batteries are specifically excluded under the warranty.

Schonstedt shall not be liable for any injury to persons or property or for any other special or consequential damages sustained or expenses incurred by reason of the use of any Schonstedt product.

FOR SERVICE OR REPAIR

Please ship locator (in its case to):

Schonstedt Instrument Company
1775 Wiehle Avenue
Reston, VA 22090

PATENTS

Manufactured under the following Patents: United States: 2,916,696; 2,981,885; 3,894,283; 3,909,704; 3,961,245; 3,977,072; 4,110,689; 4,161,568; 4,163,877; 4,258,320; 4,388,592 and Design 255552. Canada: 637,963; 673,375; 1,006,915; 1,037,121; 1,141,003, 1,177,891 and 1,206,091. Great Britain: 1,446,741; 1,446,742; 1,494,865 and 2,012,430B. France: 2,205,671 and 81 12295. Germany: 25 51 968.0-09; 25 55 630; and 29 01 163. Japan: 1,595,127 and 1,413,844. Other patents pending.

Upon receipt of meter the following operational checks should be performed:

Set toggle switch to "on" position, or turn rotary dial fully clockwise.

Circuity check: submerse the electrode (probe) in tap water. This completes the circuit and activates the buzzer.

Test button check: depress button to test the battery and circuitry (excluding the probe).

Routine Care of the Water Level Meter:

The probe and reel assembly is a simple system that will give long and reliable service, if handled with reasonable care.

1. After the depth of water has been recorded the cable should be carefully rewound onto the reel, the probe wiped dry and replaced into the probe holder.
2. The probe, cable and reel can all be cleaned with soap/ detergent and water.
3. Use of a Water Level Meter Carrying Bag adds to the service life of the meter.

NOTES:

Zero measurement point on Model 101 Water Level Meter is at tip of inner electrode, visible near center of probe.

Zero measurement point on Model 102 Water Level Meter is at base of outer body electrode.

The P4 probe has been designed to allow substantial submergence. Use of the P1, P2 or P3 probes to sound the bottom of the well may cause water to enter the probe.

Water Level Meter Maintenance

SENSITIVITY ADJUSTMENT

If on/off switch is a rotary dial:

- clockwise rotation of rotary dial turns meter on and increases sensitivity.
- always set switch to highest sensitivity position, then decrease if necessary.

If on/off switch is a toggle switch:

- the sensitivity switch is set for tap water and will operate in most situations without adjustment.
- if the alarm continues after removal from water the sensitivity should be reduced.
- if no alarm is heard (although the battery is in working order) then the sensitivity should be increased.
- to adjust the sensitivity, remove the face plate on the reel, as when replacing battery, and locate on top of the circuit board an adjustable potentiometer with a small central adjusting screw.
- to reduce sensitivity rotate the screw clockwise.
- to increase sensitivity rotate the screw counter-clockwise.

BATTERY REPLACEMENT

- battery type - alkaline, 9 volt.
- the battery is housed in the reel hub and is replaced by removing the front plate of the reel.
- to remove front plate, unscrew three faceplate screws and carefully lift off to the side to avoid damage to wiring.
- remove battery and put in new one, making sure the polarity is correct
- replace faceplate of the reel and screws, making sure the wires are fully inside.



ORS
ENVIRONMENTAL
EQUIPMENT
A DIV. OF GROUNDWATER TECHNOLOGY, INC.

Depth Meter

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INTERFACE PROBE USER GUIDE & MANUAL

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Factory Mutual System

Approved

Factory Mutual Approval applies to Interface Probe model numbers 1068013, 1068017 and 1068018.

Rev. 2
10/25/01
ORS\PPXXX010

SECTION 1: SYSTEM DESCRIPTION

The ORS Environmental Equipment Interface Probe is a hand held, battery powered device for measuring depth to water or oil in tanks or wells. The Interface Probe can be used in numerous applications including measuring oil and water levels in monitoring wells, detecting tank leakage and obtaining accurate measurements of water levels in cascading wells. The system is Factory Mutual approved for Class 1, Division 1, Group D applications.

This manual applies to Interface Probes with ORS part numbers 1068013, 1068017 and 1068018. These three models differ only in the graduations on the front/back of their measuring tapes. Measuring tape alternatives are as follows: # 1068013 (Engineering/Metric), # 1068017 (Metric/Engineering), # 1068018 (English/Metric). Engineering scales are in decimal feet, Metric scales are in millimeters and English scales are in inches.

The Interface Probe consists of an oil/water sensing probe, a measuring tape/probe cable and a housing into which the tape and probe can be withdrawn when not in use. See below for a more detailed explanation of these components, and see Fig. 1, p. 2 for a drawing of the entire assembly.

1.1 System Components

1.1.1 Probe

The probe is a 1" (25 mm) diameter cylinder which can be used in wells as small as 1-1/8" (29 mm) in diameter. The probe contains two different sensor units, one for detecting the liquid/air interface, and one for distinguishing between water and hydrocarbon. The liquid sensor is an optical prism located on the end of the probe. This sensor detects liquid by reacting to the differences in the indices of refraction of air and liquids. An infrared light source is internally reflected to an infrared detector by a prism on the face of the sensor. When the prism becomes immersed in liquid, the light beam is refracted away from the detector. To determine if the liquid is conductive (water), or nonconductive (hydrocarbon), a small Intrinsically Safe electrical current is passed between two electrodes on the sensor. Current flow will occur only in conductive fluids such as water. The Interface Probe is capable of measuring oil slicks less than 1/16 of an inch (1.6 mm) in thickness.

1.1.2 Measuring Tape

The specially coated measuring tape connects the probe with the housing assembly and provides an accurate means of measuring the distance from the well head or tank port to the air/water, air/oil or oil/water interface. The tape also contains all the wires running between the probe and the circuitry in the housing assembly.

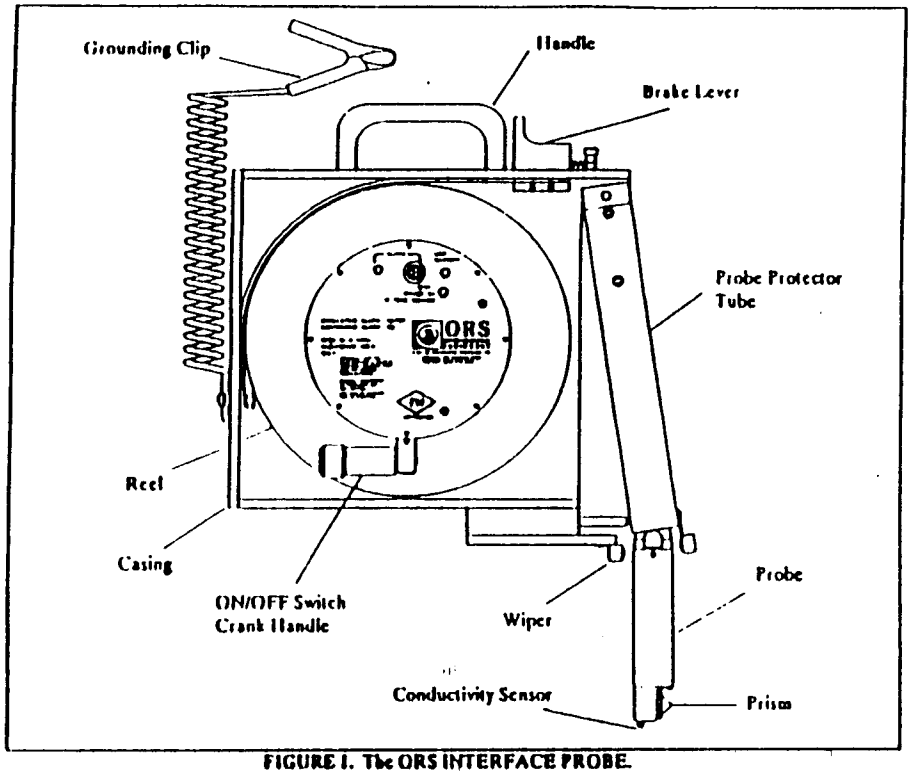


FIGURE 1. The ORS INTERFACE PROBE.

1.1.3 Housing Assembly

The components of the weatherproof NEMA 3 housing assembly are shown in Fig. 1, p. 2. The housing includes a casing and reel to protect and deploy the measuring tape and probe. The housing also has a Low Battery indicator, a visual/audible alarm and a test button for the alarm. A grounding clip is attached to the housing.

1.2 Intrinsic Safety & Approval

The intrinsic safety and approval of the Interface Probe is subject to the following requirements.

- Batteries must be changed only in a non-hazardous location.
- Batteries must be Duracell Type MN1500 (size AA). Substitution will impair intrinsic safety and void approval.

- When in operation, the unit must be grounded with the grounding clip provided.
- Substitution of components will impair intrinsic safety and void approval.

SECTION 2: SYSTEM INSTALLATION

Attach grounding clip to a confirmed ground before lowering the probe. No further installation is required.

SECTION 3: SYSTEM OPERATION

3.1 Taking A Measurement

> WARNING: BEFORE ACTIVATING THE PROBE, ATTACH THE GROUNDING CLIP TO A SUITABLE EARTH GROUND.

3.1.1 To turn the unit on, unfold the crank handle away from the reel housing (See Fig. 1, p. 2). This activates a power switch inside the reel.

3.1.2 To verify that the unit is operational, press the test button on the face plate. If the power is ON, the visual/audible alarm will be activated. A low battery condition will cause the Low Battery indicator to be illuminated.

> IMPORTANT: BEFORE REPLACING BATTERIES, READ WARNING IN SECTION 1.2 ABOVE.

3.1.3 To release the probe, pull the protector tube outward from the reel casing. To lower the probe, tilt the front of the reel housing forward and press the brake release. The brake release is located just forward of the handle. The tape will reel out as long as the brake release is depressed.

> Note: The tape should not be allowed to rub against the well casing.

3.1.4 When the probe contacts liquid, the visual/audible alarm on the reel will be activated. An oscillating alarm indicates water, a continuous alarm indicates hydrocarbon. To determine the exact thickness of a hydrocarbon layer, the probe should be slowly lowered to the air/hydrocarbon interface until the alarm is activated. With the probe at the exact point where the alarm comes on, read the numbers on the tape to determine the distance from the top of the tank or well to the air/hydrocarbon interface. Next, lower the probe through the hydrocarbon layer and well into the water. An oscillating alarm will be obtained. The probe should then be raised slowly to the hydrocarbon/water interface until

APPENDIX A

INTERFACE PROBE CHEMICAL RESISTANCE CHART

The compatibility of the Interface Probe with various chemicals is listed in the table on the following pages. For chemicals not listed, please consult the factory.

Chemical resistance is rated as follows:

A = Good: At 20 degrees C.

B = Fair: Slight attack and absorption. Inspect and rinse after use.

C = Poor: Use ORS Environmental Equipment's Chemical Interface Probe.

* Indicates that the probe material has not been tested specifically with that chemical but the results can be predicted from tests with similar chemicals.

A summary of the resistance of the sensing head to water, organic and inorganic chemicals is given below.

WATER

The probe is not attacked chemically by water.

INORGANIC CHEMICALS

The probe is unaffected by most inorganic reagents. Aqueous solutions do not generally damage the prism, although it may be temporarily softened by absorbed water. The prism is attacked by concentrated oxidizing mineral acids (nitric, sulfuric, hydrochloric) at room temperature but is not affected by more dilute acids. Resistance to alkalis is good.

ORGANIC CHEMICALS

In general, aliphatic hydrocarbons, alcohols, benzene, petroleum spirits, aliphatic organic acids, oils and fats do not attack the prism. Slight absorption may occur but does not usually cause degradation. The prism is attacked in highly polar organic solvents such as dimethysulphoxide, aromatic amines, nitrobenzene, and certain chlorinated hydrocarbons such as dichloromethane and chloroform.

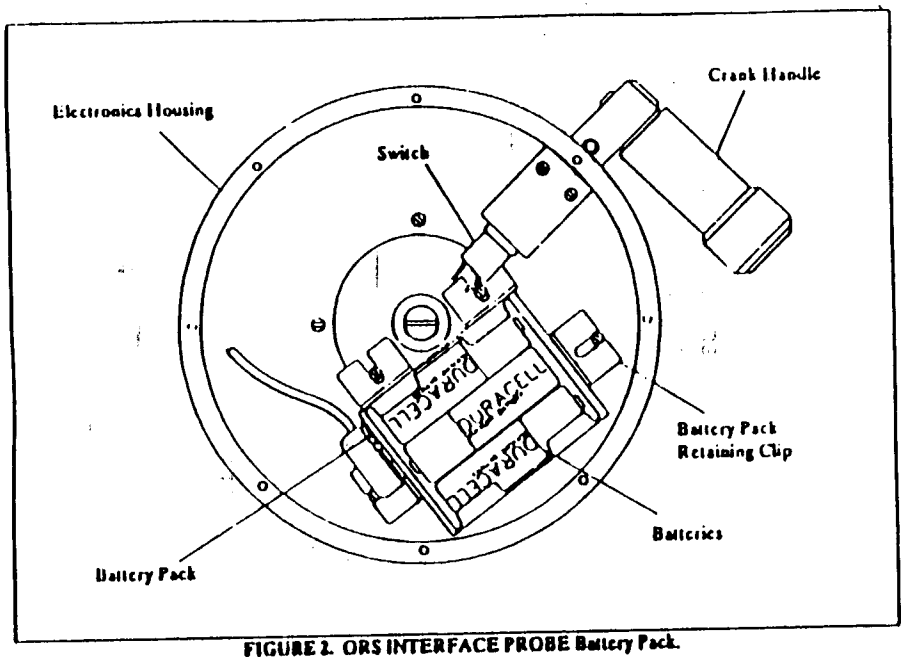


FIGURE 2. ORS INTERFACE PROBE Battery Pack.

the point is reached where the alarm changes from oscillating to continuous. The thickness of the hydrocarbon layer is determined by subtracting the first reading from the second reading.

Remember: The most accurate results are obtained by moving the probe as slowly as possible.

3.1.5 After taking a measurement, snap the protector tube shut so that the wiper rests against the tape. Release the brake and slowly reel in the tape until the probe is just below the wiper. Do not allow the probe to bottom out against the wiper, as this will apply stress to the tape. Next, open the protector tube and gently reel the probe 2/3 of the way into the tube. Forcibly reeling the probe all the way into the tube may stress or break the measuring tape. Now, turn the entire Interface Probe assembly upside down so that the probe falls the rest of the way into the protector tube. Make sure that the probe is entirely within the protector tube. Finally, close the protector tube.

The Interface Probe is equipped with an automatic shutoff circuit. If the probe has not sensed liquid within 3 minutes from the time power is applied, the unit will automatically switch to a low power mode. This prevents battery drain should the power be left on accidentally. To restore power, place the handle in the OFF position and then back to the ON position.

SECTION 4: SYSTEM MAINTENANCE

The Interface Probe is designed to be virtually maintenance free. The only maintenance required is cleaning of the reel and probe and periodic replacement of the batteries.

After every measurement, the probe should be washed in Alconox detergent, rinsed in distilled water, washed again in Alconox and rinsed for a final time in distilled water. Also clean all accessible parts of the reel assembly. Before replacing the batteries, read the cautions in Section 1.2 .

CAUTION: NEVER USE ACETONE OR ANY KETONE AS A CLEANER. DOING SO COULD CAUSE PERMANENT DAMAGE TO THE PRISM.

SECTION 5: SYSTEM TROUBLESHOOTING

The Interface Probe is a sealed unit and is not easily repaired in the field. With the exception of replacing a damaged prism (see below), any major malfunction should be referred to the Repair Department, ORS Environmental Equipment.

To remove a damaged prism, use a 3/4" (19 mm) wrench (hex socket 6 point) and unthread the prism assembly from the probe bottom. A replacement prism assembly (consisting of a prism and an O-ring) is available by ordering Part Number 2060010.

NOTE: To prevent water from entering the prism cavity, carefully dry the probe before removing the old prism. Throughout the prism removal and replacement procedure, hold the probe with the prism pointed downward.

To install the new prism assembly, simply thread the prism into place and secure finger tight. Then use a 3/4" (19 mm) wrench to firmly seat the O-ring. Be careful not to overtighten.

CHEMICAL	RESULTS
Acetaldehyde	C
Acetic acid-glacial	A
Acetic acid- 10%	A
Acetone	C
Aluminum salts	A*
Ammonia- 880	A
Ammonium hydroxide- 10%	A
Ammonium chloride- 10%	A
Amyl acetate	B
Aniline	C
"Arcton" propellants	A*
Aviation hydraulic fluid	B
Aviation spirit	A
Barium salts	A*
Benzaldehyde	C
Benzene	A
Benzoic acid	A
Benzene sulfonic acid	A*
Bleach	A
Boric acid	A*
Brake fluid	B
Brine	A
Butane	A
Butanol	A
Butyl acetate	B*
Calcium nitrate	A
Calcium hypochlorite	A
Carbon disulphide	B*
Carbon tetrachloride	A
Chlorine	C
Chlorobenzene	C
Chloroform	C
Chlorosulfonic acid	C*
Chromic acid	A
Citric acid	A
Cooking oil	A
Copper sulfate	A
Creosote	A
Cresols	C
Cyclohexane	A
Cyclohexanol	A
Cyclohexanone	C
Detergent solutions	A
Dibutyl phthalate	A
Dichlorobenzene	C
Dichloroethane	C
Dichloroethelyne	B
Diesel oil	A
Diethylamine	A
Dimethyl formamide	C
Dioctyl phthalate	A
Dioxane	B*
Edible fats & oils	A
Ethanol	A
Ethyl acetate	C
Ethyl alcohol	A
Ethylene glycol	A
Ferric chloride	A
Formaldehyde	A
Formic acid	A
Gasolene (premium)	A
Glycerol	A
Heptane	A
Hexane	A
Hydrochloric acid- 10%	A
Hydrochloric acid (conc.)	A
Hydrogen peroxide	A
Hydrogen sulfide	A
Iodine	B
Isopropanol	A
Iso-octane	A
Kerosene	A
Lactic acid	A*
Lead acetate	A*
Linseed oil	A
Magnesium sulfate	A
Mercuric chloride	A*
Mercurous chloride	A*
Mercury	A*
Methanol	A
Methyl ethyl ketone	C
Methyl chloride	C
Milk	A
Motor oil	A
Nickel salts	A*
Nitric acid- 10%	A
Nitric acid (conc.)	C
Nitrobenzene	C
Oils (vegetable)	A
Oleic acid	A*
Oleum	C
Oxalic acid	A
Perchloroethylene	C
Petrol	A
Petroleum ether	A
Phenols	C
Potassium hydroxide- 10%	A
Potassium hydroxide- 50%	A
Propane	A*
Pyridine	C
Silicon fluids	A
Silver nitrate	A
Soap solution	A
Sodium chloride	A
Sodium hydroxide- 10%	A
Sodium hydroxide- 50%	A
Sodium hypochlorite	A*
Sulfur dioxide	B
Sulfuric acid- 10%	A
Sulfuric acid (conc.)	C
Sulfurous acid	C*
Tar	A*
Tartaric acid	A*
Tetrahydrofuran	C
Toluene	C
Transformer oil	A
Trichloroethylene	B
Turpentine	A
Vaseline	A*
Varnish	A
Water	A
Wax	A*
White spirit	A
Wines & spirits	A*
Xylene	B
Zinc salts	A*

ORS ENVIRONMENTAL EQUIPMENT RETURN POLICY

Permission is required to return equipment to the ORS Environmental Equipment factory in Greenville, NH. A Return Authorization Number will be issued upon receipt of your request to return, which should include reasons for the return. Your return shipment to us must have this R.A.# clearly marked on the outside of each package.

Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN AUTHORIZATION, PLEASE CALL OUR SERVICE DEPARTMENT AT 800-228-2310 or 603-878-2500.

Equipment Decontamination

Prior to return, all equipment must be thoroughly cleaned and decontaminated. During decontamination, personnel should wear protective clothing and observe the cautions outlined below.

ORS reserves the right to refuse any equipment not properly decontaminated. ORS may also choose to decontaminate equipment at a fee which will be applied to the repair invoice.

Decontamination Solutions

The determination of what decontamination solution to use should be based on the types of contaminants present and the materials to be decontaminated. The fabrics of protective clothing are made of organic polymers which may be dissolved or destroyed by organic solvents. The metals and gaskets of tools may be damaged by overly acidic or basic compounds. Some decontamination solvents should be entirely avoided. The toxicity or physical hazards associated with using some once commonly used decontamination solutions can be as potentially dangerous as the site contaminants.

It is important to be certain that the decon solution, the contaminant, and the material to be cleaned are all compatible with each other. If they are not, it is possible to produce toxic or flammable gases, heat, splattering, bubbling, fire, or explosion. If an uncommonly used method and/or chemical solution is being considered for decontamination, it is important to consult with an experienced chemist to ensure chemical compatibility.

ORS

ıe common decontamination solutions are listed below along with the contaminants
/ are effective against:

ıtion	Effective Against
ter	Short-chain hydrocarbons, inorganic compounds, salts, some organic acids, other polar compounds.
ute Acids	Basic (caustic or alkaline) compounds, amines, hydrazines.
ute Bases	Acidic compounds, phenols, thiols, some nitro- and sulfonic compounds.
ganic Solvents	Nonpolar compounds (such as some organic compounds)

e use of organic solvents is not recommended because 1) organic solvents can per-
ate and/or degrade the protective clothing, and 2) they are generally toxic and may
ult in unnecessary employee exposure to hazardous chemicals.

hen in doubt, use a dish washing liquid detergent. As a decontamination solution, it is
adily available, is the safest of all the above, and is usually strong enough if used
nerously.

he use of steam can also be effective for decontamination. A water-lazer (pressurized
ater) is exceptionally valuable.

he following substances are noted for their particular efficiency in removing certain
ntaminants or for decontaminating certain types of equipment.

olution	Effective Against
enetone	PCB Contamination (since penetone may also remove paint, it is a good idea to spot-test before use)
iquinox	Contaminated pumps
vory liquid	Oils
)iluted HTH	Cyanides
Radiac	Low level radioactivity
sopropanol	Biological agents (should not be used on rubber products since it will break down rubber)
Hexane	Certain types of lab or sampling equipment (use of hexane is discouraged due to its flammability and toxicity)
Zep	General purpose cleaning
Alconox	General purpose cleaning

Decontamination Solutions to Avoid

Some decontamination solutions should be avoided because of their toxicity, flammability, or harmful effects to the environment.

Halogenated hydrocarbons, such as carbon tetrachloride, should not be used because of their toxicity, possible incompatibility, and some because of their flammability.

Organic decontamination solutions should not be used on personal protective equipment (PPE) because they may degrade the rubber or other materials comprising the PPE.

Mercurials are sometimes used for sterilization. They should be avoided because of their toxicity.

Chemical leaching, polymerization, and halogen stripping should all be avoided because of possible complications during decontamination.

Sand-blasting, a method of physical removal, should be avoided because the sand used on the contaminated object usually needs to be disposed of as hazardous waste, a very costly proposition. Also, sand-blasting exposes personnel to silica, a carcinogen.

Freon is known to be particularly effective for the cleansing of PCB's, but its effect on the ozone layer is extremely harmful. Its use should be discouraged.

Strong acids or bases should not be used when cleaning metals and gaskets of tools or other equipment because of the possibility of corrosion.

Disposal of Decontamination Solutions and Waste Water

All solutions and water used for decontamination must be collected. If lab analyses indicate that the water and/or solutions exceed allowable contamination levels, they must be treated as hazardous waste. Alternatively, the solutions and water may be treated on-site to lower the contamination levels and render them nonhazardous.

Containers such as 55-gallon drums should be available for storage of wastes.

Spent decontamination solutions can be collected by using heavy-duty plastic sheets, visqueen sheets, kiddie pools, or if needed, a larger containment basin. The decontamination of equipment must be performed on the sheets or in the basins. They could

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be placed on a slight angle so that the spent decontamination solutions drain into a collection basin or drum.

Recommended Supplies for Decontamination of Personnel, Clothing, and Equipment

The list below contains recommendations for supplies which should be on hand for the decontamination of personnel, clothing and equipment. Depending on the site activities, not all of these items may be needed. Alternatively, some additional items not listed here may be required.

- Drop cloths of plastic or other suitable material, such as visqueen, for heavily contaminated equipment.
- Disposal collection containers, such as drums or suitably lined trash cans for disposable clothing and heavily contaminated personal protective clothing or equipment to be discarded.
- Lined box with adsorbents for wiping or rinsing off gross contaminants and liquid contaminants.
- Wash tubs of sufficient size to enable workers to place booted foot in and wash off contaminants (without a drain or with a drain connected to a collection tank or appropriate treatment system).
- Rinse tubs of sufficient size to enable workers to place booted foot in and hold the solution used to rinse the wash solutions and contaminants after washing (without a drain or with a drain connected to a collection tank or appropriate treatment system)
- Wash solutions selected to wash off and reduce the hazards associated with the contaminated wash and rinse solutions.
- Rinse solution (usually water) to remove contaminants and contaminated wash solutions.
- Long-handled, soft-bristled brushes to help wash and rinse off contaminants.
- Lockers and cabinets for storage of decontaminated clothing and equipment.
- Storage containers for contaminated wash and rinse solutions.
- Plastic sheeting, sealed pads with drains, or other appropriate method for containing and collecting contaminated wash and rinse water spilled during decontamination.
- Shower facilities for full body wash or, at a minimum, personal wash sinks (with drains connected to collection tank or appropriate treatment system).
- Soap or wash solution, wash cloths and towels.
- Clean clothing and personal item storage lockers and/or closets.

ORS

Standard Equipment Limited Warranty

All references to the Customer herein shall mean the Customer or the Lessee as applicable.

(a) ORS Environmental Equipment, a Division of Groundwater Technology, Inc. (ORS), warrants that any Equipment which it manufactures will be free from substantial defects in material and workmanship for a period of one (1) year from the date such goods are delivered to a carrier by ORS for shipment to the Customer.

(b) The Customer agrees that the liability of ORS hereunder shall be limited to replacing, repairing or issuing credit for, at ORS's discretion, any Equipment which is returned F.O.B. ORS's plant within the applicable term of the warranty, provided that (i) upon examination of the Equipment ORS determines that the alleged defect constitutes a substantial defect, and (ii) the warranty made herein is not invalid pursuant to Section (d) hereof. The Customer agrees that such replacement, repair or credit shall be its sole and exclusive remedies hereunder. For purposes hereof, a substantial defect shall mean any defect which prevents the Equipment from operating in accordance with ORS's published specifications. In the event that ORS determines that Equipment which is no longer manufactured by it contains a substantial defect and the warranty covering the defective equipment is not invalid pursuant to Section (d) hereof, the Purchaser's sole and exclusive remedy hereunder shall be the repair of such Equipment or the replacement of such Equipment with new equipment at ORS's discretion. In no case is Equipment to be returned by the Customer without first submitting a warranty claim in writing to ORS and obtaining a return authorization number from ORS. Equipment which is repaired or replaced pursuant to this warranty shall continue to be warranted for the unexpired portion of the warranty term applicable to the Equipment so repaired or replaced. ORS shall make the final determination as to the existence or cause of any alleged defect.

(c) The foregoing warranty shall not be valid (i) if the alleged defect is the result of abuse, misuse, accident, alteration, neglect or unauthorized repair; (ii) if ORS requires installation of Equipment by specifically approved ORS employee and such installation is not effected, or the Equipment is otherwise installed improperly; or (iii) if the Equipment is resold by the Customer. Any repair shall be deemed unauthorized unless it is made (i) by ORS or a duly authorized agent of ORS or (ii) with the written consent of ORS.

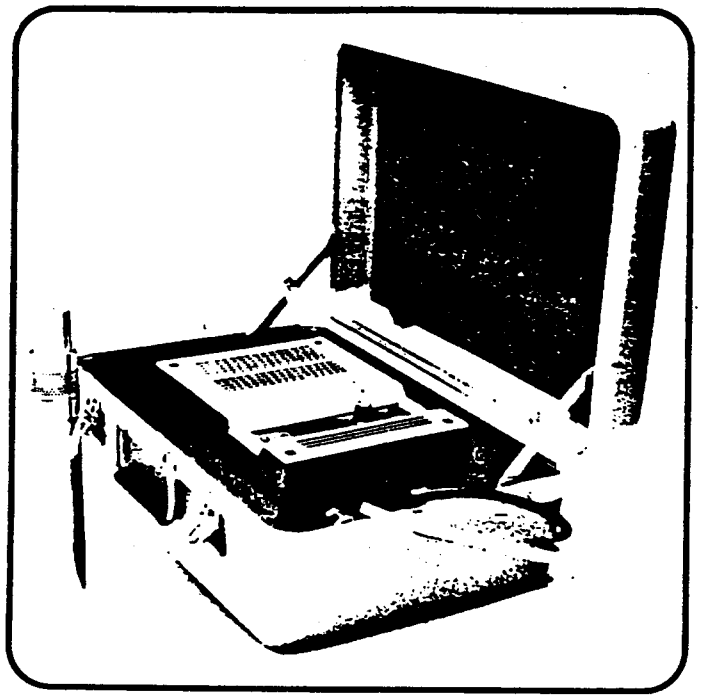
(d) The operating efficiency of treatment, abatement, and recovery Equipment and systems is affected by factors extrinsic to their manufacture, including operating environment and such conditions of use as contaminant and related substance build-up, the frequency and [illegible] of operator maintenance and other external variables. For these reasons, specific levels of performance cannot be guaranteed for such Equipment and systems.

(e) THIS WARRANTY IS THE SOLE WARRANTY MADE BY ORS TO THE CUSTOMER AND IS IN LIEU OF ALL OTHER WARRANTIES OR OBLIGATIONS, EXPRESS OR IMPLIED. ORS EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

(f) THE CUSTOMER AGREES THAT IN NO EVENT SHALL ORS BE LIABLE FOR SPECIAL, INCIDENTAL, INDIRECT, EXEMPLARY OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS OR LOSS OF USE OR ANY OTHER ECONOMIC LOSS, WHETHER BASED ON CONTRACT, TORT OR ANY OTHER LEGAL THEORY.

(g) THE REMEDIES PROVIDED HEREIN ARE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES.

Redi-Flo2



Installation and Operating Instructions

GRUNDFOS

SAFETY WARNING

Adherence To Environmental Regulations

When handling and operating the Redi-Flo2 system, all environmental regulations concerning the handling of hazardous material must be observed. When the pump is taken out of operation, great care should be taken to ensure that the pump contains no hazardous material that might cause injury to human health or to the environment.

Motor Fluid

The pump motor is filled with approximately .85 ounces (25 milliliters) of contaminant-free water. During operation, it is possible that a very small portion of this water could be replaced by the fluid being pumped. Therefore, there is a potential risk for cross contamination if used in portable applications. A filling syringe is provided with each pump to simplify the replacement of this water with clean water.

Returning A Pump For Service

Only pumps that are certified as uncontaminated will be accepted by GRUNDFOS for servicing. GRUNDFOS must receive this certification prior to receiving the pump. If not, GRUNDFOS will refuse to accept delivery of the pump. In these cases, all costs incurred in returning the product to the customer will be paid by the customer.

Electrical Hazards

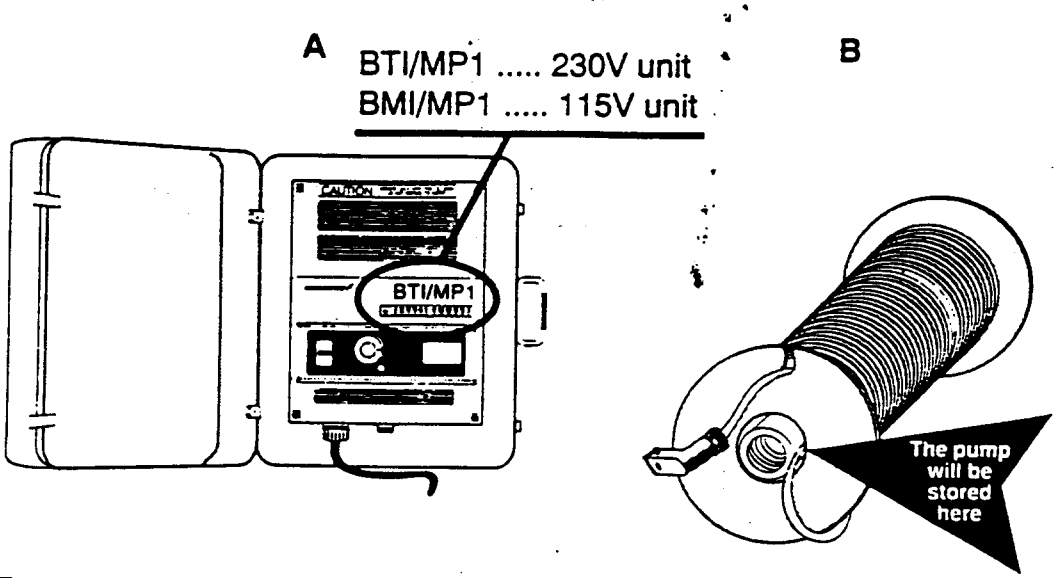
The Redi-Flo2 pumping system is not approved for Class I, Division I, Group D locations as specified by the National Electrical Code (NEC). Consult local authorities and regulations if you have any doubt about its suitability for a specific application.

PRE-INSTALLATION CHECKLIST

Components of Your Redi-Flo2

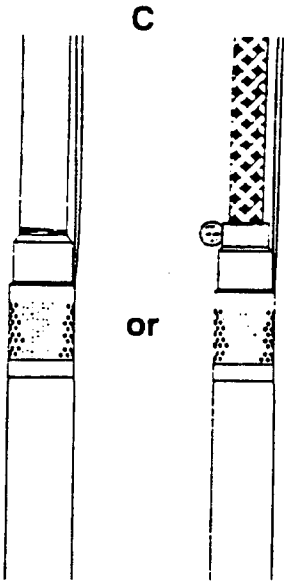
Your Redi-Flo2 Environmental Pumping system should contain the following components:

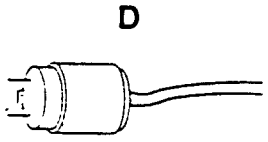
A. Converter in a protective carrying case
B. MP1 pump and motor with motor lead



To operate the system you will also need:

C. Hose or pipe to connect to the pump and lower it into the well
D. An electrical plug to connect the converter power cord to your portable generator or other power source (BTI/MP1 only plug supplier on BMI/MP1).
E. Some type of safety cable (and attachments) for lowering and lifting the pump





(The exact type of plug used will depend upon your generator).

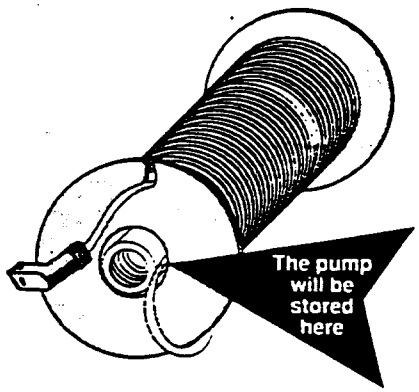


ASSEMBLING THE Redi-Flo2

Assembly Instructions

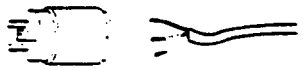
All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

1

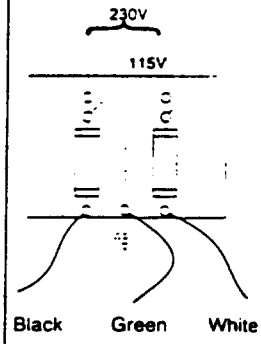


Unpack the components of the Redi-Flo2 system. The MP1 pump will be packed in the center of the motor lead roll.

2

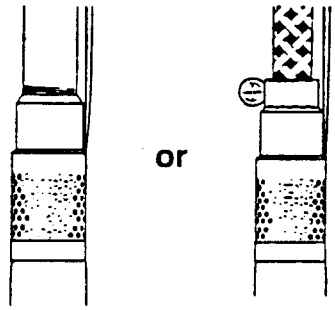


Strip the cord jacket and insulation from the ends of the converter power cord. Consult your local electrician to connect the leads to the electrical plug. (The ground wire should be connected to the elongated plug terminal and single phase 230 volt power should be measured across the black and white leads.)



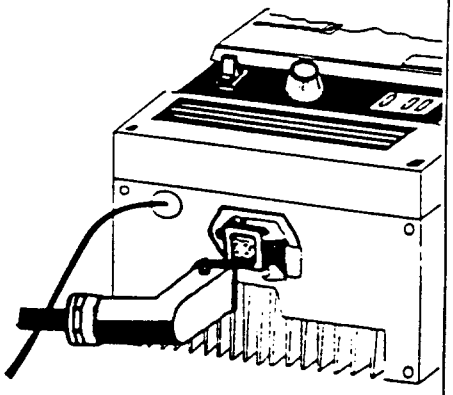
If the converter connects directly to a permanent power supply, consult your local electrician to connect the wires as shown.

3



Connect the MP1 pump to the pipe or hose through which the fluid will be pumped. If a hose is connected, a compression coupling should be used to ensure a strong, watertight fit. A safety cable may be attached to the pump (using a special bracket), as well as a plastic spiral flex clamp to secure the wire. A check valve may also be fitted to prevent liquid from flowing back into the pump after it is turned off (backflow prevention).

4



Fit the motor lead plug into the converter. Fit the converter plug into the generator (or other power source).

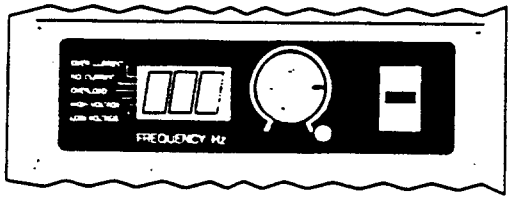
OPERATING THE Redi-Flo2

Starting

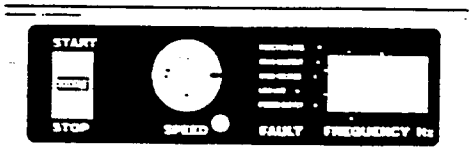
The Redi-Flo2 is easy to operate. Simply:

1. Submerge the pump in water.
2. Start the generator (or other power source).
3. If the generator has a circuit breaker, turn it on. Plug power cord into generator.
4. Check the frequency display on the front of the converter. It should read "0" (zero). If it doesn't, refer to theTroubleshooting section on pages 13-14.
5. If this is the first time the converter is being used or it has not been used for more than six months, leave the converter on for at least 15 minutes before proceeding to step 6.
6. Set the converter's speed dial near the middle of the dial (12 o'clock position).
7. Start the pump by pressing the **Start/Stop** switch into the "Start" position.
8. Adjust the pump performance by turning the speed dial.

BMI/MP1 Panel
115 Volt



BTI/MP1 Panel
230 Volt



Stopping

To stop the pump, press the **Start/Stop** switch on the converter to the "Stop" position. There is no need to reduce the pump speed first. Turn the POWER OFF at the generator **BEFORE** removing the motor lead from the converter.

Operating Conditions

To ensure the Redi-Flo2 operates properly, follow these guidelines:

- The MP1 pump must be installed vertically with the discharge end pointing upwards.
- The electrical voltage to the converter must always be + or -10% of the specified power supply.
- SPECIFIED POWER SUPPLY- BTI/MP1- 220-230 Volts, single phase, AC.(198 to 253 Volts) BMI/MP1- 115 Volts, single phase, AC. (109 to 126 Volts)
- The motor and pump must always be completely submerged in fluid to ensure lubrication of the shaft seal and cooling of the motor.
- While the pump is pumping, the distance down from the ground level to the level of the water in the well must not be greater than 270 feet.
- If the pump is used in a well larger than 4" in diameter, a shroud should be used around it to ensure proper motor cooling.
- The temperature of the water being pumped should be between 34°F and 86°F (1°C and 30°C)

Purging A Well

If the pump is being used to purge a well, start it at the maximum speed. Do not stop the pump until the pumped water contains no visible particles (to avoid blockage within the pump).

Thawing A Frozen Pump

If the liquid in the pump is frozen so the motor shaft cannot rotate, lower it into water and start it at the slowest speed. Continue to operate the pump at this speed for about 10 minutes, at which time it will be thawed and ready for operation.

MAINTENANCE AND CARE

Dismantling & Reassembling

The MP1 pump can be dismantled and reassembled quickly and easily by referring to the diagram on page 11 and following these steps:

DISMANTLING

1. Shut the pump off using the converter's Start/Stop switch.
2. Turn the generator (or other power supply) OFF.
3. Disconnect the motor lead from the converter.
4. Remove the pipe or hose connected to the pump (OPTIONAL).
5. Remove the Set Screw (position 12 in the diagram on page 11). Grasp the Inlet Screen (position 1) and slowly but forcefully pull it up over the Pump Housing (position 2).

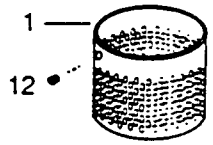
DO NOT ALLOW THE INLET SCREEN TO SCRAPE THE INSULATION FROM THE MOTOR LEADS.

6. Unscrew and remove the Pump Housing (counterclockwise when viewed from the top). This will expose the impeller assembly (guide vanes, wear rings, etc.), which can now be removed by hand for extended cleaning or replacement.

REASSEMBLY

To reassemble the MP1 pump, refer to the diagram on page 11 and:

1. Make sure the motor lead is not connected to the converter.
2. Return the impeller assembly components (guide vanes, wear rings, etc.) to the shaft in the proper order.
3. Screw the Pump Housing (position 2) back onto the top of the pump. If all of the impellers and chambers were replaced correctly, the Pump Housing should screw on easily. Hand tighten.
4. Slip the Inlet Screen (position 1) back over the Pump Housing. Screw the Set Screw (position 12) back into the Inlet Screen.



MAKE SURE YOU LINE UP THE MOTOR LEAD WITH THE RECESSED AREA IN THE PUMP HOUSING TO AVOID SCRAPING THE INSULATION FROM THE LEADS

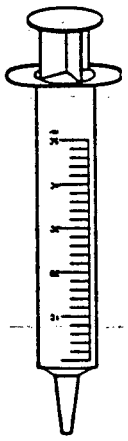
Replacement Of Motor Fluid

If the pump is moved from well to well, it should be thoroughly decontaminated prior to being installed in the next well. In addition to cleaning the individual components inside and outside, the water in the pump motor should be replaced using the syringe that came with your pump. This can be accomplished through the following steps:

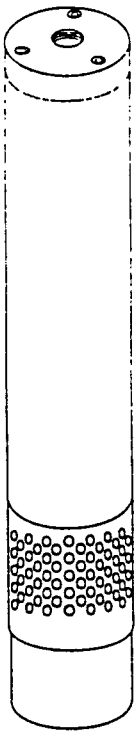
1. Shut the pump off using the converter's Start/Stop switch.
2. Turn the generator (or other power supply) OFF.
3. Unplug the pump from the converter.
4. Turn the pump and motor upside down.

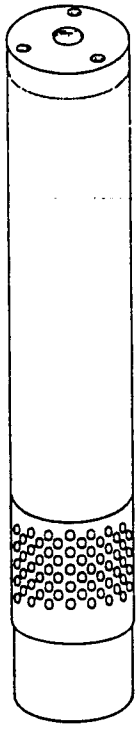


5. Use a flat screwdriver to remove the filling screw on the bottom of the motor.



6. Empty the water from the motor and refill it using contaminant-free water and the syringe that came with your MP1 pump. The water level should be even with the bottom edge of the screw hole.
7. Replace and tighten the filling screw.
8. Turn the pump over several times, then remove the filling screw again to let any trapped air escape (if air is left inside the motor, the life of the motor will be shortened). Add more water, if necessary.
9. Replace and tighten the filling screw.





MAINTENANCE AND CARE

Replacing the Motor Lead

To replace the motor lead, refer to the diagram on page 11 and follow these steps:

REMOVING THE OLD MOTOR LEAD

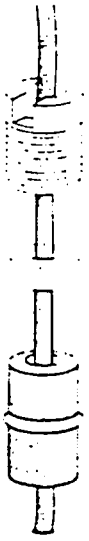
1. Make sure the power is turned **OFF**, the converter is turned **OFF**, and the motor lead is not connected to the converter.
2. Loosen and remove the Set Screw (position 12) from the Inlet Screen (position 1).
3. Slide the Inlet Screen off the pump. If you plan to use this motor lead again, be careful not to scrape insulation from it as the Inlet Screen is removed.
4. Loosen and remove the Pump Housing (position 2). Remove the impeller assembly (impellers, guide vanes, etc.).
5. Refer to the illustration on page 8. Use the special Motor Lead Screwdriver (shown at right) that came with your new motor lead to loosen and remove the Motor Lead Screw (position 14) for the ground lead (green/yellow wire).
6. Pull up on the ground lead to remove it. Using a small screwdriver and precision electronics pliers, pry up and remove the Teflon® Washer (position 15) and Brass Washers (position 16) from inside the enlarged Ground Motor Screw (position 13). Remove the Ground Motor Screw.
7. Use an allen wrench (2.5 mm) to remove the two Motor Screws (position 19) holding the Suction Interconnector (position 10) in place. Remove the Suction Interconnector but be very careful to note which of its slots is lined up with which motor lead -- this will be very helpful during reassembly. You may wish to scratch a mark on both the Suction Interconnector and the motor to aid in matching them up later.
8. Refer to the illustration at the bottom of this page. Use the special Motor Lead Screwdriver to loosen and remove the remaining Motor Lead Screws (position 14).
9. Pull up on each of the leads to remove them. Make a note which color conductor comes out of each hole -- **this is a MUST** when installing the new motor lead. Using a small screwdriver and precision electronics pliers, unscrew and remove the Teflon ® Washer (position 15) and the Grommet (position 17).



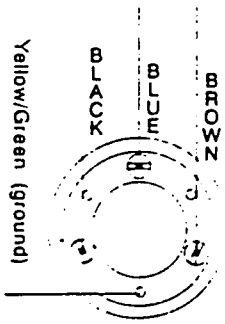
INSTALLING THE NEW MOTOR LEAD

10. Ensure the motor lead holes are clean and free of moisture.
11. String the Inlet Screen (position 1) onto the motor lead.
12. String the motor lead components (shown at right) onto the end of each motor lead wire (except the yellow/green ground wire).
13. For each wire, place the Crimped Pin (position 18) down into the motor lead hole. Press the Grommet (position 17) and Teflon ® Washer (position 15) down around the lead.

Power Conducting Motor Leads



Motor Leads

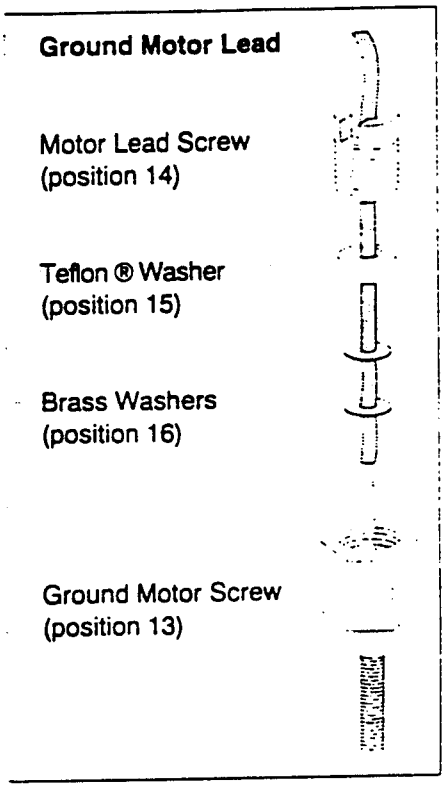


Be sure to reconnect the lead wires in their previous pattern shown at left so that in clockwise order they are **black-blue-brown.**

For Tefzel motor lead use the following wiring pattern: Green stripe (Ground), 1st wire to the right (previously black), 2nd wire to the right (previously blue), third wire to the right (previously brown).

14. While pushing the lead down into the motor lead hole, use the special Motor Lead Screwdriver to tighten the Motor Lead Screw (position 14) into place. Repeat for the other two lead wires.
15. Replace the Suction Interconnector (position 10). Replace the Ground Motor Screw (position 13). Since the ground wire will be attached to this screw, you will want to put it into the hole that will cause the least amount of twisting to the wire.
16. Replace and tighten the two Motor Screws (position 19) with an allen wrench.
17. Repeat steps 12-14 for the ground motor lead. Note on the illustration (at right) that the ground lead uses two Brass Washers (position 16) instead of a Grommet and Crimped Pin.
18. Return the impeller assembly to the top of the Suction Interconnector (position 10). Refer to the diagram on page 11 for the proper sequence.
19. Screw the Pump Housing (position 2) back onto the Suction Interconnector.
20. Position the motor lead in the recessed area of the Pump Housing.
21. Carefully push the Inlet Screen (position 1) over the Pump Housing and the Suction Interconnector.

BE VERY CAREFUL TO AVOID SCRAPING THE INSULATION FROM THE MOTOR LEAD AS THE INLET SCREEN IS FITTED.



22. Line up the screw hole in the Inlet Screen with the screw hole in the Pump Housing. Fit and tighten the Set Screw (position 12).
23. Connect the motor lead to the converter and test the rotation of the pump. Submerge the pump in water, start it at its slowest speed and make sure the pump shaft is turning counterclockwise (when viewed from the top). If the rotation is incorrect, switching any two power leads (with POWER OFF) will correct the problem.
24. Reconnect the hose or pipe.



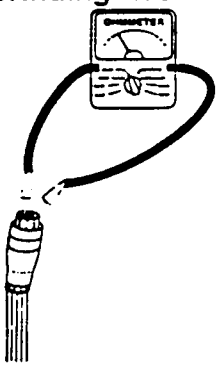
Teflon® is a registered trademark of Du Pont

Periodic Motor Inspection

If the pump is operating at a decreased capacity and the impeller assembly components (impellers, guide vanes, etc.) do not appear to be the cause, the motor should be checked. A checklist of things to examine includes:

- ❑ Check the fluid level inside the motor (refer to page 6). Replace and refill as necessary.
- ❑ Inspect the outside of the motor for cracks, dents, etc.
- ❑ Remove the Inlet Screen (position 1), Pump Housing (position 2), and the impeller assembly (guide vanes, wear rings, etc.). Try to spin the motor shaft by hand. It should spin freely. If it does not, the motor must be replaced.
- ❑ Check the winding and insulation resistance of the motor and lead.

Winding Resistance



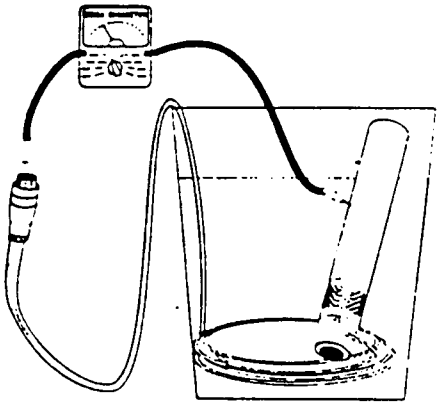
Turn the power off and disconnect the motor lead from the converter. Using an ohmmeter, set the scale to R X 1. Zero-adjust the meter and measure the resistance between any two power conducting leads (prongs on the motor lead plug).

If the ohm value is too low, the motor may be shorted. If too high, the motor windings or the leads may be open.

Lead Length	Ohm Value
0 ft	3.0 - 3.5 Ω
50 ft	3.6 - 4.1 Ω
75 ft	3.9 - 4.4 Ω
100 ft	4.2 - 4.7 Ω
125 ft	4.5 - 5.0 Ω
150 ft	4.8 - 5.3 Ω
175 ft	5.1 - 5.6 Ω
200 ft	5.4 - 5.9 Ω
250 ft	6.0 - 6.5 Ω
300 ft	6.6 - 7.1 Ω

Insulation Resistance

Turn the power off and disconnect the motor lead from the converter. Use a **meg**ohmmeter or megger (1 Meg = 1 M = 1 million). Zero-adjust the meter and measure the resistance between any power conducting leads (prongs on the motor lead plug) and ground. A good way to accomplish this (as shown at right) is to submerge the motor lead and MP1 pump in a bucket of water. Touch one lead of the megohmmeter to the pump and one to a motor lead.

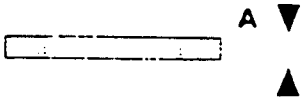


If the ohm value is lower than 2MΩ, the motor is defective and must be replaced.

Checking Components For Wear

The pump components should be periodically checked to ensure they are still within their minimum operating tolerances (illustrated below).

Impeller (position 5) ..... The impellers should show no visible wear.
Guide Vane (position 3) ..... The guide vanes should show no visible wear
Wear Ring (position 4) ..... The minimum thickness ("A" in the illustration) should never be less than 1.0 mm



In addition, visually check all components for cracks, corrosion, or wear.

Storage Requirements

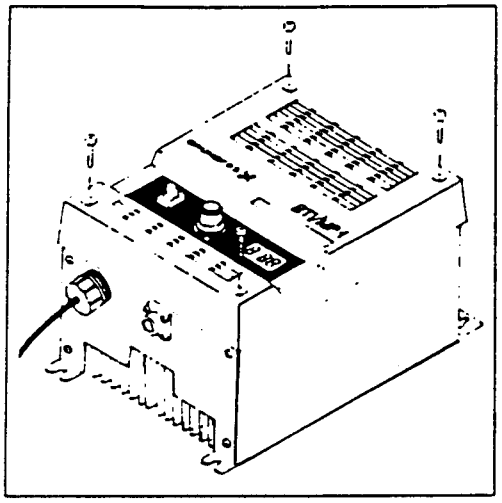
The pump should be thoroughly cleaned before storage to ensure no contamination is present. Both the pump and the converter should be stored in a clean and dry area in the following temperature range:

- 20°C to +50°C
or
0°F to 120°F

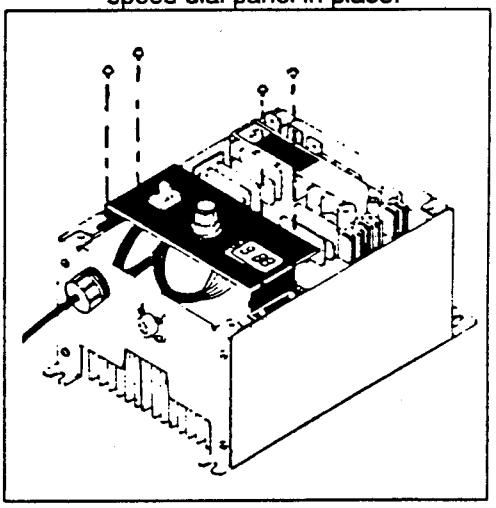
Replacing the Converter Fuses

The converter fuses can be replaced by following these steps:

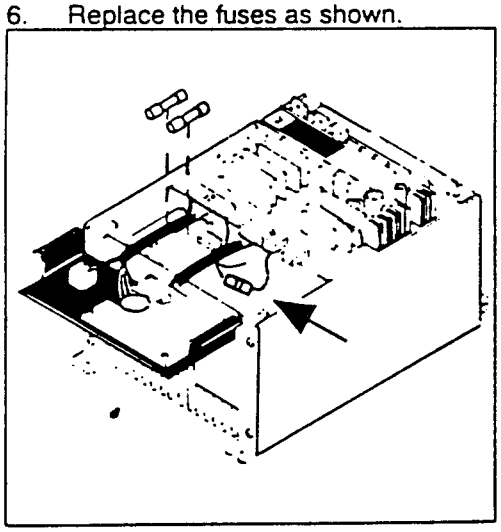
1. Turn the **POWER OFF.**
2. Disconnect the converter from the power source.
3. Wait at least 3 minutes to give the capacitors time to discharge any remaining voltage.
4. Remove the four screws holding the front cover of the converter in place and remove the front cover.



5. Remove the four screws holding the speed dial panel in place.



6. Replace the fuses as shown.



NOTE:
The BTI/MP1 converter uses two 30A, 250V, single element, fuses, and one fuse-able link fuse (250V 3/10A). .

PARTS LIST

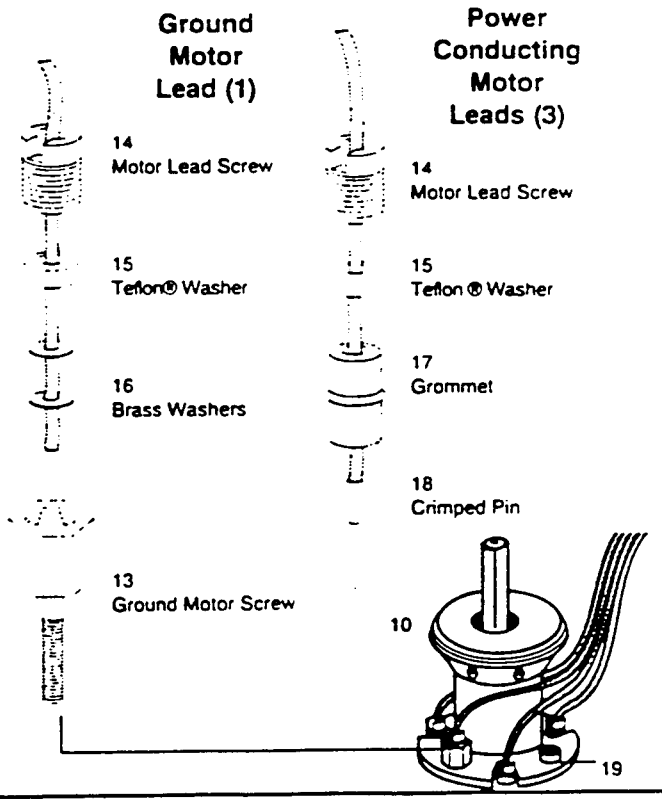
Pump Components

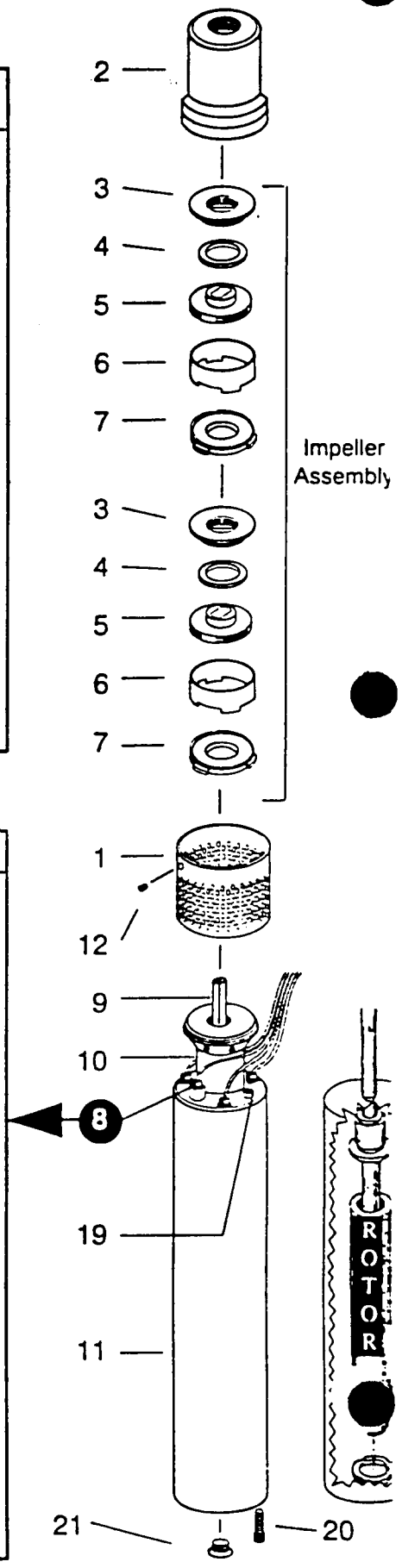
Position No.	Part Description	No. Used Per Pump	Part Number
1	Inlet Screen	1	1A0004
2	Pump Housing 1/2" NPT	1	1A0044
3	Guide Vane	2	see Service Kits
4	Wear Ring	2	*
5	Impeller	2	*
6	Spacer Ring	2	*
7	Wear Plate	2	*
8	Motor Lead Assembly	4	see Pos. 13 - 18
9	Shaft	1	not available *
10	Suction Interconnector	1	1A5004
11	Stator Housing	1	not available *
12	Set Screw	1	see Service Kits
13	Ground Motor Screw	1	*
14	Motor Lead Screw	4	*
15	Teflon® Washer	4	*
16	Brass Washer	2	*
17	Grommet	3	*
18	Crimped Pin	3	*
19	Motor Screw (long)	2	*
20	Motor Screw (short)	6	*
21	Filling Screw w/ O-Ring	1	*
22	Motor Thrust Washers	2	*

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* Not economical to replace. Must purchase complete pump/motor

MOTOR LEAD ASSEMBLY (position 8)

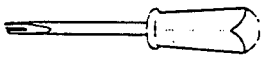
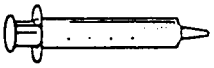
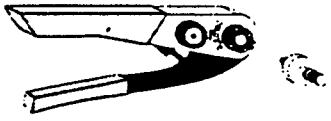


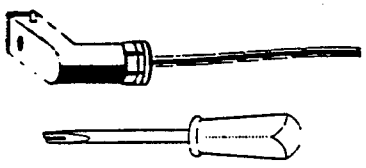


Service Kits, Tools, and Motor Leads

Replacement parts, service tools, and motor leads are available using the following part numbers:

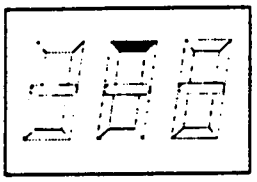
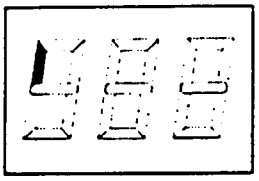
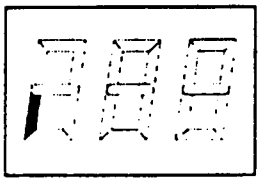
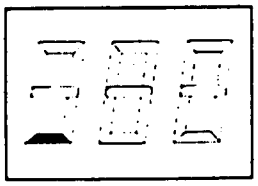
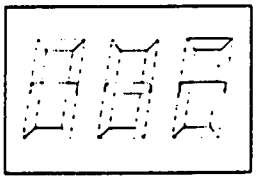
Service Kits			Part Number
Position No. In Diagram	Part Description	No. In Kit	
3	Guide Vane	2	125061
4	Wear Ring	2	
5	Impeller	2	
6	Spacer Ring	2	
7	Wear Plate	2	
4	Wear Ring	4	1A5050
7	Wear Plate	4	
13	Ground Motor Screw	1	1A00028
14	Motor Lead Screw	4	
15	Teflon Washer	4	
16	Brass Washer	2	
17	Grommet	3	
18	Crimped Pin	3	
5	Impeller	2	1A00018
12	Set Screws	25	1A00038
14	Motor Lead Screws	12	1A00048
15	Teflon Washer	25	1A00058
16	Brass Washer	25	1A00068
17	Grommet	25	1A00078
18	Crimped Pin	50	1A00088
19	Motor Screw (long)	25	1A00098
20	Motor Screw (short)	25	1A00108
21	Filling Screw with O-Ring	5	1A00118
22	Motor Thrust Washers	4	1A00128

Service Tools	Part Number
Special Motor Lead Screwdriver 	SV0370
Syringe (to refill motor) 	ID6066
Crimping Tool Kit (Required to crimp, "crimped pin"). 	1A00141

Motor Leads		Part Number
All motor leads come with a Converter Plug attached and a special Motor Lead Screwdriver 	30 foot length	1A5070
	50 " "	1A 5071
	75 " "	1A 5072
	100 " "	1A 5073
	125 " "	1A 5074
	150 " "	1A 5075
	175 " "	1A 5076
	200 " "	1A 5077
	250 " "	1A 5078
	300 " "	1A 5079

TROUBLESHOOTING

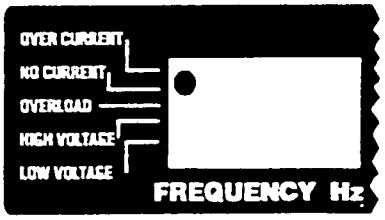
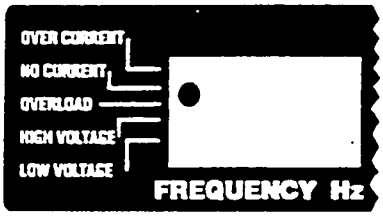
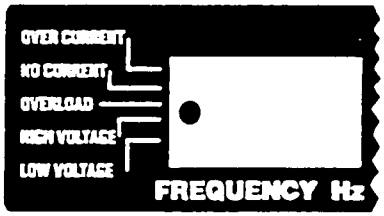
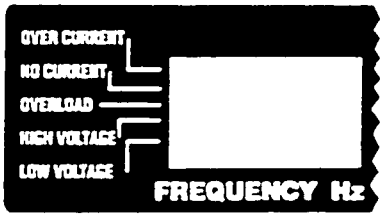
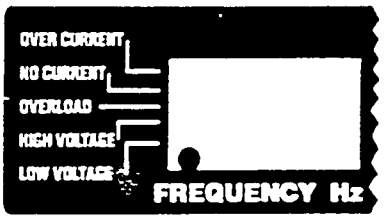
The converter will shut itself off if any major faults occur, and signal (on the converter display) the cause of the fault. These include:

If the display shows this:	The fault is:	Which is caused by:
		· A thermal cut-out or shutdown
	**Function Loss**	· Defective motor lead or pump · Momentary problem (transient fault)
	**Overvoltage**	· The input voltage is too high · There was a momentary power surge
	**Low Line**	· The input voltage is too low · There was a momentary voltage drop
	**Power Supply**	The power supply is defective
	**Pump Problem** (if numbers climb only to about 50 - 130)	· The pump shaft is locked · One of the 3 motor leads is not making contact with the motor
	**No Display = No Power**	· The converter is not being supplied with power · The power being supplied is a very low voltage · The internal fuses are defective

To correct, simply:
Wait until the motor has cooled to a normal temperature. Restart the motor using the on/off switch on the converter.
1. Reset the converter and restart it. If it shuts down again, then ... 2. Switch off the power supply. Turn the power supply back on and restart the converter. If the converter shuts down again, the pump or the motor lead may be defective. If the converter **doesn't** shut down again, it was probably a transient fault (momentary power surge, etc.). **IF ALL CHECKS INDICATE THAT THE PUMP IS O.K., THEN THE CONVERTER MAY BE DEFECTIVE**
1. Reset the converter and restart it. If it shuts down again, then ... 2. Reduce the voltage coming into the converter (refer to the "Technical Data" section on the following pages for operating ranges).
1. Reset the converter and restart it. If it shuts down again, then ... 2. Increase the voltage coming into the converter (refer to the "Technical Data" section on the following pages for operating ranges).
Check the voltage of the incoming power supply (should be between 190-253 V).
1. Turn the speed dial to maximum frequency. If this results in a **Function Loss**, follow the troubleshooting instructions listed above. 2. If you **don't** get a Function Loss, the problem is with the converter.
1. Check the amount of the incoming voltage. If it is within allowable limits (190 - 253 V), then ... 2. Flip the generator circuit breaker (if it has one) to the "ON" position. Reset the converter and restart it. If the converter still shows no display, then ... 3. Switch the power supply off. Check the fuses in the converter and replace if necessary. If the fuses are OK, then ... 4. Check the electrical plugs to ensure all connections are made properly.

TROUBLESHOOTING

The converter will shut itself off if any major faults occur, and signal (on the converter display) the casue of the fault. These include:

If the display shows this:	The fault is:	Which may be caused
	Overcurrent	· Output line-to-line · Output line-to-ground · Momentary overload · Overheat
	No Current	· Motor disconnection
	Overload	· Internal thermal overload
	High Voltage	· Input voltage is too high
	Low Voltage	· Input voltage too low

To correct, simply:
Check insulation among each output line.
Check insulation between ground and output line.
Reduce load on motor.
Check ambient temperature. If incorrect, cool unit. Possible Power Circuit board defect.
Check continuity for motor coils and motor leads. Check motor lead output connector.
Reduce load on motor.
Check input voltage. If incorrect, reduce input voltage.
Check input voltage.

TECHNICAL SPECIFICATIONS

Converter Specifications - BTI/MP1 230 Volt

Power

Supplied By Generator/Power Supply

Voltage:	Single phase, 230 volt (+ or - 10%)
Frequency:	50-60 Hz (+ or - 2%)
Maximum Current:	10 amps

Produced By Converter

Output Voltage:	3 phase 25-220 volts
Frequency:	46 - 400 Hz
Maximum Current:	5.5 amps
Internal Fuses:	2 each of 250V single element 1 of 250V 3/10A

Connections

Motor Lead Connector:	AMP CPC Plug, Type 206429-1
Power Cable:	Type SJOW, 14 AWG, 10' long

Dimensions and Weight

Dimensions:	Case is 9"x14"x18.5"
Net Weight:	25 lbs

Operating Conditions

Ambient Temperature:	32°F to 104°F (0° to 40° C)
Relative Air Humidity:	Maximum 95%
Radio Noise Filter:	Noise may occur when the converter is connected to the municipal electrical supply. It can be eliminated by adding a filter, such as a Siemens filter, type B 84112-B-A 120/20 A.

Storage Conditions

Ambient Temperature:	-13°F to 149°F (-25° to 65°C)
Relative Air Humidity:	Maximum 50% at 104°F (40°C) unlimited Maximum 90% at 68°F (20°C) for periods not exceeding 30 days per year. 75% annual average Non-condensing

Performance

Acceleration Time:	0 to 400 Hz in 10 seconds
Deceleration Time:	400 to 0 Hz in 10 seconds

Converter Specifications - BMI/MP1 115 Volt

Power

Supplied By Generator/Power Supply

Voltage:	Single phase, 115 volts (+ or - 10%)
Frequency:	50-60 Hz (+ or - 2%)
Maximum Current:	16 amps

Produced By Converter

Output Voltage:	3 phase 25 - 220 volts
Frequency:	50 - 400 Hz
Maximum Current:	6 amps

Dimensions and Weight

Dimensions:	Case is 9"x14"x18.5"
Net Weight:	18 lbs

Storage Conditions

Ambient Temperature:	-40°F to 149°F (-40°C to 65°C)
Relative Air Humidity:	5% up to 95% relative air humidity

Performance

Acceleration Time:	0 to 400 Hz in 6 seconds
Deceleration Time:	400 to 0 Hz in 6 seconds

Motor/Pump Specifications

Power

Input Power:	1.5 Kw (2 Horsepower)
Voltage:	3 phase, 220 volts at 400 Hz
Maximum Current:	6 amps
Motor Protection:	Thermal overload - Thermik Geratebau, Series SY6 Disconnect Temperature: 176°F (80°C) Rate Current: 5 amps Current Overload - Incorporated into converter

Connection

Discharge Port:	1/2" Female NPT

Available Lead Lengths: 30, 50, 75, 100, 125, 150, 175, 200, 250, and 300 feet

Operating Conditions

Max. Fluid Temp.:	86°F (30°C)
Min. Fluid Temp.:	34°F (1°C)

Dimensions and Weight

Dimensions:	(Including pump and motor) 11.3" length x1.81" diameter
Net Weight:	5.5 lbs., excluding motor lead

LIMITED WARRANTY

Redi-Flo2 pumps manufactured by GRUNDFOS are warranted to the original user only to be free of defects in material and workmanship for a period of 12 months from the date of installation or 18 months from the date of manufacture. GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operation instructions.

To obtain service under this Warranty, contact the Distributor or Dealer from which it was purchased to obtain instructions. **Under no circumstances should defective product be returned to the Distributor, Dealer, or GRUNDFOS without specific instructions from them to do so.**

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

LRF-IO-002	Rev. 10/92

GRUNDFOS Pumps Corp. · 2555 Clovis Avenue · Clovis, CA 93612
Support Centers: Allentown, PA · Atlanta, GA

Warning

The HERMIT 1000C uses lithium batteries which the Department of Transportation considers a hazardous material. The HERMIT 1000C must never be transported on passenger aircraft. To do so is a violation of Federal Law (49 CFR 171.2). Please read and observe shipping instructions in Appendix C of this manual before attempting to ship the instrument.

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1 Introduction

Your HERMIT 1000C Environmental Data Logger is a versatile, self-contained, and extremely rugged field instrument that enables you to accurately perform a wide variety of hydrologic and environmental tests. To mention just a few of the special features of your HERMIT 1000C, you have the ability to:

- Measure and record parameters such as level, pressure, temperature, conductivity, and pH using standard In-Situ transducers.
- Easily reprogram your HERMIT 1000C to measure and record parameters from most industry standard 4-20 mA (milliampere) current loop transducers.
- Collect fast, accurate time-drawdown data from constant-rate or stepped-rate pump tests, including the recovery phase. This powerful feature is equally suited to slug tests.
- Perform unattended long-term monitoring of aquifers, lakes, streams, reservoirs, waste-disposal sites, or any environment where data collection is critical or difficult.
- Record data in as much as 32K bytes (32,768 characters of information) of non-volatile data storage. Even if the HERMIT 1000C's battery pack should fail, data will remain safe.
- Display and report all measured parameters in their selected measurement units. Data may be viewed on the LCD (liquid crystal) display, printed on an optional field printer, or transferred to most personal and portable computers via the built-in RS232C interface.
- Operate the HERMIT 1000C at extreme temperatures without having to supply an external power source.

What's New in Software Version 4.3

If you are already familiar with a previous version of the HERMIT 1000C, you may want to take notice of several new features that have been added to software Version 4.3.

- You can store up to 20 tests without erasing data.
- There is a new log schedule.
- The HERMIT checks that the programmed sample rate is long enough to accommodate the transducer delays before you exit the ENTER DATA menu and again before you exit the ENTER XD menu.

How to Use This Manual

This manual has been designed to enable you to gain the maximum benefit from your HERMIT and to answer your questions concerning field installations. If you have just received your new HERMIT, read Appendix B before you attempt to operate the instrument. Appendix B contains unpacking instructions and other important owner's information.

Then familiarize yourself with the HERMIT system by reading and following through the examples in Section 2 of this manual – with your HERMIT. The best way to feel at ease with the instrument is to sit down with the manual and the HERMIT and actually key in the examples provided. It won't take long to become familiar with your HERMIT and it is well worth the time invested to obtain a more complete understanding of the instrument.

Sections 3 through 11 of the manual discuss each of the programming and control features of the HERMIT, in the order you will most likely come to use them.

Sections 12 and 13 present field applications of the HERMIT. The procedures presented will give you a guide to programming the HERMIT to solve several common data-collection problems.

After you've become familiar with the HERMIT system, you may wish to enhance your data-collection capabilities with new types of transducers or other field accessories. Be sure to check the accessories list in Appendix A.

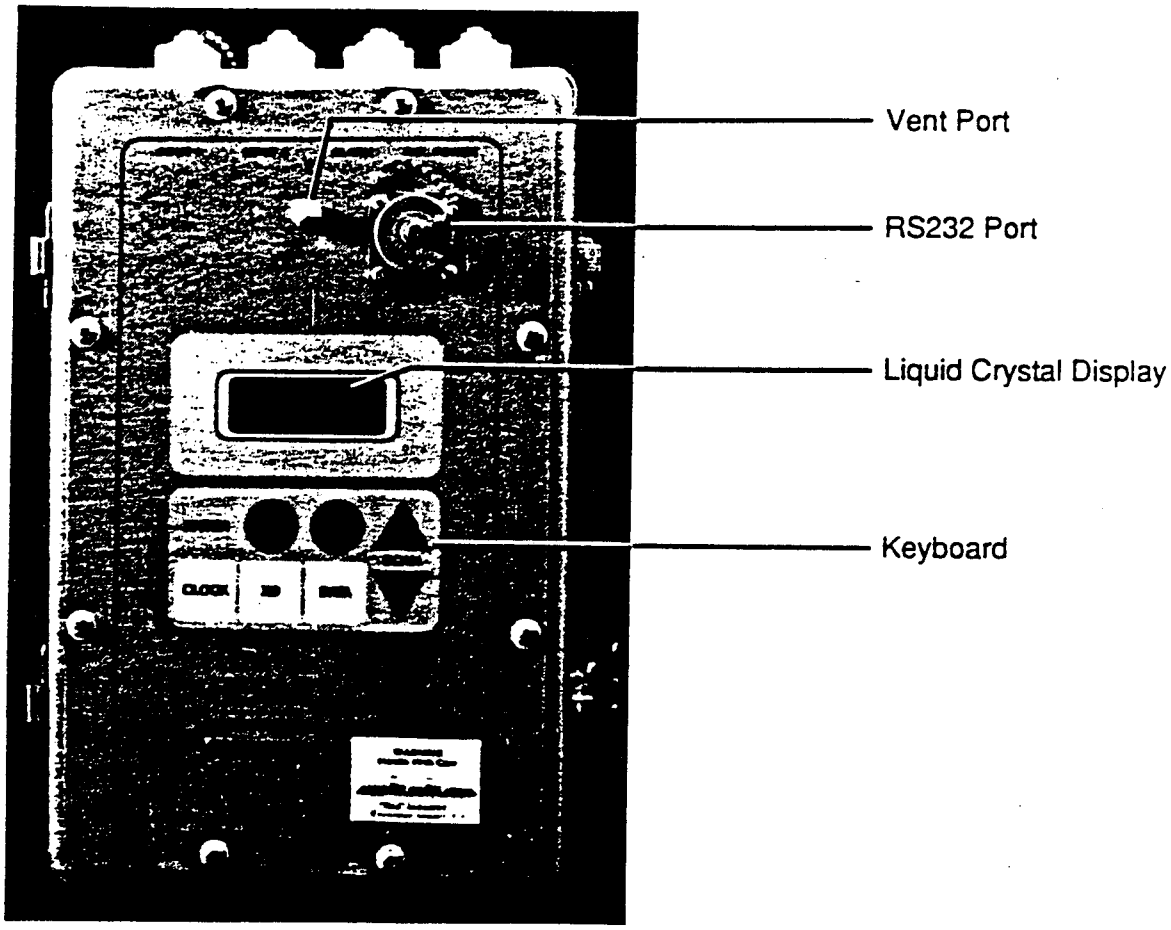
> ***CAUTION***
>
> *Do not attempt to set up the HERMIT without first becoming thoroughly familiar with Appendix B; it contains information that is important to avoid damaging your instrument when it is set up.*

2 Getting Started

In this section, we will discuss many topics in relatively few pages so that you can "get on board" fast. For this reason, some of the more sophisticated concepts are greatly simplified or reserved for later sections.

After working through this section, you'll have enough background to try things on your own, which is an excellent way to attain a good working knowledge of your instrument. *And don't worry, you can't damage the HERMIT or its accessories with any keyboard operation.*

Keyboard Operation



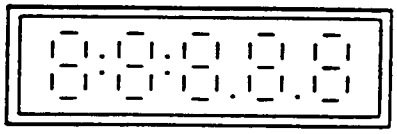
Wakeup

The HERMIT uses a technique called "sleeping" to minimize power consumption and achieve a battery life measured in years instead of months. Your HERMIT is naturally narcoleptic, falling asleep whenever there is no immediate task to perform. When the instrument is asleep, only its internal clock and keyboard circuits remain active (the data storage memory is non-volatile and requires no power to retain stored information). The HERMIT will "wake" when its internal clock indicates it is time to take a data point, or when you press a key on the front panel.

The ***sleep mode*** is recognized by a blank display.



Lightly press and release any key. The HERMIT will wake up . . .



. . . and respond with its ***status display***. The unit is now ready for a keypad command. Your status display may look different from this one; see "The Status Display," p. 13.

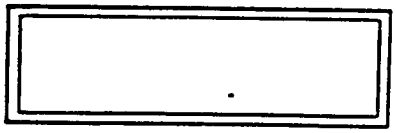


The HERMIT will remain awake as long as you are using the keyboard. In most cases it will return to the sleep mode if no key has been pressed for sixty seconds. If you pause long enough between keystrokes to let the unit sleep, you must wake it and repeat the operation. This will probably occur often at first, when you are learning how to operate the instrument. As you become familiar with the keystrokes needed to do what you want to do, you will be able to enter them more quickly and won't have to consult the manual as often.

Putting the HERMIT to Sleep

You can put the instrument to sleep manually and conserve battery power by pressing the STOP/NEXT key when the status display is shown.

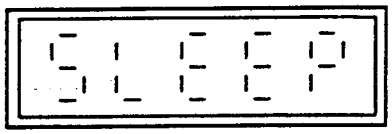
If the instrument has dozed off, press and release any key to wake it up.



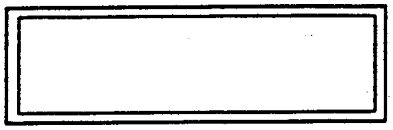
Press STOP/NEXT.



The unit confirms the command by displaying 'SLEEP.'



When you release the key, the unit returns to its sleep mode, as indicated by the blank display.





BATTERY LIFE TIP

Make a habit of putting the unit to sleep at the end of every keyboard session; however, if you forget, the instrument will put itself to sleep after 60 seconds.

Note: The **STOP/NEXT** key, like all of the keys on the HERMIT, has several functions. Pressing it will put the HERMIT to sleep only if the status display is showing on the LCD.

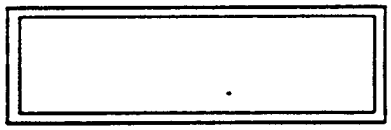
View/Program Keys

These are the main keys used to view information stored in the HERMIT and to access the HERMIT's programming features. "XD" is an abbreviation for "transducer."



The **CLOCK** key allows you to view and program the instrument's time of day clock. The **XD** key permits direct viewing of transducer status and the programming of transducer parameters. The **DATA** key allows you to view stored data and to program data collection parameters.

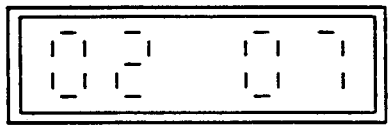
Press and release any key to wake the unit.



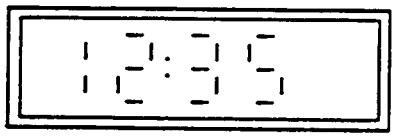
As an example, press the **CLOCK** key to view the instrument's time of day clock.



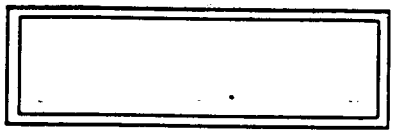
The HERMIT responds by displaying the current date for a few seconds . . .



. . . followed by the current time . . .



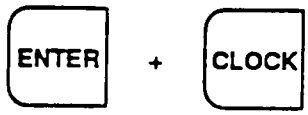
. . . and returns to the status display.



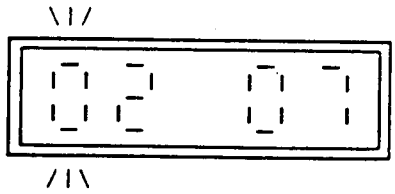
The ENTER Key

The **ENTER** key, when pressed together with another key, is used to "enter" or "program" parameters.

For example, to "enter" a new date and time into the clock, press the **ENTER** key with the forefinger of your left hand and hold it down while you press the **CLOCK** key with the forefinger of your right hand. Release both keys together.

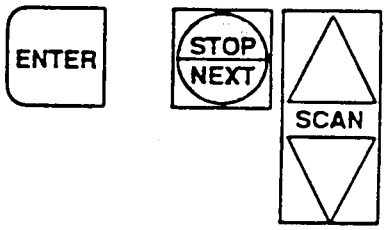


The HERMIT displays its current date, but this time the leftmost digit is flashing, indicating that a numeric entry is required.

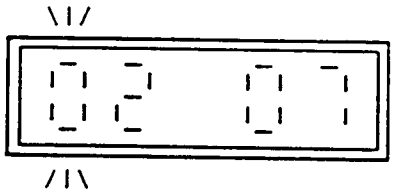


Basic Numeric Entry

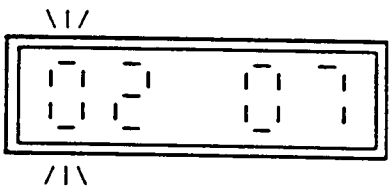
The **SCAN**, **NEXT**, and **ENTER** keys are used to program numeric values. The other keys are also used during some types of numeric entry; however, these are infrequent, and discussion of them is deferred to a later section.



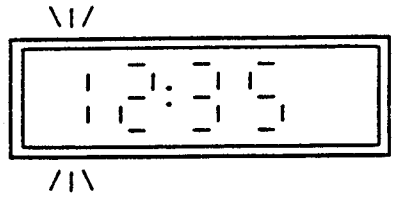
Whenever a number is displayed with a flashing digit, you are being prompted for a numeric entry. If the instrument is asleep, wake it up and repeat the last section so that the current date is in the display.



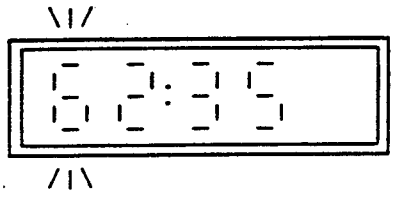
With any numeric entry, you may accept the default value shown in the display, or modify it. To accept the default value, just press **ENTER**.



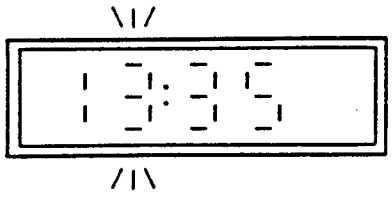
The current time is displayed next, again with the leftmost digit flashing.



Use the **SCAN** keys to modify the flashing digit. You can scan the digit up or down. The **SCAN** keys repeat automatically when you hold them down.

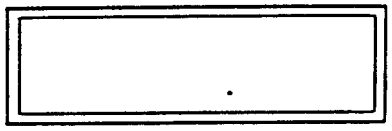


Use the **NEXT** key to flash the next digit. Use the **SCAN** keys to change the digit as needed. Repeat this process until the display shows the required value.

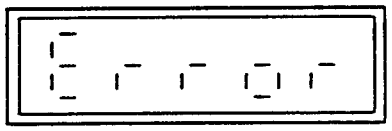


Press the **NEXT** key several times. Note that the flashing digit wraps back around to the leftmost position when the end of the display has been reached.

Press **ENTER** to set the displayed value. If you have entered a valid value, the instrument will continue with the next parameter. In this case, the HERMIT will return to the status display.



If you try to enter an invalid value, the HERMIT will display an error message and reprompt you for a correct entry.



Review of Keystrokes During Numeric Entry (flashing digit)

SCAN UP:	Increases the value of the flashing digit.
SCAN DOWN:	Decreases the value of the flashing digit.
STOP/NEXT:	Makes the next digit flash.
ENTER:	Stores the displayed number in the HERMIT's memory. Can be used to check the default or pre-programmed value then move to the next display without changing that value.

All keys will repeat automatically when pressed longer than one second. This is particularly useful when entering numeric values using the **SCAN** keys.

Data Collection Keys

Use the **START** and **STOP** keys to control the start and stop of data collection. Like other programming keys, they do not take action immediately when pressed, but instead present a menu, or prompt you for additional information. An accidental press will not cause a sudden start or stop of data collection.



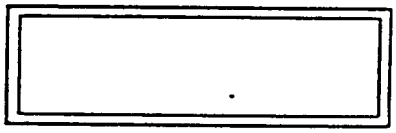


Selecting from Menus

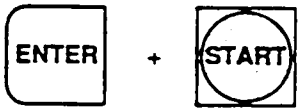
Each of the programming keys provides access to several related programming options. To simplify the access to any given option, the options are listed in menus. Most of us are accustomed to seeing menus displayed in a vertical list, or sometimes side by side in a horizontal list – like the menus of the HERMIT's big brother, the HERMIT 2000. Because its LCD displays only 5 characters at a time, the HERMIT's menus have to be shown on several screens.

The System Setup menu makes a good example. Do not be concerned with the details of the options presented in the menu at this time – they will be covered in a later section.

If the instrument has dozed off, lightly press any key to wake it up and get a status display.



Access the System Setup menu by holding down the **ENTER** key and pressing the **START** key.



The HERMIT responds by displaying the System Setup menu – but you can only see the very first option at the top of the menu: 'UNIT.'

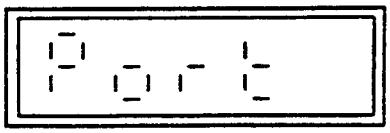


Note: Whenever you encounter the *name* of a programming option instead of a numeric value with a flashing digit, you have entered a menu.

Press **SCAN DOWN** (the bottom of the **SCAN** key) . . .



. . . and you will be able to see the next selection: 'PORT.'

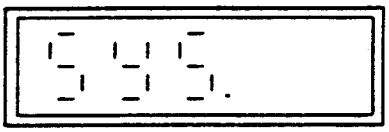


SCAN



Press **SCAN DOWN** again . . .

. . . and you will see the third menu option: 'SYS.'

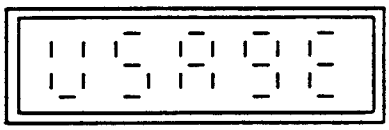


SCAN



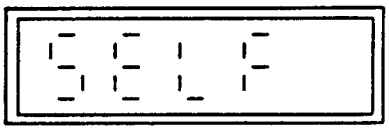
Press **SCAN DOWN** three more times to see the final three options in the System Setup menu, 'USAGE,' 'SELF,' and 'DOG.'

> Later in the manual you'll find out what all these options mean. For now, we are just experimenting with looking at the menus.



SCAN





SCAN

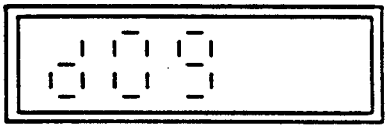




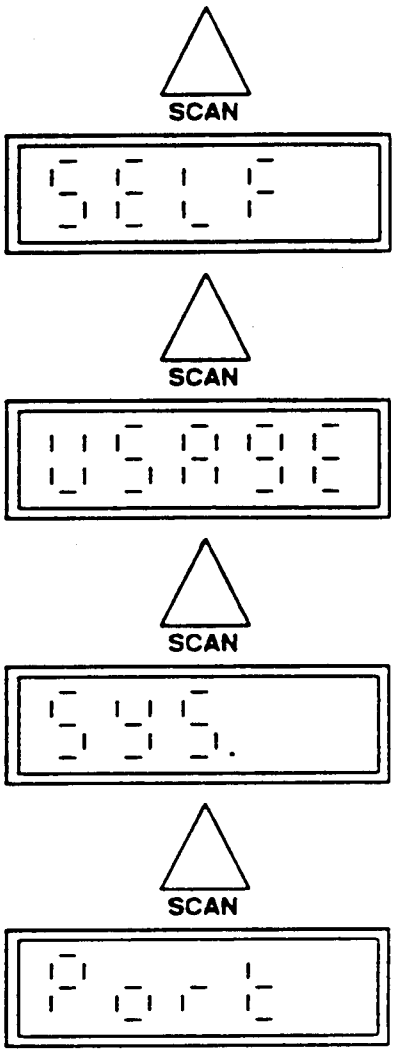
Now press **SCAN DOWN** again. 'DOG' stays on the display because you have reached the bottom of the menu, where **SCAN DOWN** no longer has any effect.

SCAN





Now press **SCAN UP** (the top of the SCAN key) four times to move back up through the menu to 'PORT.'



Some menu options have submenus of their own. 'PORT' is one of these. Let's look at the Port submenu.

While 'PORT' is on the display, "select" it by pressing **ENTER**.



The display shows the first item in the Port submenu of the System Setup menu.

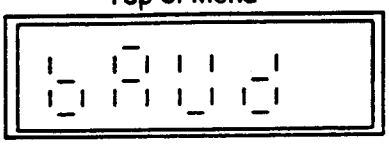


Press **SCAN DOWN** several times to display the entire Port submenu. You should see the menu shown on the next page. When **SCAN DOWN** no longer changes the display, you know you have reached the bottom of the menu.

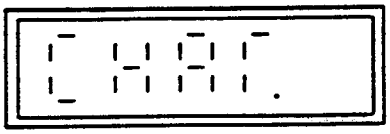


Port Submenu

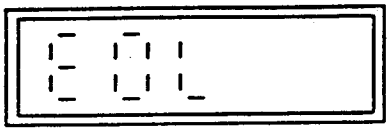
Top of Menu



Baud rate



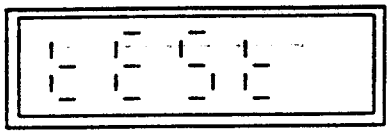
Character length/parity



End-of-line sequence



Print width



RS232 port test

Bottom of Menu

Now SCAN back UP to 'EOL' . . .



. . . and let's take a look at another type of submenu. When 'EOL' is on the display . . .

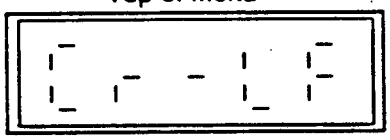


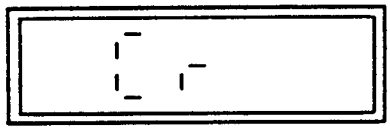
. . . press ENTER to select it.



Top of Menu

There are two options for the EOL (end-of-line) sequence for the RS232 port. They are shown as a two-item menu on the HERMIT's display when you select the EOL option. The currently set EOL sequence will appear first. Press **SCAN UP** or **SCAN DOWN** to see the other choice.





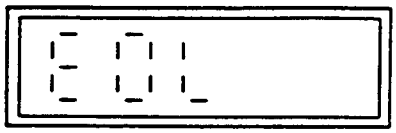
Bottom of Menu

If we wanted to change the EOL sequence, we would simply press **ENTER** when the desired choice was on the display. Here, we just want to look at the setting without changing it, so now let's exit all the way back to the status display.

Press **STOP/NEXT** once . . .



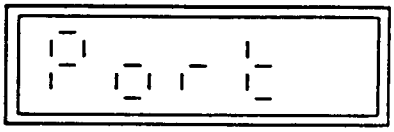
. . . and the display will return to the point where it entered the Port submenu ('EOL') without changing the end-of-line setting.



Press **STOP/NEXT** again . . .



. . . and the display will return to 'PORT,' the point where it entered the System Setup menu.



Press it again . . .



. . . and we are back to the status display.



Notice how you travel backwards through all the levels you have encountered.

Review of Keystrokes In a Menu

SCAN DOWN: Displays the next option.

SCAN UP: Displays the previous option.

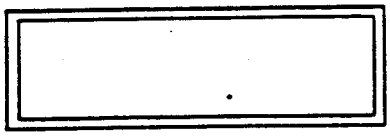
ENTER: "Selects" the displayed option so that you can look at its default (previously programmed) value, modify it, or see its submenu, if there is one.

STOP/NEXT: Aborts the selection process without changing the current setting and backs out of the menu. Hold down to back all the way out of a deep menu to the status display.

All keys will repeat automatically when pressed longer than one second.

The Status Display

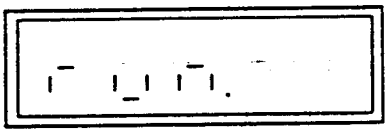
You have already seen the status display several times. It is presented whenever the HERMIT is awake and ready to accept a keypress. The status display shown here indicates that:



- The instrument is in ***idle mode.*** No test is running or programmed to start.
- The HERMIT is operating on its internal battery pack and the battery pack is in good condition.
- The instrument is ready for you to press a key.

As the operating status of the HERMIT changes, other information is added to the status display.

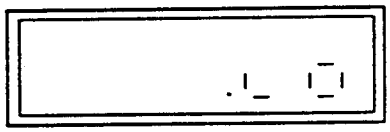
The left side of the status display is used to show the instrument's current operating mode. This display shows ***run mode:*** a test is running and the HERMIT is recording data.



This display shows ***delay mode:*** a test has been programmed, and the HERMIT is waiting for a delayed start.



If the internal battery pack begins to run low, the low battery indicator will be displayed on the right side of the LCD. This status display indicates a low battery in idle mode.



> ***CAUTION***
>
> ***When the low battery indicator appears on the status display, the internal battery pack has no more than one month capacity remaining, even less depending on instrument usage. If you are caught with a low battery during a test, connect to external power if possible. You cannot lose stored data even if the battery becomes completely drained. Simply connect to external power, dump your data, and return the instrument for a battery replacement.***

The external power indicator is displayed when the instrument is operating on external power.

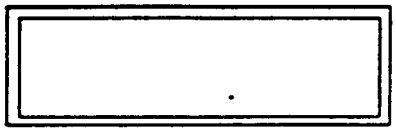


If the alarm is programmed "on," the alarm indicator will appear on the right side of the display during a test.

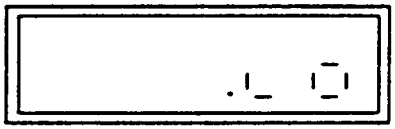


The following combinations of the test status indicators (left side) and power/alarm status indicators (right side) are possible.

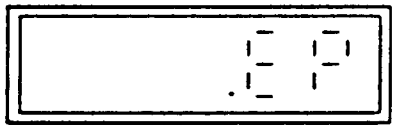
Idle mode, battery OK.



Idle mode, battery low.



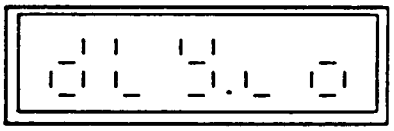
Idle mode, external power in use.



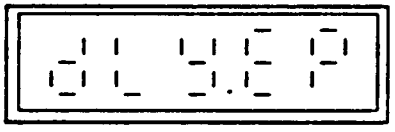
Delay mode, battery OK.



Delay mode, battery low.



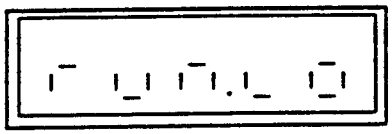
Delay mode, external power in use.



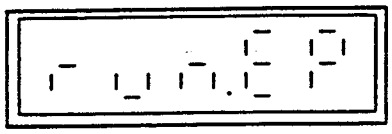
Run mode, battery OK.



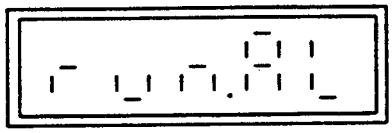
Run mode, battery low.



Run mode, external power in use.



Run mode, alarm activated.



Regardless of the specific combination of status indicators, the HERMIT is ready for a keypress.

Note: The displays shown throughout the manual are presented as though the HERMIT were operating on its internal battery pack; however, you may wish to use external power (see Appendix B) while you are learning to use the instrument.

Using Your HERMIT

Let's try a simple data collection problem to get the feel of your HERMIT. For the example illustrated here, it will not be necessary to connect a transducer to the instrument. If the HERMIT happens to fall asleep while you are working through the problem, you will have to wake it up and repeat the section you were on from the beginning.

For our example, we will record pressure for a few minutes using a standard In-Situ pressure transducer.

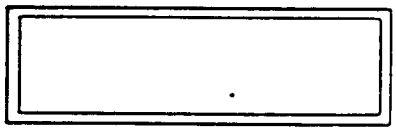
Defining the Test

The process of collecting a set of data with the HERMIT is referred to as "running a test." **The first step in running a test is to define the basic test conditions:**

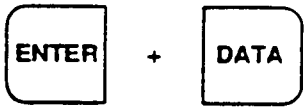
1. what test number we will be performing,
2. at what rate to sample the input channels,
3. how many input channels we will be using,
4. what type of transducer will be connected to each input channel.

The HERMIT allows you to record as many as twenty different tests in memory, each with its own unique setup and data, without having to dump the data between tests. Tests are always recorded sequentially from test 0 to test 19. Let's clear the memory of any old tests and begin with test 0.

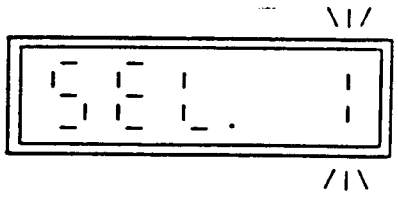
Press and release any key on the keyboard to wake the instrument and get a status display.



Press the **ENTER** key and hold it down while you press the **DATA** key.



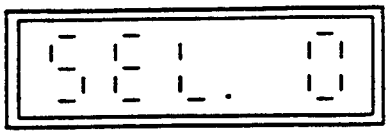
The HERMIT responds by asking you to select a test number.



The default test number shown in the display is the next *safe* test number: the next available test number that can be run while still retaining data recorded in lower numbered tests. The default number is also the highest test number you can select

since tests are recorded consecutively. You may select any test number from 0 to the default selection shown.

Use the SCAN keys to select test 0 and press ENTER.



The HERMIT will warn you if your selected test number will cause previously recorded tests to be erased.

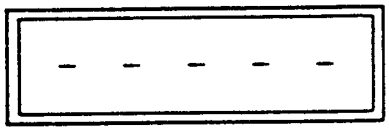


The display will toggle between 'ERASE' and a list of the test numbers that will be erased. Press **ENTER** to confirm the erasure.

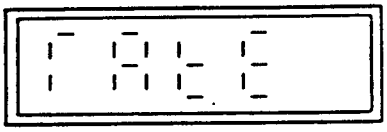


Note: If you do not wish to have data erased, press the **STOP/NEXT** key to cancel and then use the default test number shown in the display.

A line of dashes may appear briefly as the HERMIT erases old tests and configures its memory for the new test.



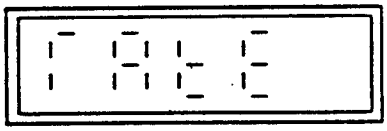
The display then shows 'RATE,' the top option in the ENTER DATA menu.



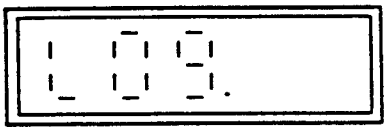
Programming the Sample Rate

Let's set up this test to use the linear sample mode, which will collect data points at evenly spaced time intervals. Since we want to see things happen fast, let's take a data point every minute.

While 'RATE' is on the display, press **ENTER** to select the sample rate option.



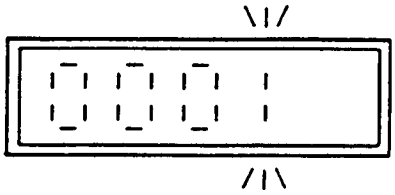
The current sample mode selection is displayed first.



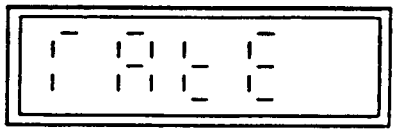
Use the **SCAN** keys to display 'LIN.1' (linear mode 1), to collect data points spaced evenly over time. Press **ENTER** to select this option.



Next we are prompted to enter the sample rate in minutes. Press **SCAN UP** to increase the numeric value of the blinking digit. Press **SCAN DOWN** to decrease the value. Then press **NEXT** to blink the next digit. Use these keys to set a one-minute sample rate, as shown here. When you are finished, press **ENTER**.



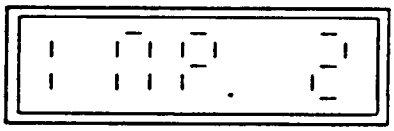
The display will return to 'RATE' in the ENTER DATA menu.



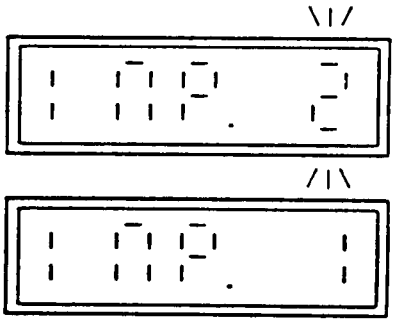
Selecting the Number of Inputs

Next, we need to program the number of input channels that will be used during the test. For our example we will be using one input.

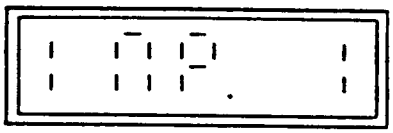
If the display is still showing 'RATE,' press **SCAN DOWN** to display 'INP.' (number of active inputs). If the HERMIT has dozed off, repeat this section from page 16 to wake the instrument and re-access the ENTER DATA menu. Then **SCAN DOWN** to 'INP.' and press **ENTER**.



The current number of active inputs will start to blink, either a 1 or a 2. If 1, press **ENTER**. If 2, **SCAN DOWN** to 1, then press **ENTER**.



The number of inputs will stop flashing, confirming our new selection.



Defining Input Data Types

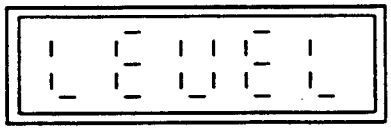
The last step in defining our test is to select the type of data to be collected on each input channel. Selection of the data type will determine both the measurement technique used to sample the transducer connected to that input and the equations used to convert the measurement results to appropriate units.

If the display is still showing 'INP.,' press **SCAN DOWN** to display 'TYPE' (the input type option). If the display has gone blank, repeat this section from page 16 to wake the instrument and re-access the ENTER DATA menu. Then SCAN DOWN to 'TYPE' and press **ENTER**.



The input type is independently programmable for each input channel. Since we specified only one input in the last step, the HERMIT doesn't need to ask which input we want to define; it displays the input type menu for the single input.

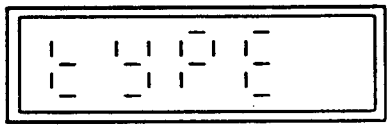
There are three data types available to choose from; the display shows the currently selected type.



Use the **SCAN** keys to display 'FUNC.' (function type). Press **ENTER** to select the function type.

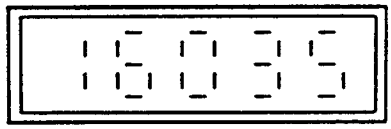


The display will return to 'TYPE' in the ENTER DATA menu.

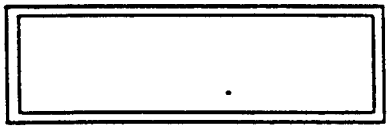


The function data type allows you to collect data from any 4-20 mA transducer and convert the results to the desired units using a simple linear or quadratic equation. The other data types provide more complex data reduction features and will be discussed in later sections.

Press **STOP/NEXT** to exit the menu. The display shows the number of data points that can be taken with the present setup . . .



. . . and returns to the status display.

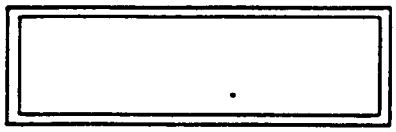


From this point on, all other functions and menu displays will automatically be tailored to match your test setup. For this reason it is important to configure the test through the ENTER DATA menu before attempting to alter other programmable settings.

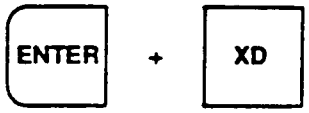
Setting Up the Inputs

Now that we have entered the basic test parameters, we need to program the values that will determine how the 4-20 mA output of the transducer will be converted to meaningful units.

If the HERMIT has dozed off, press any key to wake it up again.

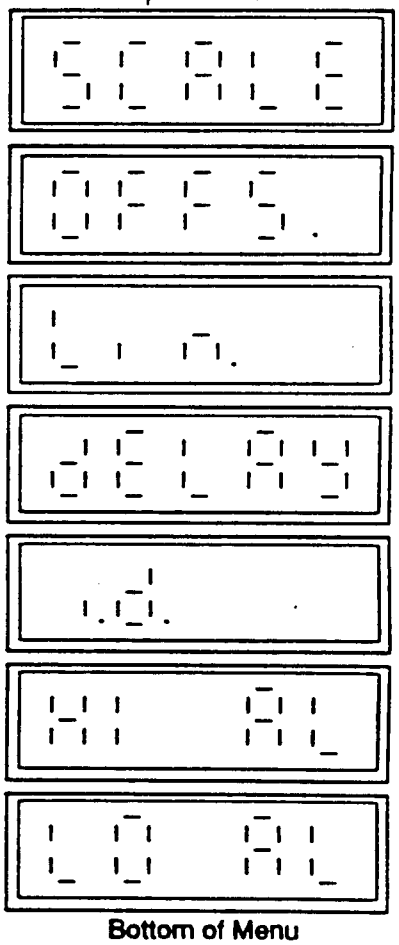


Press the **ENTER** key and hold it down while you press the **XD** key.



Top of Menu

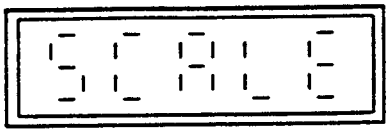
The top selection of the transducer menu for input 1 is displayed. The transducer menu will vary according to the input type specified in the ENTER DATA menu. Since we programmed input 1 as a function type, the display will show 'SCALE,' the top selection of the function menu. If you would like to see all the options in this menu now, you can do so by pressing **SCAN DOWN** repeatedly.



Bottom of Menu

The scale factor ('SCALE'), offset ('OFFS.'), and linearity ('Lin.') parameters shown in the menu will program the coefficients of a quadratic equation that will convert the transducer output to the desired units. The values for these parameters are found on the cable reel. For purposes of this example, our pressure transducer has a scale factor of 50.078 and an offset of 0.036. These values will convert readings to PSI units.

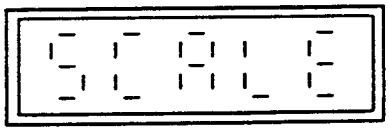
Press **SCAN**, if necessary, to move the display back to "SCALE' and press **ENTER**.



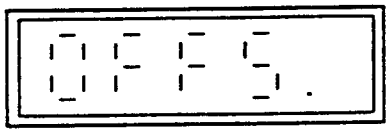
Use the **SCAN** and **NEXT** keys to set the scale factor. It may be necessary to round the value to fit the instrument's display. Press **ENTER** to set the value.



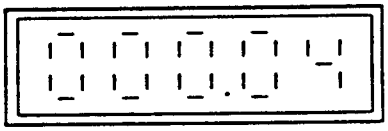
The display will return to 'SCALE.'



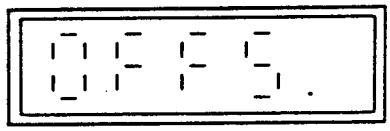
Press **SCAN DOWN** to display the 'OFFS.' (offset) option and press **ENTER**.



Use the **SCAN** and **NEXT** keys to enter the transducer offset. Press **ENTER** to set the value.



The display will return to the offset option.



SCAN DOWN to display the 'LIN.' (linearity) option and press **ENTER**.



If a parameter is not specified, make certain it is programmed to zero. Use the **SCAN** and **NEXT** keys to set zero and press **ENTER**.



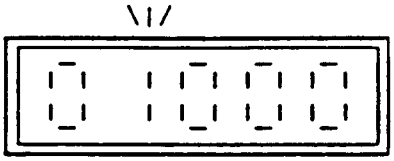
The display returns to the 'LIN.' menu option.



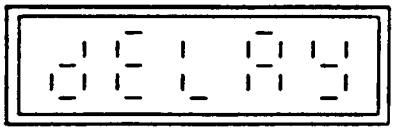
Press **SCAN DOWN** to display the 'DELAY' (transducer warmup delay) option and press **ENTER**.



Use the **SCAN** and **NEXT** keys to set a warmup delay of 1000 mSEC (milliseconds) and press **ENTER**. The HERMIT will power the transducer for one second before taking a reading.



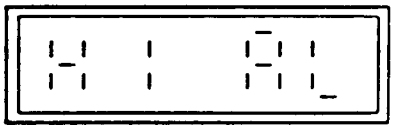
The display returns to 'DELAY.'



Note: The warmup delay is rarely specified on third-party transducers and must often be determined by experiment. In-Situ's standard transducers use a warmup delay of 50 mSEC unless specified otherwise. A one-second delay is used here only for the purpose of example.

You could program a unique identification number for this channel using the 'I.D.' menu option, but let's skip this option for now. The high and low alarm options will be explained in detail in a later section. For the time being, let's make sure that both the high alarm and the low alarm are turned off.

Press **SCAN DOWN** to display 'HI AL' (the high alarm option) and press **ENTER**.



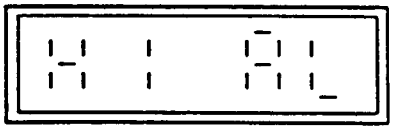
The current on/off status of the high alarm is displayed. Use **SCAN UP** to turn the alarm on and **SCAN DOWN** to turn it off.

Press **ENTER** when the display shows 'OFF.'





The display will return to 'HI AL.'



SCAN DOWN to 'LO AL' (the low alarm option) and press **ENTER**.



The current on/off status of the low alarm is displayed. Use **SCAN UP** to turn the alarm on and **SCAN DOWN** to turn it off.



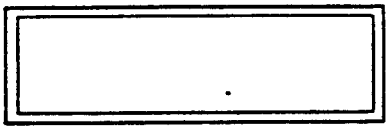
Press **ENTER** when the display shows 'OFF.'



The display will return to 'LO AL.'



Press **STOP/NEXT** to exit the menu and return to the status display.

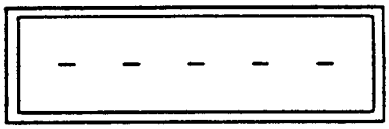


Reading the Transducer

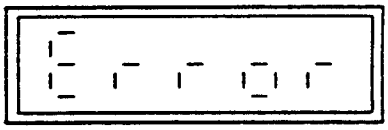
Now let's take a quick reading on this channel. Press the **XD** key.



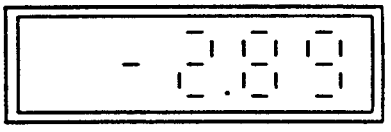
The HERMIT will power the transducer and wait for the programmed warmup delay period . . .



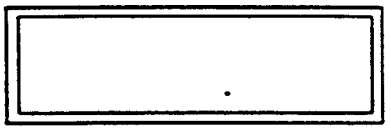
. . . then take a reading, and turn the transducer off. We are warned that no transducer has been connected to the input . . .



. . . then presented with a default transducer reading. If a transducer had been connected, a correct pressure reading would have been displayed. For this example, we will leave the transducer disconnected.

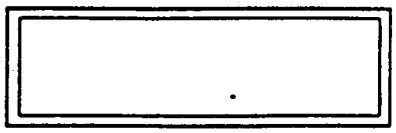


Press **STOP/NEXT** to return to the status display. Now we're ready to start collecting some data.



Starting the Test

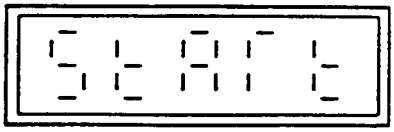
At the status display . . .



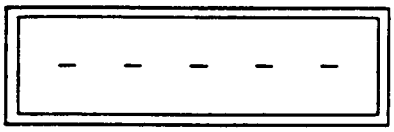
. . . press the **START** key.



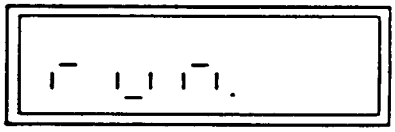
The display will show 'START,' the top option of the HERMIT's start menu. Press **ENTER** to select this option (immediate start).



Dashes are displayed briefly to indicate that a data point is being recorded.

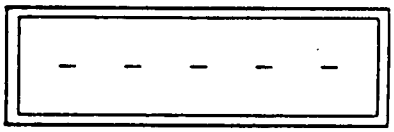


We are then returned to the status display. Notice that an indicator has been added to show that a test is running.



The HERMIT will record a transducer reading once every minute until you STOP the test or all the available data storage space is used up.

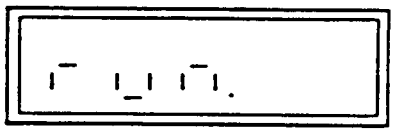
As you continue with the example, you will be interrupted occasionally as the instrument takes another data point.



Viewing Recorded Data

Recorded data can be viewed while the test is running or after the test is stopped.

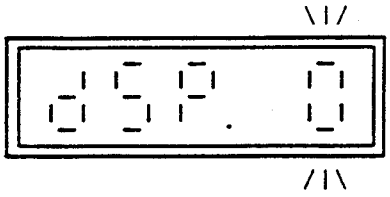
At the status display . . .



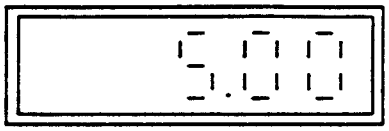
. . . press the **DATA** key.



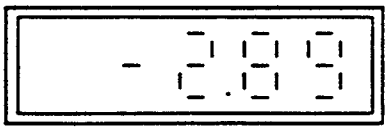
The display will show 'DSP' and prompt you to enter the number of the test you want to view (you can also view tests other than the one that is running). The default selection is the currently running test. Press **ENTER** to view our sample test.



The display shows the elapsed time in minutes of the last data point recorded . . .

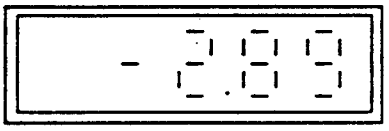


. . . and then the recorded transducer value in PSI.



Press **SCAN DOWN**. The display will show the time of the previous data point, then the data point value. You can hold down this key to move backward through the data file, although we haven't recorded much data for this test.



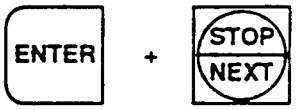


Press **STOP/NEXT** twice to exit the view data mode and return to the status display.

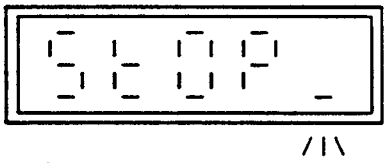


Stopping the Test

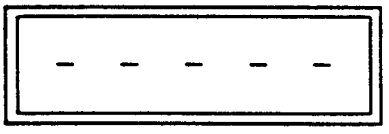
To stop data recording, press the **ENTER** key and hold it down while you press **STOP/NEXT**.



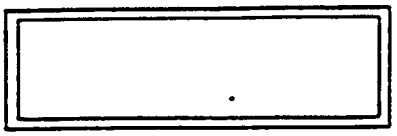
STOP does not act immediately. Confirm the stop command by pressing **ENTER**. This will stop the test.



The HERMIT will take a moment to organize the data storage . . .



. . . then will return you to the status display. Note that the 'run' indicator is no longer displayed.





Battery Life Tip

Don't waste battery power and memory endurance by leaving the HERMIT running after the test is finished. Use the STOP function to turn data recording off.

Data Security

Once you have stopped a test, the raw transducer data recorded in memory cannot be altered; however, you may edit the transducer parameters in the ENTER XD menu. Since raw data (transducer data before computing the units) is stored separately from the transducer parameters, you may correct errors in the parameters without having to recalculate your data.

If you set up for a new test by selecting the next test number as presented in the ENTER DATA menu, all previous data and setup parameters become protected and cannot be altered. Any changes you make in programming will pertain only to your current test.

REMINDER

Always begin the setup of a new test by first selecting a test number in the ENTER DATA menu. If you begin with any other function you may be inadvertently editing the parameters of your previous test. Your test data is completely secure and uneditable only after incrementing to the next test number.

Review

As you may have begun to realize, the HERMIT is capable of running much more sophisticated tests than the one demonstrated in this section. We will jump right into the detailed operating and programming features beginning with the next section. If you are not yet comfortable with the basic operation of the instrument, you may wish to review the material presented in this section before continuing.

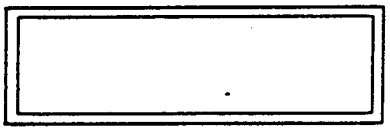
3 Time of Day Clock

The HERMIT 1000C maintains an internal, battery powered, time of day clock. The clock remains operational when the instrument sleeps, keeping track of the month, day of the month, and the time of day in hours, minutes, and seconds. The clock is used to record the start date and time of a test, and may be used to program delayed start operations.

Time is kept in the 24-hour, or military, format, where 0 hours is midnight. A time of 11:00 indicates 11 A.M. and a time of 23:00 indicates 11 P.M. The clock runs on a four-year cycle and does not keep track of leap years.

Displaying the Clock

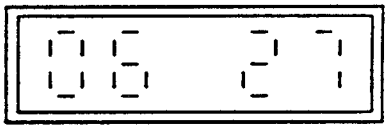
Begin at the status display. The clock can be displayed in any mode (idle, run, or delay).



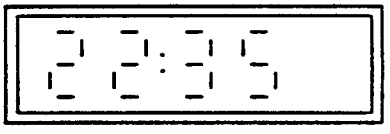
Press the **CLOCK** key.



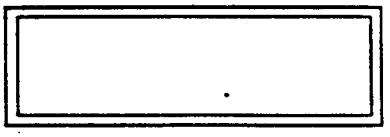
The HERMIT will display the month and day for a few seconds . . .



. . . then the hours and minutes with the colon blinking . . .



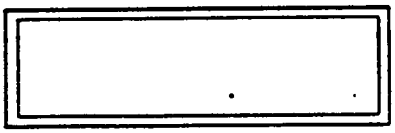
. . . and return to the status display.



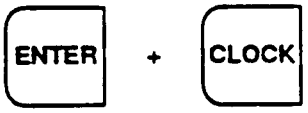
Setting the Clock

The time of day clock can only be set when the HERMIT is in idle mode. The clock cannot be set if the instrument is running a test or waiting for a delayed start.

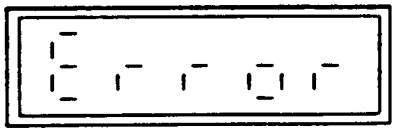
Begin at the status display.



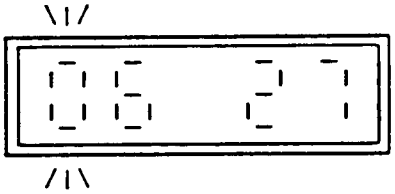
Press the **ENTER** key and hold it down while you press the **CLOCK** key.



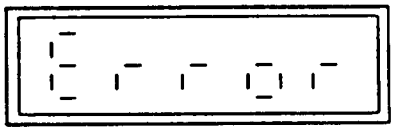
If the HERMIT is not in idle mode, 'Error' will be displayed for a few seconds and you will be returned to the status display. Wait until the test is over before trying to set the clock.



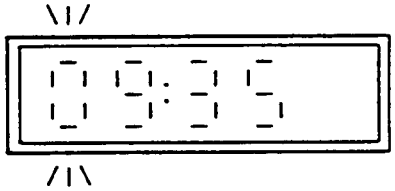
The HERMIT first prompts for the date. Use the **SCAN** and **NEXT** keys to set the correct month and day, then press **ENTER**.



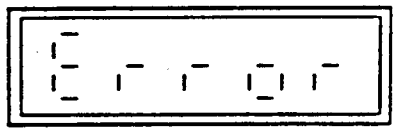
The month must be in the range 1-12, the day in the range 1-31 depending on the month. If you enter an invalid date, the 'Error' message will flash and you will be reprompted for a correct entry.



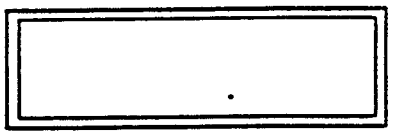
You are prompted for the time of day next. Use the **SCAN** and **NEXT** keys to set the correct hour and minute, then press **ENTER** to set the time and start the clock.



The hours must be in the range 0-23, the minutes in the range 0-59. If you enter an invalid time, the 'Error' message will flash and you will be reprompted for a correct entry.



Then the HERMIT returns to the status display.



To synchronize the HERMIT's time of day clock with an external clock, set the time one minute ahead of the external clock and press **ENTER** when the clocks match. The HERMIT sets the seconds of its clock to zero when you press **ENTER**.

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4 Setting Up a Test: The ENTER DATA Menu

In Section 2, the ENTER DATA menu was used to program the four basic parameters of a test:

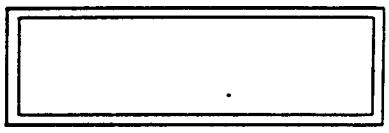
1. Selection of the test number
2. The sample rate
3. The number of input channels to use
4. The type of data to be collected on each input channel

Since other functions and menu displays will be tailored to your selections in the ENTER DATA menu, it is important to properly set up a test *before* programming other instrument functions. This section will expand on the options made available to you in the ENTER DATA menu.

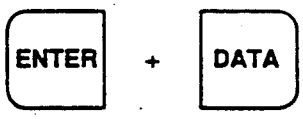
Note: You cannot set up a new test if a test is running or if the HERMIT is waiting for a delayed start.

Selecting the Test Number

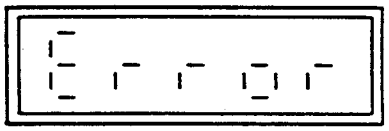
Begin at the status display. If the instrument is asleep, press and release any key to wake it.



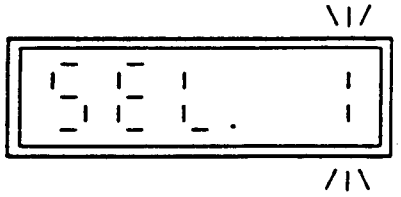
Hold down the **ENTER** key and, while holding it down, press the **DATA** key.



If the HERMIT is not in the idle mode, the 'Error' message will be displayed. Wait until the currently programmed test is finished before trying to set up another test.

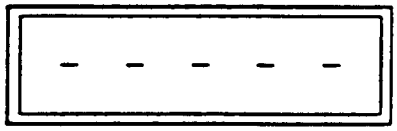


The HERMIT responds by asking you to select a test number.

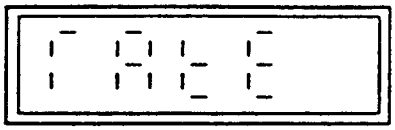


You can record as many as twenty tests, numbered consecutively from 0 to 19, each with its unique setup and data. The default test number shown on the display is the next available test number; selecting it will ensure that test data already recorded in the instrument will not be overwritten. Test numbers cannot be selected out of sequence. The test number shown in the display is the highest entry you can make.

Press **ENTER** to select the default test number. The HERMIT takes a few seconds to copy the previous test setup to the new test . . .

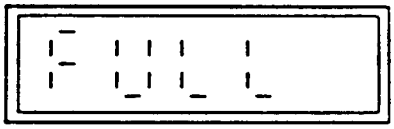


. . . and then presents the top option of the ENTER DATA menu.



Note: The setup parameters are copied from the previous test to simplify re-running a test (you don't have to re-enter all of the test parameters). Of course, the test setup can be modified or completely changed if you wish.

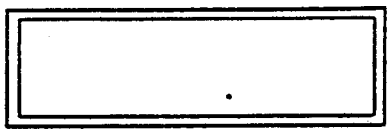
This message is displayed if there is insufficient memory remaining to set up a new test



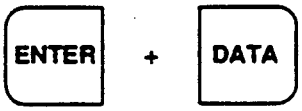
Erasing Old Tests

As you continue to record tests into the memory, you will find that the amount of memory available for new tests continues to grow smaller. This translates into fewer days of recording at a given sample rate, or longer sample rates to achieve the required test lengths. At some point it will become desirable to erase old test data to free up the memory for a new test. You can erase old test data by selecting a lower test number than the default test presented by the HERMIT.

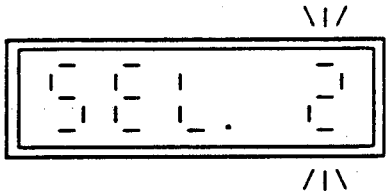
Begin at the status display.



Hold down the **ENTER** key and, while holding it down, press the **DATA** key.

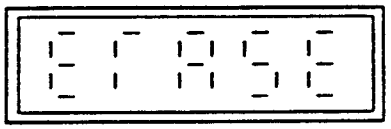


When you are prompted to select a test number, **SCAN** to the lowest test number you wish to erase, and press **ENTER**.

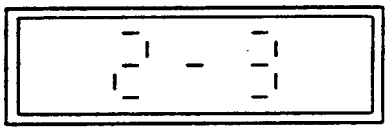


The test number you select, *and all higher test numbers*, will be erased. Selecting test 0 will cause all test data to be erased.

The HERMIT will warn you that your selection will cause previously recorded tests to be erased by repeating the 'ERASE' warning . . .

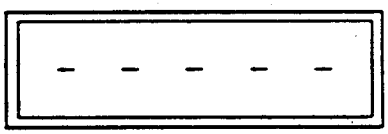


. . . followed by a list of the test numbers that will be erased.

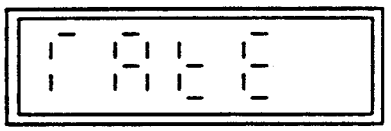


Note: If you do not wish to have data erased, press **STOP/NEXT** and use the default test number.

Press **ENTER** to confirm erasure. The indicated test(s) will be erased and the previous test setup copied to the new test . . .



. . . the display then shows the top option in the ENTER DATA menu.

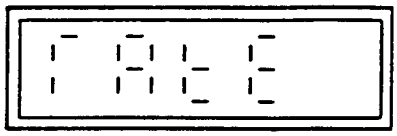


The ENTER DATA Menu

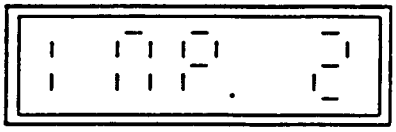
The ENTER DATA menu consists of three options, as shown below. Use the **SCAN** keys to move the display between options. Use the **ENTER** key to select an option. Each option is explained in detail in the following pages.

ENTER DATA Menu

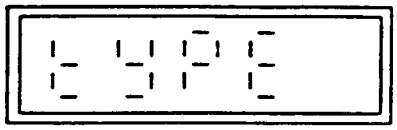
Top of Menu



The sample rate



The number of input channels to use



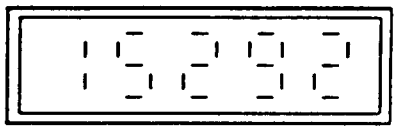
The type of data to be collected on each input channel

Bottom of Menu

Use the **STOP/NEXT** key when you are ready to exit the menu.



The display will show the number of data points that can be collected with the current setup . . .



. . . and then return to the status display.



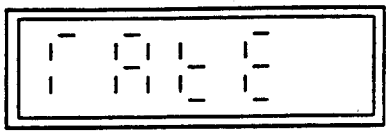
Sample Rate Options

The sample rate setting determines how often the HERMIT will record input channel readings. Both input channels share the common sample rate setting. There are two parts to the sample rate:

- The **sample mode** is set first. It can be
  - Linear 1: data points spaced evenly over time, measured in minutes,
  - Linear 2: data points spaced evenly over time, measured in seconds, or
  - Logarithmic.

- The **sample rate** (interval between readings) is prompted next. It can range from 2 seconds to 1440 minutes (24 hours), depending on the sample mode.

To program the sample rate, press **ENTER** to select the 'RATE' option in the ENTER DATA menu.



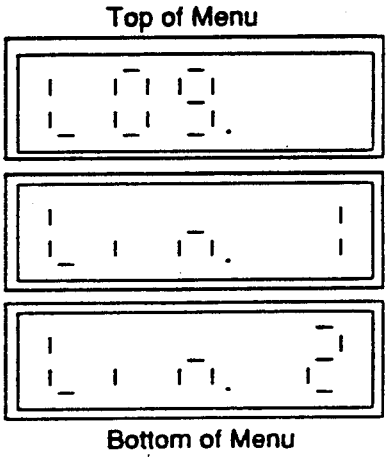
The following menu will be displayed. The currently selected sample mode is shown first. The **SCAN UP** key moves toward the top of the menu, the **SCAN DOWN** key toward the bottom. **STOP/NEXT** will exit this menu and return to the ENTER DATA menu without changing the current sample mode or rate setting. Press **ENTER** to select the desired sample mode.

Sample Mode Menu

Logathrimic sampling

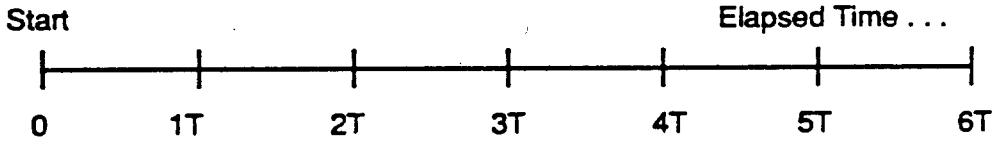
Linear mode 1 (minutes)

Linear mode 2 (seconds)



Linear Sampling (Modes 1 & 2)

Selection of a linear sampling mode causes the HERMIT to record one reading from each active input channel at the specified sample rate:



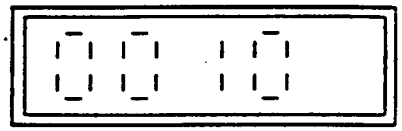
T = Programmed Sample Rate

Linear mode 1 allows the sample rate to be programmed from 1 to 1440 minutes. This mode is useful for collecting long-term data and for recording background data prior to running pump or slug tests.

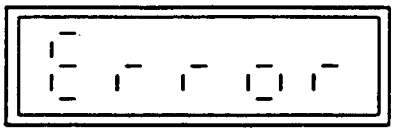
When you select the 'LIN.1' option from the sample mode menu . . .



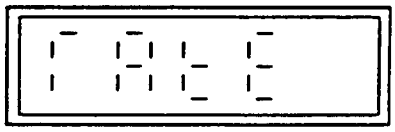
. . . you will be prompted to enter a sample rate in minutes. Use the **SCAN** and **NEXT** keys to set the sample rate and press **ENTER**.



The sample rate must be in the range 1-1440 minutes. If you enter an illegal value, you will get the 'Error' message and then be reprompted for a correct entry.



The display returns to 'RATE' in the ENTER DATA menu.

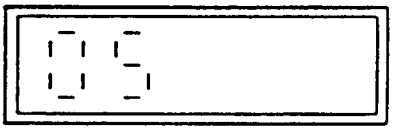


Linear mode 2 allows faster sampling. The sample rate may be set from 2 to 59 seconds. Use this mode for collecting fast, continuous data.

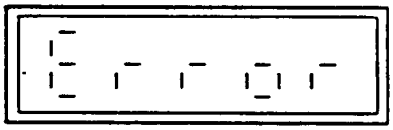
When you select the 'LIN.2' option from the sample mode menu . . .



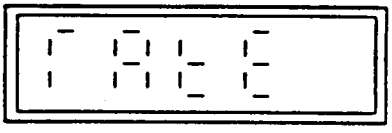
. . . you will be prompted to enter a sample rate in seconds. Use the **SCAN** and **NEXT** keys to set the sample rate and press **ENTER**.



The sample rate must be in the range 2-59 seconds. If you enter an illegal value, you will get the 'Error' message and then be reprompted for a correct entry.



The display returns to 'RATE' in the ENTER DATA menu.



The following points should be considered when setting up a test in the Linear 2 sample mode with a very fast sample rate:

Transducer Delay: The sample interval must be longer than the transducer delays. These include the warmup delay, prompted in the ENTER XD menus (Section 5), and the time required to read a dual-mode probe (5 seconds), plus one second for the HERMIT to perform internal calculations. You will not be allowed to exit the ENTER DATA menu if the sum of the delays exceeds the sample rate.

Keyboard Operation During the Test: Because of the rapidity of data collection in this sample mode, the HERMIT can't do anything else while the test is running. Only the **STOP** function is active (see Section 7).



Battery Life Tip

Battery life improves with longer sample intervals. Select a sample rate that gives good data quality without wasting battery energy collecting excessive or redundant points.

Logarithmic Sampling

Log sampling optimizes data collection speed and memory usage for pump and slug tests. These tests characteristically begin with very rapid changes in values, and end with very slowly changing values. If you were to program a very fast linear rate, you could characterize the early stages of the test; however, you would be quickly inundated with excessive data during the later stages of the test, possibly running out of memory before the test is complete. Conversely, a slower linear rate would allow you to run a test longer, but would not provide enough early-time information to properly characterize the data.

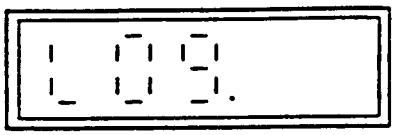
The HERMIT's log sampling mode solves these problems by using the sampling schedule outlined below.

Standard Log Schedule

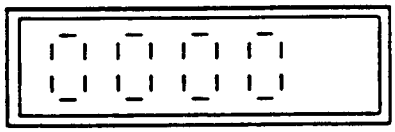
Log Cycle	Elapsed Time	Sample Interval	Points/Cycle
1	0-20 seconds	0.2 second	101
2	20-60 seconds	1 second	40
3	1-10 minutes	12 seconds	45
4	10-100 minutes	2 minutes	45
5	100-1,000 minutes	20 minutes	45
6	1,000-10,000 minutes	200 minutes	45
7	> 10,000 minutes	1440 minutes	

As you can see, the sample intervals begin closely spaced and are automatically made longer with each log cycle.

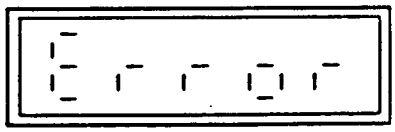
When you select the 'LOG' option from the sample mode menu . . .



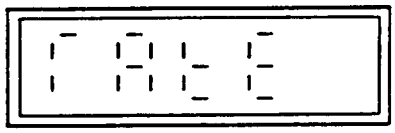
. . . you will be prompted to enter a maximum sample interval in minutes. Use the **SCAN** and **NEXT** keys to set the interval and press **ENTER**. To use the standard log schedule shown above, enter a value of 0 or 1440.



The maximum sample interval must be in the range 0-1440 minutes. If you enter an illegal value, you will see the 'Error' message and then be reprompted for a correct entry.



The display returns to 'RATE' in the ENTER DATA menu.



You can tailor the standard log schedule to suit your test requirements by entering an appropriate maximum sample interval. The HERMIT will collect data according to the standard log schedule until it reaches a log cycle with a sample interval greater than the programmed maximum interval. Sampling then switches over to the maximum interval for the remainder of the test.

For example, if you select the log sample mode and enter a maximum sample interval of 5 minutes, the instrument would record data using the following modified log schedule:

Log Cycle	Elapsed Time	Sample Interval
1	0-20 seconds	0.2 second
2	20-60 seconds	1 second
3	1-10 minutes	12 seconds
4	10-100 minutes	2 minutes
5	100 minutes . . .	5 minutes

Since the fastest maximum sample interval you can enter is one minute, the instrument will always use the standard schedule through log cycle 3.

The following points should be considered when setting up a test in the log sample mode:

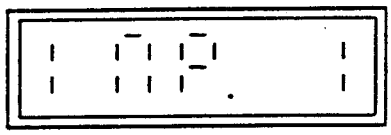
Transducer Warmup Delay: During the first minute of the log mode (log cycles 1 and 2), the HERMIT uses a transducer warmup delay of 50 mSEC for all active inputs, regardless of the warmup delays programmed. After cycle 2, the programmed warmup

delays are used. Make certain that the transducers you choose are compatible with the fast data requirements of the log sample mode.

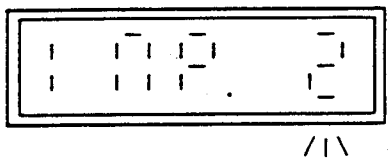
Dual-Mode Transducers: Due to the time required to read a dual-mode transducer, all dual-mode data recorded during the first minute of log mode will be meaningless and should be ignored. The data recorded during this period will vary depending on the setting of the transducer's coefficients, but the start of good data should be readily apparent when looking at the data.

The Number of Inputs

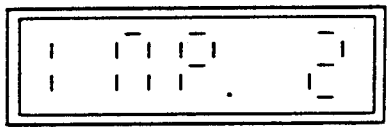
To program the number of active inputs, press **ENTER** to select the 'INP.' option in the ENTER DATA menu.



You will be prompted to enter the number of active inputs for the test. Use **SCAN DOWN** to select 1 active input, **SCAN UP** to select 2 active inputs. Press **ENTER** to set the new number.



The display returns to 'INP.' in the ENTER DATA menu with the new input number set.



Input channels are always used sequentially. If you program one input for a test, it must be connected to channel one.

Selecting two active inputs will reduce the number of sample points available for a test by at least half, will increase the average power consumption of the unit during data collection, and will increase the complexity of instrument setup.

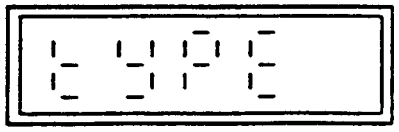


Battery Life Tip

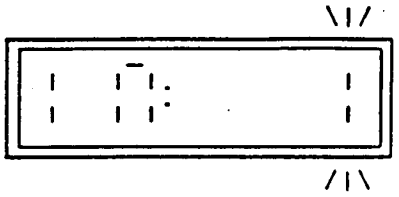
Do not program the number of inputs to be greater than the number that will actually be used. Recording data from an unused input channel wastes battery power and data storage space.

Input Data Types

To review or change input types, press **ENTER** to select the 'TYPE' option in the ENTER DATA menu.



If two inputs are active, the HERMIT will prompt for the input you wish to set first. Press **ENTER** to select the input and display the type menu. This prompt is skipped if only one input is active.



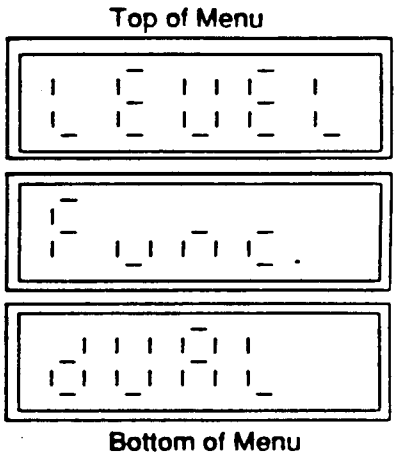
The following menu will be displayed. The currently selected input type is shown first. The **SCAN UP** key moves toward the top of the menu, the **SCAN DOWN** key toward the bottom. **STOP/NEXT** will exit this menu without changing the current input type setting. Press **ENTER** to select the desired input type.

Input Type Menu

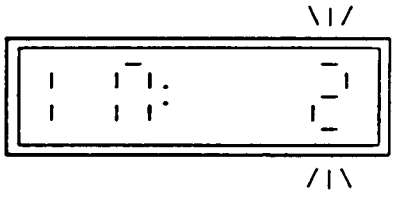
Level type

Function type

Dual type

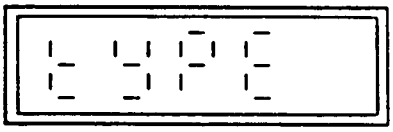


If two inputs are active, the other input number is displayed with a blinking digit after the type for the first input is set. Press **ENTER** to display the type selection and menu for this input. Select the type for the second input as above, and press **ENTER**.



Note: If you are using one level or function type and one dual type, for best results the dual type should be connected to input channel 2.

When you have set the data type for all active input channels, press **STOP/NEXT**. The display will return to 'TYPE' in the ENTER DATA menu.



The selection of a data type defines two important characteristics of an input channel:

- The technique used to power up, and take a reading from, the transducer connected to the input channel.
- The data reduction equations that will be used to convert the raw output of the transducer to meaningful results in the desired units.

The following is a brief description of each of the input types and their basic uses. The parameters used with each input type are programmed via the ENTER XD menus and are discussed in detail in Section 5.

Level Type

The level type input allows you to use pressure transducers to solve a wide variety of water level measurement problems. It first uses the basic quadratic equation to convert the 4-20 mA output of a pressure transducer to units of PSI (pounds per square inch). PSI units are then automatically converted to water levels in selectable units of feet or meters. You can even select surface water or top of casing orientation.

Function Type

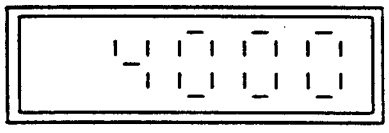
The function type input uses a flexible quadratic equation to convert the output of any conventional 4-20 mA transducer to its basic measurement units. Use this type to obtain direct readings of pressure from a pressure transducer, temperature from a temperature transducer, flow from a flow transducer, etc. With proper modification of the quadratic equation coefficients, transducer readings can be reported in any equivalent units of measurements (temperature in degrees Fahrenheit or degrees Celsius, for example).

Dual Type

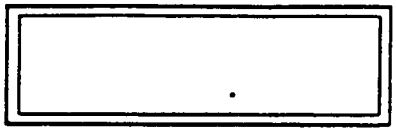
The dual type selection is used with dual-parameter transducers such as In-Situ's conductivity/temperature and pH/temperature transducers. This type of transducer permits the recording of two parameters with a single input channel.

Exiting the ENTER DATA Menu

Exit the ENTER DATA menu by pressing **STOP/ NEXT** at any of the three main menu options. The amount of free storage will be displayed . . .

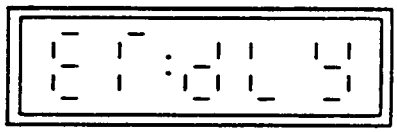


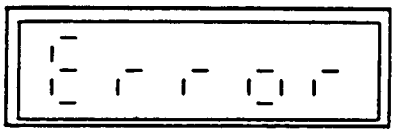
. . . and then the status display will return to the screen.



The HERMIT checks for illegal test parameters before you can exit.

This message means that the programmed delays exceed the programmed sample rate. You need to select a longer sample rate or shorten the transducer delays (if possible, consistent with the requirements of the transducers being used).





The interval between transducer readings must be longer than the sum of the transducer delays. The delays include:

(1) the warmup delay for each level and function type input programmed; these are prompted in the ENTER XD menus (Section 5) and will normally be 50 mSEC, plus
(2) 5 seconds for each dual type programmed, plus
(3) 4 seconds for instrument wake-up (log mode and LIN1 only – the HERMIT doesn't go to sleep in LIN2 mode), plus
(4) 1 second for internal calculations.

For example,

1 XD with 50 mSEC delay	=	0.05 second
1 dual probe	=	5 seconds
Internal calculation	=	1 second
Total delays	=	6.05 seconds.

You would not be allowed to exit the ENTER DATA menu with a sample rate less than 7 seconds in the LIN2 sample mode.

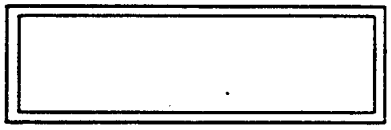
Hint: If you change transducers and then try to set up a new test with a fast LIN2 sample rate (say, 2 seconds), it is possible that the test setup copied from the previous test will include transducer delays that exceed the new fast sample rate. In this case, you will have to "trick" the HERMIT into letting you exit the ENTER DATA menu: First, program a sample rate long enough to accommodate the previous delays. Then access the ENTER XD menu and input the new delays. Then re-access the ENTER DATA menu and set the 2-second LIN2 sample rate.

5 *Setting Up Transducers: The ENTER XD Menus*

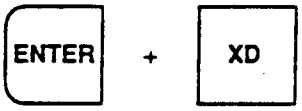
After setting up the basic test parameters using the ENTER DATA menu, you need to identify the transducers that will be connected to each input channel. Once identified, the HERMIT will have enough information to convert the output of each transducer to the appropriate measurement units.

Note: Do not begin setting up transducer parameters until you have selected a test number and programmed the basic test parameters using the ENTER DATA menu. Otherwise you will be editing transducer parameters from the previous test, causing a change in your test data.

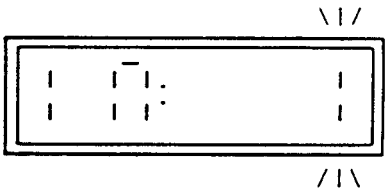
Begin at the status display. Transducer parameters for the current test can be programmed or modified in any mode (idle, run, or delay).



Hold down the **ENTER** key and, while holding it down, press the **XD** key.



If two inputs are active for this test, the HERMIT will prompt for the input you wish to program first. Press **ENTER** to select the input channel and display the transducer menu for that channel. This prompt is skipped if only one input is active.



The display proceeds to the appropriate transducer menu, as determined by the type of input (Level, Function, or Dual) specified for that channel when you set up the test. Discussion of the Level type menu begins on p. 44, the Function type on p. 50, and the Dual type on p. 53.

If two inputs are active, they may be programmed in any order. When you have entered all the parameters for one input, the display will automatically proceed to the other input. When both inputs have been programmed, press **STOP/NEXT** until the status display returns to the screen.

The final step is to connect the transducer(s) and take a reading on each active channel (see p. 56).

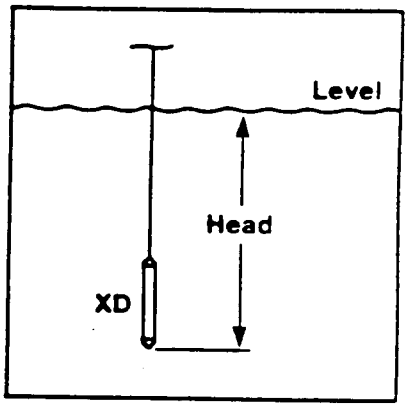
Advanced Numeric Entry

Up to this point numeric entry has been limited to positive numbers less than 1000. This is sufficient for most applications, but the HERMIT is capable of more flexible input. During the entry of a number, all of the keys can actually be used as follows:

CLOCK:	Clear number to 000.00	Use these keys to change the decimal point position to accommodate larger or smaller numbers. They also offer an easy way to clear the entry to zero.
XD:	Clear number to 0000.0	
DATA:	Clear number to 00000	
SCAN:	Change the blinking digit.	
STOP/NEXT:	Move the blinking digit.	
START:	Change the sign of the number after the number is input. Note that the negative sign occupies one digit position, causing a loss of significant figures.	
ENTER:	Enter the number as displayed.	

Programming Level Types

The level type input derives level readings from head values taken with a pressure transducer. There are several programmable parameters that allow you to solve a variety of level measurement problems.



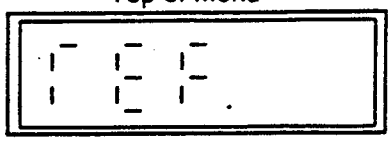
The following menu will be displayed for a level type input. Use the **SCAN DOWN** key to move toward the bottom of the menu, **SCAN UP** to move toward the top. **STOP/NEXT** will exit the menu for the current input channel without changing any of the programmed settings. Press **ENTER** to select an option.

The individual options are discussed on the following pages.

ENTER XD Menu: Level Type

Top of Menu

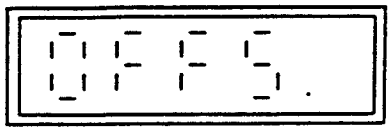
Reference level setting



Transducer scale factor



Transducer offset



Transducer linearity



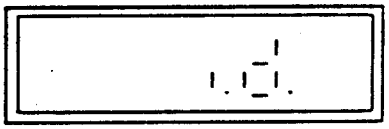
Transducer warmup delay



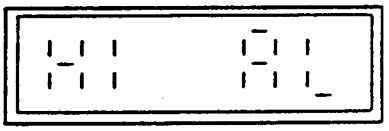
Display mode



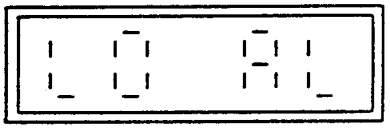
Input channel I.D. (optional, see p. 56)



High alarm setting (optional, see Section 6)



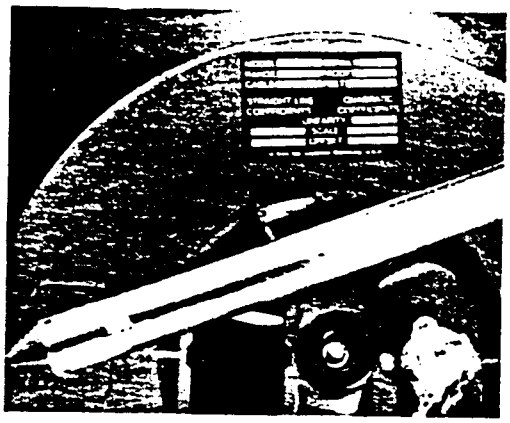
Low alarm setting (optional, see Section 6)



Bottom of Menu

If two inputs are active: When you have entered all the parameters for one input, the display will automatically proceed to the other input. When both inputs have been programmed, press **STOP/NEXT** until the status display returns to the screen.

Transducer Parameters



Four of the menu parameters are used to convert the 4-20 mA transducer output to a pressure in PSI units. These parameters may be found on the cable reel, or on a data tag attached to the cable. For the HERMIT 1000C, be sure to use the "Quadratic Coefficients."

- **Scale factor** – Select 'SCALE' from the menu, input the transducer scale factor, and press **ENTER**. This value should not be zero for a pressure transducer.
- **Offset** – Scan down to 'OFFS.,' input the transducer offset, and press **ENTER**. Set to zero if not specified by the transducer manufacturer.
- **Linearity** – Scan down to 'LIN.,' input the linearity, and press **ENTER**. Set to zero if not specified.

Remember that the **CLOCK**, **XD**, and **DATA** keys can be used to change the position of the decimal point. If the coefficient is negative, be sure to include the minus sign (**START** key). Refer to the box on p. 44. Since the HERMIT can accommodate a maximum of 2 decimal places, you may need to round the values to fit the display.

- **Warmup delay** – Scan down to 'DELAY,' input the transducer warmup delay in milliseconds (mSEC), and press **ENTER**. For an In-Situ transducer, set to 50 mSEC unless specified otherwise. You will most likely have to determine this value by experiment for third-party transducers. **Reminder:** During the first minute of log sampling, the HERMIT uses a warmup delay of 50 mSEC, regardless of the delay programmed. If you've selected the log sample mode, make certain that the transducers you choose are compatible with this requirement.

The unit will check that the sum of the delays does not exceed the selected sample rate. (This is only likely to be a problem with third-party XDs and a very fast LIN2 sample rate.) If you see this screen and then the 'Error' message, select a longer sample rate.



The HERMIT calculates the intermediate pressure reading using the quadratic formula:

$$P = LX^2 + SX + O$$

where P = Pressure in PSI
X = Normalized transducer value (0-1)
L = Linearity
S = Scale factor in PSI full scale
O = Offset in PSI

Choosing a Display Mode

The HERMIT can display readings in English units (feet of water) or Standard International units (meters of water), and readings may be referenced either to the surface or to the top of the well casing.

The following menu will be displayed when you select the display mode option ('DSP.') from the ENTER XD menu. The currently selected display mode is shown first. The **SCAN UP** key moves toward the top of the menu, the **SCAN DOWN** key toward the bottom. **STOP/NEXT** will exit this menu and return to the ENTER XD menu without changing the current display mode setting. Press **ENTER** to select the desired display mode.

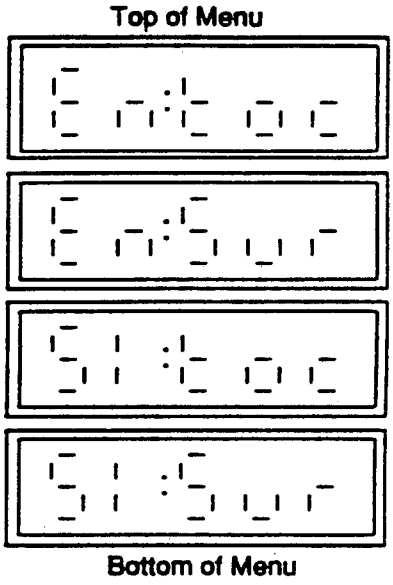
Display Mode Menu

Feet of water, Top of Casing reference

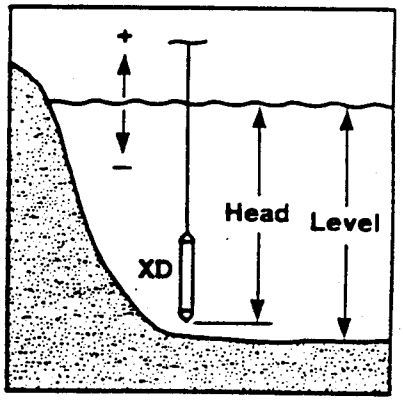
Feet of water, Surface reference

Meters of water, Top of Casing reference

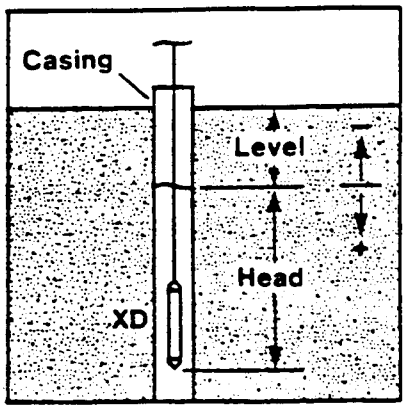
Meters of water, Surface reference



Use the surface mode to monitor surface water situations such as streams and lakes, or to use head data directly. *Increasing* water levels correspond to *increasing* level readings. *Decreasing* water levels correspond to *decreasing* level readings.



Select the **top of casing** mode when monitoring groundwater, and readings referenced to the top of the well casing are required. In this case *decreasing* water levels correspond to *increasing* top of casing readings. *Increasing* water levels will correspond to *decreasing* top of casing readings.



The intermediate transducer pressure is converted to a head value using the following formula:

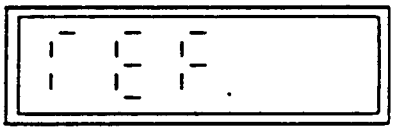
$$H = P \cdot U$$

where H = Head value
P = Pressure in PSI
U = Conversion units: 2.30667 feet of water/PSI
or 0.703072 meters of water/PSI

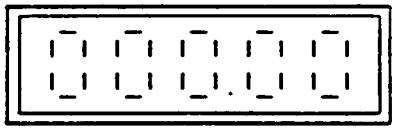
Entering the Reference Level

The transducer must be connected to the instrument and placed at its initial depth before the reference level is entered. Therefore, although it's prompted first, it's a good idea to leave the reference level until last. You can program the other transducer parameters in the office; then when the instrument is in the field and the transducer is in the water, re-access the ENTER XD menu and enter the reference level.

To program the reference level, press **ENTER** to select the 'REF.' option in the ENTER XD menu.



You will be prompted to enter a value for the reference level. Use the **SCAN** and **NEXT** keys to enter the reference level and press **ENTER**.



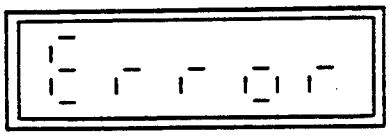
The HERMIT will power up the transducer and take a corresponding reference head reading . . .



. . . then the display returns to 'REF.' in the ENTER XD menu.



The transducer must be connected and set at its initial depth before the reference level is entered; otherwise the 'Error' message will appear.



The reference level is used to reference changes in head to changes in an initial water level. The reference level is arbitrary and may be set to any value suitable for the test conditions. When monitoring a lake, for example, you might set the reference level at:

- The present depth of the lake with respect to the lake bottom so that readings are presented as lake depth.
- The altitude of the lake surface so that readings are displayed as altitudes.
- Zero, so that readings will reflect only changes, both positive and negative, from the initial reference level.

> ***CAUTION***
>
> *Though the reference level is very flexible in definition, you must select and enter a reference level for each level input, with the transducers connected and set, before starting a test.*

Once the reference levels are entered, the HERMIT can compute surface levels as:

$$L(t) = R - [H(r) - H(t)]$$

Similarly, top of casing levels are computed as:

$$L(t) = R + [H(r) - H(t)]$$

where
- $L(t)$ = Level at time t
- R = Reference level
- $H(r)$ = Head at time when reference level was entered
- $H(t)$ = Head at time t

Level Setup Procedure

You can use the following procedure to properly set up a pressure transducer with a level type input channel.

1. Program the transducer parameters of scale factor, offset, and linearity. Remember to set to zero any parameter not specified.

2. Program the transducer warmup delay. Set it to 50 mSEC if not specified otherwise.

3. Select the display mode (units and TOC or surface level) you require for the test.

4. Lower the transducer beneath the water surface. Secure it in place below the lowest anticipated water level, but not so low that the range of the transducer might be exceeded at the highest anticipated level.

5. Connect the transducer to the input channel.

6. Press the **XD** key to check the transducer operation.



The reading shown on the display is the transducer head.



7. Adjust the transducer until the head reading indicates that the transducer is set at the desired depth.

8. Input the reference level with the transducer set and connected to the instrument.

Programming Function Types

The function mode is used to convert the 4-20 mA current values obtained from a transducer to meaningful measurement units. This mode can be used to obtain direct readings in PSI from pressure transducers or used with other transducers to measure temperature, flow rate, barometric pressure, etc.

The following menu will be displayed for a function type input. Use the **SCAN DOWN** key to move toward the bottom of the menu, **SCAN UP** to move toward the top. **STOP/NEXT** will exit the menu for the current input channel without changing any of the programmed settings. Press **ENTER** to select an option.

The individual options are discussed on the following pages.

If two inputs are active: When you have entered all the parameters for one input, the display will automatically proceed to the other input. When both inputs have been programmed, press **STOP/NEXT** until the status display returns to the screen.

ENTER XD Menu: Function Type

Top of Menu

Transducer scale factor

Transducer offset

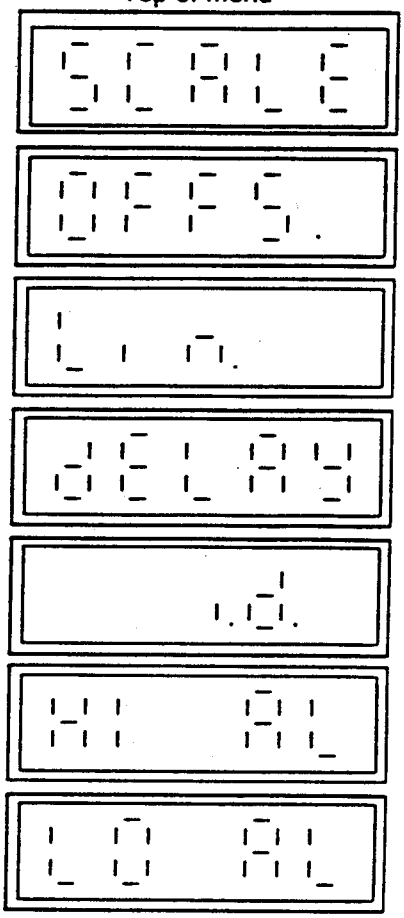
Transducer linearity

Transducer warmup delay

Input channel I.D. (optional, see p. 56)

High alarm setting (optional, see Section 6)

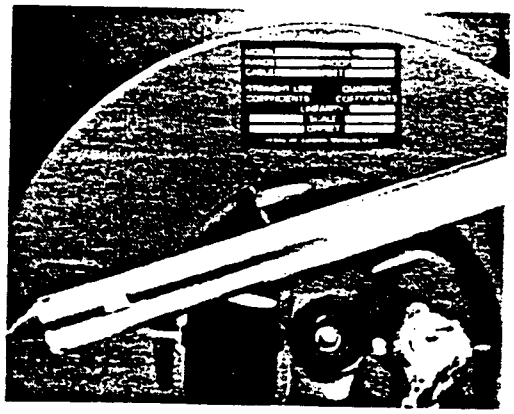
Low alarm setting (optional, see Section 6)



Bottom of Menu

Transducer Parameters

There are four transducer parameters that you must enter for a function type. These parameters may be found on the cable reel, or on a data tag attached to the cable. For the HERMIT 1000C, be sure to use the "Quadratic Coefficients."



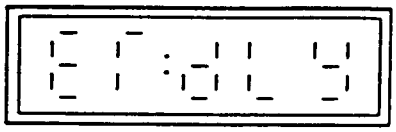
- **Scale factor** – Select 'SCALE' from the menu, input the transducer scale factor, and press **ENTER**. This value should not be zero for a pressure transducer.
- **Offset** – Scan down to 'OFFS.,' input the transducer offset, and press **ENTER**. Set to zero if not specified.

- **Linearity** – Scan down to 'LIN.,' input the linearity, and press **ENTER**. Set to zero if not specified.

Remember that the **CLOCK**, **XD**, and **DATA** keys can be used to change the position of the decimal point. If the coefficient is negative, be sure to include the minus sign (**START** key). Refer to the box on p. 44. Since the HERMIT can accommodate a maximum of 2 decimal places, you may need to round the values to fit the display.

- **Warmup delay** – Scan down to 'DELAY,' input the transducer warmup delay in milliseconds (mSEC), and press **ENTER**. For an In-Situ transducer, set to 50 mSEC unless specified otherwise. You will probably have to determine this value by experiment for third-party transducers. **Reminder:** During the first minute of log sampling, the HERMIT uses a warmup delay of 50 mSEC, regardless of the delay programmed. If you've selected the log sample mode, make certain that the transducers you choose are compatible with this requirement.

The unit will check that the sum of the delays does not exceed the selected sample rate. (This is only likely to be a problem with third-party XDs and a very fast LIN2 sample rate.) If you see this screen and then the 'Error' message, select a longer sample rate.



The HERMIT computes function readings as follows:

$$\text{READING} = LX^2 + SX + O$$

where X = Normalized transducer value (0-1)
L = Linearity
S = Scale factor in units full scale
O = Offset

The units of the scale, offset, and linearity determine the units of the reading. Readings in units other than those specified by the manufacturer can be obtained by multiplying or dividing the scale, offset, and linearity by the appropriate conversion factor before entering them into the HERMIT.

The parameters for a third-party 4-20 mA transducer must often be calculated. As an example, if a 4-20 mA flow transducer specifies an output range of 10 to 100 GPM (gallons per minute), calculate the parameters as

Scale factor = 100 - 10 = 90 GPM full scale
Offset = 10 GPM
Linearity = 0 (will most often be the case)

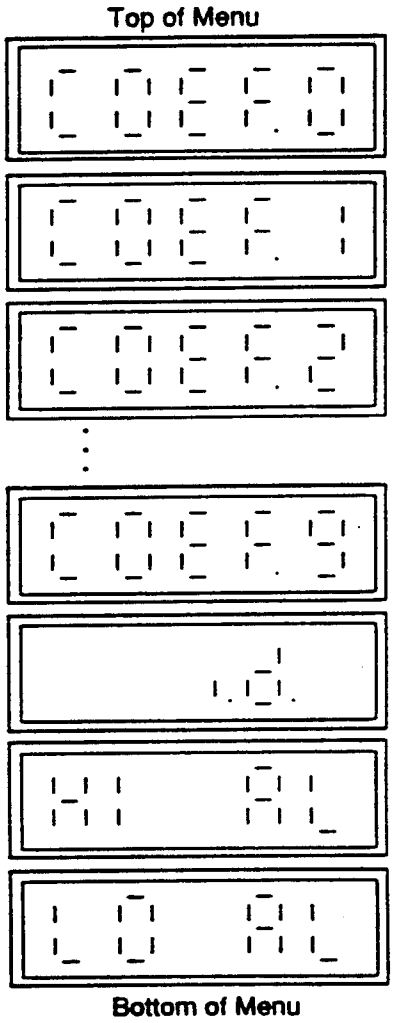
You can have readings in any other units of flow by multiplying all three parameters by the appropriate conversion factor. The warmup delay will have to be determined by experiment if it is not identified by the manufacturer. Use the shortest warmup delay possible that gives consistent and stable readings.

Programming Dual Types

The dual type input allows you to interface with one of In-Situ's unique dual parameter transducers such as conductivity/temperature or pH/temperature. These transducers permit the measurement of temperature and a temperature-dependent parameter with a single input channel.

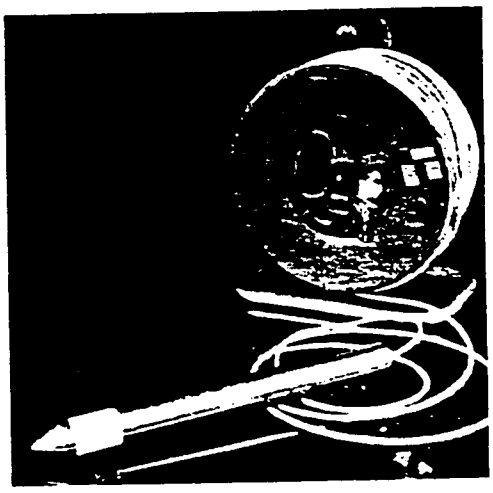
The following menu will be displayed for a dual type input. Use the **SCAN DOWN** key to move toward the bottom of the menu, **SCAN UP** to move toward the top. **STOP/NEXT** will exit the menu for the current input channel without changing any of the programmed settings. Press **ENTER** to select an option.

ENTER XD Menu: Dual Type



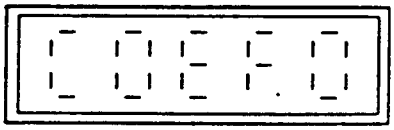
If two inputs are active: When you have entered all the parameters for one input, the display will automatically proceed to the other input. When both inputs have been programmed, press STOP/NEXT until the status display returns to the screen.

Coefficient Entry



The dual type input uses ten coefficients to convert the transducer output to meaningful readings. The coefficients can be found on the cable reel or with accompanying documentation.

To program the ten coefficients, press **ENTER** to select the 'COEF.0' option from the ENTER XD menu.



You will be prompted to enter the coefficient 0 value provided with the transducer.

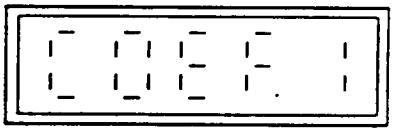
\ | /



/ | \

Remember that the **CLOCK**, **XD**, and **DATA** keys can be used during numeric entry if you need to change the position of the decimal point. If the coefficient is negative, be sure to include the minus sign (**START** key). Refer to the box on p. 44. Since the HERMIT can accommodate a maximum of 2 decimal places, you may need to round the values to fit the instrument's display.

Press **ENTER** to set the new value. The display will proceed to the next coefficient.



Enter all ten coefficients in this way, pressing **ENTER** after each entry. When you have entered the last coefficient ('COEF.9'), you can use the **SCAN** and **ENTER** keys to review or edit the coefficients individually. Press **STOP/NEXT** to return to the menu.

Coefficients C0, C1, and C2 are used to compute temperature in degrees Celsius using the following formula:

$$T = C0 + X*C1/10 + X^2*C2/100$$

where T = Temperature in degrees Celsius
X = Transducer temperature reading

Coefficients C3 through C7 are used to calculate the primary value (e.g., pH or conductivity)

$$V = [C3 + Y*C4/10 + Y^2*C5/100] * C7/1000 + C6$$

where V = Value
Y = Transducer value

Coefficients C8 and C9 are used to correct the primary value for temperature variations:

$$V_c = \frac{V}{1 + \frac{C8}{1000}(T-25)} + C9$$

If you wish to display uncompensated primary values, set coefficients C8 and C9 to zero. Refer to the specific dual-mode transducer manual for other coefficient options you may have.



Battery Life Tip

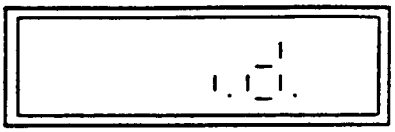
Dual-mode transducers consume considerably more power than their single-function counterparts. Minimizing the number of reads will help to extend battery life, as will increasing the sample interval. Select a sample rate that gives good data quality without recording excessive or redundant points.

Reminder: Due to the time required to read a dual-mode transducer, all dual-mode data recorded during the first minute of a test in the log sample mode will be meaningless and should be ignored.

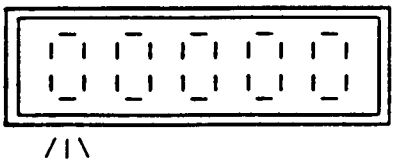
Assigning an I.D.

Each input channel can be assigned a five-digit identification number to help document field test conditions. You can program the I.D. with a well number, transducer serial number, or any other piece of meaningful information. The I.D. parameter is optional and may be left at 00000.

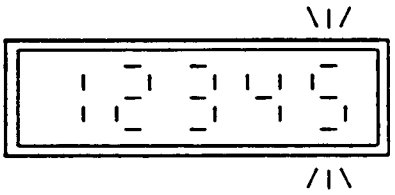
Press **ENTER** to select the 'I.D.' option from any ENTER XD menu.



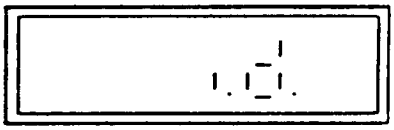
You will be prompted to enter the identification number. The current I.D. is shown on the display.



Use the **SCAN** and **NEXT** keys to set the desired I.D. When the number is as you want it, press **ENTER**.



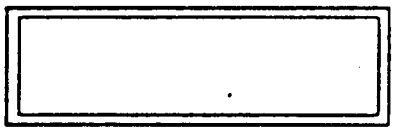
The display will return to the ENTER XD menu.



Reading a Transducer

When you have entered all of the parameters in the ENTER XD menu, connect the transducer to its input channel and take a quick reading to verify operation. A transducer will not read correctly until the cable is properly connected and all of the parameters contained in the menu have been programmed.

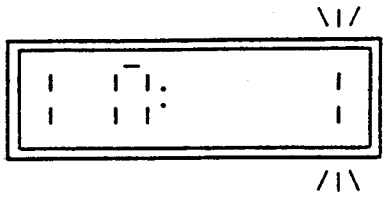
Starting from the status display . . .



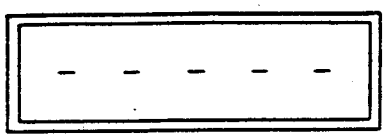
. . . press the **XD** key.



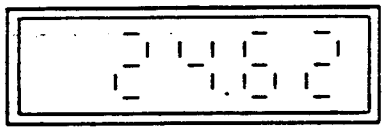
If two inputs are active, an input number is displayed with a blinking digit. **SCAN** to the desired input number, if necessary, and press **ENTER** to select the input. This prompt is skipped if only one input is active.



The HERMIT will power the input channel, wait for the programmed warmup delay period . . .

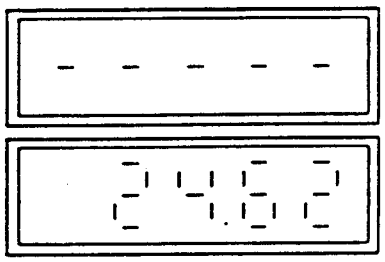


. . . then take a transducer reading and display the result in the programmed units, and turn the transducer off.

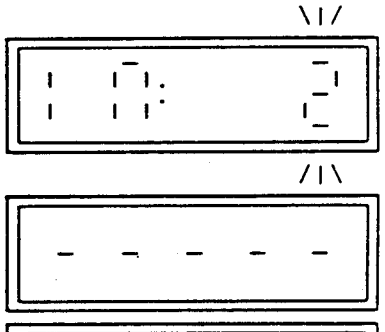


Press **XD** again to take repeated readings from the same transducer.

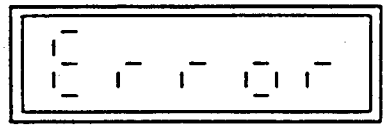




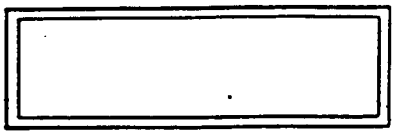
If two inputs are active, pressing **STOP/NEXT** will bring up the prompt for the other input. Press **ENTER** to select the new input and the HERMIT will take a reading as before.



If the HERMIT cannot obtain a valid reading, the 'Error' message will flash briefly, and then a default value will be displayed. Make certain that the transducer is connected to the proper input channel and that all connections are secure.



When the inputs have been read, press STOP/ **NEXT** until the status display returns to the screen.



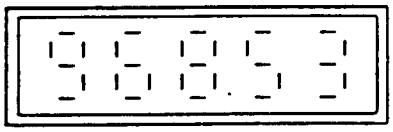
Level Mode: When a level mode transducer is connected and the HERMIT is idle or waiting for a delayed start, the transducer depth (head) is displayed instead of the water level. This allows the operator to properly set the transducer below the largest expected drop in water level.

Dual Mode: A dual mode reading takes about 4 seconds.

The temperature is displayed first, to one decimal place, followed by a 'C' to indicate degrees Celsius . . .



. . . then the primary parameter (e.g., conductivity), to two decimal places.



When the dual-mode data are printed, temperature will be complete to three decimal places. The shortened display is to help differentiate between the two readings.

6 Setting Up Alarms

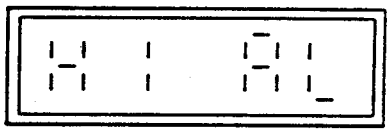
The alarm function allows you to synchronize other field equipment, such as pumps or automatic samplers, with alarms detected by the HERMIT. Refer to Section 14 for wiring details.

Each input on the HERMIT has an independently programmable alarm with a high and low limit setting. Since there is only one contact output for a high alarm and one for a low alarm, the alarms for each input are "or'ed" together. A high alarm on input 1 *or* a high alarm on input 2 will activate the high alarm contact. Similarly, a low alarm on input 1 *or* a low alarm on input 2 will activate the low alarm contact.

The values programmed for each alarm setting must be in the same units as the measured value. The alarm outputs are only active while the HERMIT is running a test and are updated at each sample interval. If the high or low alarm contact is activated, it will remain activated even if the instrument is asleep. When in the logarithmic sample mode, alarms are not checked during the first two minutes of the test. Only the primary parameter of a dual mode transducer is compared with alarm settings (dual mode temperature does not have alarm settings).

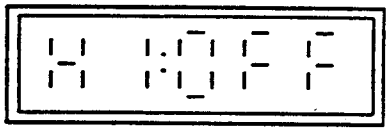
Programming the High Alarm Limit

Select the high alarm option at any ENTER XD menu by pressing **ENTER** when the display shows 'HI AL.'

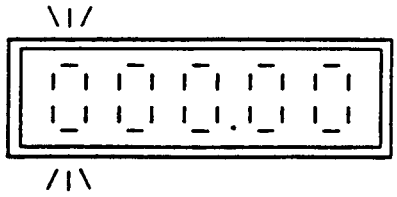


The current on/off status of the high alarm for the active input is displayed. **SCAN UP** to turn the alarm on, **SCAN DOWN** to turn it off. **STOP/NEXT** will return to the ENTER XD menu without changing the current status. Press **ENTER** to select the desired on/off setting.



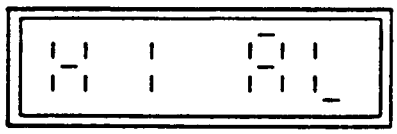


If selected off, the display returns to the ENTER XD menu. If selected on, you are prompted to enter a value to activate the high alarm. Use the **SCAN** and **NEXT** keys to enter the value.



Enter the high limit in the same units used for other transducer parameters on this input channel. The high alarm will activate when a data point reading is greater than or equal to the high alarm limit.

Press **ENTER** to set the new value. The display returns to the ENTER XD menu. The high alarm will be activated if a data point is greater than or equal to the programmed value.



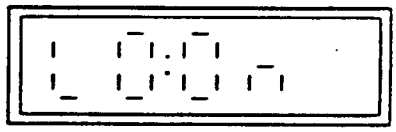
Note: If you have already programmed a low alarm for an input, the HERMIT will require that your high limit be greater than the low limit. The instrument will not accept a high limit entry that is less than or equal to the low limit entry.

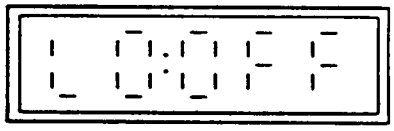
Programming the Low Alarm Limit

Select the low alarm option at any ENTER XD menu by pressing **ENTER** when the display shows 'LO AL.'

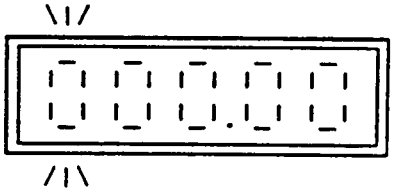


The current on/off status of the low alarm for the active input is displayed. **SCAN UP** to turn the alarm on, **SCAN DOWN** to turn it off. **STOP/NEXT** will return to the ENTER XD menu without changing the current status. Press **ENTER** to select the desired on/off setting.



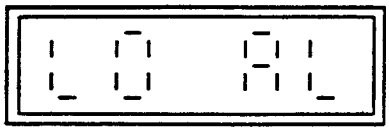


If selected off, the display returns to the ENTER XD menu. If selected on, you are prompted to enter a value to activate the low alarm. Use the **SCAN** and **NEXT** keys to enter the value.



Enter the low limit in the same units used for other transducer parameters on this input channel. The low alarm will activate when a data point reading is less than or equal to the low alarm limit.

Press **ENTER** to set the new value. The display returns to the ENTER XD menu. The low alarm will be activated if a data point is less than or equal to the programmed value.

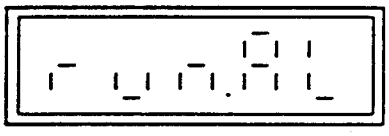


Note: If you have already programmed a high alarm for an input, the HERMIT will require that your low limit be less than the high limit. The instrument will not accept a low limit entry that is greater than or equal to the high limit entry.

Press **STOP/NEXT** to return to the status display.



When you start the test, the status display will contain an indication that the alarm is programmed on.



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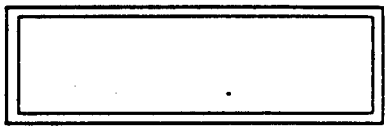
7 Running a Test

When all test and transducer parameters have been programmed as described in Sections 4 and 5, and when the transducers are connected and emplaced, the test may be started. First, use the following checklist to be certain that all parameters have been properly programmed.

- Check that the clock indicates the correct date and time.
- Check that all transducers are connected and read properly.

Accessing the Start Menu

Beginning from the status display . . .

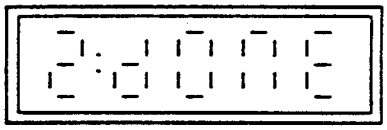


. . . press the **START** key.

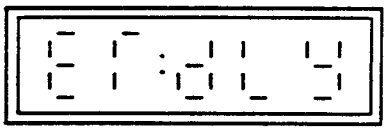


Before allowing access to the start menu, the HERMIT checks your test setup for illegal test conditions.

If the currently active test has already been run, you will not be allowed to start. Be sure to select a test number and set up the test in the ENTER DATA menu before trying to start a test.



This message means that the programmed delays exceed the programmed sample interval. If dual type inputs are being used with a very fast linear 2 sample rate, or if the sum of the transducer warmup delays exceeds the sample rate, select a longer sample rate.



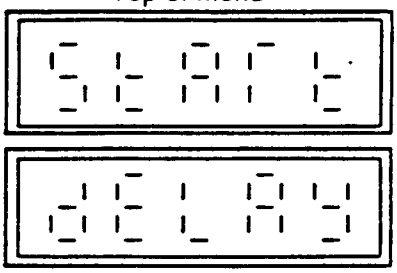
If the test conditions pass this check, the HERMIT displays the start menu. Press **SCAN DOWN** to display the delayed start option, **SCAN UP** to display the immediate start option. Press **STOP/NEXT** to cancel the start function without collecting data. Press **ENTER** when the desired start type is on the display.

Start Menu

Immediate start option

Delayed start option

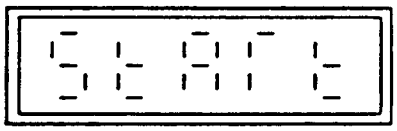
Top of Menu



Bottom of Menu

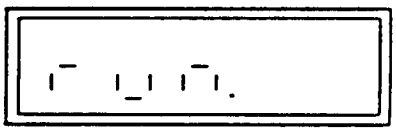
Immediate Start Option

For an immediate start, press **ENTER** when the display shows 'START.' The HERMIT begins collecting data immediately.

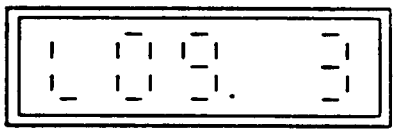


The screen display will vary depending on the sample rate programmed for the test. In addition, the availability of keyboard functions during the test (p. 67) will be different depending on how fast the HERMIT is recording data.

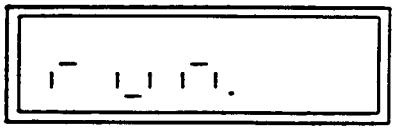
If the **Linear 1** sample mode has been selected, the status display returns to the screen with the 'run' indicator added. All keyboard functions are available.



If the **Log** sample mode has been selected, the unit displays 'LOG' and the number of the log cycle (p. 37) during the first ten minutes. Only the **STOP** function is active until . . .



. . . the status display returns to the screen. At this point, normal keyboard operation is restored.

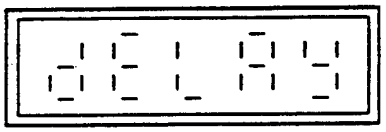


If the Linear 2 sample mode has been selected, the unit displays 'LIN.2' until you stop the test. Because of the rapidity of data collection in this sample mode, the HERMIT can't do anything else while the test is running. Only the STOP function is active.

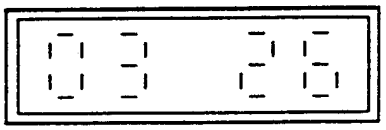


Delayed Start Option

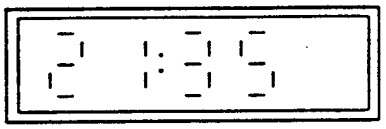
To set up a delayed start, press **ENTER** when the display shows 'DELAY.'



The HERMIT prompts for the delayed start date first. Use the **SCAN** and **NEXT** keys to enter the date you want the test to start, and press **ENTER**.

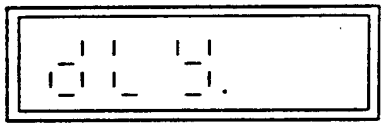


Then you are prompted for the delayed start time. Use the **SCAN** and **NEXT** keys to enter the time you want the test to start, and press **ENTER**.



To avoid an 'Error' message, the delayed start date and time must meet the same criteria as an internal clock setting. See Setting the Clock in Section 3.

The status display returns to the screen. An indicator is added to show that the HERMIT is waiting for a delayed start.



The HERMIT will automatically start the test at the programmed date and time. You can edit the start date and time by re-accessing the start menu and entering a new delayed start time. You can also override a delayed start by selecting the immediate start option.

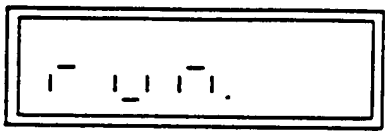
Stepping the Test

The HERMIT gives you the option to subdivide a test into steps. This feature is useful when running constant-rate and stepped-rate pump tests, with or without a recovery phase. When you step a test, the HERMIT will:

- Partition the storage memory to keep step data separated.
- Record the start date and time of the step.
- Restart its programmed sampling schedule with an elapsed time of 0.

You can have as many as five steps within a test, numbered 0 to 4. When you first start a test, you are actually starting Step 0.

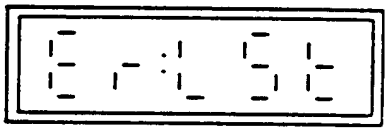
Begin at the status display. A test can be stepped only if it is already running.



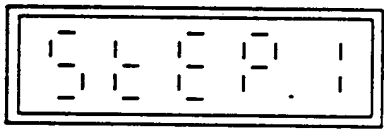
Press the **START** key.



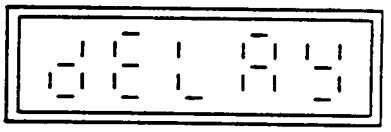
An error message will be displayed if the last step is already running, or if there is insufficient memory to start the next step.



Otherwise the next step number is displayed. To start the step immediately, press **ENTER** while the display is showing the step number.



To program a delayed start for the step, **SCAN DOWN** to display the delayed start option and press **ENTER**.



If you select a delayed start, the HERMIT will prompt you through the set-up procedure for a delayed step start, which is exactly the same as the delayed test start procedure described on the preceding page.

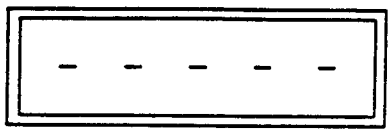
Note: When a delayed start is programmed for a step, ***data collection for the previous step will stop.*** The HERMIT does not record data while it is waiting for a delayed start.

While the Test is Running

In most cases, the HERMIT's data functions are available while the test is running. The exceptions are (1) the first 10 minutes of a test in the log sample mode, and (2) an entire test in the Linear 2 sample mode.

- You can view data for any test or step stored in memory using the **DATA** key.
- You can print data for any test or step by connecting a printer through the RS232 port and turning it on, then pressing the **DATA** key.
- You can take manual readings on any transducer using the **XD** key.
- You can modify the transducer and alarm parameters of the test that is running.

You may be interrupted occasionally as the instrument collects and records a data point.

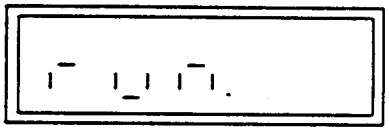


There is no function that you can perform that will cause the HERMIT to miss or delay taking a data point.

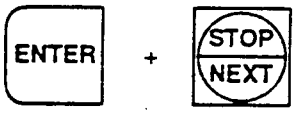
Stopping the Test

Data collection is stopped manually from the keyboard; it is not a programmable function. Data collection stops automatically when the memory is full.

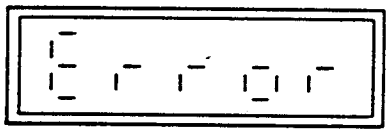
Begin at the status display with the unit in an active data collection mode (either run or delay).



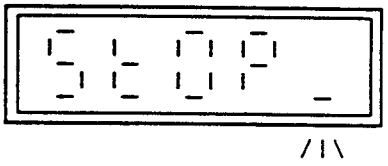
To stop data collection, press the **ENTER** key and hold it down while you press **STOP/NEXT**.



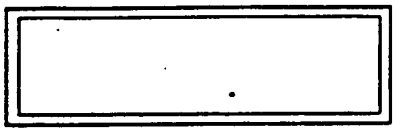
The 'Error' message is displayed if the unit is already stopped and is in the idle mode.



Otherwise the stop prompt is displayed with an underline cursor flashing. Press **ENTER** to confirm the stop selection, or press **STOP/NEXT** to cancel the selection.



When the stop function is confirmed, the status display returns to the screen.



Note: When the HERMIT is collecting data very rapidly (Linear 2 sample mode or the first three log cycles), there will be no opportunity to confirm or cancel the STOP selection. Simply hold the **ENTER** and **STOP/NEXT** keys until the test stops.



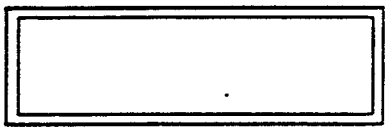
Battery Life Tip

Don't waste battery power and memory endurance by leaving the HERMIT running after the test is finished. Use the STOP function to turn data recording off.

8 Viewing Stored Data

Data from any test may be viewed at any time.

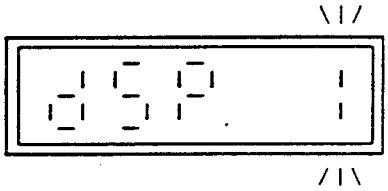
Starting from the status display . . .



. . . press the **DATA** key.



The display will show 'DSP' and the HERMIT will prompt for a test number. The highest test number is the default selection. Select the default by pressing **ENTER**, or **SCAN** to your selection and press **ENTER.**



The selected test number must be in the range zero to the default test or you will get an 'Error' message.

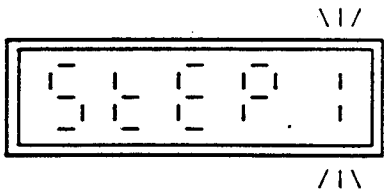


If the selected test has not been run and contains no data, 'NONE' will be displayed.

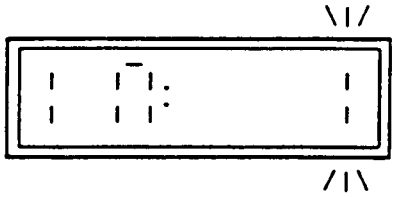


The message will display briefly and you will be reprompted for the test number.

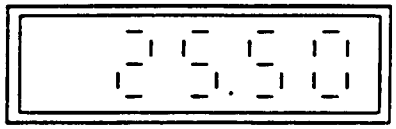
If the test was stepped, you are prompted to select the step you wish to view. The highest step number is displayed as the default. Press **ENTER**, or **SCAN** to the desired step and press **ENTER.** This prompt is skipped if no steps were used.



If both input channels were active during the test, the HERMIT will prompt for an input number. To view data for the default input, just press **ENTER**; or **SCAN** to the other input and press **ENTER**. This prompt is skipped if only one input was active.



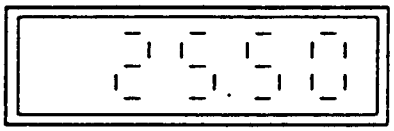
The display will show the elapsed time in minutes of the last data point recorded . . .



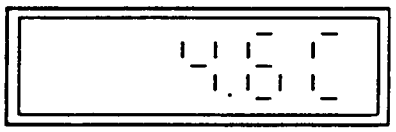
. . . and then the data point value in the specified units.



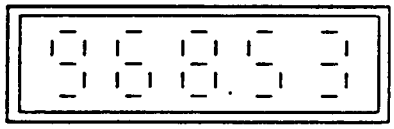
Data for a dual-mode probe will be shown on three screens: elapsed time . . .



. . . then the temperature in degrees Celsius . . .



. . . then the primary value (conductivity, pH, etc.) in the programmed units.



Scanning the Data

The **SCAN** keys may be used to scan through the recorded data.

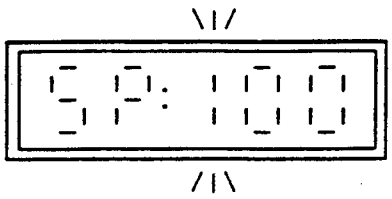
- **SCAN UP** moves toward the end of the test, in the direction of increasing elapsed time (later data points)
- **SCAN DOWN** moves toward the beginning of the test, in the direction of decreasing elapsed time (earlier data points)

Press a **SCAN** key once, the display will show elapsed time, then the data point value. If you hold down a **SCAN** key, the display will scroll rapidly through the elapsed time; when you release the key, the display will show the data point value for the last displayed time.

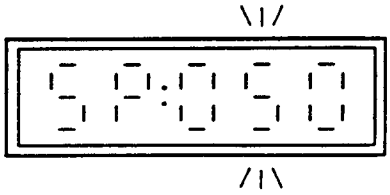
Selecting a View Percentage

To move quickly to a different segment of data without scanning, you can specify the point in the test where you would like to start viewing. Zero percent is the beginning of the test, 100 percent is the end of the test (or the most recent data point if the test is still running). The default is 100 percent.

Press **ENTER** during the data display. The HERMIT will prompt for a "Start Percentage," the percentage into the test where you want to view the data.



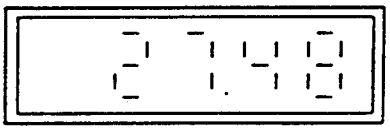
Use the **SCAN** and **NEXT** keys to select the view percentage and press **ENTER**. 50 percent will jump to the middle of the test.



The display will show the elapsed time at the midpoint of the test . . .

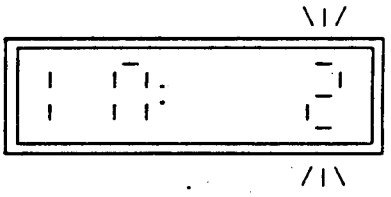


. . . then the data point value.

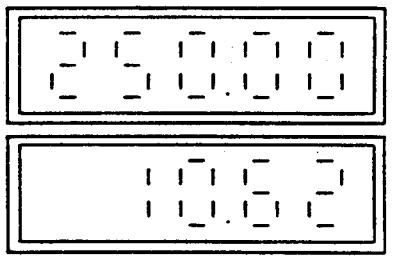


Changing the Input Channel

If two inputs were active during the test, pressing **STOP/NEXT** during the data display will bring up the prompt for the other input.



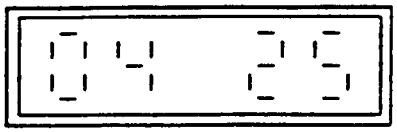
Press **ENTER** to select the new input. The display will remain at the same elapsed time on the new channel.



This sequence of **STOP/NEXT** followed by **ENTER** can be used to move back and forth between channels. When you change channels, the display stays at the same elapsed time value, allowing you to review the data for both inputs at any given elapsed time.

Viewing the Start Time

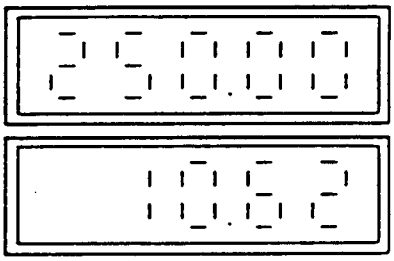
Press **START** during the data display. The HERMIT will show the start date of the test or selected step . . .



. . . then the start time . . .



. . . then return to the view data display at the point where you displayed the start time.



Log Mode Data

Elapsed time values for the first few seconds of log mode data will appear somewhat ambiguous due to the LCD's inability to show small decimal values. Elapsed time up to one minute cannot be displayed with full resolution, though it will print properly. Use the table on the opposite page to convert the displayed terms to their full resolution.

Reminder: Due to the time required to read a dual-mode transducer, all dual-mode data recorded during the first minute of log sampling will be meaningless and should be ignored. The data recorded during this period will vary depending on the transducer's coefficients, but the start of good data should be readily apparent when looking at the data.



Battery Life Tip

It can be very time-consuming to use the view display to retrieve stored data from long tests. If done often, it can be tough on battery life as well. Use external power if possible, or consider dumping the data to a printer or computer using the RS232 port.

Log Mode Elapsed Time Values

Sample No.	Minutes Display	Minutes Actual	Sample No.	Minutes Display	Minutes Actual	Sample No.	Minutes Display	Minutes Actual
0	0.00	0.0000	49	0.16	0.1633	98	0.32	0.3266
1	0.00	0.0033	50	0.16	0.1666	99	0.33	0.3300
2	0.00	0.0066	51	0.17	0.1700	100	0.33	0.3333
3	0.01	0.0100	52	0.17	0.1733	101	0.35	0.3500
4	0.01	0.0133	53	0.17	0.1766	102	0.36	0.3666
5	0.01	0.0166	54	0.18	0.1800	103	0.38	0.3833
6	0.02	0.0200	55	0.18	0.1833	104	0.40	0.4000
7	0.02	0.0233	56	0.18	0.1866	105	0.41	0.4166
8	0.02	0.0266	57	0.19	0.1900	106	0.43	0.4333
9	0.03	0.0300	58	0.19	0.1933	107	0.45	0.4500
10	0.03	0.0333	59	0.19	0.1966	108	0.46	0.4666
11	0.03	0.0366	60	0.20	0.2000	109	0.48	0.4833
12	0.04	0.0400	61	0.20	0.2033	110	0.50	0.5000
13	0.04	0.0433	62	0.20	0.2066	111	0.51	0.5166
14	0.04	0.0466	63	0.21	0.2100	112	0.53	0.5333
15	0.05	0.0500	64	0.21	0.2133	113	0.55	0.5500
16	0.05	0.0533	65	0.21	0.2166	114	0.56	0.5666
17	0.05	0.0566	66	0.22	0.2200	115	0.58	0.5833
18	0.06	0.0600	67	0.22	0.2233	116	0.60	0.6000
19	0.06	0.0633	68	0.22	0.2266	117	0.61	0.6166
20	0.06	0.0666	69	0.23	0.2300	118	0.63	0.6333
21	0.07	0.0700	70	0.23	0.2333	119	0.65	0.6500
22	0.07	0.0733	71	0.23	0.2366	120	0.66	0.6666
23	0.07	0.0766	72	0.24	0.2400	121	0.68	0.6833
24	0.08	0.0800	73	0.24	0.2433	122	0.70	0.7000
25	0.08	0.0833	74	0.24	0.2466	123	0.71	0.7166
26	0.08	0.0866	75	0.25	0.2500	124	0.73	0.7333
27	0.09	0.0900	76	0.25	0.2533	125	0.75	0.7500
28	0.09	0.0933	77	0.25	0.2566	126	0.76	0.7666
29	0.09	0.0966	78	0.26	0.2600	127	0.78	0.7833
30	0.10	0.1000	79	0.26	0.2633	128	0.80	0.8000
31	0.10	0.1033	80	0.26	0.2666	129	0.81	0.8166
32	0.10	0.1066	81	0.27	0.2700	130	0.83	0.8333
33	0.11	0.1100	82	0.27	0.2733	131	0.85	0.8500
34	0.11	0.1133	83	0.27	0.2766	132	0.86	0.8666
35	0.11	0.1166	84	0.28	0.2800	133	0.88	0.8833
36	0.12	0.1200	85	0.28	0.2833	134	0.90	0.9000
37	0.12	0.1233	86	0.28	0.2866	135	0.91	0.9166
38	0.12	0.1266	87	0.29	0.2900	136	0.93	0.9333
39	0.13	0.1300	88	0.29	0.2933	137	0.95	0.9500
40	0.13	0.1333	89	0.29	0.2966	138	0.96	0.9666
41	0.13	0.1366	90	0.30	0.3000	139	0.98	0.9833
42	0.14	0.1400	91	0.30	0.3033	140	1.00	1.0000
43	0.14	0.1433	92	0.30	0.3066	141	1.20	1.2000
44	0.14	0.1466	93	0.31	0.3100	142	1.40	1.4000
45	0.15	0.1500	94	0.31	0.3133	143	1.60	1.6000
46	0.15	0.1533	95	0.31	0.3166	144	1.80	1.8000
47	0.15	0.1566	96	0.32	0.3200	145	2.00	2.0000
48	0.16	0.1600	97	0.32	0.3233			

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9 Using the RS232 Port

The HERMIT's RS232 port allows you to print stored data on a field printer, or dump data to most personal or portable computers that are also equipped with an RS232 port. This section will explain how to program the RS232 port parameters to match the requirements of your printer or computer. If you are not familiar with making the cable connections between the instrument and the printer or computer, be certain to read the information contained in Appendix B of this manual.

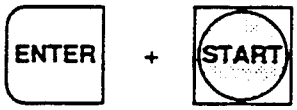
Accessing the System Setup Menu

The RS232 port parameters are accessed through the System Setup menu.

Begin at the status display. The System Setup menu can be displayed in any mode.



Press the **ENTER** key and hold it down while you press the **START** key.

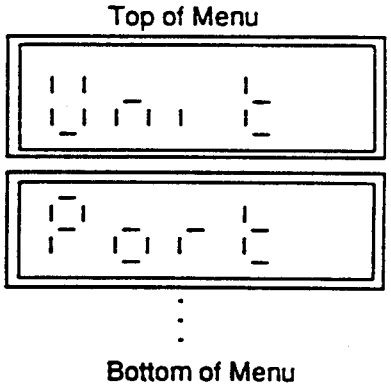


The System Setup menu consists of six options. We are only concerned with the first two options here. (the remaining options will be discussed in Section 11). Use the **SCAN DOWN** key to move toward the bottom of the menu, **SCAN UP** to move toward the top. To select an option, press **ENTER**.

System Setup Menu

Unit identification

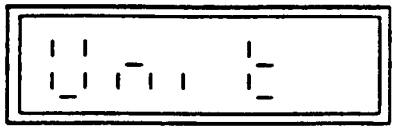
RS232 Port



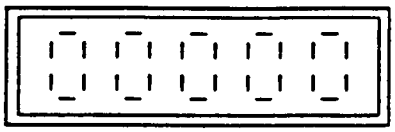
Programming a Unit Identification

The optional five-digit unit identification number may be used to help identify printouts and data transfers when data is output to the RS232 port.

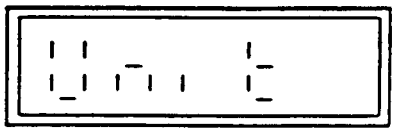
To modify the unit's identification number, select 'UNIT' from the System Setup menu.



You are prompted to enter a unit identification number. Use the **SCAN** and **NEXT** keys to set the unit i.d. and press **ENTER**.



The display returns to 'UNIT' in the System Set-up menu.



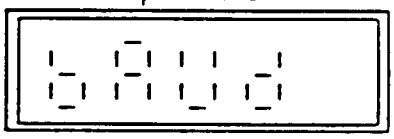
RS232 Port Parameters

To program the RS232 port parameters, select 'PORT' from the System Setup menu. The following menu will be displayed. The **SCAN DOWN** key moves toward the bottom of the menu, the **SCAN UP** key toward the top. **STOP/NEXT** will exit this menu and return to 'PORT' in the System Setup menu without changing the current port parameters. To select an option, press **ENTER**.

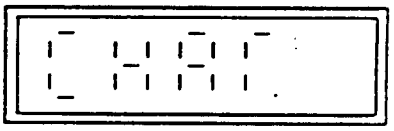
RS232 Port Menu

Top of Menu

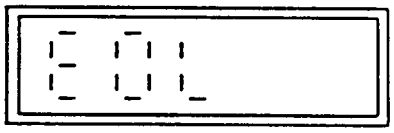
Baud rate



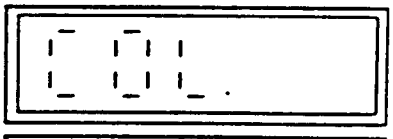
Character length/parity



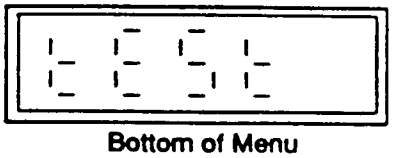
End-of-Line sequence



Print width



RS232 port test



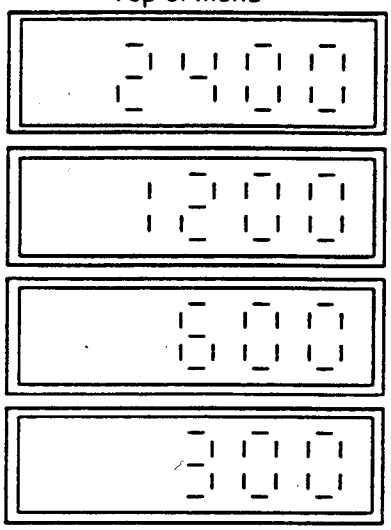
Bottom of Menu

Baud Rate

Four options will be presented when you select 'BAUD' from the Port menu. The current baud rate is shown first. Use the **SCAN** keys to display additional options. Press **ENTER** to accept the baud rate shown and return to the Port menu, or **STOP/NEXT** to return to the Port menu without changing the current baud setting.

Baud Rate menu

Top of Menu



Bottom of Menu

Character Length and Parity

Three options will be presented when you select 'CHAR.' from the Port menu. The current character configuration is shown first. Use the **SCAN** keys to display additional options. Press **ENTER** to accept the character length/parity shown and return to the Port menu, or **STOP/NEXT** to return to the Port menu without changing the current character setting.

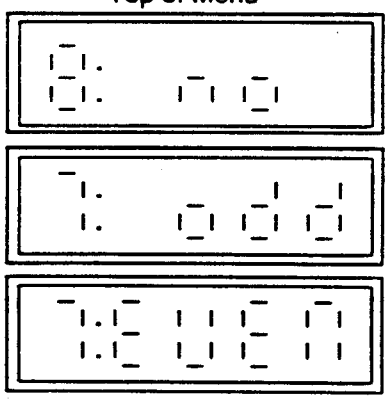
Character/Parity Menu

Top of Menu

8 bits per character, no parity bit

7 bits per character plus an odd parity bit

7 bits per character plus an even parity bit



Bottom of Menu

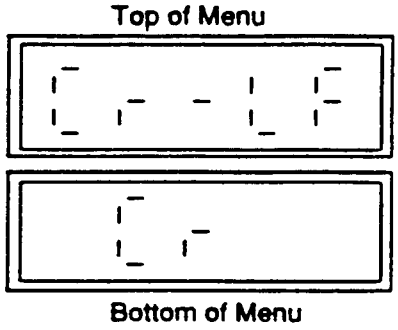
End-Of-Line Sequence

Two options are available for the end-of-line sequence ('EOL'). The current EOL sequence is shown first. Press **SCAN UP** or **SCAN DOWN** to display an additional option. Press **ENTER** to accept the EOL sequence shown and return to the Port menu, or **STOP/NEXT** to return to the Port menu without changing the current EOL sequence.

EOL Menu

Carriage return with line feed

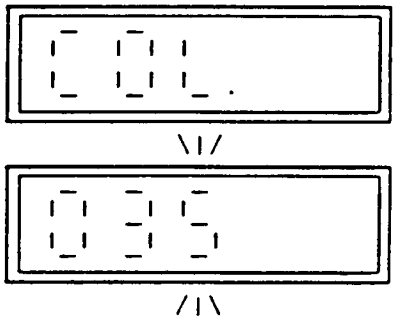
Carriage return only



Print Width

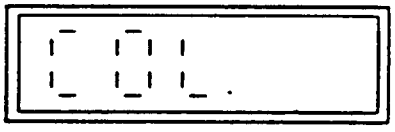
The HERMIT supports multiple-column print formats and will adjust the number of columns of data to match the size of your printer. The smallest print width that can be used with the HERMIT is 24 columns. The largest is 255.

To set the print width, select 'COL.' from the RS232 Port menu.



You will be prompted to enter the column width of your printer. You can select a print width from 24 to 255 columns. Use a print width of 34 or more to print both inputs at once. Press **ENTER** to set the print width.

The display will return to the RS232 Port menu.



A print width of 24 columns causes printouts to be made in a format compatible with older versions of the HERMIT. Print widths of 25 to 255 columns allow the HERMIT to print in its newer expanded formats. Section 10 contains examples of printouts with different settings.

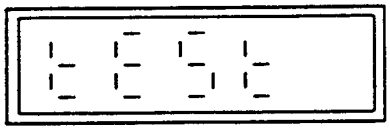
The first four port parameters must be set to match the settings of the printer or computer to be connected; refer to the owner's manual of the particular device. Settings for interfacing to several In-Situ accessories are outlined below.

	Field Printers		PC's with	
	SE1004B	GFP-80	DataTransfer	HERMIT-DM
Baud rate	1200	2400	2400	2400
Character length:Parity	8:No	8:No	8:No	8:No
EOL sequence	CR	CR	CR	CR
Print width	24-25	80	80	24

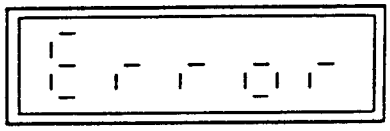
Testing the RS232 Port

A special RS232 port test feature is available in the Port menu that will allow you to test your port configurations without having to collect and dump data. First, make certain that all cables are connected and that the printer or computer is switched on.

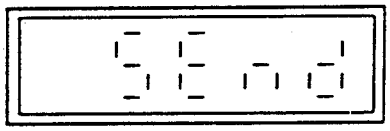
Select 'TEST' from the Port menu.



The HERMIT will prompt you to double check the connections if it does not detect that a device is connected to the RS232 port. You will also get this message if the print device is not turned on.

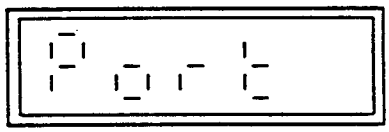


The display will show 'Send' and several single-spaced test lines will be output to the print device. If the lines are not single spaced or appear garbled in any way, check the RS232 parameter settings of the HERMIT and the print device.



```
OUTPUT TEST LINE
OUTPUT TEST LINE
OUTPUT TEST LINE
OUTPUT TEST LINE
OUTPUT TEST LINE
```

Press and hold the **STOP/NEXT** key to abort the test output early. The display will then return to 'PORT' in the System Setup menu.



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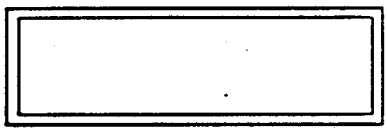
10 Outputting Data

This section will describe the procedures necessary to generate tabular printouts of test data on a field printer. These same procedures can be used to transfer test data to a personal or portable computer. You can print data from any test at any time. You can even print the partial data from a test that is still running.

> ***CAUTION***
>
> *Transferring data to a computer will require a program on the receiving computer that allows proper handling of the incoming data. This does not happen automatically. In many cases a terminal emulation program with file storage capabilities may be sufficient.*

The steps are identical to those for displaying data (Section 8), except that ***the RS232 port must be connected and the receiving device switched on*** before you begin. Refer to Section 9, Using the RS232 Port, if you encounter difficulties while attempting to print data.

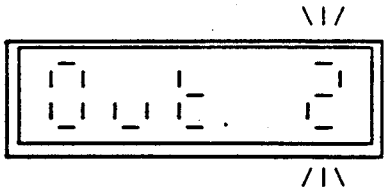
Get the port and receiving device ready, then press any key to wake the instrument and get a status display.



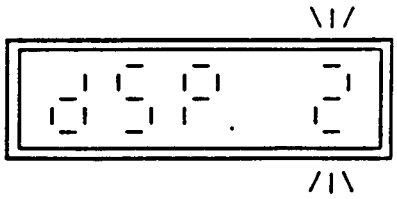
Press the **DATA** key.



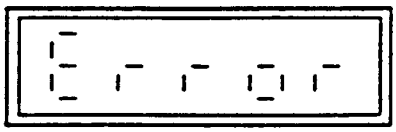
If the RS232 port is properly connected, the unit will automatically direct data to the port instead of to the LCD; the display will show 'Out' and prompt for a test number. The highest test number available is shown as the default. Select the default by pressing **ENTER**; or **SCAN** to the desired test number and press **ENTER**.



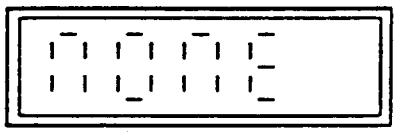
If the instrument does not detect that the printer is connected, the display will show 'DSP,' meaning data will be routed to the display for viewing. Double check all connectors and make sure the printer is switched on. Then begin again from the status display.



The selected test number must be in the range zero to the default test or you will get an 'Error' message.

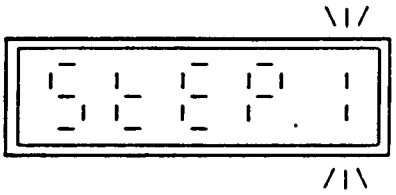


If the selected test has not been run and contains no data, the display will show 'NONE.'

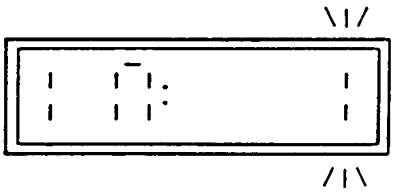


The message will display briefly and you will be reprompted for the test number.

If the test was stepped, you are prompted to select the step to be printed. Only one step is output at a time. The highest step number in the test is displayed as the default. To print data for the default step, just press **ENTER**; or **SCAN** to the desired step and press **ENTER**. This prompt is skipped if no steps were used.

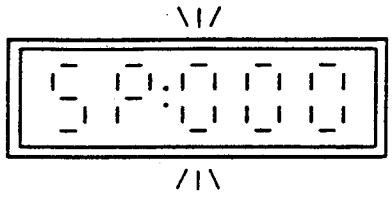


If both input channels were active during the test and the print width will not allow both to be printed, the HERMIT will prompt for an input number. To print data from the default input, just press **ENTER**; or **SCAN** to the other input and press **ENTER**. This prompt is skipped if only one input was active or if the print width can handle both.

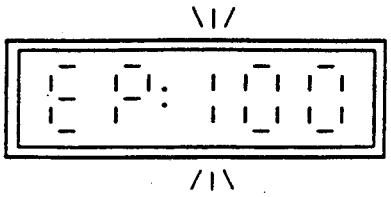


The print width is set in the RS232 Port submenu of the System Setup menu. The setting should be at least 34 columns to transfer or print two inputs. Refer to Section 9, page 78.

You will be prompted for the "Start Percentage," the percentage into the test at which you wish to start printing. The default is 0%, the start of the test. Use the **SCAN** and **NEXT** keys to set the start percentage and press **ENTER**.



You will be prompted for the "End Percentage," the point in the test data at which you wish to stop printing. The default is 100%, the end of the test. Use the **SCAN** and **NEXT** keys to set the end percentage and press **ENTER**.

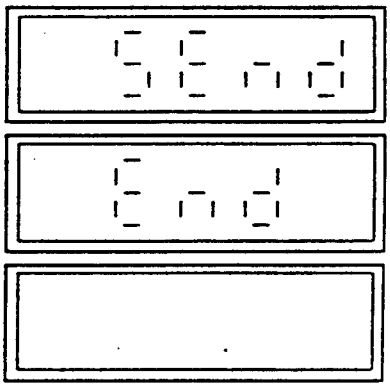


Any portion of the data may be printed. For example, select 0% to 50% to print just the first half of the test or step.

When you press **ENTER**, data transfer will begin. The display will show 'Send.'

You can abort a printout early by pressing **STOP/NEXT**. The display will show 'End' and then return to the status display.

The status display will return to the screen when the printout is finished.



Battery Life Tip

If you have a lot of data to print, we recommend that you use external power if possible. The HERMIT consumes considerably more power when it must stay awake than it does when it can use its sleep mode.

Reminder: Due to the time required to read a dual-mode transducer, all dual-mode data recorded during the first minute of a test using the log sample mode will be meaningless and should be ignored. The data recorded during this period will vary depending on the setting of the transducer's coefficients, but the start of good data should be readily apparent when looking at the data.

Print Formats

The organization of the printed test data will vary slightly depending on the print width you have selected and the number of input channels printed.

Multiple-Input Format

When you select a print width other than 24 columns (25 to 255 columns) the HERMIT will automatically transfer as many inputs as the printer width can handle. You can use the multiple-input format with 24-column printers such as In-Situ's SE1004B by selecting a print width of 25 columns. A printout of one input in the multiple-input format is shown below.

(1) Title identifying the type of instrument that was used to record the data.

(2) Date and time of printout.

(3) Unit identification number and the test number.

(4) Identifies the input channel, type of data, Surface or TOC mode for a level type, and the input channel I.D. if one was programmed.

(5) A record of the transducer parameters used to collect the data.

(6) The step number of the data and the start date and time of the step (or test if step 0).

(7) Tabular data of elapsed time in minutes and the input channel data in the selected units.

(8) End-of-printout marker.

```
(1)          SE1000C
        Environmental Logger
(2)          04/18 09:40

(3)      Unit# 04018  Test 0

     Setups:          INPUT  1
     ------------     ---------
(4)  Type             Function
     I.D.             00420

     Linearity          0.000
(5)  Scale factor     16.000
     Offset            4.000
     Delay mSEC       50.000

(6)  Step 0  04/18 09:26:55

     Elapsed Time     INPUT  1
     ------------     ---------
        0.0000         19.926
        0.0033         19.922
        0.0066         19.922
        0.0100         19.922
        0.0133         19.920
        0.0166         19.920
        0.0200         19.922
        0.0233         19.924
        0.0266         19.924
(7)     0.0300         19.926
        0.0333         19.928
        0.0366         19.926
        0.0400         19.928
        0.0433         19.926
        0.0466         19.926
        0.0500         19.924
        0.0533         19.926
        0.0566         19.924

        9.2000         19.922
        9.4000         19.924
        9.6000         19.922
        9.8000         19.920
       10.0000         19.924
       12.0000         19.924
(8)  END
```

The multiple-input format is the same when both input channels are printed; however, the header information is centered for greater readability. Shown below is a printout of data from two inputs using a print width setting of 34 columns or greater.

```
                SE1000C
          Environmental Logger
              12/13 11:13

            Unit# 00002  Test 18

Setups:          INPUT  1  INPUT  2
-------------    --------- ---------
Type             Function  Dual
I.D.             00000     00000

Linearity          0.000
Scale factor      16.000
Offset             4.000
Delay mSEC        50.000

Coef. 0                      25.310
Coef. 1                     268.950
Coef. 2                      27.540
Coef. 3                      -0.730
Coef. 4                     3258.10
Coef. 5                      91.160
Coef. 6                       0.360
Coef. 7                     -17.180
Coef. 8                       3.200
Coef. 9                       6.760

      Step 0  12/13 11:09:55

Elapsed Time  INPUT  1  INPUT  2
------------  --------- ---------
    0.0000        9.192     2.059
                           29.156
    0.2000        9.192     2.059
                           29.156
    0.4000        9.190     2.059
                           29.156
    0.6000        9.195     2.059
                           29.152
    0.8000        9.188     2.059
                           29.156
    1.0000        9.190     2.059
                           29.156
    1.2000        9.190     2.059
                           29.154
    1.4000        9.192     2.059
                           29.156
    1.6000        9.190     2.059
                           29.156
    1.8000        9.192     2.059
                           29.156
    2.0000        9.192     2.059
                           29.156
END
```

24-Column Mode

If you require data transfer compatibility with previous versions of the HERMIT, such as when transferring data to a PC or compatible using In-Situ's HERMIT-DM program, set the print width to 24 columns.

This format will restrict you to printing or transferring one input channel at a time. To maintain compatibility, the input channel I.D. does not appear in the header. If a level input type is operating in the Top of Casing mode, TOC will be indicated; if no indication appears, the mode is Surface. All other input parameters are printed.

```
          SE1000C
    Environmental Logger
        04/18 10:23

    Unit# 04018  Test 1

INPUT  1: Level (F)

Reference          0.000
Linearity          0.050
Scale factor       9.930
Offset             0.080
Delay mSEC        50.000

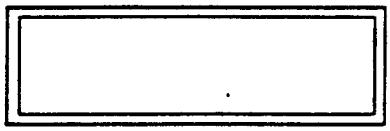
Step 0  04/18 10:08:24

Elapsed Time  INPUT  1
------------  ---------
    0.0000        0.000
    1.0000        0.000
    2.0000       -0.003
    3.0000        3.389
    4.0000        3.389
    5.0000        8.234
    6.0000        5.807
    7.0000       10.660
    8.0000        3.377
    9.0000       -3.870
   10.0000        3.383
   11.0000        8.234
   12.0000        0.971
   13.0000       -0.254
   14.0000        4.592
END
```

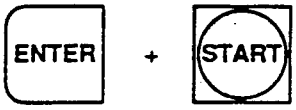
11 System Configuration & Self-Test

Four options in the System Setup menu keep track of the HERMIT's internal operations.

Begin at the status display. The System Setup menu can be displayed in any mode.



Press the **ENTER** key and hold it down while you press the **START** key.



The first two menu options were discussed under the RS232 port, Section 9. Here we are interested in the next four. Use the **SCAN DOWN** key to move toward the bottom of the menu, **SCAN UP** to move toward the top. To select an option, press **ENTER**.

System Setup Menu

Unit identification (see p. 76)

RS232 Port (see p. 76)

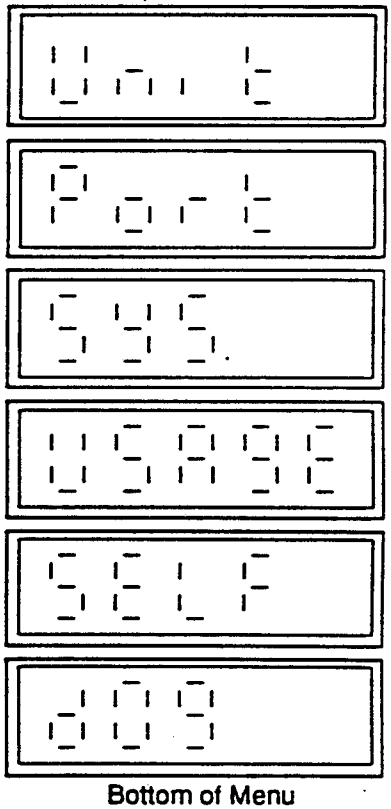
System configuration

Memory usage

System self-test

Watchdog counter

Top of Menu

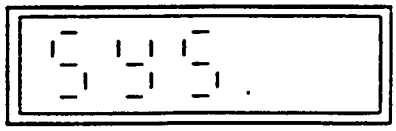


Bottom of Menu

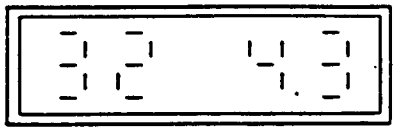
System Configuration

This option presents a two-screen display identifying the HERMIT's configuration and all installed options.

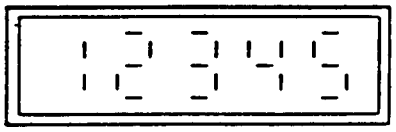
To view the system configuration, select 'SYS.' from the System Setup menu.



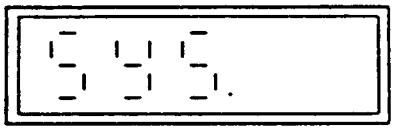
The display first shows the number of kilobytes of data memory installed and the unit's program version . . .



. . . then the unit's serial number . . .



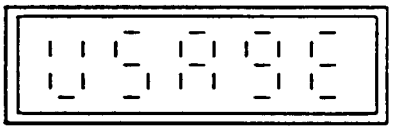
. . . and returns to the System Setup menu.



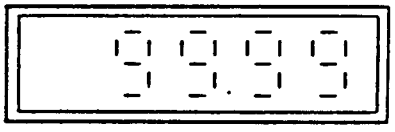
Memory Usage

The non-volatile data storage used in the HERMIT has a limit to the number of times that data can be written to it, referred to as the memory "usage." This option shows the amount of memory usage remaining. Your HERMIT is shipped with 100%. Typically, over 700,000 data points can be stored before "wearing out" the memory and reaching 0%.

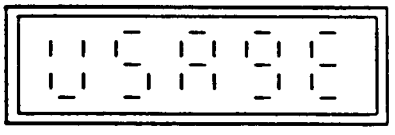
Select 'USAGE' from the System Setup menu.



The display shows the amount of memory usage remaining, in percent, . . .



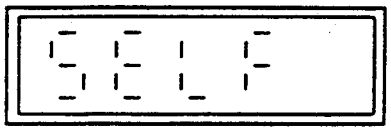
. . . and returns to the System Setup menu.



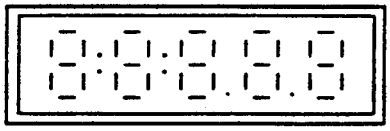
System Self-Test

The self-test feature enables you to check the operational integrity of the HERMIT. In a self-test the instrument runs through an electronic check of all internal components, including program memory, data storage memory, and the display. The self-test operation does not affect the contents of test data stored in memory.

Select 'SELF' from the System Setup menu.

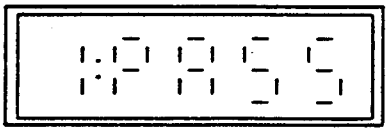


First, the display is tested . . .



. . . then six individual tests are performed and pass/fail is indicated for each . . .

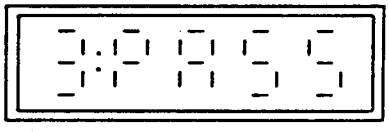
1: CPU board ROM checksum



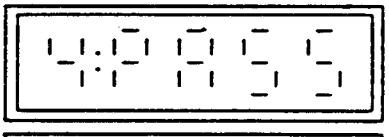
2: expansion board ROM checksum



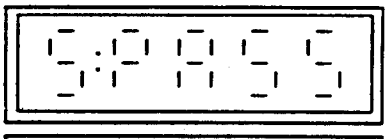
3: CPU board test



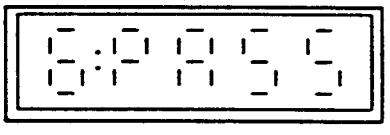
4: keyboard/display card test



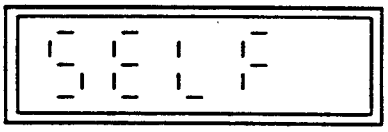
5: measurement board test



6: non-volatile memory test



. . . and the display returns to the System Setup menu.

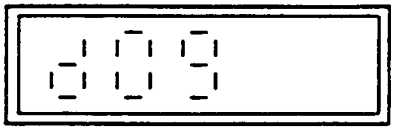


If **FAIL** is indicated at any point in the self-test sequence, the instrument may require service. See Appendix B for information on how to obtain repair service.

Watchdog Counter

The watchdog is an internal electronic circuit that resets the HERMIT when normal operation is upset by nearby lightning strikes, static discharges, and other similar types of electrical surges. Ideally the number of recorded watchdogs will remain zero; however, occasional watchdogs associated with storm events can be considered normal. Unusually high or frequent watchdogs may indicate a malfunction. See Appendix B for information on how to obtain repair service.

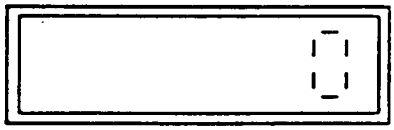
Select 'DOG' from the System Setup menu.



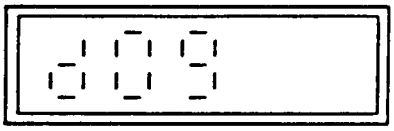
The HERMIT then reports the number of watchdog occurrences . . .



. . . and the most recent error code generated. Appendix D contains a list of watchdog error codes.



. . . and returns to the System Setup menu.



Press **STOP/NEXT** to return to the status display.



System Reset

If the instrument wakes up with 'RESET' displayed, this indicates that the non-volatile memory has been compromised. In the rare event that this should occur, refer to Appendix D for assistance.

12 Running a Pump Test

This section summarizes procedures for collecting downhole water level data in a well during a pump test. The HERMIT will be used to collect background data prior to the test, drawdown data during the test, and recovery data after the test. A pressure transducer will be used to measure head and the HERMIT will be programmed to present all readings as water levels measured from the top of the well casing (positive numbers increasing into the well). A transducer is selected that is capable of measuring the maximum drawdown expected in the well.

Detailed keyboard and display sequences are omitted to permit using this section as a checklist. If you have any difficulty following the procedures outlined in this section, refer back to the appropriate programming section for details.

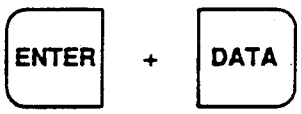
Setting Up

Begin by programming the HERMIT to collect background data in the well:

1. Check that the clock shows the correct date and time. Set it if necessary.

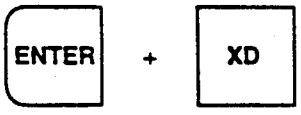


2. Use the ENTER DATA menu to enter the basic test parameters.



   SEL. If no other tests are stored in memory, select test 0 to get the maximum storage capacity.
   RATE Select the linear 1 sampling mode and enter an appropriate sample rate. In this case, set the sample rate to 30 minutes.
   INP. Select 1 active input.
   TYPE Select the type of input as LEVEL.

3. Use the ENTER XD menu to enter the transducer parameters.



REF.	Skip the entry of the reference level for now.
SCALE **OFFS.** **LIN.**	Enter the transducer coefficients found on the cable reel. Set to zero any coefficient that is not specified.
DELAY	Enter a warmup delay of 50 mSEC unless specified otherwise.
DSP.	Select the Top Of Casing mode and feet or meters of water as you prefer.
I.D.	Optional; you may leave it zero or enter your own identifying label.
HI AL **LO AL**	Set off or to desired value.

4. Lower the pressure transducer into the well. The transducer must be set below the lowest anticipated drawdown, though it is not necessary that it be at the bottom of the well. Connect the transducer to the HERMIT.

> ***CAUTION***
>
> *Do not allow the cable jacket to come in contact with the sharp edges of the well casing as the transducer is lowered into the well. Exposing a punctured or ripped cable jacket to water can result in permanent damage to the transducer.*

5. Use the **XD** key to display the transducer's depth and to verify that all connections have been made properly.

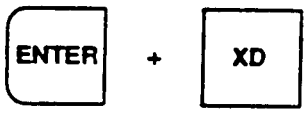


6. Secure the cable to the casing to prevent the transducer from slipping away from its initial setting.

Note: It may be necessary to allow time for the transducer to come to temperature equilibrium with the water before continuing. This usually requires no more than two hours. If your head reading appears to drift, allow more time for stabilization.

> ***CAUTION***
>
> *Do not set a pressure transducer below the level of the pump in a pumping well. The pressure transients generated by the pump will cause false level readings. Large pumps can swallow the transducer and cause permanent damage to both the transducer and the pump.*

7. Access the ENTER XD menu again, select the **REF.** option, and set the initial water level as measured from the top of the casing. Drawdown can be recorded directly by setting the reference to zero.



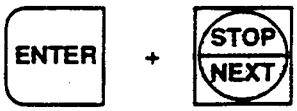
Collecting Background Data

1. Use the START function to begin collecting data.



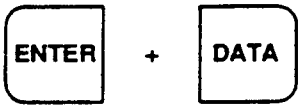
   The HERMIT is now left in the field to collect background data on the well.

2. Upon returning to the field the day of the pump test, use the STOP function to end the background data collection.



Setting Up the Pump Test

1. Enter the basic parameters for the pump test.



   SEL. Select test 1.
   RATE Select the LOG sampling mode so that fast time-drawdown data will be recorded early in the test. The maximum sample interval should be selected as appropriate for the test. In this case, set it to 15 minutes.
   INP. TYPE } The number and type of inputs do not need to be changed.

2. The transducer parameters do not need to be re-entered. They were automatically copied when test 1 was selected.

3. Double check the transducer setting and connections by observing the transducer depth with the XD key.



   The HERMIT is now ready to begin the drawdown phase of the test.

The Drawdown Phase

4. Use the START function to begin collecting drawdown data. The START (immediate start) option can be used if the pump start switch is conveniently close to the HERMIT or if synchronization is not critical. If the instrument is too far away from the pump start switch, program the HERMIT for a delayed start using the DELAY option.



Once the test is started the HERMIT will be recording time-drawdown data. After the first ten minutes of the test, the HERMIT keyboard will be available for you to use.

- You can use the DATA key to monitor the progress of the test.
- You can print any portion of the test while it is running by connecting the RS232 port before pressing the DATA key.

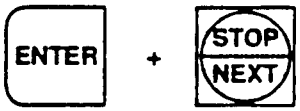
The Recovery Phase

Recovery data are most conveniently recorded by stepping the test.

5. Use the START function to begin collecting recovery data. Synchronize the HERMIT to the pump shutoff using either the immediate or delayed start option. The instrument will restart its logarithmic sampling rate, providing you with fast early recovery data.



6. Use the STOP function to stop recording when the test is completed.



The final data may be viewed or output, or another test may be run by selecting a new test number (memory capacity permitting).

Test Variations

Many variations to the basic pump test are possible. Here are several common ones:

- A second input could be used, in the function mode, during drawdown to monitor the flow rate out of a well.
- Stepped rate pump tests require that the flow rate be stepped one or more times during the course of drawdown. The HERMIT allows you to step a test as many as five times. Steps 0 through 3 could be used to record four different flow steps, saving step 4 for the recovery phase.
- The pump test procedure is readily adapted to slug testing. By changing the test number after each test, you can run as many as twenty slug tests without having to dump data in between.

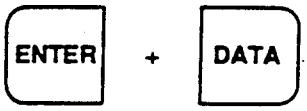
13 Long-Term Monitoring

This section presents the procedure for monitoring the depth of a reservoir, lake, or stream over an extended period of time. As in the previous example, a pressure transducer is used to measure head, but this time the HERMIT will be programmed to present the water level references as elevation. Additionally, the second input will be used to monitor conductivity as a measure of the water quality; temperature is also monitored when the In-Situ conductivity probe is used so, in effect, three parameters are being monitored and recorded.

1. Check that the clock is correct and set it if necessary.

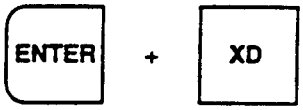


2. Use the ENTER DATA menu to enter the basic test parameters.



SEL. Select test 0 to get the maximum storage capacity.
RATE Select the linear 1 sampling mode and enter the required sample rate.
INP. Select 2 active inputs.
TYPE Select input 1 as a LEVEL input; select input 2 as a DUAL input.

3. Enter the transducer parameters for input 1.



REF. Skip the entry of the reference level for now.
SCALE, **OFFS.**, **LIN.** Enter the transducer coefficients found on the cable reel. Set to zero any coefficient that is not specified.
DELAY Enter a warmup delay of 50 mSEC unless specified otherwise.
DSP. Select the Surface mode and feet or meters of water as you prefer.
I.D. Optional; you may leave it zero or enter your own identifying label.
HI AL, **LO AL** Set off or to desired value.

4. Enter the transducer parameters for input 2:

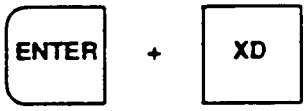
COEF.0 COEF.1 COEF.2 : :	Enter ten coefficient values marked on cable reel or data tag.
I.D.	Optional; leave it zero or enter an identifying label.
HI AL LO AL	Set off or to desired value.

5. Set both transducers at the desired depth (below the lowest anticipated water level) and connect both transducers to the HERMIT.

6. Use the **XD** key to display the depth of the pressure transducer on input channel 1, and the conductivity and temperature values of the dual-mode probe on input channel 2. This will verify that all connections have been made properly.



7. Access the ENTER XD menu again, select input 1 and the 'REF.' option, and enter the reference elevation of the water surface. This reference is arbitrary and may reflect the actual elevation, the depth of the water, or may be set to zero if only changes in level are important.



8. Use the START function to begin collecting data. Often it is convenient to use the delayed start to begin, for example, at the quarter hour when a fifteen-minute sampling rate is being used.



The HERMIT is now left to collect data in the field. Data may be displayed or output at any time without affecting data collection. Use the STOP function to terminate data collection. Data collection will stop automatically when memory is full.

14 Hardware Interfacing

The information contained in this section is designed to help you interface third-party peripherals to your HERMIT. To make proper use of this information you should be prepared to:

- Read and understand a schematic diagram.
- Research other equipment manuals for interface details.
- Run to an electronics store for parts.
- Use a soldering iron and other small tools for electronic assembly.

If any of these resources are not available to you, contact In-Situ's service personnel for assistance, or quotes on custom cables and interfaces.

> ***WARNING***
>
> *In-Situ does not warrant the HERMIT against damages caused by the interfacing of peripheral devices not provided by In-Situ. In-Situ cannot guarantee the accuracy of the information contained in this section, or its suitability for your application.*

External Power

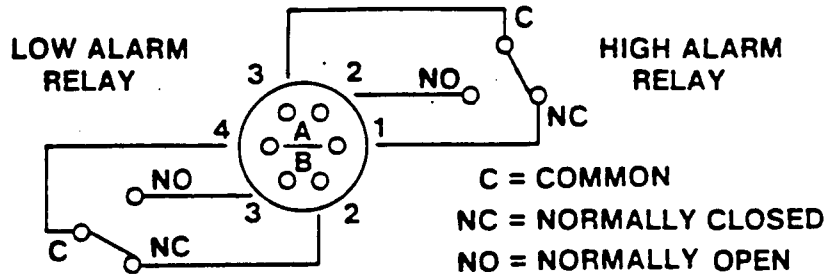
The external power accessories supplied with your HERMIT should satisfy most requirements for conserving the life of the internal battery pack. It is recommended that you do not use any other type of external power accessory.

Alarm Outputs

The alarm connector contains connections for both the high and low alarm contacts. An alarm interface cable is supplied with the HERMIT. Do not use any other type of cable as this will compromise the integrity of waterproof operation.

The alarm contacts and their pinouts on the back (cable) side of the mating connector are shown below. Note that no power is supplied by the instrument for use by the alarm

circuitry. Any devices connected to the alarm contacts must supply their own power. The alarm relays are of a mechanical latching type so that the correct position is maintained even when the HERMIT is asleep.



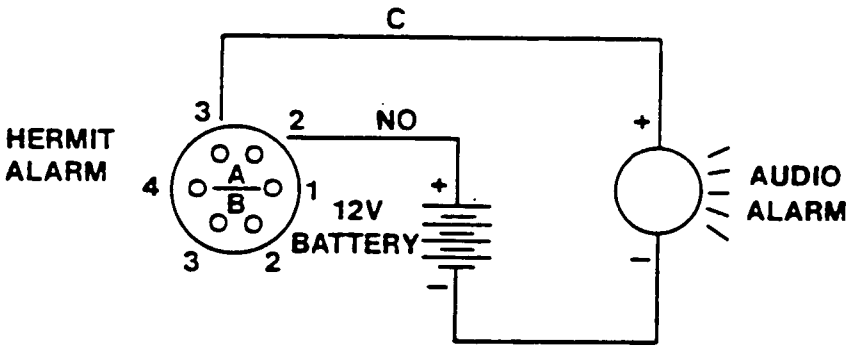
The interface cable color code assignments are as follows:

Function	Color
High Alarm – Normally closed	Black
High Alarm – Normally open	White or Brown*
High Alarm – Common	Red
Low Alarm – Normally closed	Blue or Orange*
Low Alarm – Normally open	Yellow
Low Alarm – Common	Green

* One or the other will be present.

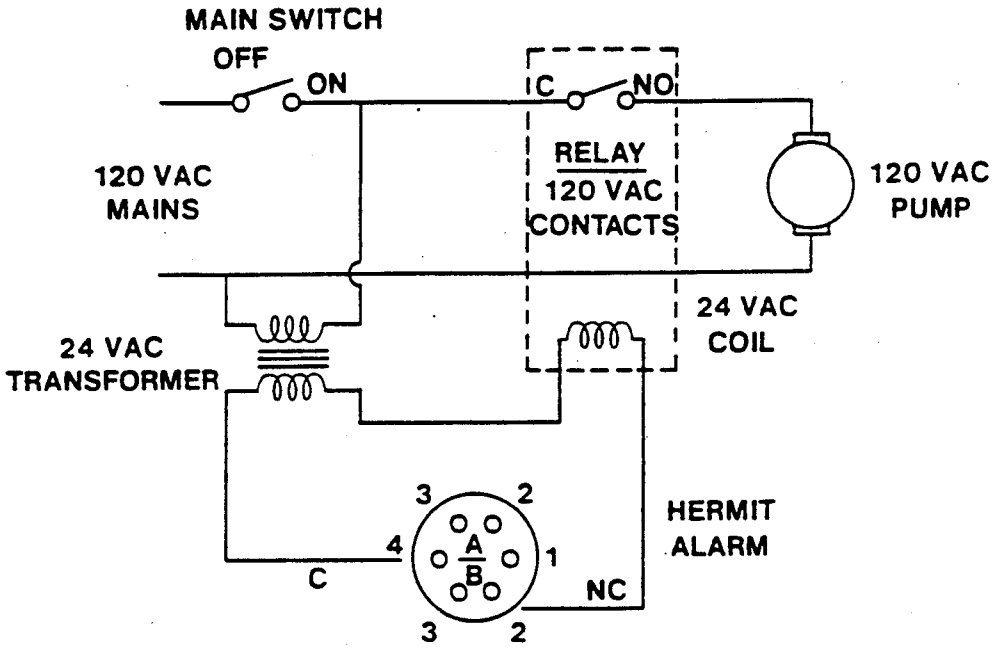
> ***WARNING***
> *Never use the relay contacts to switch more than 30 volts AC or DC. Damage to the HERMIT could result.*

The alarm connection illustrated below is used to turn on a 12 VDC audio alarm when a high alarm occurs.



LOOP IS CONNECTED WHEN HIGH ALARM OCCURS

The connection shown below is used to turn off a 120 VAC pump when a low alarm occurs.



LOOP IS BROKEN WHEN LOW ALARM OCCURS

RS232 Port

In addition to the data transmission parameters discussed in Section 9, the following hardware characteristics must be satisfied for proper operation of an RS232 interface:

- Correct matching of cable genders
- Correct matching of DTE and DCE devices
- Correct matching of handshake method

RS232 serial interfaces are designed to connect one piece of Data Terminal Equipment (DTE) to one piece of Data Communications Equipment (DCE). The accessory cable supplied with your HERMIT is configured as DCE with a male connector. As such it will connect directly to any RS232 port that is configured as DTE with a female connector. If the RS232 port of the printer or computer being interfaced is not configured as DTE with a female connector, it will be necessary to wire an adapter.

If the operator's manual or labeling at the connector of the device does not use the DTE/DCE terminology, its configuration can be determined by identifying the function of pin 3 on the RS232 connector from a schematic, pinout, or signal diagram. If pin 3 is labeled as INPUT, DATA IN, RECEIVED DATA, RD, RxD, or a similar phrase, then the device is DTE; otherwise it is DCE.

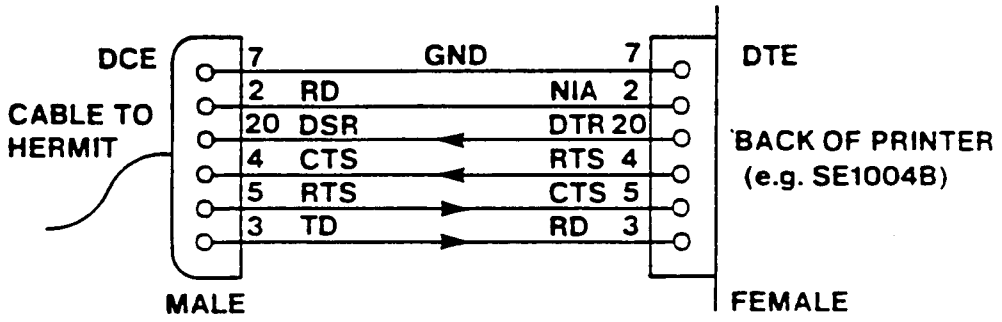
The pins on the RS232 cable of the HERMIT that must be connected properly are listed below. Signal directions are referenced to the HERMIT.

Panel Connector	RS232 Connector	Signal Name	Direction
A	7	Signal Ground	–
B	2	Receive Data (RD)	Input
C	20	Data Set Ready (DSR)	Input
D	4	Clear to Send (CTS)	Input
E	5	Request to Send (RTS)	Output
F	3	Transmit Data (TD)	Output

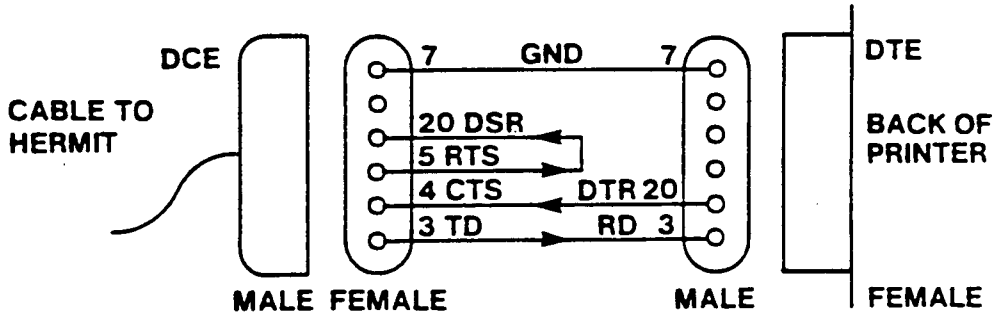
The RTS output goes high when the HERMIT is ready to dump data and remains high until the output is complete. The DSR input must be high and remain high for the HERMIT to recognize that an external device is connected. Data are output via TD.

The CTS and RD inputs are used for handshaking. CTS high indicates that the receiving device is ready; low indicates that it is not ready. The HERMIT will accept XON/XOFF (DC1/DC3) character handshaking on the RD input. If CTS remains low (not ready) or no XON character is received after XOFF for 90 seconds, the HERMIT will abort the output procedure. If DSR is lost any time during the transfer, the instrument will abort immediately.

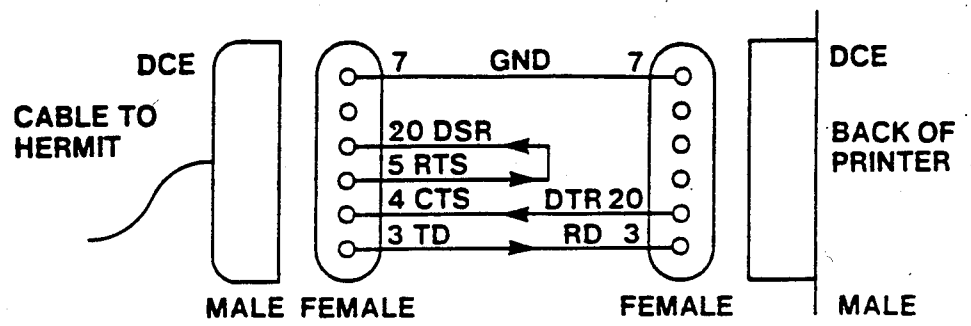
Signal connections for the standard printer interface, where no adapter is required, are shown below for reference.



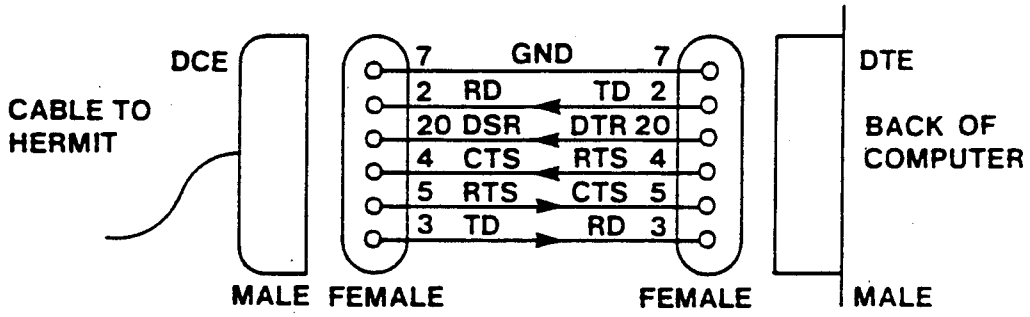
The illustration below shows the adapter necessary to connect to a printer that uses DTR (Data Terminal Ready) handshaking instead of CTS and does not supply a signal to maintain DSR active.



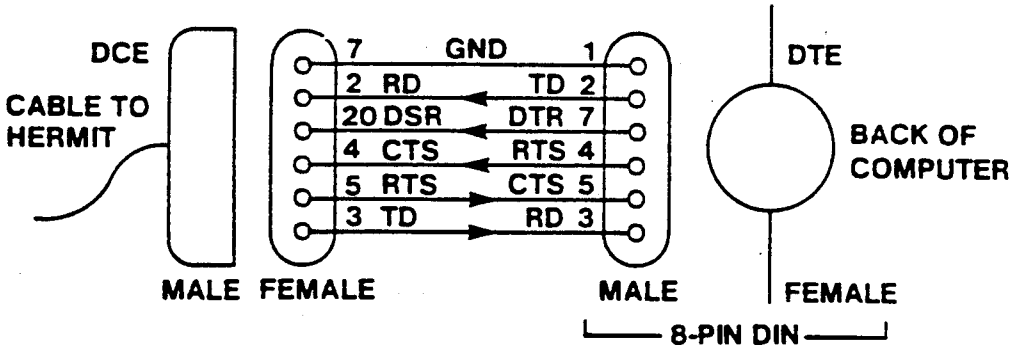
Many printers, such as those from IBM and HP, have a male connector, are configured as DCE, and use DTR/DSR handshake. An adapter for these printer types is shown below.



A computer interface adapter for IBM PCs and compatibles is shown below. Note that this adapter is supplied as a standard accessory. This type of adapter is also available as a standard product from most computer accessory sales companies.



Some computers do not use the standard 25-pin connector. An adapter is supplied with the HERMIT for connection to an IBM PC/AT or compatible. The example below shows a connection for the Epson HX-20.

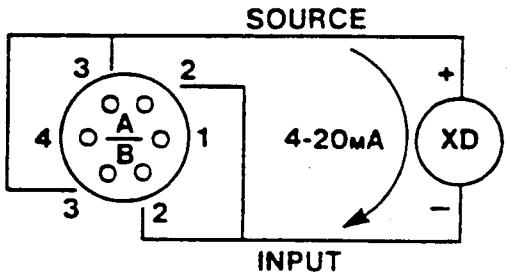


Finally, many computers do not require an adapter to work. Radio Shack's TRS-80 Model 100 is a good example.

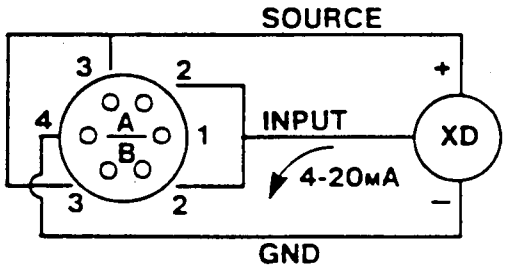
Transducers

Transducers other than those provided by In-Situ may be adapted for use with the HERMIT. Mating connectors must be ordered separately from In-Situ. Do not use any other type of connector as this will compromise the integrity of waterproof operation.

The wiring of a standard 2-wire 4-20 mA transducer is shown here. The HERMIT provides loop power at approximately 24 VDC and has a nominal resistance of 185 ohms. Loop power is supplied only when the instrument needs to take a measurement.



Transducers that require more power than can be supplied within the 4-20 mA loop can be used in the 3-wire configuration shown here. The source output of the HERMIT can supply as much as 100 mA. The output is protected by current-limiting circuitry..



A Accessories

Standard Accessories

Your HERMIT comes equipped with one each of the following standard accessories:

- HERMIT 1000C Operator's Manual
- HERMIT 1000C Pocket Guide
- Factory-installed lithium battery pack
- Serial interface cable kit for connection to the RS232C port, including:
  - Serial cable with 6-pin circular to DB9 female connector
  - DB9 male to DB25 male adapter
  - DB9 male to DB25 female adapter
- External power pack, including:
  - 12 VDC automobile cigarette lighter adapter
  - 120 VAC to 15 VDC wall-mount power pack
- Alarm interface cable
- DataTransfer software for transferring raw data from the HERMIT to the IBM PC and compatibles.

Optional Accessories

In addition to the standard accessories shipped with your HERMIT, In-Situ also makes available the following optional accessories.

Field Printers

- SE1004B 24-Column Printer

  The SE1004B is a compact, lightweight printer that permits low to moderate speed printouts of tabularized and graphic data. The SE1004B requires an external 12 VDC power source for operation and includes adapters for an automobile cigarette lighter and 120 VAC wall outlet.

- GFP-80 80-Column Printer

  The GFP-80 is a high speed, portable field printer that permits printouts of multi-column, tabularized data and large 8.5 × 11 inch, high-resolution graphic data. It operates on its own internal, rechargeable battery pack.

Transducers

All of In-Situ's transducers come to the customer ready to use: fully calibrated and complete with cable, reel, and pre-wired connectors.

- Pressure

  Pressure transducers can be used with the HERMIT to measure pressure, level, and flow. In-Situ offers a variety of pressure transducer sizes and ranges to cover most measurement requirements.

- Conductivity/Temperature

  A dual-mode transducer, the conductivity/temperature probe permits the simultaneous measurement of both conductivity and temperature while using only one input channel. The HERMIT can be programmed to provide readings of uncompensated or temperature-compensated conductivity.

- pH/Temperature

  Also a dual-mode transducer, the pH/temperature probe permits measurement of temperature and temperature-compensated pH on one channel.

- Barometric Pressure

  This transducer provides an accurate measurement of absolute pressure in the 8 to 16 PSIA range. Pressure is displayed in PSIA; conversion factors are provided to display results in mm Hg, inches H_2O, and inches Hg, to name a few.

Shipping Containers

Heavy-duty polyethylene shipping containers are water-tight, pressure-tight to 0.5 psi, have sturdy and comfortable carrying handles, and can be used as a seat in the field. They are approved by the U.S. Department of Transportation as configured by In-Situ Inc. and have appropriate decals affixed. The containers are specifically sized and fitted with high-density foam inserts to accommodate the most common combinations of instruments. Space is provided for a packet of documents, computer software, and other necessary accessories.

- **1KPO**

  Holds one HERMIT 1000C and one SE1004B field printer.

- **1KP1**

  Holds one HERMIT 1000C, one SE1004B field printer, and one of the following:

  – transducer with 400 ft. cable on ABS plastic reel
  – 400 ft. extension cable on ABS plastic reel.

- **1KP2**

  Holds one HERMIT 1000C, one SE1004B field printer, and two of the following:

  – Transducer with 400 ft. cable on ABS plastic reel
  – 400 ft. extension cable on ABS plastic reel.

- **4XD**

  Holds any four-reel combination of the following:

  – Transducer with 400 ft. cable on ABS plastic reel
  – 400 ft. extension cable on ABS plastic reel.

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B Installation, Maintenance, & Service

The information presented in this appendix covers the initial setup of your HERMIT Environmental Data Logger and includes procedures for the proper use and care of the instrument.

Note: Become thoroughly familiar with the information in this appendix before attempting to operate your HERMIT.

Unpacking and Inspection

Your HERMIT is another example of the quality and attention to detail in engineering and construction that have become a trademark of In-Situ instrumentation. Each instrument is thoroughly tested and calibrated by people who are dedicated to providing you with the best possible product and service.

Your HERMIT was carefully inspected before shipping and should be ready to operate right out of the box. Check the instrument for any physical damage sustained during shipment. Notify In-Situ and file a claim with the carriers involved if there is any such damage; do not attempt to operate the instrument.

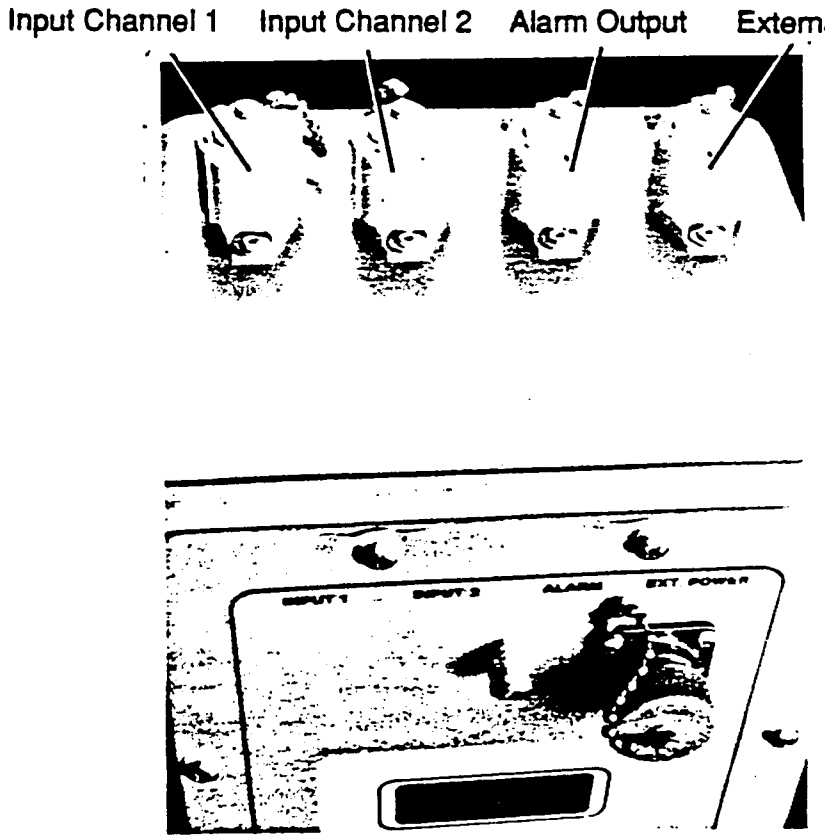
Please check to ensure that you have received all of the standard accessories included with the HERMIT. Review the list of standard accessories in Appendix A. If any accessory items are missing, please contact In-Situ immediately.

Note: Transducers and other optional accessories are shipped separately and should also be inspected for physical damage and the fulfillment of your order.

Please save all packing materials and accompanying shipping documents. Due to the lithium battery pack used in the HERMIT, it must always be shipped in its original carton and with the necessary documentation.

Connector Panel

Understanding the connector panel layout of your HERMIT is important for safe and efficient operation. The connectors are as follows:



Although the connectors are water-resistant even without their protective caps, the connecting pins are subject to damage by dirt and other foreign objects unless the connectors are properly attached to a mating cable or protective cap. Always cap a connector when it is not in use.

Installing Transducers and Accessories

All connectors are labeled and keyed so that mating cables and accessories fit only one way; never try to force a connection. It is possible to accidentally plug a cable or accessory into the wrong connector (e.g., external power into an input channel), *but don't worry, you can't damage the HERMIT or its accessories with any wrong combination of connections.*

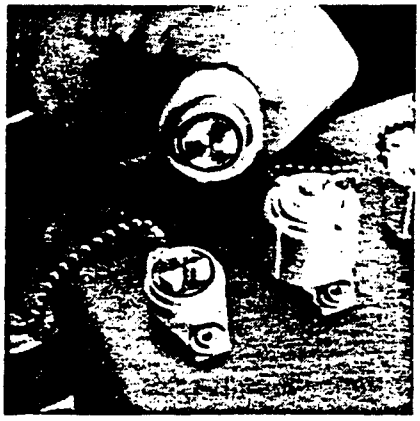
General Connector Installation and Removal

Cables and accessories may be installed or removed as often as your needs require. To install connectors, observe the following procedures.

1. Remove the protective cap from the connector. If the mating cable or accessory has a protective cap, remove it also.

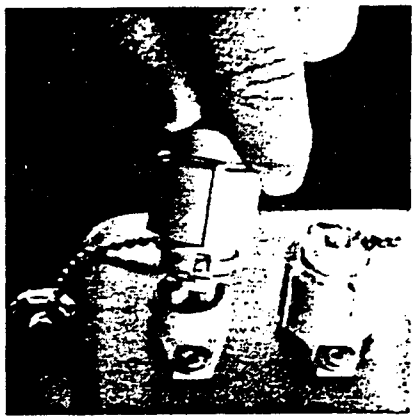


2. Orient the connector patterns so that the large tab in the cable or accessory connector is up.



> ***CAUTION***
>
> *Proper operation of a transducer or accessory is dependent upon a clean, dry connection. Make certain that connectors are clean and dry before attempting to install them.*

3. Gently press the connector halves together. Excessive force should not be required.



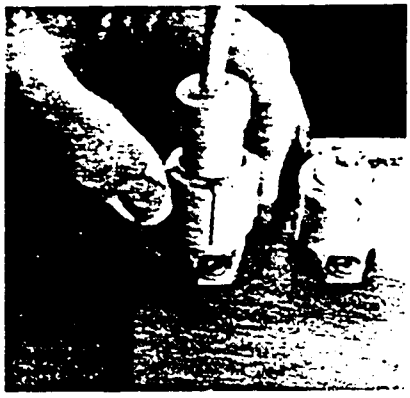
> ***CAUTION***
>
> *If a connector jams during installation, it may be upside down or blocked by dirt or other foreign objects. Attempting to force it further may result in damage to the connector or instrument.*

4. Tighten the connector's lock ring to establish a tight connection and watertight seal.



To remove a connector, observe the following procedure.

1. Loosen the connector's lock ring.



2. Gently pull the connector halves apart. Store the cable or accessory in its original container or where it will be safe from damage to the contacts.



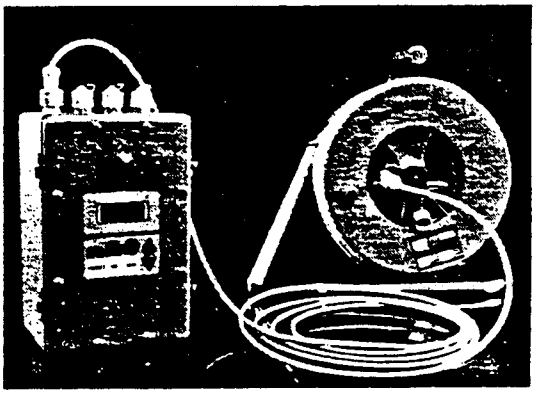
3. Replace the protective cap on the instrument connector.



Transducer Installation

Transducers can be installed at either of the input channel connectors on the HERMIT. Transducers should be installed consecutively beginning at input channel one. The HERMIT must then be programmed to identify the type and characteristics of each transducer connected.

Transducers mounted on reels are supplied with a jumper cable for convenient connection to the instrument.



Transducers on cable without a reel connect directly to the instrument without a jumper cable.

External Power Installation

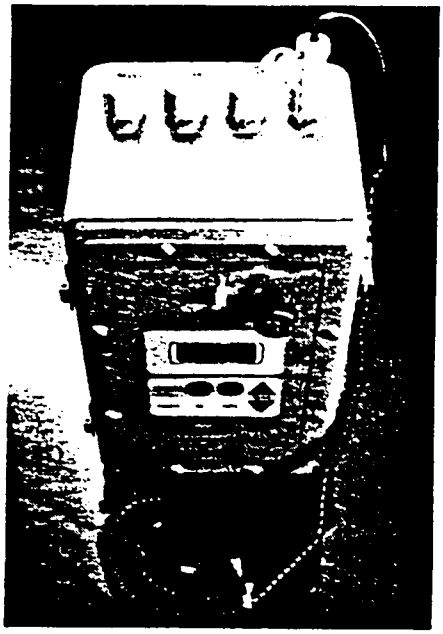
The HERMIT's internal lithium battery pack is designed to supply the instrument and its connected transducers with clean, reliable power for several years. You can extend the life of the battery pack by using the external power accessories supplied with your HERMIT whenever it is convenient. The HERMIT will automatically switch over to external power when it is present and will automatically switch back to its own internal battery pack if the external power source is disconnected or depleted.

> ***WARNING***
>
> *Use only the external power accessories provided with your instrument. Connection of an improper power source could cause permanent damage to the instrument and the transducers connected to it.*

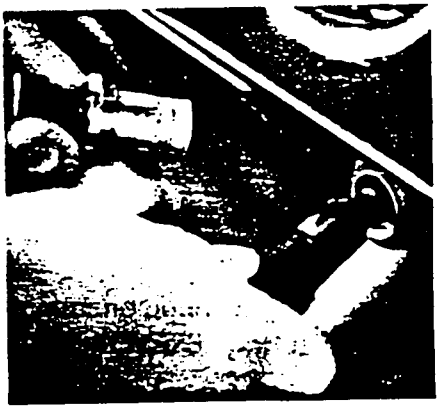
Cigarette Lighter Adapter

The cigarette lighter adapter allows the HERMIT to tap into the 12 VDC battery of most vehicles. Use only with vehicles employing a 12 VDC negative ground system. Some vehicles require that the ignition switch be left in the "ON" or "ACC" (accessory) position for proper operation of the cigarette lighter.

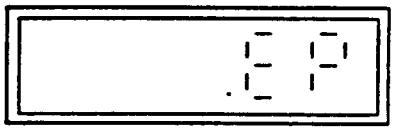
To connect the cigarette lighter adapter:



1. Connect the lighter adapter to the External Power port of the HERMIT.



2. Remove the car's cigarette lighter and install the adapter in the socket. Turn the car's ignition switch to "ON" or "ACC" if required.



3. Wake the HERMIT to confirm that external power is properly connected.

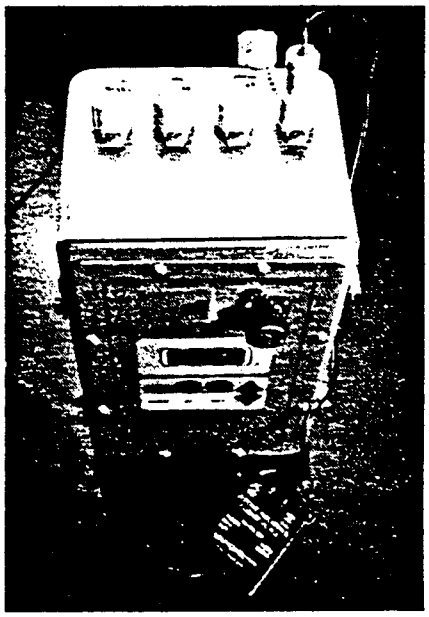
Power Pack

The wall-mounted power pack converts the 120 VAC available at a wall socket to power suitable for the HERMIT.

> ***WARNING***
>
> - *The power pack is designed for 120 VAC power sources only. Connection to an improper power source can cause permanent damage to the instrument and the transducers connected to it.*
> - *The power pack is designed for indoor use only.*
> - *Improper use of the power pack will present an electrical shock hazard to personnel.*

To connect the power pack:

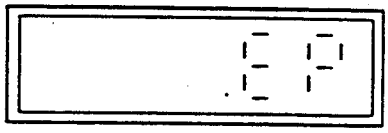
1. Connect the power pack to the External Power port of the HERMIT.



2. Plug the power pack into a 120 VAC indoor wall outlet.

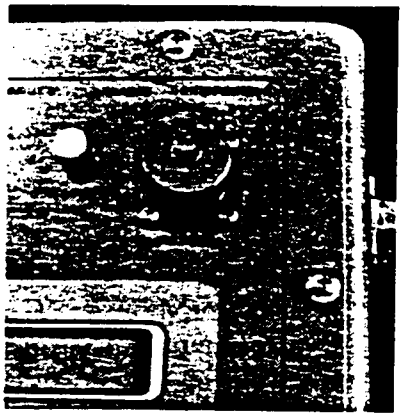


3. Wake the HERMIT to confirm that external power is properly connected.



RS232 Installation

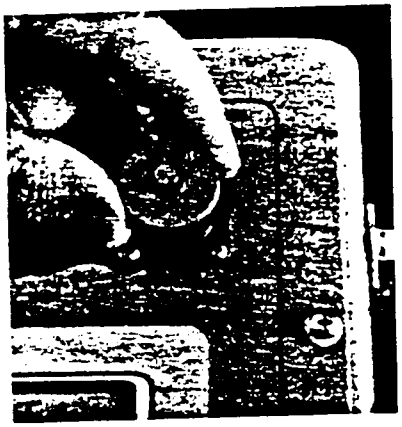
The RS232C port on the front panel of the HERMIT allows the instrument to communicate with field printers and personal or portable computers.



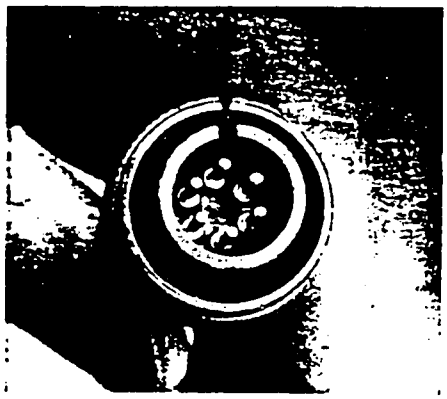
> ***CAUTION***
>
> ***The RS232C port is water-resistant only when attached to its mating cable or protective cap. As with other connectors on the HERMIT, always cap it when it is not in use.***

To install the RS232 connector, observe the following procedures:

1. Remove the protective cap from the front panel RS232 port.

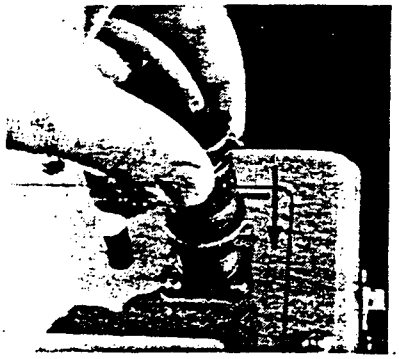


2. Orient the cable connector so that the key-way is lined up with the key on the RS232 port.



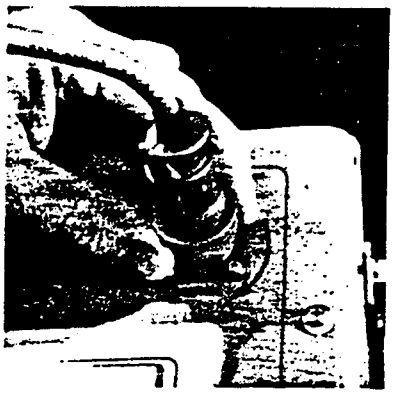
> ***CAUTION***
>
> *Proper operation of the RS232C interface is dependent upon a clean, dry connection. Make certain that the connector is clean and dry before attempting to install it.*

3. Gently press the connector halves together. Excessive force should not be required.



> ***CAUTION***
>
> *If the connector jams during installation, it may be oriented incorrectly or blocked by dirt or other foreign objects. Attempting to force it further may result in damage to the connector or instrument.*

4. Tighten the connector's lock ring to establish a tight connection and watertight seal.



5. Select the end of the general-purpose cable that matches the connector style of the accessory. Attach the RS232 cable to the accessory. The RS232 port is ready to communicate.

Note: It may be necessary to match the communication protocol between the HERMIT and RS232 accessory. Refer to Section 9 for assistance.

Disconnect RS232 accessories in the reverse order of installation.

Operating Considerations

The HERMIT is an extremely rugged instrument and has been designed to withstand the harsh treatment frequently encountered in field situations. However, as with any electrónic instrument, the HERMIT can be permanently damaged if used outside its operating specifications.

Temperature Ranges

The storage and operating temperatures for the HERMIT are:

-40° to 70°C -40° to 158°F

Installation in extremely hot and sunny climates may require the use of a shade to prevent temperatures inside the HERMIT from exceeding the upper limit. In extremely cold climates, it may be necessary to bury the instrument to prevent internal temperatures from dropping below the lower limit.

Potential for Water Damage

The HERMIT is designed to be used around water, but reasonable caution should be exercised to prevent water damage. Do not submerge the instrument or allow it to remain in standing water. If you're using it in rain or snow, close the cover. If the face plate gets wet, dry it off. Cap all connectors that are not in use.

Special care should be taken to ensure that no water is introduced into the HERMIT through the transducer vent tube outlet (to the left of the RS232 port). If you suspect that water has gotten inside the instrument, contact In-Situ's Product Service facility at your earliest convenience.

Calibration

The HERMIT is designed to maintain its accuracy specifications through its useful service life without requiring periodic calibration. The accuracy of the instrument can be adversely affected, however, by such factors as:

- improper care and handling
- lightning strikes and similar surges
- exceeding operating temperature limits
- physical damage or abuse

Under these circumstances it may become necessary to recalibrate the instrument. Contact In-Situ's Product Service facility for information on periodic check-ups and recalibration.

Potential for Radio/Television Interference

The HERMIT generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with this manual, may cause interference to radio communications. Your instrument has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of the HERMIT in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be necessary to correct the interference.

General Cleaning

Before cleaning, disconnect the HERMIT from external power sources and make certain that unused connectors are properly capped.

Clean the HERMIT with a soft cloth dampened in clean water or in water containing a mild detergent. Dry the instrument promptly with another soft cloth. Avoid using an excessive amount of water, and do not use any abrasive cleaners, especially on the display window.

Warranty Information

The HERMIT is warranted by In-Situ against defects in materials and workmanship for two (2) years from the date of original purchase. If you transfer ownership, this warranty is automatically transferred to the new owner and remains in effect for the original 2-year period.

During the warranty period, In-Situ will repair or, at our option, replace at no charge any instrument that proves to be defective, provided it is returned, shipping prepaid, to In-Situ's Product Service facility. The customer is responsible for any customs duties in connection with the return of the instrument.

This warranty does not apply to the discharge of the internal lithium battery pack due to normal operation of the instrument, or if the instrument has been damaged by accident or misuse, or as a result of service or modification by other than In-Situ's Product Service facility, or by interfacing of peripherals not provided by In-Situ. In-Situ shall have no obligation to modify or update instruments once manufactured. This warranty does not apply to In-Situ transducer products.

No other warranty is expressed or implied. Under no circumstances does this warranty provide a remedy in excess of the price of the equipment. The repair of an instrument is your exclusive remedy. In-Situ, Inc., shall not be liable for consequential damages.

How to Obtain Repair Service

If you suspect that your HERMIT is malfunctioning and repair is required, you can help assure efficient servicing by following these guidelines:

1. Call In-Situ's Product Service facility toll-free at 1-800-446-7488.

2. Be prepared to describe the configuration of the HERMIT exactly as it was at the time of the malfunction; transducers, accessories, and programming in use at that time should be noted.

3. Write a description of the malfunction symptoms for service personnel, indicating whether the malfunction occurs intermittently or constantly.

4. Save printouts or any other materials that illustrate the problem area.

5. If service is required, obtain an RMA (return material authorization) number from service personnel.

6. Ship your HERMIT according to the shipping instructions outlined in Appendix C.

Please do not return equipment to In-Situ's Product Service facility without first contacting service personnel by phone.

> ***WARNING***
>
> *There are no user-serviceable parts in the HERMIT. Do not attempt to service the unit yourself; doing so can cause permanent damage to the instrument and will void your warranty. Instrument design and circuitry are proprietary to In-Situ and service manuals are not available to customers.*

Serial Number

Each HERMIT carries an individual serial number on the inside surface of the lid. This serial number is also programmed into the instrument and is displayed as part of the System Configuration (see Section 11). It is recommended that owners keep a separate record of this number. Should your instrument be lost or stolen, the serial number is often necessary for tracing and recovery, as well as any insurance claims. If necessary, In-Situ maintains complete records of original HERMIT owner's names and instrument serial numbers.

C Shipping Instructions

The information contained in this appendix covers the shipping restrictions and procedures necessary for the safe transport of the HERMIT.

> ***WARNING***
>
> *The HERMIT uses an internal battery pack containing lithium which the Department of Transportation (DOT) considers a hazardous material. The HERMIT must never be transported on passenger aircraft. Follow all shipping instructions carefully.*

Due to the hazardous materials requirements, it is necessary to prepare special documentation for shipping the HERMIT. The process is greatly simplified when the original packing materials and documentation are used. If the original materials are lost or have been rendered unusable, or you have difficulties arranging shipment of the instrument, please contact our shipping and receiving department toll-free at 1-800-446-7488.

Instruments returned for service should be sent, shipping prepaid, to In-Situ's Product Service facility:

In-Situ, Inc.
Product Service Department
210 South 3rd Street
Laramie, WY 82070

RMA# (assigned number here)

Please include the RMA (return material authorization) number assigned to you by service personnel on the shipping label. Refer to the Section **How to Obtain Repair Service** in Appendix B. Damage sustained during transit is not covered under your warranty. In-Situ recommends that the customer insure all shipments. Warranty repairs will be shipped back to the customer prepaid.

Rental customers should return cleaned equipment, shipping prepaid, to In-Situ's Instrument Rental facility:

In-Situ, Inc.
Instrument Rental Department
210 South 3rd Street
Laramie, WY 82070

Federal Express Checklist

When shipping the HERMIT via Federal Express, observe the following procedures.

1. Package the HERMIT in its original shipping container. If the original container is not available, replacement containers are available from In-Situ, or consult the Shipping Container Checklist provided in this appendix.

2. Place a complete, current copy of the DOT-E 7052 exemption document in a clear pouch and attach it to the outside of the shipping container (alternatively, the document may be placed in the airbill pouch). If the copy of the DOT-E 7052 supplied with your original shipping container has been lost or misplaced, photocopy the one included at the end of this appendix. The DOT-E 7052 must be current; they are updated & reissued irregularly; to find out if a later version has been issued, call us.

3. Write your address, or place a sticker containing your address, directly on the shipping container. This is required in addition to information that will be contained on the airbill.

4. Fill out the airbill portion of a Federal Express Airbill following the instructions.

5. Fill out the Restricted Articles portion of the airbill as shown below. Do not omit any part of the information. Your name, title, emergency telephone number and signature must also be included, along with the city, state, and date.

8556751626

SHIPPER'S CERTIFICATION FOR RESTRICTED ARTICLES/DANGEROUS GOODS

CHECK ONE ➡ X 49 CFR ☐ IATA/ICAO (TYPE OR PRINT)

DANGEROUS GOODS IDENTIFICATION: PROPER SHIPPING NAME	CLASS OR DIVISION	UN OR ID NO	SUBSIDIARY RISK	QUANTITY AND TYPE OF PACKING	PACKING INST	AUTHORIZATION
Lithium Batteries N/A per DOT-E 7052 Cargo Aircraft Only	Flammable Solid			55 Grams (11 Grams per cell)	Shipped per DOT-E 7052	

ADDITIONAL HANDLING INFORMATION

TRANSPORT DETAILS	THIS SHIPMENT IS WITHIN THE LIMITATIONS PRESCRIBED FOR ➡	PASSENGER AIRCRAFT	CARGO AIRCRAFT ONLY	(DELETE NON-APPLICABLE)
AIRPORT OF DEPARTURE	AIRPORT OF DESTINATION	SHIPMENT TYPE ➡ NON-RADIOACTIVE	XXXXXXX	(DELETE NON-APPLICABLE)

IF ACCEPTABLE FOR PASSENGER AIRCRAFT THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN OR INCIDENT TO RESEARCH MEDICAL DIAGNOSIS OR TREATMENT

I HEREBY DECLARE THAT THE CONTENTS OF THIS CONSIGNMENT ARE FULLY AND ACCURATELY DESCRIBED ABOVE BY PROPER SHIPPING NAME AND ARE CLASSIFIED, PACKED, MARKED, AND LABELED, AND ARE IN ALL RESPECTS IN PROPER CONDITION FOR TRANSPORT BY AIR ACCORDING TO THE APPLICABLE INTERNATIONAL AND NATIONAL GOVERNMENT REGULATIONS.

NAME AND TITLE OF SHIPPER	PLACE AND DATE	
Jane/John Doe, Shipper	Hometown, XX	02/25/91
EMERGENCY TELEPHONE NUMBER: (307)760-0273	SIGNATURE OF SHIPPER	SEE WARNING ON BACK

6. Place the completed airbill (and the DOT-E 7052 document if it's not in a separate pouch) into a clear pouch and attach to the outside of the shipping container.

7. Present the completed package to Federal Express for shipping.

United Parcel Service (UPS) Checklist

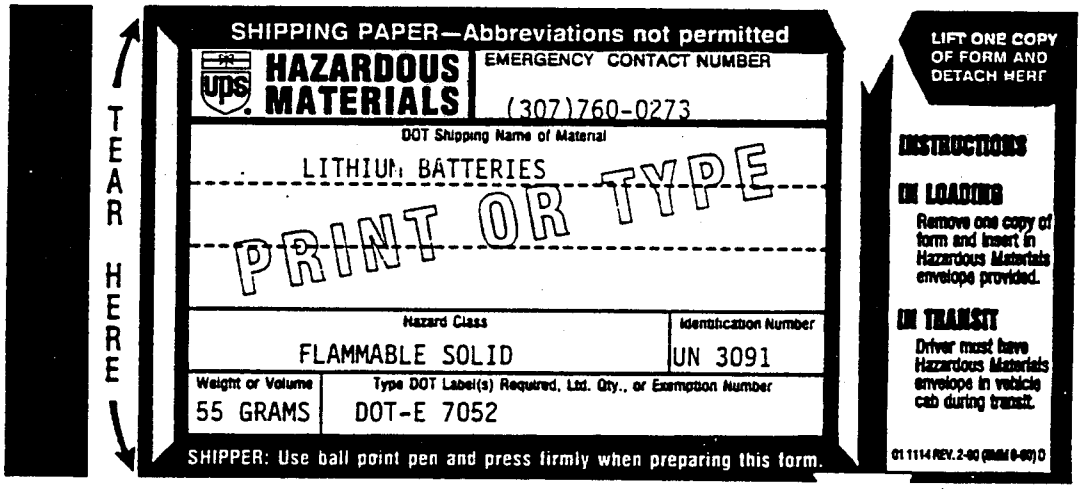
When shipping the HERMIT via UPS (surface only), use the following checklist. Please note that UPS will not accept a HERMIT for shipment by air.

1. Package the HERMIT in its original shipping container. If the original container is not available, replacement containers are available from In-Situ, or consult the **Shipping Container Checklist** provided in this appendix.

2. Place a complete, current copy of the DOT-E 7052 exemption document in a clear pouch and attach it to the outside of the shipping container. If the copy of the DOT-E 7052 supplied with your original shipping container has been lost or misplaced, photocopy the one included at the end of this appendix. The DOT-E 7052 must be current; they are updated & reissued irregularly; to find out if a later version has been issued, call us.

3. Write your address, or place a sticker containing your address, directly on the shipping container. This is required in addition to information that will be contained on the weigh bill.

4. Complete a **Hazardous Materials** sticker as shown below and attach it to the shipping carton following the directions provided with the sticker. Do not omit any portion of the information.



5. Fill out a UPS weigh bill following the normal weigh bill instructions. This document will be handed to the UPS agent; do not attach it to the shipping container.

6. Fill out a **Shipper's Certification for Hazardous Materials** form as shown on page 122. Do not omit any portion of the information. This document will be handed to the UPS agent; do not attach it to the shipping container.

7. Present the completed package, weigh bill, and hazardous materials form to UPS for shipping.

UPS COPY

United Parcel Service

2181504

SHIPPER'S CERTIFICATION FOR HAZARDOUS MATERIALS

Your Company Name
123 Anywhere Street
Hometown, USA

EMERGENCY CONTACT NUMBER
(307)760-0273

STAMP YOUR UPS SHIPPER NUMBER HERE

Lithium Batteries Contained in Equipment	Flammable Solid	UN 3091	55	Flammable Solid Per DOT-E 7052	ABC Company	Anywhere, USA

CERTIFICATION This is to certify that the above named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation, according to the applicable regulations of the Department of Transportation, and Requirements of United Parcel Service

Shipper's Signature _____ *Date* _____

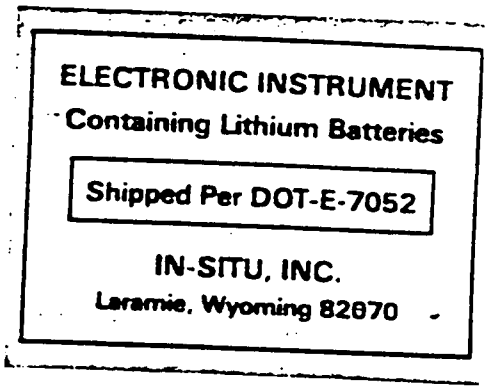
Shipping Container Checklist

Regardless of the carrier you choose to ship your HERMIT, an appropriate shipping container with the required labels must be used. Use the following checklist to ensure safe, trouble-free shipment of the instrument.

Note: The labels described below must be affixed neatly to the shipping container in such a manner that they do not overlap or touch any other label or document.

1. Use a container rated DOT-12B-30 or equivalent. The HERMIT must be padded on all sides by at least one-inch foam corners or an equivalent packing material.

2. A label indicating **Electronic Instrument Containing Lithium Batteries Shipped per DOT-E 7052** or the same written statement must appear on the box.



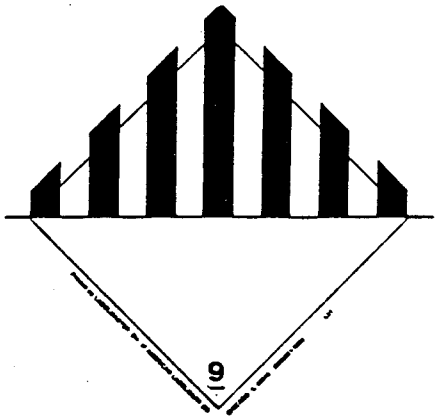
3. Two **Flammable Solid** labels must appear on opposite ends of the box. These must be approved labels – hand-written will not be accepted.



4. Two **Cargo Aircraft Only** labels must appear on opposite ends of the box. These must be approved labels – hand-written will not be accepted.



5. If the HERMIT is to be shipped outside of the United States, two **Miscellaneous Dangerous Goods** labels must appear on opposite ends of the box. These must be approved labels – hand-written will not be accepted.



6. It is recommended, but not required, that one **INNER PACKAGES COMPLY** label be placed on the box.



7. It is recommended, but not required, that two **DELICATE INSTRUMENTS** labels be placed on opposite ends of the box.



Exemption Documentation

The following pages may be copied and used as a replacement exemption document DOT-E 7052 as required for shipping the HERMIT. All pages must appear together to constitute an acceptable exemption document.

The DOT-E 7052 must be current. Please note the revision number and expiration date on the following page. If it has expired, the latest revision may be obtained by calling In-Situ toll-free at 1-800-446-7488.

Other Documentation

Copies of the Product Safety Data Summary and D.O.T. Emergency Response Guide 40 are included at the end of this appendix for your information.

U.S. Department
of Transportation

Research and
Special Programs
Administration

400 Seventh Street S.W.
Washington D.C. 20590

OCT 1 1991

DOT-E 7052
(TWENTY-FIRST REVISION)

1. Power Conversion, Inc., Elmwood, New York, is hereby granted an exemption from certain provisions of this Department's Hazardous Materials Regulations to offer packages prescribed herein of certain lithium batteries for transportation in commerce subject to the limitations and special requirements specified herein. This exemption authorizes the shipment of lithium batteries and lithium batteries contained in equipment and provides no relief from any regulation other than as specifically stated. Each of the following is hereby granted the status of a party to this exemption (SEE APPENDIX I).

2. BASIS. This emergency exemption is based on Power Conversion's application dated September 2, 1987, submitted in accordance with 49 CFR 107.105. The granting of party status is based on the following applications submitted in accordance with 49 CFR 107.111 and the public proceeding thereon (SEE APPENDIX II).

3. HAZARDOUS MATERIALS (Descriptor and class). Lithium batteries and cells containing Metallic lithium, Vanadium pentoxide, Chromium oxide, Lithium cobalt dioxide, Manganese dioxide, Monofluorographite, Sulfur dioxide, Lithium bromide salts, Acetonitrile, or mixtures of Acetonitrile and Propylene carbonate, Methyl formate and Methyl acetate; also Lithium batteries and cells containing Lithium copper oxide and Lithium copper oxyphosphate, Lithium ferrosolfate, Lithium metal, a depolarizer such as Titanium disulfide, Thionyl chloride or Sulphuryl chloride or Polycarbonmonofluoride and a Lithium salt such as Lithium tetrachloroaluminate or Lithium perchlorate or Lithium tetrafluoroborate, Lithium molybdenum disulfide and Lithium hexafluoroarsenate, Vanadium pentoxide - classed as flammable solid; or miscellaneous Class 9, of International Civil Aviation Organization (ICAO).

Rechargeable lithium batteries and devices containing any lithium batteries other than those excepted under Section 173.206(f) or Special Provisions A45 of ICAO, must be specifically identified to, and acknowledged in writing by, the Office of Hazardous Materials Exemptions and Approvals (OHMEA), prior to the first shipment.

NOTE: Those rechargeable lithium batteries and devices or equipment containing lithium batteries, not excepted as described above and not acknowledged in writing by OHMEA prior to September 1, 1991, must be identified, approved, and shipped under the provisions of 49 CFR Section 173.185. This exemption does not authorize the transportation of cells containing lithium metal which have been discharged to the extent that the open circuit voltage is less than two volts, or batteries containing one or more such cells. However, cells or batteries discharged to below 2 volts, not to exceed 100 cells or batteries per shipment, may be shipped for testing purposes by highway only.

4. PROPER SHIPPING NAME (49 CFR 172.101). Lithium batteries, liquid cathode; Lithium battery, solid cathode (UN 3090) or Lithium batteries contained in equipment (UN 3091) which have been identified to and acknowledged in writing by OHMEA prior to September 1, 1991.

5. REGULATION AFFECTED. 49 CFR 172.101, 172.400, 175.3.

6. MODES OF TRANSPORTATION AUTHORIZED. Motor vehicle, rail freight, cargo vessel and cargo-aircraft only and crew carrying helicopter used to service off-shore oil rigs only.

7. SAFETY CONTROL MEASURES. Packaging prescribed is as follows:

a. Cells and batteries must be packed in strong inner fiberboard containers limited to a maximum of 500 grams of lithium in one inner container. No cell containing more than 12 grams of lithium may be shipped under this exemption.

b. When drums are used, the inner containers must be separated from each other and all inner surfaces of the drum by at least one inch thickness of vermiculite or other equivalent noncombustible cushioning materials.

c. Inside boxes must be further overpacked as specified in paragraphs (8.c.) or (8.d.).

d. Packages must be marked as prescribed in Subpart "D" of 49 CFR Part 172. Packages must be labeled with the FLAMMABLE SOLID label shown in 49 CFR 172.420 or MISCELLANEOUS label shown in Fig. 4-20 OF ICAO Technical Instructions.

e. Each cell and battery must be equipped with an effective means of preventing external short circuits.

f. Each cell and battery must incorporate a safety venting device or be designed in such a manner that will preclude a violent rupture under any condition incident to transportation such as a "dead short". The design of cells and batteries not equipped with a safety venting device must be specifically identified to this office prior to the first shipment of package. Batteries containing cells or series of cells connected in parallel must be equipped with diodes to prevent reverse current flow.

g. Three representative cells must be taken from each week's production of each cell type and be subjected to the test prescribed in Section 3.2.1(1) of Appendix B, Report ECOM730242F on file with the OHMEA.

h. One representative battery must be taken from each week's production of each battery type and must be subjected to the test prescribed in Section 3.2.2(1) of the above reference report.

i. At least 10 cells and one battery of each type of each week's production must be subjected to a thermal stability test at 75°C. for 48 hours and show no evidence of distortion, leakage or internal heating.

j. When shipped in oil rig service helicopter, maximum amount of lithium in one inner packaging shall not exceed 300 grams.

8. SPECIAL PROVISIONS.

a. Persons who receive packages covered by this exemption may reoffer them for transportation provided no modifications or changes are made to the packages, all terms of this exemption are complied with, and a current copy of this exemption is maintained at each facility from which such reoffering occurs.

b. In accordance with the provisions of 49 CFR Part 107, Appendix B to Subpart B, Paragraph 3, the shipper shall furnish a copy of this exemption to the air carrier before or at the time the shipment is tendered. In addition, a copy of this exemption must be carried aboard each aircraft, and cargo vessel used to transport packages covered by this exemption.

c. For shipment by cargo-aircraft only, the outside container must be a removable head drum of the DOT Specification 17H or 17C series (or equivalent) and be equipped with a gastight gasket.

d. For shipment by water, motor vehicle, or rail freight, the outside container must be either a : (1) strong wooden box, (2) DOT Specification 12B fiberboard box (or equivalent), (3) DOT Specification 21C fiber drum, or equivalent, or (4) metal drum as authorized in paragraph (c) above.

e. Cells containing no more than 12 grams of lithium metal and also containing lithium molybdenum disulfide and lithium hexafluoroarsenate or vanadium pentoxide, polycarbonmonofluoride, manganese dioxide, titanium disulfide, thionyl chloride and lithium tetrachloroaluminate, lithium tetrafluorobonate or acetonitrile and sulfur dioxide,or thionyl chloride/bromine complex or sulfuryl chloride and chlorine which are hermetically sealed, and batteries constructed of such cells, are excepted from the requirements of paragraphs 7.g., 7.h., and 7.i., and 8.c. of this exemption when in conformance with the following:

Prior to the first shipment, 10 cells or 4 batteries of each type to be offered for transportation must be tested as follows, without showing any evidence of out-gassing, leakage, loss of weight, or distortion:

i. The cells or batteries shall be stored for 6 hours at a pressure corresponding to an altitude of 50,000 feet at 24°C + 4°C.

ii. The cells or batteries shall then be subjected to the thermal stability test at 75°C for 48 hours as required in paragraph 7.i.

iii. The cells or batteries shall be rigidly clamped to the platform of a vibration machine. A simple harmonic motion having an amplitude of 0.03inch (0.06 inch maximum total excursion) shall be applied. The frequency shall be varied at the rate of 1 cycle per second per minute between the limits of 10 and 55 cycles per second. The entire range of frequencies and return shall be traversed in 95 ± 5 minutes for each of three mutually perpendicular mounting positions of the battery and two perpendicular positions of the cells. One of the directions of vibration shall be perpendicular to the terminal face of the battery or cell. Open circuit voltage shall be observed for 30 seconds during the last quarter of each vibration period. Periodic retesting is not required.

iv. The batteries (not cells) must be subjected to a shock test as follows:

The battery shall be secured to the testing machine by means of a rigid mount which will support all mounting surfaces of the battery. Each battery shall be subjected to a total of three shocks of equal magnitude. The shocks shall be applied in each of three mutually perpendicular directions. Each shock shall be applied in a direction normal to a face of the battery. For each shock, the battery shall be accelerated in such a manner that during the first 3 milliseconds the minimum average acceleration is 75 gravity units (G). The peak acceleration shall be between 125 and 175 G. Cells and batteries meeting the requirements of this paragraph must be packaged in accordance with paragraphs 7.a. and 8.d. of this exemption.

f. For transportation by motor vehicle, the labeling requirements in paragraph 7.d. of this exemption do not apply to package(s) containing lithium/manganese dioxide batteries provided:

1. The batteries contain no more than 4 cells with each cell containing not more than 0.5 grams of lithium, and

2. The gross weight of a package(s) in one motor vehicle does not exceed 65 pounds.

g. This exemption also constitutes the approval of the appropriate authority of the United States for shipment of these batteries on cargo aircraft pursuant to State Variation US25 of the International Civil Aviation Organization (ICAO) Technical Instructions.

h. The "FLIGHTS OF CARGO-AIRCRAFT ONLY" requirements of Appendix B to 49 CFR Part 107 do not apply to operations subject to this exemption.

9. REPORTING REQUIREMENTS.

a. Any incident involving loss of packaging contents or packaging failure must be reported to the Associate Administrator for Hazardous Materials Safety as soon as practicable.

b. Test data obtained under paragraph 7.g., 7.h., and 8.e. of this exemption must be kept on file and be made available upon request by the OHMEA.

10. EXPIRATION DATE. September 30, 1993.

Issued at Washington, D.C.

OCT 1 1991

(DATE)

Alan I. Roberts
Associate Administrator
for Hazardous Materials Safety

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Research and Special Programs Administration, U.S. Department of Transportation, Washington, D.C. 20590. Attention: Exemptions Branch.

Dist: USCG, FAA, FHWA, FRA.

APPENDIX I

Honeywell Incorporated, Horsham, Pennsylvania - PTE-1
Saft America, Inc., (Formerly Durcell International, Inc.) Cockeysville, MD - PTE-2
Eagle-Picher Industries, Inc., Joplin, Missouri - PTE-3
U.S. Department of Defense, Washington, DC - PTE-4
Ray-O-Vac Corporation, Madison, Wisconsin - PTE-5
U.S. Department of Energy, Washington, DC (including its contractor Sandia Laboratories, Albuquerque, New Mexico) -PTE-6
National Aeronautics and Space Administration, Washington, DC - PTE-7
The Boeing Company, Seattle, Washington - PTE-8
The Jet Propulsion Laboratories, Pasadena, California - PTE-9
MODICON, Incorporated, North Andover, Massachusetts, - PTE-10
Electrochem Industries, Inc., Clarence, New York - PTE-11
Sonatech, Incorporated, Goleta, California - PTE-12
Altus Corporation, Palo Alto, California - PTE-13
Plainveiw Electronics Corporation, Plainview, New York - PTE-14
Hazeltine Corporation, Braintree, Massachusetts, - PTE-15
Magnavox Government & Industrial Electronics Co., Ft. Wayne, Indiana - PTE-16
Geophysical Research Corporation, Tulsa, Oklahoma - PTE-17
Northrop Corporation, Hawthorne, California - PTE-18
In-Situ, Incorporation, Laramie, Wyoming - PTE-19
DME Corporation, Pompano Beach, Florida - PTE-20
Moli Energy Limited, Burnaby, BC, Canada - PTE-21
McDonnell Douglas Corporation, St. Louis, Missouri - PTE-22
Sippican Ocean Systems, Incorporated, Marian, Massachusetts - PTE-23
Martin Marietta Corporation, Denver, Colorado -PTE-24
TNR Technical, Incorporated, Altamonte Springs, Florida - PTE-25
General Motors Corporation, Warren, Michigan - PTE-26
General Electric Company, Philadelphia, Pennsylvania - PTE-27
Tadiran, Ltd. Industries, Incorporated Renvot, Israel (U.S. Agent - Tadiran Electronic Industries, Woodland Hills, California) - PTE-28
Bren-Tronics, Incorporated, Commack, New York, -PTE-29
Allen-Bradley Company, Milwaukee, Wisconsin - PTE-30
Panasonic Industries Company, Secaucus, New Jersey - PTE-31
Matsushita Battery Industrial Company, Osoka, Japan, (U.S. Agent - Panasonic Industrial Company) - PTE-32
Spar Aerospace limited, Arlington, Virginia, (Formerly: Leigh Instruments, Ltd.,) - PTE-33
Sparton Corporation, Jackson, Michigan - PTE-34
Halliburton Services, Duncan, Oklahoma - PTE-35
General Dynamics, Fort Worth, Texas - PTE-36
Ballard Technologies Corporation, North Vancouver, Canada (U.S. Agent - Dr. Lynn Marcoux, Tustin, California - PTE-37

Flow Research Corporation, Houston, Texas - PTE-38
Battery Engineering, Incorporated, Hyde Park, Massachusetts - PTE-39
Exploration Logging, Incorporated, Sacramento, California - PTE-40
Flopetrol Johnson, (Division of Schlumberger), Houston, Texas - PTE-41
Datasonic's Incorporated, Cataumet, Massachusetts - PTE-42
Crompton Parkinson, Ltd., (U.S. Agent - Crompton Instruments, Inc., Glendale Heights, Illinois) - PTE-43
ACR Electronics Incorporated, Hollywood, Florida - PTE-44
Syntron, Incorporated, Houston, Texas - PTE-45
Macrodyne, Incorporated, Schenectady, New York - PTE-46
Tadiran Electronic Industries, Port Washington, New York - PTE-47
Beckman Instruments, Incorporated, Fullerton, California - PTE-48
Aluminum Company of America, Pittsburgh, Pennsylvania - PTE-49
Smith International, Houston, Texas - PTE-50
ITT Barton Instruments, Co., City of Industry, California - PTE-51
Eveready Battery Co., Inc., Rocky River, Ohio - PTE-52
Telonics, Incorporated, Mesa, Arizona - PTE-53
Toshiba Battery Co., Ltd. (U.S. Agent - Marks, Murase and White, New York - PTE-54
Schlumberger Well Service, Rosharon, Texas - PTE-55
EIC Laboratories, Incorporated, Norwood Massachusetts - PTE-56
Clifton Precision Systems Division, Springfield, Pennsylvania - PTE-57
ENDECO, Incorporated, Marion, Massachusetts, - PTE-58
Hughes Electronic Products, Corporation, Livonia, Michigan - PTE-59
Priebe Electronics, Redmond, Washington, - PTE-60
Engineered Assemblies Corporation, Clifton, New Jersey - PTE-61
Tracor Applied Sciences, Incorporated, Rockville, Maryland - PTE-62
FABRIKA Ni-cd Baterija "TREPC" Gnjilane, Yugoslavia (U.S. Agent - Metalchemical Commercial Corporation, Los Angeles, California - PTE- 63
American Meter Company, Philadelphia, Pennsylvania - PTE-64
Eastman Christensen, Salt Lake City, Utah - PTE-65
Teledyne Systems Company, Northridge, California - PTE-66
Interstate Electronics, Corporation, Anaheim, California - PTE-67
Wilson Greatbatch Ltd., Clarence, New York - PTE-68
ECO Energy Conversion, Somerville, Massachusetts - PTE-69
Siemens Corporation Research & Support, Incorporated, Jamaica, New York - PTE 70
Siemens, Ag., Munchen, West Germany (U.S. Agent - Siemens Corporation Research & Support, Inc., Jamaica, New York) - PTE-71

Battery Assemblies, Incorporated, Bohemia, New York - PTE-72
Wildlife Materials, Incorporated, Carbondale, Illinois - PTE-73
Lockheed Aeronautical System Company, Burbank California - PTE-74
Tauber Electronics, Incorporated, San Diego, California - PTE-75
Adcour, Incorporated, Sharon, Massachusetts - PTE-76
Enscan, Incorporated, Eden Prairie, Minnesota - PTE-77
Acme Aerospace Products Group, Salt Lake City, Utah - PTE-78
Hoppecke Battery Company, Hoppecke, West Germany (U.S. Agent - Acme Aerospace Products Group, Salt Lake City, Utah) - PTE-79
Maxell Corporation of America, Fairlawn, New Jersey - PTE-80
Hitachi-Maxell, Ltd., Osaka, Japan - PTE-81
Beta Phase, Inc., Menlo Park, California - PTE-82
3M, St. Paul, Minnesota - PTE-83
Hydril Production Technology Division, Houston, Texas - PTE-84
DigiCourse, Incorporated, Harahan, Connecticut - PTE-85
GE Reuter Stokes, Twinsburg, Ohio - PTE-86
DC - Battery Products, St. Paul, Minnesota - PTE-87
Tracor Aerospace, Inc., Austin, Texas - PTE-88
TDW Pipeline Surveys (Division of TDW Service, Inc.), Tulsa, Oklahoma - PTE-89
R-Con International, Salt Lake City, Utah, - PTE-90
Mercury Instruments, Inc., Cincinnati, Ohio - PTE-91
Honeywell, Inc., Defense Avionics Systems Div., Albuquerque, New Mexico - PTE-92
Ocean Technology, Inc., Burbank, California - PTE-93
SAB/NIFE, Inc., Greenville, North Carolina, - PTE-94
Medtronic, Incorporated, Brooklyn Center, Minnesota - PTE-95
Fairchild Industries, Inc., Germantown, Maryland - PTE-96
Environmental Pacific Corporation, Lake Oswego, OR - PTE-97
DURACELL, Inc., Bethel, CT - PTE-98
LO-KATA Communication Electronics Cornwall, England (U.S. AGENT: Furuno USA Inc.San Francisco, CA) - PTE-99
Foxboro Company, Foxboro, MA - PTE-100
FDK America, Inc., Englewood Cliffs, NJ - PTE-101
Fuji Electrochemical Company, Limited, Tokyo, Japan (U.S. AGENT: Honeywell, Inc., Albuquerque, New Mexico - PTE-102
Multiplier Industries Corp., Mt. Kisco, NY - PTE-103
Unitech Industries Inc., Scottsdale, AZ - PTE-104
Ansul Fire Protection Wormald U.S., Inc., Marinette, WI - PTE-105
Computalog Wireline Services, Inc., Houston, TX - PTE-106
TOTCO, Houston, TX - PTE-1075
Halliburton Logging Services, Inc., Fort Worth, TX - PTE-108
Baker Hughes Drilling Systems, Inc. (BHDS), Houston, TX - PTE-109
Sperry-Sun Drilling Services, Inc., Houston, TX - PTE-110
Yardney Technical Products, Inc., Waltham, MA - PTE-111
Starburst Electronics Inc., Calgary, Alberta, Canada - PTE-112
Dukane Corporation/Seacom Division, St. Charles, IL - PTE-113
FME Corporation, Hayward, CA - PTE-114

K Power Electronics, (division of Kent Electronics) Houston, TX - PTE-114
Pointer Inc., Tempe, AZ - PTE-115
Sony Energytec, Inc., Fukushima 963-05, Japan (U.S. AGENT: Ansum Enterprises, Inc., Boca Raton, FL) - PTE-116
Ferranti International Signal, Inc., Lancaster, PA - PTE-117
S&G Photographic, Princeton, NJ - PTE-118
Informatique Electronique Securite Martime, Guidel, France (U.S. AGENT: Electronics Safety Device, Inc. Manhasset, NY) - PTE-119
Mid-Atlantic Electronics Corp., Bellmawr, NJ - PTE-1290
AVT, Inc., Englewood, CO - PTE-121
EMF Systems, Boulder Creek, CA - PTE-122
Sanyo Electric Trading Co., Ltd, Moriguchi City, Osaka, Japan (U.S. Agent - Sanyo Energy Corporation San Diego, CA) - PTE-123
Sanyo Energy Corporation, San Diego, CA - PTE-124
Digit Nav Company (DNC), Dallas, TX - PTE-125
Battery Specialties, Costa Mesa, CA - PTE-126
Nautronix, Inc., San Diego, CA - PTE-127
Computer Components Corp., Dallas, TX - PTE-128
Raynet Electronics Company, Inc., Houston, TX - PTE-129
Micro Power Electronics, Beaverton, OR - PTE-130
Amtech Technology Corporation, Sante Fe, New Mexico - PTE-131
Pacific Electro Dynamics, Redmond, WA - PTE-132
SimTronix, Bergen, Norway (U.S. Agent - Sand Dollars Instruments, Inc., Pocasset, MA) - PTE-133
Southwest Electronics, Inc., Stafford, TX - PTE-134
Gould, Inc., Eastlake, OH - PTE-135
Sand Dollar Instruments, Inc., Pocasset, MA - PTE-136
Ensco Technology Company, Houston, TX - PTE-137
Chamberlain MFG. Corporation, Waterloo, IA - PTE-138
Artex Aircraft Supplies, Inc., Canby, OR - PTE-139
Texas Instruments Incorporated, Dallas, TX - PTE-140
Alden Electronics, Inc., Westborough, MA - PTE-141
General Dynamics/Convair Division, San Diego, CA - PTE-142
Ross Laboratories, Inc., Seattle, WA - PTE-143
SuperFlow Corporation, Colorado Springs, CO - PTE-144
Promark Electronics, Inc., Columbus, OH - PTE-145
Ball Aerospace Systems Group, Boulder, CO - PTE-146
Northrop Corporation Aircraft Division, Newbury Park, CA - PTE-147
LSM International/Lone Star Marketing, Houston, TX - PTE-148
Smith Industries (Formerly Lear Siegler) Grand Rapids, MI - PTE-149
Advanced Telemetry Systems, Inc., Isanti, MN - PTE-150
Household Data Service (HDS), Reston, VA - PTE-151

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APPENDIX II

Honeywell Incorporated's application dated September 14, 1989
Saft America, Inc.'s, (Formerly Durcell International, Inc.) application dated September 18, 1989
Eagle-Picher Industries, Inc.'s application dated August 7, 1989
U.S. Department of Defense's application dated September 3, 1989
Ray-O-Vac Corporation's October 25, 1989
U.S. Department of Energy's application dated October 4, 1989
National Aeronautics and Space Administration's July 10, 1989
The Boeing Company, Seattle's September 18, 1989
The Jet Propulsion Laboratories' application dated April 18, 1989
MODICON, Incorporated's application dated October 31, 1989
Electrochem Industries, Inc.'s application dated September 15, 1989
Sonatech, Incorporated's application dated January , 1990
Altus Corporation's application dated October 1, 1989
Plainveiw Electronics Corporation's application dated October 27, 1989
Hazeltine Corporation's application dated November 21, 1989
Magnavox Government & Industrial Electronics Co.'s application dated September 15, 1989
Geophysical Research Corporation's application dated October 23, 1989
Northrop Corporation's application dated June 6, 1989
In-Situ, Incorporation's application dated November 8, 1989
DME Corporation's application dated November 21, 1989
Moli Energy Limited's application dated September 19, 1989
McDonnell Douglas Corporation's application dated September 11, 1989
Sippican Ocean Systems, Incorporated's application dated September 29, 1989
Martin Marietta Corporation's application dated October 19, 1989
TNR Technical, Incorporated's application dated January 22, 1990
General Motors Corporation's application dated September 27, 1989
General Electric Company's application dated September 20, 1991
Tadiran, Ltd. Industries' application dated September 29, 1989
Bren-Tronics, Incorporated's application dated November 20, 1989
Allen-Bradley Company's application dated September 20, 1989
Panasonic Industries Company's application dated February 22, 1990
Matsushita Battery Industrial Company's February 22, 1990
Spar Aerospace Limited's application dated November 5, 1990
Sparton Corporation's application dated October 30, 1989
Halliburton Services' application dated September 26, 1989
General Dynamics' application dated August 30, 1990
Ballard Technologies Corporation's application November 30, 1990
Flow Research Corporation's application dated September 15, 1990
Battery Engineering's application dated September 5, 1989
Exploration Logging, Incorporated's application dated September 15, 1989

Datasonic's Incorporated's application dated December 12, 1989
Crompton Parkinson, Ltd.'s application dated October 10, 1989
ARC Electronics, Incorporated's application dated November 20, 1989
Syntron, Incorporated's application dated December 6, 1989
Macrodyne, Incorporated's application dated January 17, 1990
Tadiran Electronic Industries' application dated September 29, 1989
Beckman Instruments' application dated February 22, 1990
Aluminum Company of America's application dated December 13, 1989
Smith International's application dated December 6, 1989
ITT Barton Instruments, Co.'s application dated July 11, 1989
Eveready Battery Co., Inc.'s application dated December 13, 1989
Telonics, Incorporated's application dated September 22, 1989
Toshiba Battery Co., Ltd.'s application dated May 18, 1990
Schlumberger Well Service's application dated September 20, 1989
EIC Laboratories, Incorporated's application dated April 26, 1990
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FABRIKA Ni-cd Baterija "TREPC"'s application dated February 9, 1990
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Siemens, Ag.'s application dated October 31, 1989
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Wildlife Materials, Incorporated's application dated November 1, 1990
Lockheed Aeronautical System Company's application dated October 22, 1990
Tauber Electronics, Incorporated's application dated March 26, 1990
Adcour, Incorporated's application dated June 29, 1990
EnScan, Incorporated's application dated October 16, 1989
Acme Aerospace Products Group's application dated November 20, 1989

Hoppecke Battery Company's application dated August 4, 1989
Maxell Corporation of America's application dated September 5, 1989
Hatachi-Maxell, Ltd.'s application dated May 22, 1990
Beta Phase, Inc.'s application dated October 23, 1989
3M's application dated September 1, 1989
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Medtronic, Incorporated's application dated October 31,1989
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Foxboro Company's application dated August 1, 1989
FDK America, Inc.'s application dated August 21, 1989
Fuji Electrochemical Company, Limited's application dated August 21, 1989
Multiplier Industries Corp.'s application dated August 21, 1989
Unitech Industries Inc.'s application dated August 28, 1989
Ansul Fire Protection Wormald U.S., Inc.'s application dated September 12, 1989
Computalog Wireline Services, Inc.'s application dated September 22, 1989
TOTCO's application dated September 26, 1989
Halliburton Logging Services, Inc.'s application dated September 27, 1989
Baker Hughes Drilling Systems, Inc.'s application dated September 28, 1989
Sperry-Sun Drilling Services, Inc.'s application dated September 29, 1989
Yardney Technical Products, Inc.'s application dated October 1, 1989
Starburst Electronics Inc.'s application dated October 1, 1989
Dukane Corporation/Seacom Division's application dated October 6, 1989
FME Corporation's application dated October 18, 1989
K Power Electronics' application dated October 27, 1989
Pointer Inc.'s application dated October 27, 1989
Sony Energytec, Inc.'s application dated October 30, 1989

Ferranti International Signal, Inc.'s application dated November 13, 1989
S&G Photographic's application dated November 17, 1989
Informatique Electronique Securite Martime's application dated November 28, 1989
Mid-Atlantic Electronics Corp's application dated December 11 1989
AVT, Inc.'s application dated application dated December 20, 1989
EMF Systems' application dated December 21, 1989
Sanyo Electric Trading Co., Ltd's application dated December 28, 1989
Sanyo Energy Corporation's application dated December 28, 1989
Digit Nav Company's application dated January 10, 1990
Battery Specialties' application dated January 30, 1990
Nautronix, Inc.'s application dated February 8, 1990
Computer Components Corp.'s application dated February 9, 1990
Raynet Electronics Company's application dated February 16, 1990
Micro Power Electronics' application dated March 15, 1990
Amtech Technology Corporation's application dated March 29, 1990
Pacific Electro Dynamics' application dated April 12, 1990
SimTronix's application dated April 18, 1990
Southwest Electronics, Inc.'s application dated May 29, 1990
Gould, Inc.'s application dated June 21, 1990
Sand Dollar Instruments, Inc.'s application dated June 25, 1990
Ensco Technology Company application dated June 27, 1990
Chamberlain MFG. Corporation's application dated June 30, 1990
Artex Aircraft Supplies, Inc.'s application dated July 17, 1990
Texas Instruments Incorporated's application dated July 25, 1990
Alden Electronics, Inc.'s application dated August 8, 1990
General Dynamics/Convair Division's application dated August 30, 1990
Ross Laboratories, Inc.'s application dated September 24, 1990
SuperFlow Corporation's application dated October 23, 1990
Honeywell Inc's application dated October 16, 1990
Promark Electronics, Inc.'s application dated October 24, 1990
Ball Aerospace Systems Group's application dated October 30, 1990
Northrop Corporation Aircraft Division's application dated November 1, 1990
LSM International/Lone Star Marketing's application dated November 1, 1990
Smith Industries's application dated November 30, 1990
Advanced Telemetry Systems, Inc.'s application dated December 3, 1990
Household Data Service's application dated February 1, 1990

PRODUCT SAFETY DATA SUMMARY

Date: January 14, 1991 **Supersedes:** none

Product Name: In-Situ Inc. Hermit Data Loggers

Product Model: SE1000B, SE1000C, SE2000 Environmental Data Loggers

Hazard Class/Division: UN3091

Product Hazard: Lithium Oxyhalide Primary Battery Pack; pack comprised of 5DD cells

Chemistry System: Lithium/Bromine Chloride in Thionyl Chloride
Chemical Formula: Li/BrCl in $SOCl_2$

I. Toxic, Caustic or Irritant Content

Important Note: The battery container (i.e., the data logger) should not be opened or incinerated since the following ingredients contained within could be harmful under some circumstances if exposed.

Materials

Li	Lithium is included in this section due to its vigorous reaction with water, forming a strong hydroxide.	(CAS # 7439-93-2)
$SOCl_2$	Thionyl Chloride.	(CAS # 7719-09-7)
Br_2	Bromine.	(CAS # 7726-95-6)
Cl_2	Chlorine.	(CAS # 7762-50-5)

In case of accidental ingestion of a cell or its contents, obtain prompt medical advice.

II. Storage and Disposal

Storage: Data logger operating and storage temperature is -40°C to +70°C. Do not subject data logger or internal battery pack to temperatures in excess of 100°C (212°F). Such abuse can result in loss of seal, leakage and/or cell explosion and possible subsequent data logger explosion.

In case of fire in an adjacent area, use water, CO_2 or dry chemical fire extinguishers if battery pack remains in the data logger. In cases where the data logger has been damaged and subsequent damage to the battery pack has occurred, or if the data logger is directly involved in flame, use Lith-X (Graphite Base). In this case, use no water, CO_2 or halogen extinguishers. Avoid fume inhalation (LiOH, $SOCl_2$, SO_2, HCl).

Disposal: In order to maintain data logger integrity and warranty, do not attempt to remove the battery pack. Should removal become necessary, follow the precautions as above and dispose of in accordance with appropriate Federal, State and local regulations.

III. Handling and Use Precautions

Use: Do not use this product for other than its original intended use. This product contains no user-serviceable parts. Do not remove front panel screws for other than emergency access to battery pack. Maintenance and service should only be performed by In-Situ, Inc., or an authorized representative.

Charging: The cells comprising the internal battery pack are primary cells and are not designed to be charged or recharged. The instrument has no capability to do so. To attempt to do so may cause the cells to leak or explode.

INITIAL ISOLATION PROTECTION TABLES FOR SELECTED HAZARDOUS MATERIALS

The table gives suggested distances for ISOLATING unprotected people from spill areas involving the hazardous materials shown, IF THE LISTED MATERIAL IS NOT ON FIRE If the material is on fire, refer to the 2-digit Guide

These materials were selected because their vapors have the potential to produce poisonous effects The table is useful for no more than the first 30 minutes of an incident involving these materials There are several good reasons for suggesting that the use of the table be limited specifically to the initial phase of a no-fire spill incident during transport

D.O.T. EMERGENCY RESPONSE GUIDE 40

TABLE OF INITIAL ISOLATION AND PROTECTIVE ACTION DISTANCES

USE THIS TABLE WHEN THE MATERIAL IS NOT ON FIRE

ID No	NAME OF MATERIAL	SMALL SPILLS (Leak or spill from a small package or small leak from a large package)		LARGE SPILLS (Leak or spill from a large package or spill from many small packages)	
		First ISOLATE in all directions - (Feet)	Then PROTECT those persons in the DOWNWIND direction - (Miles)	First ISOLATE in all directions - (Feet)	Then PROTECT those persons in the DOWNWIND direction - (Miles)
2845	Ethyl Phosphonous Dichloride, Anhydrous	150	0 2	150	0 2
2845	Methyl Phosphonous Dichloride	150	0 2	150	0 2

If the chemical name and ID Number the shipper entered on the front of this form match a name from this list, and NO FIRE exists, you must:

determine if the incident involves a small or large spill; look up the isolation distance; (Direct all person to move in a crosswind direction, away from the spill, to that distance) look up the Initial PROTECTIVE ACTION DISTANCE In the table (For practical purposes, the Protective Action Zone is a square whose length and width are the same as the downwind distance shown in the table)

WHEN APPROACHING THE SCENE OF AN ACCIDENT INVOLVING ANY CARGO (NOT ONLY REGULATED HAZARDOUS MATERIALS)

- APPROACH INCIDENT FROM AN UPWIND DIRECTION, IF POSSIBLE
- MOVE AND KEEP PEOPLE AWAY FROM INCIDENT SCENE
- DO NOT WALK INTO OR TOUCH ANY SPILLED MATERIAL
- AVOID INHALING FUMES, SMOKE AND VAPORS EVEN IF NO HAZARDOUS MATERIALS ARE INVOLVED
- DO NOT ASSUME THAT GASES OR VAPORS ARE HARMLESS BECAUSE OF LACK OF SMELL—ODORLESS GASES OR VAPORS MAY BE HARMFUL

As a first responder at the scene of a hazardous materials incident, seek additional and more specific information about any material in question as soon as possible This Guide Page is not intended for use during the cleanup phase for spilled materials, nor should it be used to determine compliance with any regulations This information on this Emergency Response Form should be augmented by expert technical advice as soon as you have assessed the situation and have seen to the immediate needs of the people involved

FOR FURTHER INFORMATION REFER TO DOT P 5800 5 (EMERGENCY RESPONSE GUIDEBOOK) AND TITLE 49 CODE OF FEDERAL REGULATIONS

D.O.T. EMERGENCY RESPONSE GUIDE 40

(FOLD ON DOTTED LINE — SIMILAR TO HAZARDOUS MATERIALS SHIPPING PAPERS)

Use basic description and technical name as described in 49 CFR 172 202 and 172 203 (c)

Basic Description: UN 3091 LITHIUM BATTERIES CONTAINED IN EQUIPMENT

Technical Name(s):

EMERGENCY RESPONSE GUIDE FORM

24 hr. Emergency Contact Tel. No.: (307)760-0273

POTENTIAL HAZARDS

FIRE OR EXPLOSION

May ignite readily if exposed to air
May re-ignite after fire is extinguished
May ignite in presence of moisture
Violent reaction with water produces flammable gas
Runoff to sewer may create fire or explosion hazard

HEALTH HAZARDS

May be poisonous if inhaled
Contact may cause burns to skin and eyes
Fire may produce irritating or poisonous gases

EMERGENCY ACTION

Keep unnecessary people away, isolate hazard area and deny entry
Stay upwind, keep out of low areas
Positive pressure self contained breathing apparatus (SCBA) and structural firefighters' protective clothing may provide limited protection
CALL CHEMTREC AT 1-800-424-9300 FOR EMERGENCY ASSISTANCE
If water pollution occurs, notify the appropriate authorities

FIRE

Do not use water or foam
Small Fires: Dry chemical, soda ash, lime or sand
Large Fires: Withdraw from area and let fire burn
Magnesium Fires: Use dry sand, Met L X® powder or G-1 graphite powder
Lithium Fires: Use dry sand, Lith X® powder or G-1 graphite powder
Move container from fire area if you can do it without risk

SPILL OR LEAK

Shut off ignition sources; no flares, smoking or flames in hazard area
Do not touch or walk through spilled material; stop leak if you can do it without risk
No water on spilled material; do not get water inside container
Small Dry Spills: With clean shovel place material into clean, dry container and cover loosely; move containers from spill area
Small Spills: Take up with sand or other noncombustible absorbent material and place into containers for later disposal
Large Spills: Dike liquid spill for later disposal
Cover powder spill with plastic sheet or tarp to minimize spreading

FIRST AID

Move victim to fresh air; call emergency medical care
Wipe material from skin immediately; flush skin or eyes with running water for at least 15 minutes
Remove and isolate contaminated clothing and shoes at the site

Information on this Guide Page is from the 1990 Emergency Response Guidebook Dot P 5800 5 It applies only to the basic Description and Technical Name entered by the shipper at the top of this form

Check to see whether the shipper commodity (Basic description entered at the top of the form) is listed by I.D.# and NAME OF THE MATERIAL in the Table of Initial Isolation and Protective Action Distances This Table is partially reproduced on the back of this Guide Page to reflect only commodities assigned to this Guide Number. Use this information from the table in addition to the Guide Page IF THERE IS NO FIRE

READ AND CHECK THE NAMES AND NUMBERS CAREFULLY BECAUSE COMPLETELY DIFFERENT HAZARDOUS MATERIALS CAN HAVE NAMES AND/OR NUMBERS WHICH ARE ALMOST THE SAME!

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D Watchdog Error Codes

The following "watchdog" errors are generated by the HERMIT under fault conditions. The number of watchdog occurrences and the most recently generated error number can be displayed through the watchdog option of the System Setup menu. A large number of recorded errors indicates that the instrument may require service. Refer to Appendix B for information on how to obtain repair service.

Code	Error Condition
1	Watchdog recovery
2	Lost program recovery
3	Unit was unable to put itself to sleep
4	Unit was unable to format the memory (on reset only)
5	Unit was unable to create its system file (reset only)
6	Unit was unable to create its pointer file (reset only)
7	Unit was unable to create its test file (reset only)
8	Unit failed a self-test

System Reset

If the instrument wakes up with 'RESET' displayed, this indicates that the non-volatile memory has been compromised. You have two alternatives:

1. Press ENTER to confirm a reset. The unit will attempt to re-initialize its memory.
   a. If successful, the status display will return to the screen. This indicates the unit is functional, but ***all previously stored data and test configurations will be lost.***
   b. If the status display does not return to the screen, it means the instrument was not able to re-initialize the memory and must be sent in for servicing. Contact In-Situ's Product Service Facility as described under "How to Obtain Repair Service" in Appendix B.
2. Press STOP/NEXT to cancel the reset. You might prefer to do this when there is valuable data in the memory that you don't want to lose. The data may be recoverable at the factory. Contact In-Situ's Product Service Facility as described under "How to Obtain Repair Service" in Appendix B.

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E Specifications

General

Dimensions	7W x 11L x 9D inches (18 x 28 x 23 cm)
Weight	12 pounds (5.5 kg)
Operating and storage temperature	-40°C to +70°C (-40°F to +158°F)
Accuracy	± 0.06% of full scale (at constant temperature) ± 0.2% of full scale (includes temperature effects)
Resolution	± 0.15% of full scale
Stability	± 0.002% of full scale per °C

Transducer Input(s)

Type	4 to 20 mA, 2 or 3 wire
Source voltage	+20 to +28 VDC, pulsed
Source current	100 mA max
Source pulse width	Programmable, 50 mSEC to 60 sec
Input resistance	185 ohms typical
Accuracy	± 0.2% of full scale
Resolution	± 0.015% of full scale
Stability	± 0.005% of full scale per °C

Data Sampling

Memory type	Non-volatile EEPROM
Memory capacity	32K
Data point capacity	16,000
Linear sampling rates	
Linear Mode 1	Programmable 2 sec to 59 sec
Linear Mode 2	Programmable 1 min to 1440 min
Logarithmic sampling rate	0.2 sec from 0 to 20 sec 1 sec from 20 to 60 sec 12 sec from 1 to 10 min 2 min from 10 to 100 min 20 min from 100 to 1000 min 200 min from 1000 to 10,000 min 2000 min from 10,000 min Programmable 1 min to 1440 min after 10 min

Battery

Type	Lithium inorganic
Expected life	Greater than 100,000 data points or 5 yrs

External Power Input

Input voltage	+12 VDC to +18 VDC
Input current	20 mA typical, 350 mA peak

Alarm Contacts

Contact voltage	30 VDC or 30 VAC max
Contact current	1 ampere max

RS232 Interface

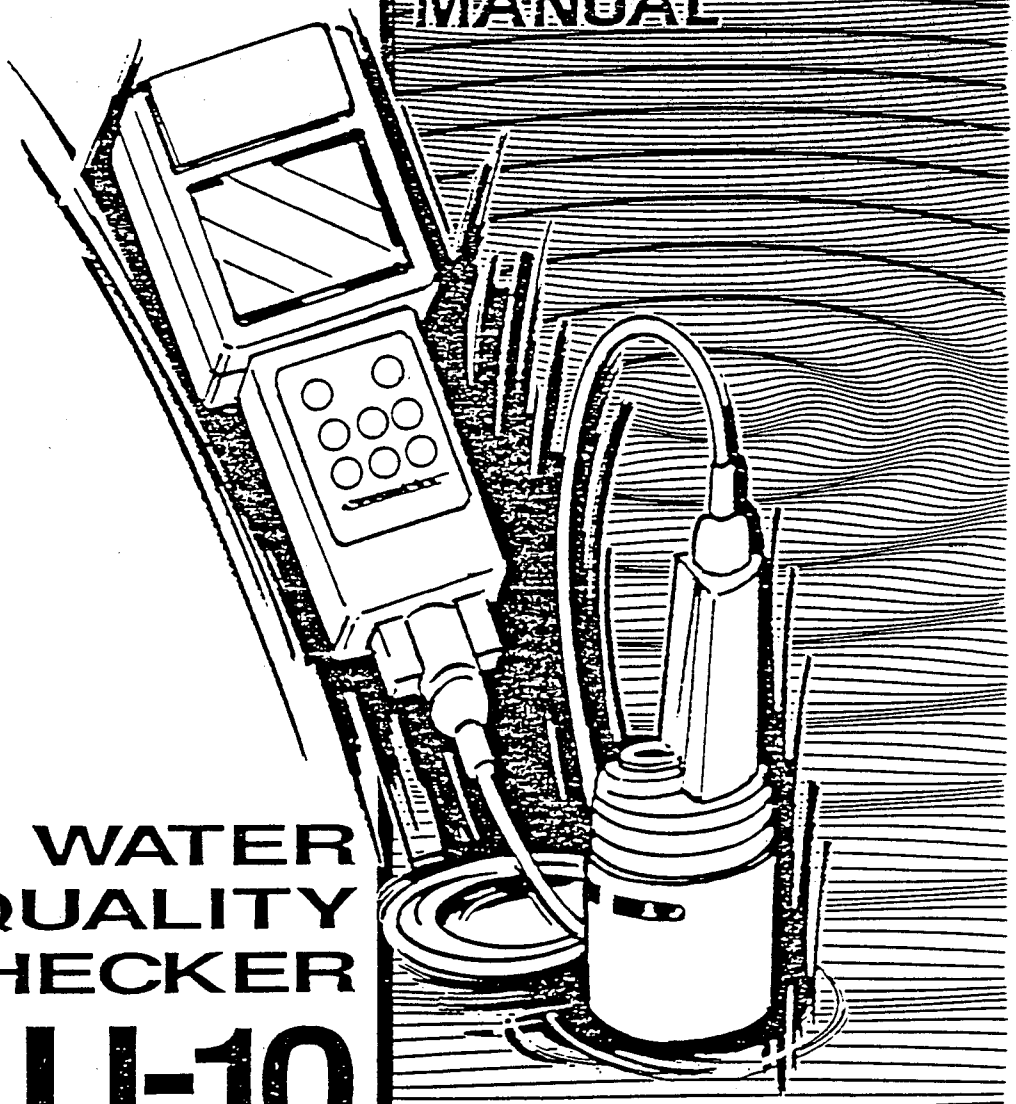
Output voltage swing	± 4 VDC min, ± 5 VDC typical
Handshake input voltage	± 15 VDC max, ± 3 VDC min
Baud rate	Selectable 300 to 2400 baud
Character length	Selectable 7 or 8 bits
Parity	Selectable Odd, Even, or None
End-of-line sequence	Selectable CR or CR/LF
Hardware Handshake	CTS

IN-SITU
Model HERMIT 1000B, 1000C
INSTRUMENT MANUAL

HAZCO Services, Inc.

HORIBA

INSTRUCTION MANUAL



WATER QUALITY CHECKER U-10

CODE: 040801000HK-2

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HERMIT
Environmental Data Logger

Model SE1000C

Operator's Manual

Version 1.1
April 1992
Software Version 4.3

In-Situ Inc.
The Solutions People
Laramie, Wyoming

INSTRUCTION MANUAL

for

U-10

WATER QUALITY CHECKER

DATE: OCTOBER 1990

Revised October 1991

HORIBA INSTRUMENTS INCORPORATED

HORIBA INSTRUMENTS INC.
17671 ARMSTRONG
IRVINE INDUSTRIAL COMPLEX
IRVINE, CALIFORNIA 92714
TELEPHONE 714/250-4811

WARNING

The DO sensor contains a strong alkaline solution. Should any of this solution come in contact with your clothing or skin, wash it away immediately with plenty of water.

Be especially careful not to allow any of the alkaline liquid in the DO sensor to get in your eyes.

The U-10 Water Quality Checker is a state-of-the-art instrument for simultaneous multiparameter measurement of water quality. The HORIBA U-10 measures six different parameters of water samples: *pH*, *conductivity*, *turbidity*, *dissolved oxygen*, *temperature*, and *salinity*.

The U-10 is compact enough to be held in one hand while taking measurements. It has a large easy-to-read LCD readout. Measurements are taken simply by immersing the probe right into the water sample.

The U-10 is extremely versatile and sophisticated, yet easy to use. You will find it a valuable addition to on-site water control operations, whatever your needs—from testing factory discharges to urban drainage, river water, lake and marsh water, aquatic culture tanks, agricultural water supplies, and sea water.

To get the most out of your U-10 Water Quality Checker, please read and this *Instruction Manual* carefully before you begin to take measurements.

Note that Horiba cannot be held responsible for any equipment malfunction or failure should the U-10 Water Quality Checker be operated incorrectly or in a manner other than specified in this *Instruction Manual*.

Horiba's aim is to produce the best possible equipment and documentation for our products. We welcome comments, questions, or suggestions for improvement concerning both our products and the accompanying documentation, such as this *Instruction Manual*.

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Note that the contents of this Instruction Manual are subject to change without prior notice as design changes are made on the instrument.

First edition: July, 1991

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Section 1

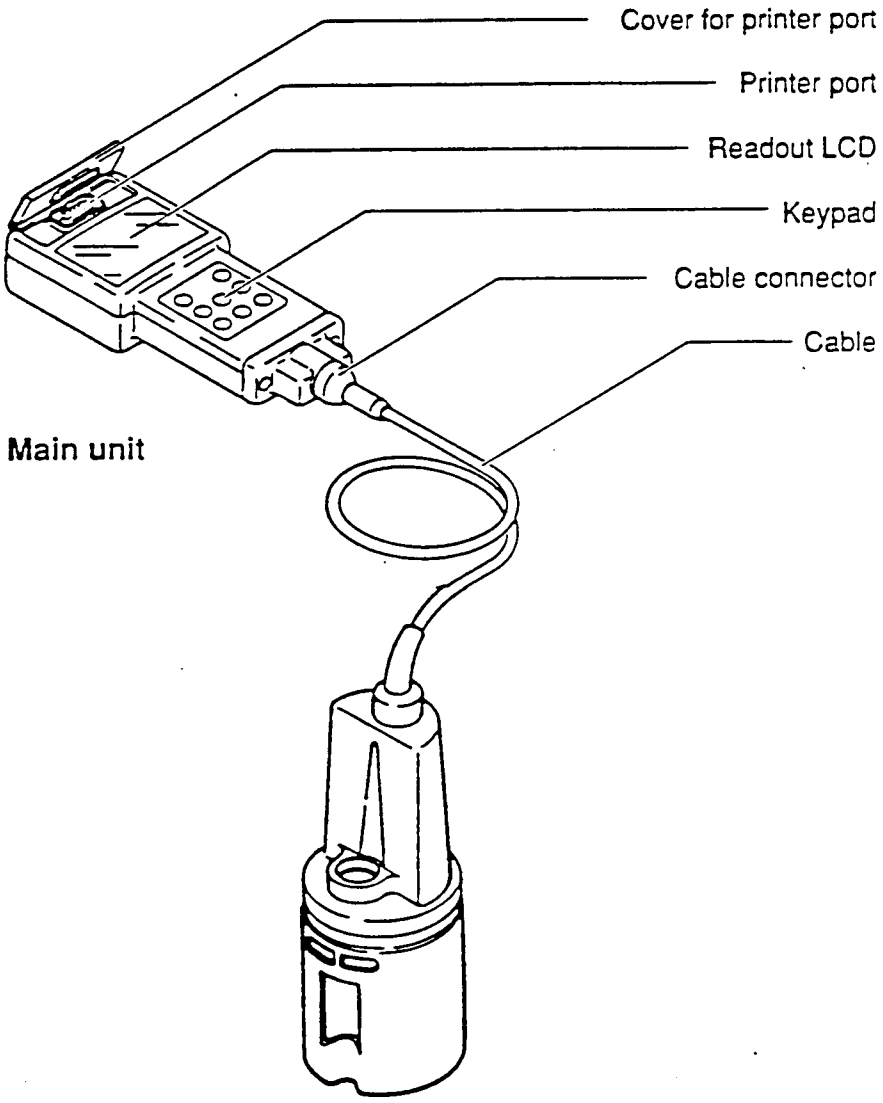
Getting Started

This section first gives an overview of the U-10. It then shows how to set up the your U-10 by inserting the DO sensor and the battery. Finally, it lists important precautions to be taken when using your U-10 Water Checker.

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Configuration of the U-10

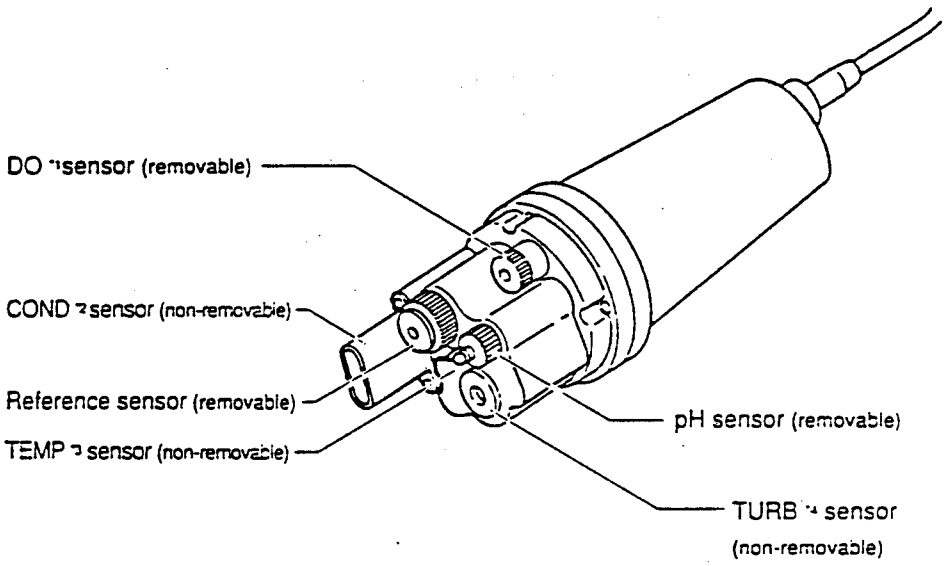
Main unit

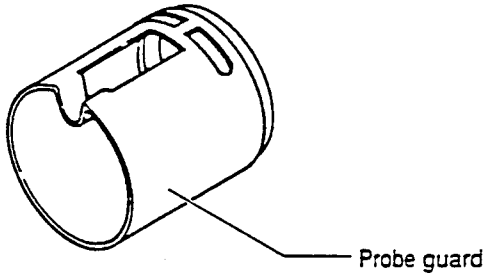


Main unit

Probe

Probe

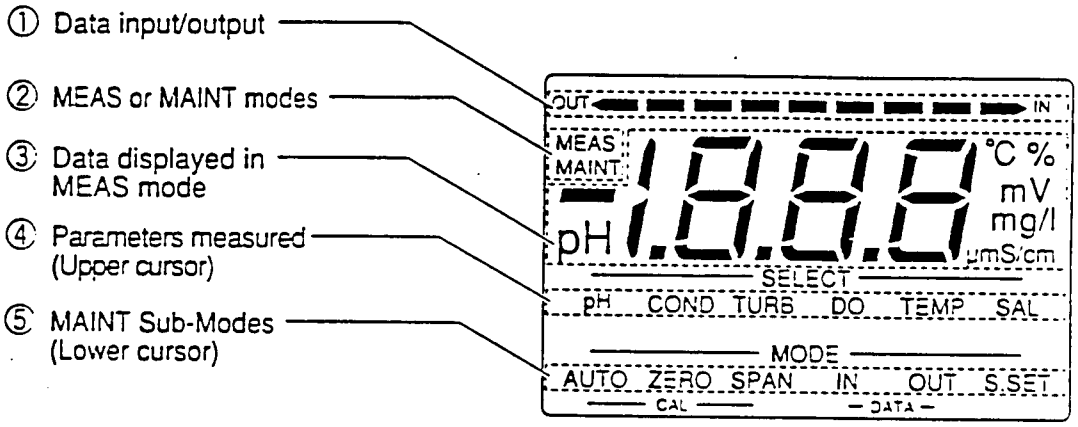




*1 DO : Dissolved oxygen
*2 COND : Conduectivity
*3 TEMP : Temprature
*4 TURB : Turbidity

The Readout

The readout is an easy-to-read LCD. The readout has two main functions: (1) it displays the results of measurements, and (2) it serves as a message board to show the operating status of the U-10.



① Data input/output

OUT Data output

IN Data input

② MEAS or MAINT modes

The U-10 may be in one of two modes: Measurement (MEAS) mode or Maintenance mode.

MEAS the U-10 is ready to make 6-parameter measurements

MAINT the U-10 is ready for other operations, e.g., calibration, data input/recall, or salinity setting

③ Data displayed in MEAS mode

- 6-parameter results:
  pH, conductivity, turbidity, DO, temperature, and salinity
- Designated value for salinity setting
- Error codes

④ Parameters measured

Value displayed on readout is highlighted by upper cursor.

pH	pH
COND	Conductivity
TURB	Turbidity
DO	Dissolved-Oxygen
TEMP	Temperature
SAL	Salinity

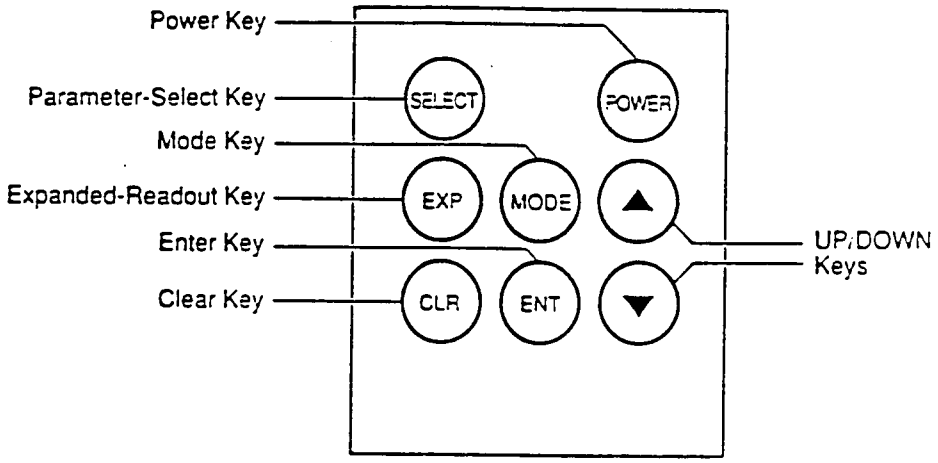
⑤ MAINT Sub-Modes

One of six Sub-Modes selected is highlighted by lower cursor.

AUTO	Automatic 1-point calibration
ZERO	Manual zero calibration
SPAN	Manual span calibration
IN	Data input
OUT	Data output (recall)
S.SET	Salinity setting correction

The Keypad

The U-10 is operated by the keypad on the main unit, which has eight surface-sealed keys, as illustrated.



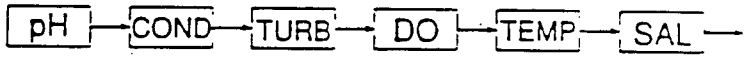


Power Key (POWER)
Turns the main unit ON/OFF.

When this key is pressed to turn the U-10 ON, the readout comes in the MEAS mode, showing the parameter last displayed in the previous measurement. If the U-10 is left with the power ON for 30 minutes without any of the keys being activated operated, the power will be turned OFF automatically.

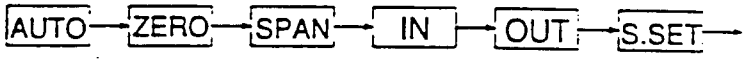


Parameter-Select Key (SELECT)
Use this key to move the upper cursor to the measured parameter you want to show on the readout. It toggles through the six parameters in order:





Mode Key (MODE)
Toggles back and forth between MEAS and MAINT modes. When in the MAINT mode, this key toggles the lower cursor through the six maintenance Sub-Modes.





Expanded-Readout Key (EXP)
Toggles between (1) standard readout value and (2) expanded readout, for greater resolution, with decimal point moved one digit to the left.



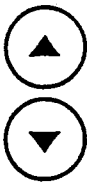
Enter Key (ENT)
This acts like the RETURN Key or Enter Key on a computer keyboard. The U-10 Enter Key has four main functions, depending on which mode the unit is in.

1. In the AUTO Sub-Mode: Press this key to start automatic calibration.
2. In either the ZERO or SPAN Sub-Modes: Used in manual calibration to set the value for the standard solution being used.
3. In the IN Sub-Mode: Inputs data being measured to memory.
4. In the OUT Sub-Mode: Recalls values from one of the 20 Data-Set Nos. that is now shown on the readout. Prints data when a printer is connected.



Clear Key (CLR)
This acts like the ESCAPE Key on a computer keyboard. It has three main functions, depending on which mode the unit is in.

1. In the AUTO Sub-Mode: Aborts the auto-calibration now in progress.
2. In the IN Sub-Mode: Deletes data in memory from all 20 Data-Sets.
3. When the readout shows an error code: Clears the error code from the readout.



UP/DOWN keys
Use these keys to select values when in one of the MAINT Sub-Modes. They have two main functions.

1. In either the ZERO or SPAN Sub-Modes: Use these keys to select value for the standard solution.
2. In the OUT mode: Used to toggle through the 20 Data-Set Nos. to select the one you wish to recall.

Setting up the U-10

Inserting the DO sensor

WARNING

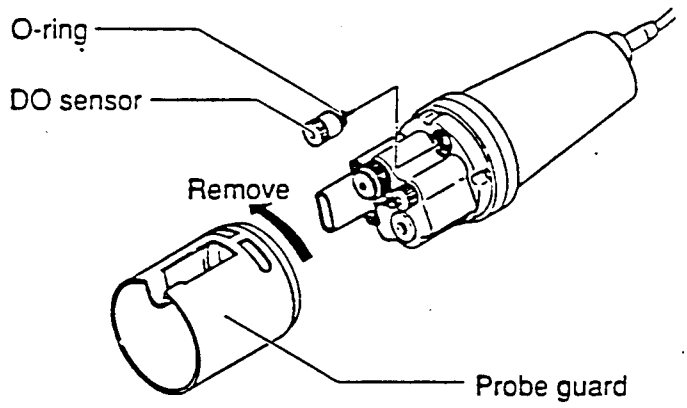
The DO sensor contains a strong alkaline solution. Should any of this solution come in contact with your clothing or skin, wash it away immediately with plenty of water. Be especially careful not to allow any of the liquid in the DO sensor to get in your eyes.

The Dissolved-Oxygen (DO) sensor has a delicate membrane that can easily be ruptured. For safety's sake, the U-10 is shipped to you with the DO sensor packed separately. You should insert the DO sensor when you unpack your U-10 unit.

1. Make sure that the DO sensor has the correct O-ring, as shown.

2. First, fit the DO sensor lightly into its socket, and then put on the probe guard to align it correctly.

3. Then, tighten the DO sensor securely to the probe body. When doing this, be especially careful not to damage the membrane, which is located in the front of the DO sensor.



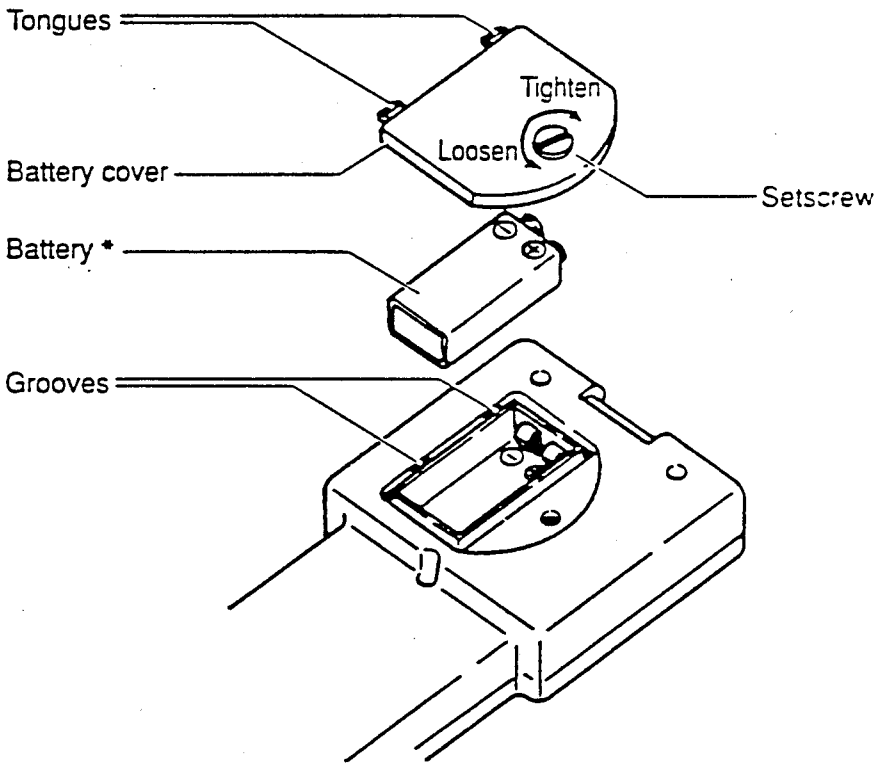
Inserting the battery

The U-10 is shipped from the factory with the battery packed separately.

The battery may be inserted by loosening the set-screw on the battery cover and pulling up the cover. Make sure that the plus and minus poles of the battery match the terminals correctly.

If the readout shows the message Er 1, it means that the battery is defective or exhausted and should be replaced.

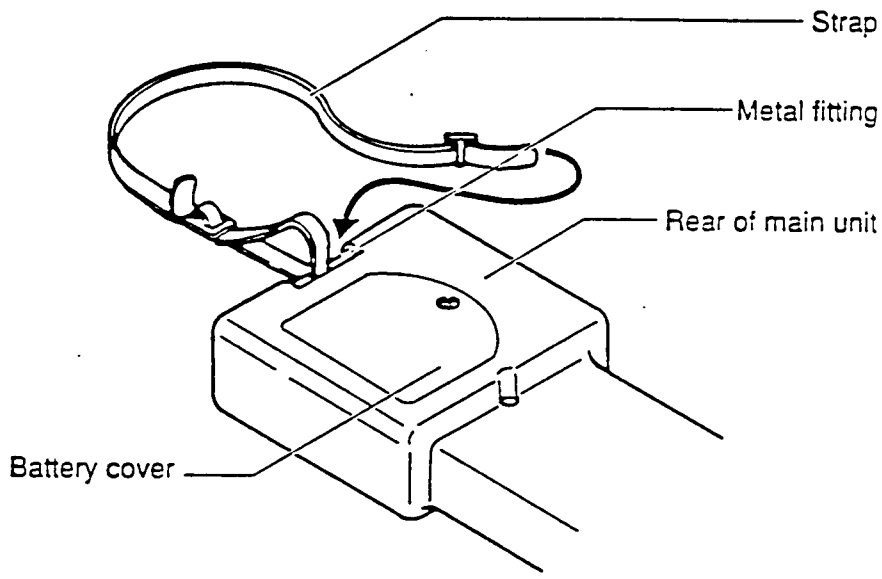
If you are replacing the battery and already have data stored in the U-10 memory that you wish to save, be sure to turn OFF the POWER Key before you remove the old battery. This will assure that data stored in memory will be maintained by the internal backup battery.



* Use the 9V-battery.

Attaching the carrying strap

Hook both ends of the strap through the metal fitting on back of the main unit, as illustrated.



Section 2

Making Measurements

Making a measurement with the U-10 Water Checker is extremely simple. Just turn on the power and place the probe in the sample of water you wish to measure.

All six parameters are measured simultaneously. These parameters may be stored in memory, printed out, or viewed one-by-one on the LCD readout. For printing and data storage, see the appropriate sections following this one. To view the parameters one-by-one on the readout, use the SELECT Key to toggle the upper cursor through them.

While the U-10 is both rugged and precise, the key to accurate measurements is cleanliness and frequent calibration. It is essential to clean the U-10 thoroughly after each measurement, and it is recommended that you re-calibrate your U-10 as frequently as possible. For best results, you should recalibrate it before each measurement session. Cleaning and calibration procedures are described below in this section and in the following one.

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How to make a measurement



1 Turn the power on

2 Gently place the probe into the water sample.

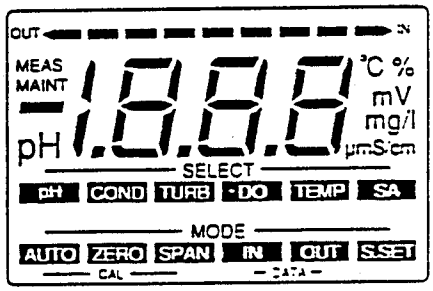
Basically, that's all there is to it: just turn it on and put the probe in the sample. Of course, the U-10 can do many sophisticated things with the sample data, and for best results, you should be careful about calibrating the unit and maintaining it in good condition. This is explained in detail below and in the next section.

Be careful!
Never drop or throw the probe into the water. It is a precision instrument containing five delicate sensors and five pre-amps; you can damage it beyond repair by unnecessarily rough handling.

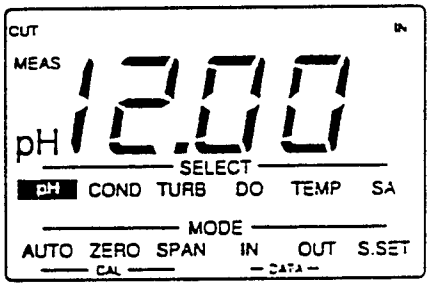
Initial readout

POWER

When you first turn the power on, the U-10 will be in the MEAS mode, the readout will look like this, with all the LCD segments activated.



After about two seconds, the readout will change to show that a new measurement is being made. The readout will show the last parameter that the upper cursor was on when the previous measurement was made, i.e., pH as illustrated here.



(Expanded readout shown)

The display of the decimal point in the readout mode will also be in the same format as was selected with the EXP Key in the previous measurement, i.e., standard or expanded (as illustrated here).

Select the parameter you want shown on the readout



All six parameters are automatically measured at once. Use the SELECT Key to toggle the upper cursor to the parameter you want.

pH	: pH
COND	: Conductivity
TURB	: Turbidity
DO	: Dissolved oxygen
TEMP	: Temperature
SAL	: Salinity

To get a uniform reading, slowly move the probe up and down to circulate the water through it. (Move it 1 foot (30 cm) per sec.) Then wait for the readout to stabilize while doing this.

Expanded readout

EXP

Use the EXP readout mode when you wish to see the results with one additional decimal place of accuracy. The EXP Key toggles the readout back and forth between standard to expanded display. The table below shows the result of using the EXP readout mode for each of the six parameters.

Table 1. Accuracy of expanded readout

Parameter	Range of measurement	Accuracy	
		Standard readout	Expanded readout
pH	0-14 pH	0.1 pH	0.01 pH
COND	0-1 mS/cm	0.01 mS/cm	0.001 mS/cm
	1-10 mS/cm	0.1 mS/cm	0.01 mS/cm
	10-100 mS/cm	1 mS/cm	0.1 mS/cm
TURB	0-800 NTU	10 NTU	1 NTU
DO	0-19.9 mg/*l*	0.1 mg/*l*	0.01 mg/*l*
TEMP	0-50°C	1°C	0.1°C
SAL	0-4%	0.1%	0.01%

Note that the salinity parameter is the only value not measured directly with its own sensor. The U-10 obtains salinity by converting the conductivity value. If large amounts of conductive ions other than salt-water components are present in the sample, an error may occur. Be cautious when interpreting the salinity results.

Measuring fresh water or salt water?

The U-10 can be set to the salinity for either fresh water or salt water when measuring DO. This is done by using the S.SET Sub-Mode.

Measuring fresh water

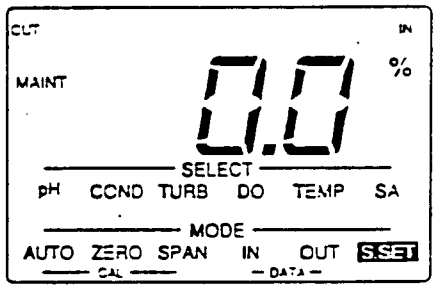


First, use the MODE Key to put the U-10 in the MAINT mode. Keep pressing the MODE Key to toggle the lower cursor to the S.SET Sub-Mode.





Once you are in the S.SET Sub-Mode, use the UP/DOWN Keys to select the salinity value. For fresh water, set the salinity to 0.0%.





Finally, press the ENT Key to complete the salinity setting while in the S.SET Sub-Mode.

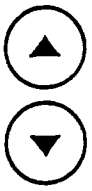


When the salinity setting has been made, switch back to the MEAS mode by pressing the the MODE Key.

Measuring salt water



First, use the MODE Key to put the U-10 in the MAINT mode. Keep pressing the MODE Key to toggle the lower cursor to the S.SET Sub-Mode.



For salt w ater, set it to *A i.e.*, for auto-salinity.

The *A* setting should be sufficient for measurements of normal sea water with a salinity value close to 3.3%. For sea water of an unusual salinity, however, and where the value is otherwise known, you may wish set the value manually to any salinity within the range of 0.0%-4.0%. (You may also possibly want to use a manual setting if, for example, the COND sensor is malfunctioning but it is still desirable to take readings of the other parameters.)



Finally, press the ENT Key to complete the salinity setting while in the S.SET Sub-Mode.



When the salinity setting has been made, switch back to the MEAS mode by pressing the the MODE Key.

After measurement: Cleaning and storing the U-10



Turn OFF the power.

Wash the probe thoroughly with tap water. Be sure to flush off all of sample solution from the probe.

Storing the U-10 for brief periods, *i.e.*, about 1 week or less:

Fill the calibration beaker with tap water and fit the probe over it.

For longer storage

The pH sensor must always be kept moist. Fill the small rubber cap with water and use it to cover the pH sensor.

The KCl internal solution in the pH reference sensor may seep out over time. Place vinyl tape around the O-ring portion to prevent this.

If you are going to store the U-10 for a prolonged period without using it, remove the battery from the main unit.

Section 3

Calibrating the U-10

The U-10 Water Checker may be calibrated either manually or automatically. The 4-parameter auto-calibration procedure is quite handy and should be sufficient for most measurement operations.

Manual calibration for each of the four parameters is more accurate but, of course, also more time-consuming. This method should be used for difficult measurements or where more than normal precision is required. The manual calibration procedure is explained below in detail, following the description of the auto-calibration procedure.

The auto-calibration procedure is extremely simple. The U-10 Water Checker uses just a single solution to do a simultaneous calibration of four parameters: *pH*, *COND*, *TURB*, and *DO*. Your U-10 comes with a bottle of standard phthalate pH solution and a calibration beaker for this purpose.

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Manual (2-point) calibration procedures 23

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1.Zero calibration 24

2.Span calibration 25

COND Calibration 26

1.Zero calibration 28

2.Span calibration 29

TURB Calibration 30

1.Zero calibration 31

2.Span calibration 31

DO Calibration 32

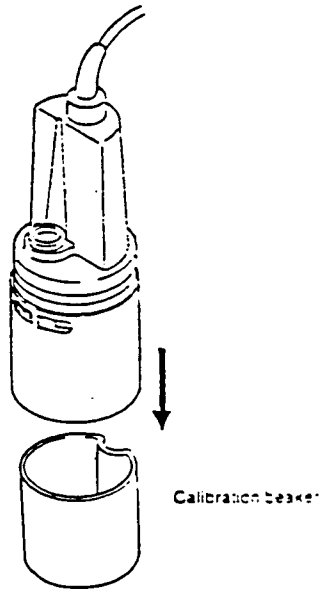
1.Zero calibration 33

2.Span calibration 33

Auto-calibration procedure

Fill the calibration beaker to about 2/3 with the standard solution. Note the line on the beaker.

Fit the probe over the beaker, as illustrated. Note that the beaker is specially shaped to prevent the DO sensor from being immersed in the standard solution. This is because the DO auto-calibration is done using atmospheric air.



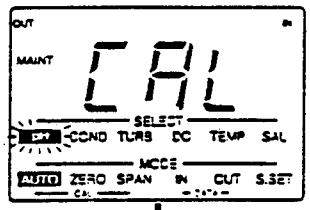
MODE

With the power on, press the MODE Key to put the unit into the MAINT mode. The lower cursor should be on the AUTO Sub-Mode; if it is not, use the MODE Key to move the lower cursor to AUTO.

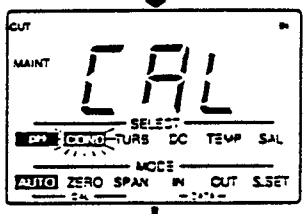
ENT

With the lower cursor on AUTO, press the ENT Key. The readout will show CAL. Wait a moment, and the upper cursor will gradually move across the four auto-calibration parameters one-by-one: *pH, COND, TURB,* and *DO.* When the calibration is complete, the readout will briefly show End and then will switch to the MEAS mode.

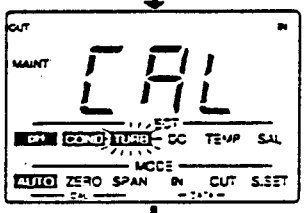
The upper cursor will blink while the auto-calibration is being made. When the auto-calibration has stabilized, the upper cursor will stop blinking.



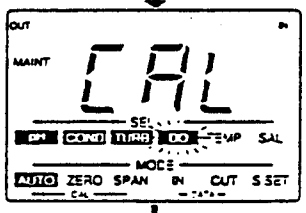
First, pH is being auto-calibrated



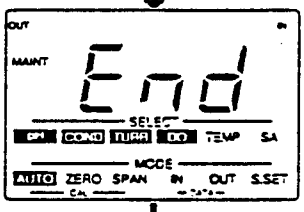
Then, COND is being auto-calibrated



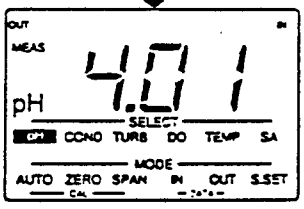
Next, TURB is being auto-calibrated



Finally, DO is being auto-calibrated



Auto-calibration now ends

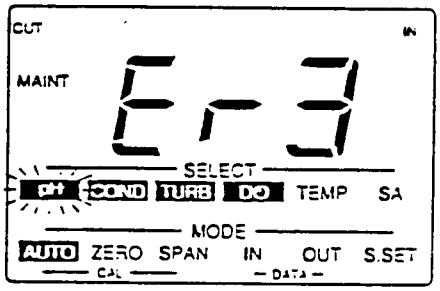


And the readout switches to the MEAS mode

Note: If you wish to abort the auto-calibration for any reason, press the CLR Key. The parameters auto-calibrated so far will be in memory.

Auto-calibration error

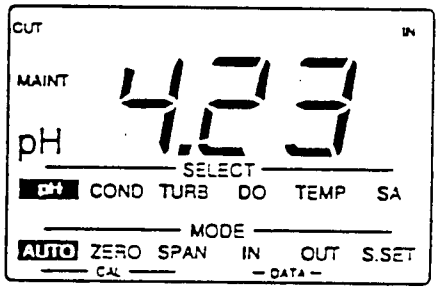
After the DO auto-calibration, if the unit does not switch to the MEAS mode as it should, and the readout shows either Er3 or Er4, an auto-calibration error has occurred. Parameters will blink where an error occurred.



pH auto-calibration error



If this happens, re-do the auto-calibration. First, press the CLR Key to cancel the error code.



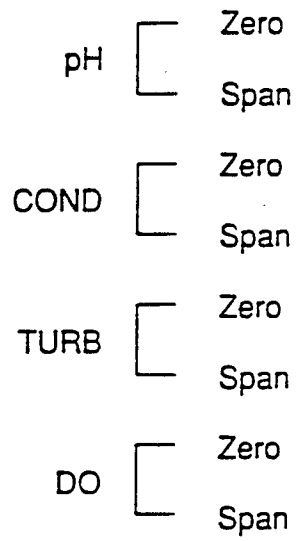


Then press the ENT Key to re-start the auto-calibration. Restart the auto-calibration beginning again with pH.

Manual (2-point) calibration procedures

For normal measurements, the 4-parameter auto-calibration described above is sufficiently accurate. However, you may wish to do a parameter-by-parameter, 2-point manual calibration of one or more of the four parameters. This is recommended either for high-accuracy measurements, especially when using the expanded readout mode. It is necessary if a new probe is being used for the *first time*.

Parameters to be calibrated manually.



pH calibration

1. Zero calibration

Wash the probe 2-3 times, using de-ionized or distilled water. Place it in a beaker of pH 7 standard solution, i.e., a neutral phosphate standard solution.



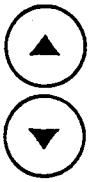
1. With the power on, press the MODE Key to put the unit into the MAINT mode.



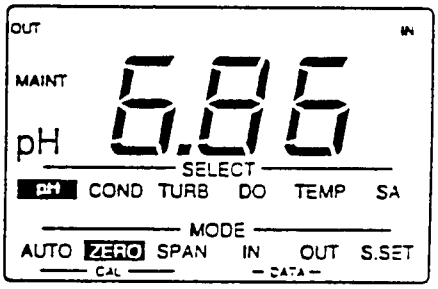
2. Press the MODE Key again to move the lower cursor to ZERO.



3. Use the SELECT Key to move the upper cursor to pH.



4. When the readout has stabilized, use the UP/DOWN Keys to select the value of the pH 7 standard solution at the temperature of the sample. Refer to Table 2 for pH values of standard solutions at various temperatures.





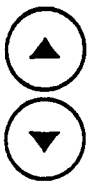
5. Press the ENT Key to complete the zero calibration for pH.

2. Span calibration

Again, wash the probe 2-3 times in de-ionized or distilled water. This time, place it in a beaker of either pH4 or pH9 standard solution.



1. Use the MODE Key to move the lower cursor to SPAN.



2. As in Step 4. above in zero calibration, when the readout has stabilized, use the UP/DOWN Keys to select the value of the standard solution (i.e., either pH4 or pH9) at the temperature of the sample. Again, refer to Table 2 for pH values of standard solutions at various temperatures.



3. Press the ENT Key to complete the span calibration for pH.

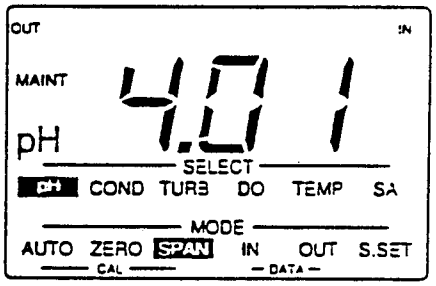


Table 2 pH values of standard solutions at various temperatures*

Temperature °C / F°	pH2[a]	pH4[b]	pH7[c]	pH9[d]	pH10[e]	pH12[f]
0 / 32	1.67	4.01	6.98	9.46	10.32	13.43
5 / 41	1.67	4.01	6.95	9.39	10.25	13.21
10 / 50	1.67	4.00	6.92	9.33	10.18	13.00
15 / 59	1.67	4.00	6.90	9.27	10.12	12.81
20 / 68	1.68	4.00	6.88	9.22	10.06	12.63
25 / 77	1.68	4.01	6.86	9.18	10.01	12.45
30 / 86	1.69	4.01	6.85	9.14	9.97	12.30
35 / 95	1.69	4.02	6.84	9.10	9.93	12.14
40 / 104	1.70	4.03	6.84	9.07	9.89	11.99
45 / 113	1.70	4.04	6.83	9.04	9.86	11.84
	1.71	4.06	6.83	9.01	9.83	11.70

a : oxalate, b : phthalate, c : neutral phosphate, d : borax,
e : carbonate, f : Sat.calcium hydroxide solution

* These pH valves are for Japanese standard solutions. Should you prefer to use different standard solutions, be save to make the proper adjustments in calibration.

COND calibration

The U-10 can measure conductivity in the range of 0-100 mS/cm. Depending on the sample concentration, however, the U-10 automatically selects the proper range out of its three possible ranges of 0-1 mS/cm, 1-10 mS/cm, and 10-100 mS/cm.

Therefore, if you are doing a manual calibration for COND, this must be done for each of the three ranges. However, since the zero point is common for all three ranges, only the three one-point span calibrations need be done separately.

Preparing the standard solution for COND span calibration

This procedure uses a potassium chloride standard solution. For greater accuracy, the solution should be freshly prepared each time. If it is unavoidable to use a stored solution, be sure to keep it tightly capped in a polyethylene or hard glass bottle. The shelf life of this solution is six months. Date-stamp the bottle for reference. Never use a KCl standard solution that has been stored for more than six months: the calibration accuracy may be adversely affected.

Use potassium chloride powder of the best quality commercially available. Dry the powder for two hours at 105°C, and cool it down, in a desiccator. Weigh out an appropriate amount of dried and cooled potassium chloride powder according to the table below. Make the potassium chloride standard solution as shown.

Table 3 Making the potassium chloride standard solution

KCl standard solution	Conductivity* mS/cm	KCl weight g	Range to be calibrated mS/cm
0.005N	0.718	0.373	0-1
0.05N	6.67	3.73	1-10
0.5N	58.7	37.28	10-100

* Temperature of solution: 25°C

To prepare the standard solution, use a 1-liter volumetric flask. First, dissolve the KCl in a small amount of de-ionized or distilled water. Then fill the flask with de-ionized or distilled water up to the 1-liter line. Finally, shake the solution to mix it thoroughly.

1. Zero calibration

Wash the probe 2-3 times, using de-ionized or distilled water. Shake the probe to remove any water droplets from the COND electrode. Then allow it dry to dry exposed to fresh air.



1. Use the MODE Key to move the lower cursor to ZERO.

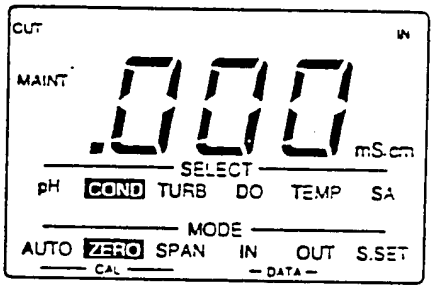


2. Use the SELECT Key to move the upper cursor to COND.





3. Use the UP/DOWN Keys to set the readout to 0.0





4. Press the ENT Key. This completes the zero calibration for COND.

2. Span calibration

Once again, wash the probe 2-3 times using de-ionized or distilled water. Following this, wash it a further 2-3 times in the KCl standard solution you have prepared. Then place the probe in a beaker of the KCl solution maintained at a temperature of 25±5°C.



1. Use the MODE Key to move the lower cursor to SPAN.





2. After the readout stabilizes, as you did for the pH calibration, use the UP/DOWN Keys to select set the value of the KCl standard solution, referring to the KCl table.



3. Press the ENT Key to complete the span calibration for this COND range.

4. Repeat this procedure for the three ranges, using each of three values of KCl standard solutions.

TURB calibration

Wash the probe 2-3 times, using de-ionized or distilled water. For the span calibration, use a prepared span solution. For the turbidity zero calibration, use de-ionized or distilled water.

Preparing the standard solution for TURB span calibration

1. Weigh out 5.0 g of hydrazine sulfate.
2. Dissolve this in 400 m*l* of de-ionized or distilled water.
3. Then weigh out 50 g of hexamethylenetetramine, and dissolve it in 400 m*l* of de-ionized or distilled water.
4. Mix these two solutions, add enough de-ionized or distilled water to make 1,000 m*l*, and stir the mixed solution thoroughly.
5. Allow this solution to stand for 24 hours at a temperature of 25±3°C.

   The turbidity of this solution is equivalent to 4000 NTUs. The shelf-life of this solution is six months; i.e., this 4,000-NTU value will remain accurate for a maximum of six months.

   Each time you carry out this calibration, it is necessary to dilute the 4,000-NTU standard solution to prepare an 800-NTU standard solution for calibration. To do this, measure out 50 m*l* of the 4,000-NTU solution into a 250-m*l* measuring flask.

   It is recommended that you use a rubber pipette aspirator for this. Then add de-ionized or distilled water up to the 250-m*l* line.

   The standard solution used here for the turbidity calibration will precipitate easily. Therefore, be sure to stir the solution thoroughly before use.

1. Zero calibration

Wash the probe thoroughly 2-3 times using de-ionized or distilled water. Shake off excess water droplets, and then place it in a beaker of de-ionized or distilled water.



1. Use the MODE Key to move the lower cursor to ZERO.



2. Use the SELECT Key to move the upper cursor to TURB.



3. After the readout has stabilized, set it to 0.0, using the UP/DOWN Keys.



4. Press the ENT Key to complete the zero calibration for TURB.

2. Span calibration

Wash the probe thoroughly, using de-ionized or distilled water. Shake off excess water droplets. Then place it in a beaker of the 800-NTU solution you have prepared for this purpose.

1. Stir this 800-NTU span standard solution thoroughly.



2. Use the MODE Key to move the lower cursor to SPAN.

3. After readout has stabilized, i.e., about 60 to 90 seconds, set the readout to "800" NTU, which is the value for this standard solution.



4. Press the ENT Key to complete the span calibration for TURB.

DO calibration

A zero standard solution is used for the DO zero calibration. An oxygen-saturated span solution is used for the DO span calibration.

Preparing the standard solution

Zero solution

Add about 50g of sodium sulfite to 1,000 m*l* of water (either de-ionized water or tap water will do). Stir this mixture thoroughly until completely dissolved.

Span solution

Put 1 or 2 liters of water in a container (either de-ionized water or tap water will do). Use an air pump to bubble air through the solution until it is oxygen-saturated.

1. Zero calibration

Wash the probe 2-3 times in tap water, and place it in the zero standard solution.



1. Use the MODE Key to move the lower cursor to ZERO.



2. Use the SELECT Key to move the upper cursor to DO.



3. After the readout has stabilized, set it to 0.0, using the UP/DOWN Keys.



4. Press the ENT Key. This completes the zero calibration for DO.

2. Span calibration

Wash the probe 2-3 times in tap water, and put it in the span standard solution.

1. First, be sure the U-10 is set for fresh water readings. To do this, set the S.SET Sub-Mode to 0.0%.



2. Then, use the MODE Key to move the lower cursor to SPAN.

3. After the readout has stabilized, while slowly moving the probe up and down in the solution, set the readout value to the appropriate DO value for the temperature of this solution. For DO values at various temperatures, refer to Table 4.



4. Press the ENT Key to complete the span calibration for DO.

Table 4 Amounts of saturated dissolved oxygen in water at various temperatures, salinity = 0.0%

Temperature °C	DO in mg/l	Temperature °C	DO in mg/l
0	14.16	21	8.68
1	13.77	22	8.53
2	13.40	23	8.39
3	13.04	24	8.25
4	12.70	25	8.11
5	12.37	26	7.99
6	12.06	27	7.87
7	11.75	28	7.75
8	11.47	29	7.64
9	11.19	30	7.53
10	10.92	31	7.42
11	10.67	32	7.32
12	10.43	33	7.22
13	10.20	34	7.13
14	9.97	35	7.04
15	9.76	36	6.94
16	9.56	37	6.86
17	9.37	38	6.76
18	9.18	39	6.68
19	9.01	40	6.59
20	8.84		

Section 4

Data Storage and Printout

The U-10 can store up to 20 sets of data, 120 data points, of the values measured for each of the six parameters: pH, COND, TURB, DO, TEMP, and SALINITY. Values stored in memory can be recalled to the readout as desired.

If a printer is connected to the U-10 printer port, whenever a Data-Set is either stored in memory or recalled to the readout, it can also be simultaneously output to the printer.

Store 36
Recall 38
Delete 40
Printing out 41

Storing data

MODE

1. Press the MODE Key to put the U-10 in the MAINT mode.

MODE

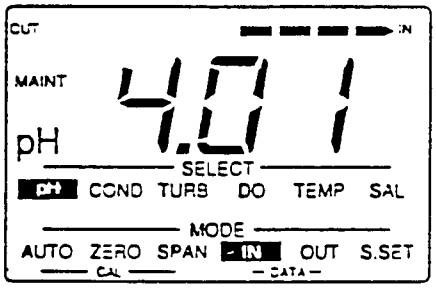
2. Continue to press the MODE Key to move the lower cursor to IN, the *Input* Sub-Mode.

SELECT

3. Use the SELECT Key to move the upper cursor to the parameter you wish to see on the readout.

ENT

4. When the readout stabilizes on a value, press the ENT Key. This will automatically input the set of six parameters for this measurement into memory.



The readout will first show the Data-Set No. for about two seconds. At the top right-hand corner, a dashed arrow points to IN, showing that data is being input. Then each parameter is automatically read into memory, one-by-one from pH to salinity. The upper cursor skips along to show this. If a printer is connected, these six values will also be printed out at the same time.

The upper cursor then returns to pH, with the U-10 still in the IN Sub-Mode.

ENT

5. You may now continue and input another set of data: simply press the ENT Key again.

The Data-Set No. will automatically advance one digit, and the next set of six parameters will be read into memory in the same manner. This procedure can be repeated for up to a total of 20 Data-Sets.

If 20 Data-Sets have been read into memory, the storage capacity is full and no more data may be input. The U-10 will beep three times to indicate the memory is full.



6. To return the readout to the previous setting in the MEAS mode, press the MODE Key again.

Recalling data

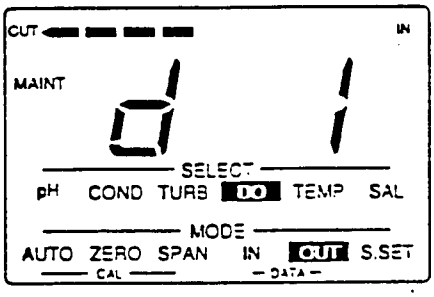
MODE

1. Press the MODE Key to put the U-10 in the MAINT mode.

MODE

2. Continue to press the MODE Key to move the lower cursor to OUT, the *Output* Sub-Mode. The readout will show d.1, meaning Data-Set No. 1.

   At the top left-hand corner, a dashed arrow points to OUT, showing that data can be output now to the readout.



▲ ▼

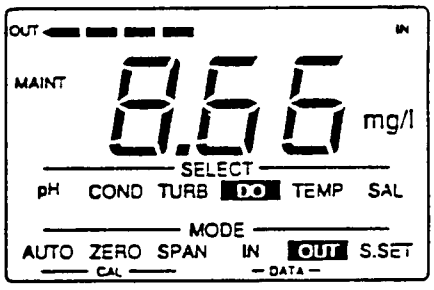
3. Use the UP/DOWN Keys to display the Data-Set No. of the values you wish to recall.

SELECT

4. Use the SELECT Key to move the upper cursor to the parameter you wish to view.

ENT

5. Press the ENT Key to display the data on the readout.

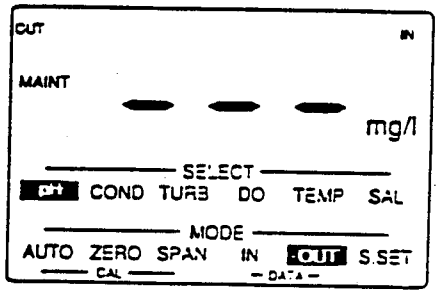


If a printer is connected, all six parameters in this Data-Set will also be printed out at the same time.

ENT

6. When the ENT Key is pressed again, the next Data-Set No. is displayed in order, i.e., *d2*, if two data sets are in memory. At this point, you can either press the ENT Key again to view the contents of this Data-Set, or you can use the UP/DOWN Keys to go up or down to another Data-Set No.

   If a particular Data-Set is empty, three dashes appear on the readout.



MODE

7. To return the readout to the previous setting in the MEAS mode, press the MODE Key again.

Deleting data

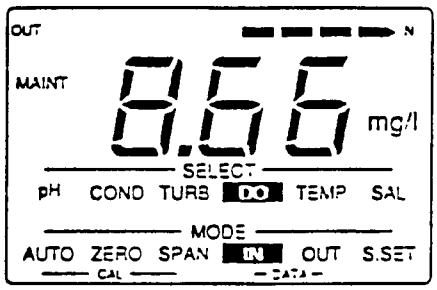
Set the U-10 as if you were going to input data:

MODE

1. Press the MODE Key to put the U-10 in the MAINT mode.

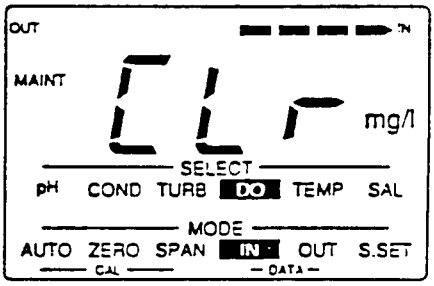
MODE

2. Continue to press the MODE Key to move the lower cursor to IN, the Input Sub-Mode.



CLR

3. Then, to erase all the data from all the Data-Sets in memory, press the CLR Key. The readout will show the message CLr for about two seconds.

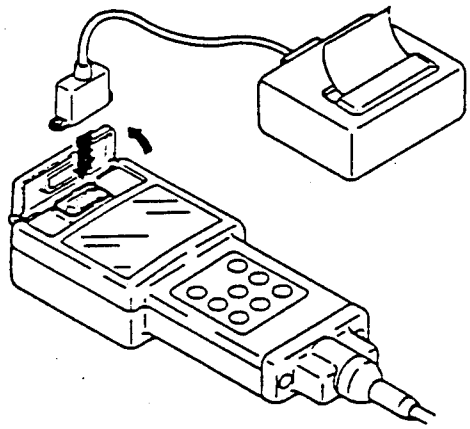


Be careful!
You cannot delete individual Data-Sets. The CLR Key always erases all data from memory.

Printing out data

If a printer is connected to the U-10 printer port, whenever a Data-Set is either stored in memory or recalled to the readout, it is also simultaneously output to the printer.

The U-10 printer port is a standard Centronics parallel port. To connect a parallel printer to the U-10: Open the rubber printer-port cover, located directly over the readout on the main unit, and connect the printer cable.



Note:
When a printer is not being used, disconnect the cable from the U-10 printer port, and close the cover tightly.

- **Sample printout**

```
NO. 1 DATE  /  /
 pH      5.0
 COND    1.5    mS/cm
 TURB  390      NTU
 DO      0.5    mg/l
 TEMP   23      °C
 SAL     3.8    %
NO. 2 DATE  /  /
 pH      3.1
 COND    1.3    mS/cm
 TURB  270      NTU
 DO      0.7    mg/l
 TEMP   25      °C
 SAL     0.1    %
NO. 3 DATE  /  /
 pH      3.1
```

Section 5

Daily Maintenance and Troubleshooting

For accurate measurements and prevention of malfunction, routine careful maintenance of the U-10 is important. In particular, failure to maintain the sensors properly can lead to serious trouble or incorrect measurements. The U-10 is provided with error-code functions for the ready detection of potential problems.

Error codes 44
Normal probe maintenance 47
Replacing faulty sensors 49
Replacing a faulty probe 50

Error Codes

The U-10 has an easy-to-understand error message function so you can spot trouble readily. Error codes are displayed on the readout and the unit will beep if an error occurs.
(Note that if you press an incorrect sequence of keys, the unit will beep three times to indicate you have pushed the wrong key.)

Error Code	Cause	Action
Bad battery Er 1	• Defective or low battery	• Replace battery
Failure in main unit Er2	• Malfunction of memory backup IC	• Push POWER Key to turn the U-10 ON again. If this error code is still displayed, contact your Horiba dealer for repair or replacement.
Zero-calibration error Er3	*for all parameters*	
	• Poor connection in probe-to-main-unit cable	• Connect the cable securely.
	• Water in one of the sensor sockets	• Dry out the sensor sockets.
	• Temperature of sample exceeds maximum scale of U-10	• Replace the probe.
	for pH	
	• Contaminated pH sensor.	• Clean the pH sensor.
	• Improper concentration of KCl internal solution in pH reference sensor	• Replace the pH reference sensor KCl internal solution.
	for COND	
	• Contaminated COND sensor	• Clean the sensor, using tooth brush and neutral detergent.
	for TURB	
	• Contaminated or defective LED sensor	• Clean out the tube containing the LED turbidity sensor, using test tube brush and neutral detergent. Never use an abrasive detergent cleanser for this.

Error Code	Cause	Action
	for DO • Broken DO sensor membrane.	• Check the LED turbidity sensor. If it defective, the entire probe must be replaced. Check DO sensor. If defective, replace.
Span-calibration error Er 4	*for all parameters* • Poor connection in probe-to-main-unit cable • Water in one of the sensor sockets • Temperature of sample exceeds maximum scale of U-10	• Connect the cable securely. • Dry out the sensor sockets. • Replace the probe.
	for pH • Contaminated pH sensor. • Improper concentration of KCl internal solution in pH reference sensor	• Clean the pH sensor. • Replace the pH reference sensor KCl internal solution.
	for COND • Contaminated COND sensor	• Clean the sensor, using tooth brush and neutral detergent.
	for TURB • Contaminated or defective LED sensor	• Clean out the tube containing the LED turbidity sensor, using test tube brush and neutral detergent. Never use an abrasive detergent cleanser for this. • Check the LED turbidity sensor. If it defective, the entire probe must be replaced.

Error Code	Cause	Action
Span-calibration error		
Er4	*DO Auto-calibration*	
	• Broken DO sensor membrane.	• Check DO sensor membrane. If defective, replace.
	• Excessive difference between DO sensor temperature and atmospheric temperature.	• Leave DO sensor in atmosphere for 30-60 min.
	DO aqueous solution calibration	
	• Broken DO sensor membrane.	• Check DO sensor membrane. If defective, replace.
	• Contaminated electrode.	• Clean the electrode using a soft brush, taking care not to scratch membrane.
	• Insufficient agitation of solution.	• Agitation solution thoroughly.
Memory full		
Er5	• Data-sets for 20 samples are already in memory.	• To delete all data from memory, put the U-10 in the IN Sub-Mode mode and press the CLR Key.
Printer error		
Er6	• Jammed printer paper.	• Eliminate jamming of printer paper.
	• Poor cable connection .	• Replace the cable.
	• Wrong printer.	• Use proper parallel Centronics printer.
	• Defective printer.	• Replace the printer as necessary.

Normal probe maintenance

Washing the turbidity sensor

The sensor is a glass tube. Wash out the tube and remove stains carefully, using tap water and a test tube brush.

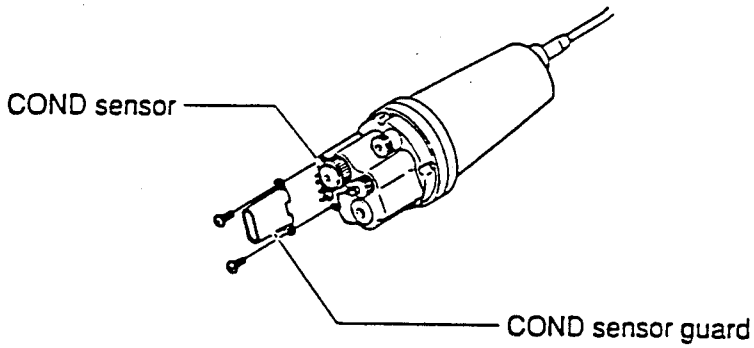
Be careful not to scratch the inside of the glass tube. Never use abrasive detergents or cleansers.



Cleaning the conductivity sensor

Remove COND sensor guard, and carefully use a soft brush to clean off any dust from the sensor unit.

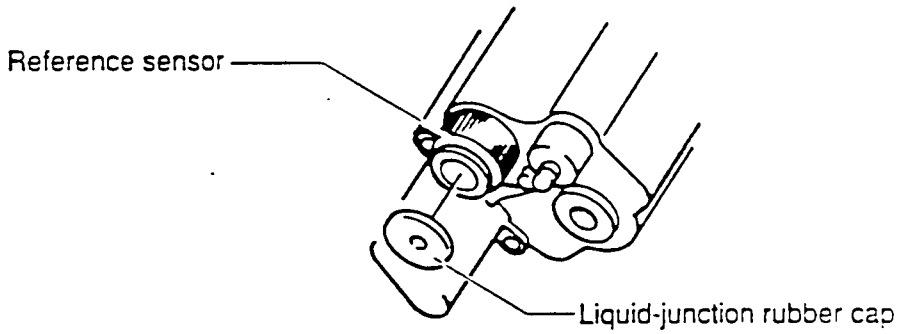
Be sure to replace the COND sensor guard before taking measurements.



Recharging the reference sensor with reference solution

Recharge the reference sensor with reference solution about once every two months, as follows.

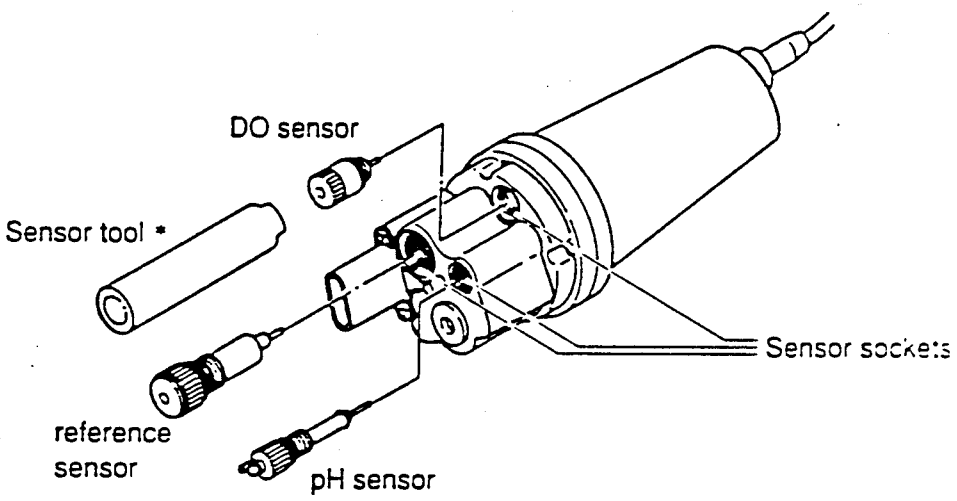
1. Remove the liquid-junction rubber cap from the reference sensor, and pour out the old solution.
2. Fill the reference sensor completely with new reference solution. Make sure there are no air bubbles.
3. Replace the liquid-junction rubber cap.
4. Carefully wash off all excess reference solution from the probe.



Replacing faulty sensors

Three of the U-10's sensors are replaceable: the *pH sensor*, the *reference sensor*, and the *DO sensor*.
These may be replaced as follows.

1. Wipe off any water droplets from the probe.
2. Remove faulty sensor.
3. Insert the new sensor carefully with your fingers.
4. Be careful not to let the sensor sockets get wet.

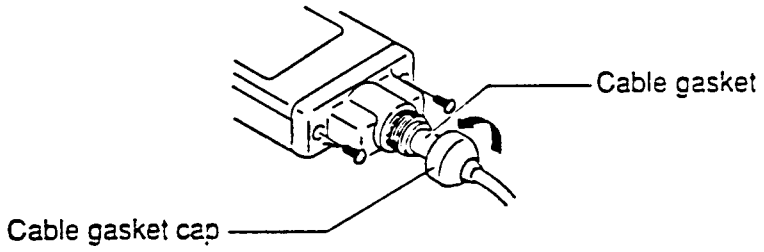


* When replacing the DO sensor, use the sensor tool provided as an accessary.

Replacing a faulty probe

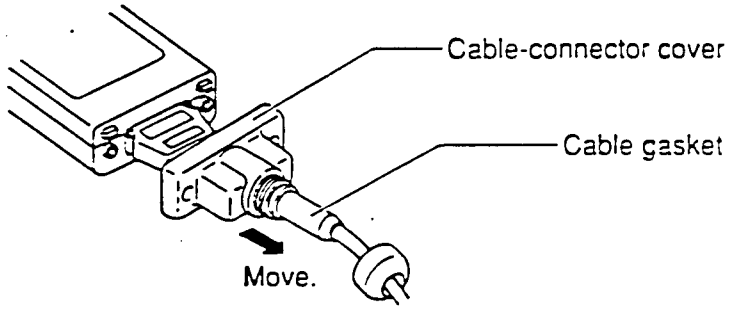
Disconnect the cable from the main unit

1. Loosen the cable gasket cap, and remove cap from gasket.



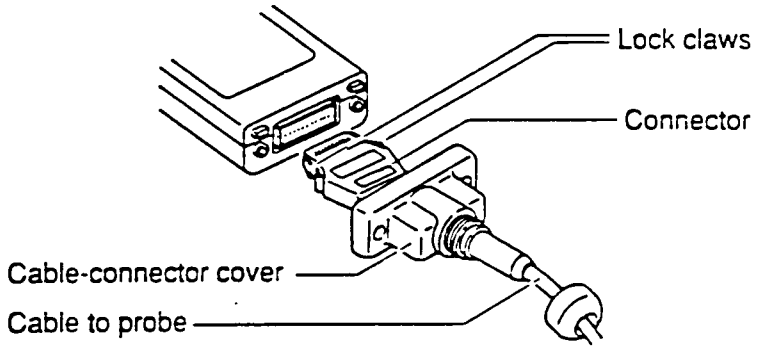
2. Slide back the gasket.

3. Back off the two screws on the cable-connector cover.



4. Slide off the cable-connector cover to expose the connector lock claws.

5. Press lock claws on both sides with your fingers to release the connector. Pull out the connector from the main unit.



Connect the new probe

1. Insert the connector until it clicks.
2. Re-attach the cable-connector cover to the main unit.
3. Slide the cable gasket toward the cable-connector cover, and screw on the cable gasket cap.

Before you use a new probe for the first time, it is necessary to calibrate it manually for all four parameters. Refer to Section 3, "Calibrating the U-10," for instructions on manual calibration.

Section 6

Reference Materials

The following descriptive information is provided for a better understanding of the U-10 Water Checker and its functions.

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Reference Materials

Conductivity (COND)

Principle of measurement

Conductivity is an index of the flow of electrical current in a substance.

Salts dissolved in water are separated into cations and anions. Such a solution is called an electrolytic solution. An electrolytic solution has the property of allowing the flow of current according to Ohm's law. This property is referred to *ionic conductivity*, since current flow is due to ion movement in an electrolytic solution. Metals, on the other hand, allow the flow of current by means of electrons. This property is called *electronic conductivity*, which is distinguished from ionic conductivity.

A cube 1 cm on each side, as each shown in Fig. 1, is used to demonstrate an electrolytic solution. Two electrode plates are placed on opposite sides, and the cube is filled with a solution. If the resistance between these two electrode plates represented by r (Ω), the conductivity of the solution L (S.cm^{-1}) is $L=1/r$. S, stand for *Siemens*, a unit of measurement of conductance.

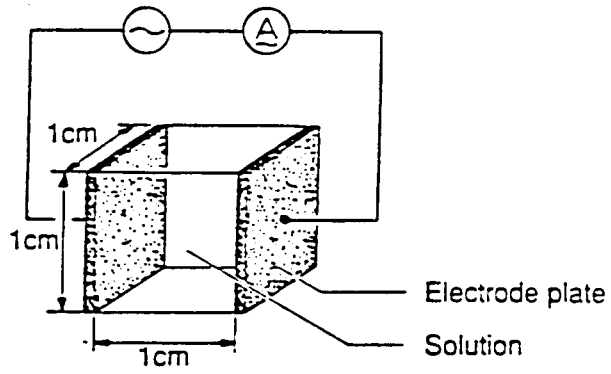


Fig. 1 Definition of conductivity

The most general method for measuring conductivity is based on the above principle, and is called the 2-electrode method. In this method, to take a measurement, it is necessary to allow flow of alternating current between the two electrode plates.

If direct current is sent between them, it will cause causes electroplating or decomposition, i.e., polarization; this results in inaccurate measurement of conductivity.

Even a flow of alternating current will also cause a certain amount of polarization. Measures must be taken to minimize the effect of this polarization, such as the application of platinum black plating to the electrode surfaces. In spite of such measures, however, the effect of polarization cannot be neglected in conductivity measurements of a high-conductivity solution. This makes accurate measurement difficult. Furthermore, depositions or stains on the electrode surfaces can cause a large apparent resistance, also making accurate conductivity measurement difficult.

The U-10 Water Checker has adopted the 4-electrode method to overcome these disadvantages of the the 2-electrode method. As shown in **Fig. 2**, the U-10 Water Checker uses two voltage-detecting electrodes and two voltage-applying electrodes, for a total of total four electrodes.

The voltage-detecting electrodes are for detecting AC voltage, and the voltage-applying electrodes are for applying AC voltage.

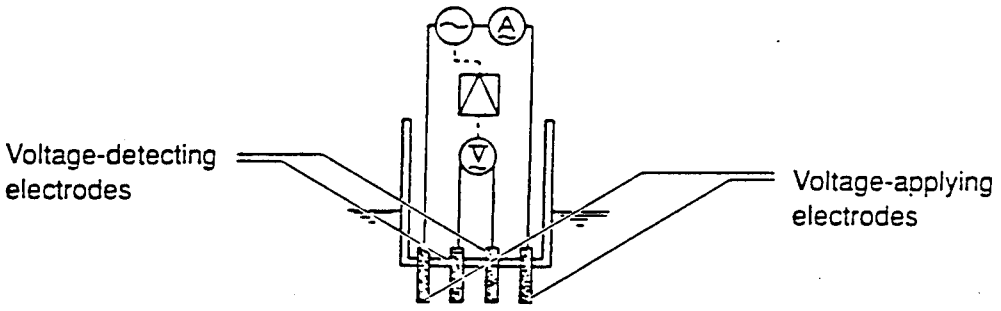


Fig. 2 Principle of the 4-electrode method

Let us assume that the current, *I(A)*, flows in a sample of conductivity *L* -- under automatic control of the voltage-applying electrodes -- so that the voltage at the voltage detecting-electrodes, *E(V)*, remains constant at all times. Then, the resistance of the sample, *R* (Ω), across the voltage-detecting electrodes is *R=E/I*. The resistance, *R*, of the sample is inversely proportional to its conductivity, *L*. That is, the conductivity, *L*, is proportional to the current, *I*. Accordingly, calibration of a standard solution of known conductivity, *Ls*, enables calculation of conductivity of a sample according to the formula *L=Ls(I/Is)* from the relation of *L:Ls=I:Is*.

Even in the 4-electrode method, polarization occurs, since *AC* current flows in the voltage-applying electrodes. The voltage-detecting electrodes are, however, free from the effects of polarization, since they are separated from the voltage-applying electrodes, and furthermore, current flow is negligible. Therefore, the 4-electrode method is an excellent method to enable measurement of conductivity covering a very high range.

Temperature compensation

In general, the conductivity of a solution varies largely with its temperature. The conductivity of a solution depends on ionic conductivity, described earlier. As the temperature rises, conductivity becomes higher, since ions begin to move more actively.

The temperature coefficient shows the change in % of conductivity per °C, with a certain temperature taken as the reference temperature. This is expressed in units of %/°C. The temperature coefficient assumes the premise that the conductivity of a sample changes linearly according to temperature. Strictly speaking, with actual samples, however, conductivity changes along a curve.

Furthermore, these curves form different shapes depending on the type of sample. In the ranges of smaller temperature changes, however, samples are said to have the temperature coefficient of 2%/°C; this holds for most samples, except in certain special cases. The U-10 Water Checker uses an automatic temperature conversion function to calculate conductivity at 25°C at a temperature coefficient of 2%/°C, based on the measured value of the temperature. Results are displayed on the readout. The U-10's temperature conversion function is based on the following formula.

$$L_{25}=Lt/\{1+0.02(t-25)\}$$

Where,

L_{25}: Conductivity of solution converted to 25°C (value displayed on U-10)

t: Temperature of solution at time of measurement (°C)

Lt: Conductivity of solution at t (°C)

Turbidity (TURB)

Principle of measurement

From among several types of turbidity-measuring methods available, the U-10 uses the light-absorption-scattering method, shown in Fig. 3.
Irradiation of a beam of light onto a sample brings about separation of the beam into (1) the light transmitted by the solution and (2) the light scattered by turbidity components in the sample. In the light-absorption-scattering method, the intensity of both transmitted light and the scattered light are measured using separate receptors, and the turbidity is obtained based on the ratio of the two.

With the U-10, the light source is a pulse-lighting infrared-emission diode. The scattered light is measured at a point 30° offset from the light source. This light-absorption-scattering method has several advantages, including the fact that (1) the actual color of the sample fluid has little effect on the measurement of turbidity, (2) fluctuations in light quantity from the light source are easily compensated for, and (3) it allows the U-10 to be operated with relatively low power consumption.

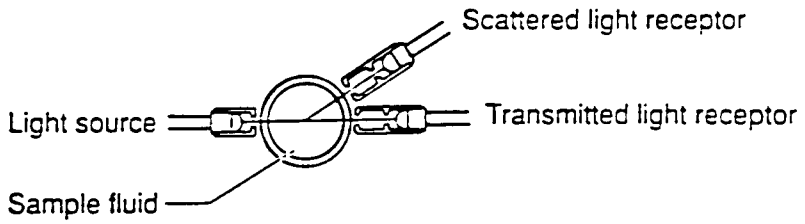


Fig. 3 Principle of the light-absorption-scattering method

NTUs (Nephelometric Turbidity Units)

For the calibration of turbidity, the U-10 uses a standard formazine solution.

Kaolin has been the conventional standard solution for many years. However, the composition of kaolin solutions often vary depending on the country of origin, and turbidity varies with the degree of purify. Furthermore, there is often individual error in preparing the solution. Kaolin is thus known for bringing about very large disparity in measurement results. As a turbidity standard solution, formazine standard solution is now increasingly being used internationally. In view of these facts, the U-10 uses the formazine standard solution for its calibration of turbidity.

In addition, the U-10 uses *NTUs* as the unit of turbidity. Other units conventionally used are formazine degrees and *FTUs*. When the measurement of turbidity is based on the phenomenon of scattering, the use of *NTUs* is preferable, and in fact, these are being used increasingly. It should be noted that *NTUs* used as turbidity units of the formazine standard solution are equivalent to formazine degrees and to *FTUs*.

Salinity (SAL)

The U-10 is designed to measure salinity as well as the other parameters.

Note that the "salinity" referred to here is the salinity of sea water. There is a constant relation between conductivity and salinity at certain temperatures.

Therefore, if data on the conductivity and temperature are available, the corresponding salinity is known. In other words, the salinity measurement of the U-10 is based on the principle of calculating the salt content, making use of the measured values of conductivity and temperature.

Note carefully. therefore, that measured results of all substances whose conductivity is detected are displayed as salinity. For example, the measured result is displayed as NaCl concentration, even if in fact the sample component is, for example, hydrochloric acid (HCl).

Temperature measurement in the U-10

Temperature changes in water have extreme biological effects on the life cycles of fish and seaweed, as well as on that of the minute organisms that cleanse the water of organic pollutants. In general, as the temperature of water increases, the amount of oxygen dissolved in the water decreases and there is a tendency for the amount of pollutants to increase.

The U-10 uses a thermistor to measure temperature. A thermistor also measures the change in electrical resistance accompany changes in temperature; these changes in resistance are measured by the thermistor and are used to calculate the temperature.

This temperature data is used by the U-10 in four different ways: (1) in pH temperature compensation, (2) in conductivity temperature conversion, (3) in the calculation of salinity, and (4) in dissolved-oxygen temperature compensation.

Dissolved-Oxygen (DO)

Principle of measurement

The "DO" referred to here means the concentration of oxygen dissolved in water.

Dissolved oxygen is essential to self-purification of rivers and seas, as well as to living of aquatic organisms and fish. Therefore, measurement of DO is vital in both waste-water treatment and water quality control.

Fig. 4 shows the principle of measurement using a DO sensor.

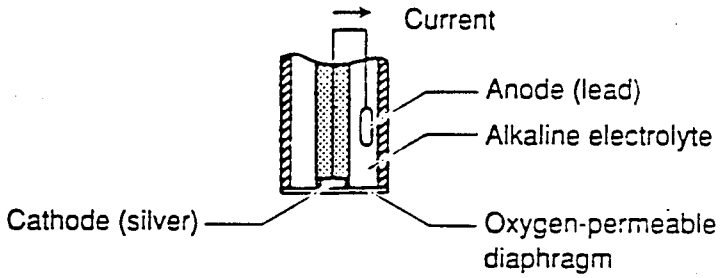


Fig. 4 Principle of DO sensor

A noble metal (silver) is fitted closely to an oxygen-permeable diaphragm to make the cathode; a base metal (lead) is used as the anode. Both are immersed in an alkaline electrolyte with the anode-to-cathode external circuit complete. Oxygen diffusing through the oxygen-permeable diaphragm causes a reduction reaction at the cathode; this allows flow of current in the external circuit:

$$O_2 + 2H_2O + 4e^- = 4OH^-$$

At the anode, oxidation reaction occurs as follows:

$$2Pb = 2Pb^{2-} + 4e^-$$

The current is proportional to the quantity of oxygen diffusing through the oxygen-permeable diaphragm. Accordingly, measurement of the current makes the DO in a sample known.

The DO measuring method based on this principle is called the *diaphragm-electrode method*. This method allows convenient measurement of DO, especially when compared with chemical-analysis methods, which need complicated pre-treatment to eliminate the effects of oxidizing or reducing substances.

DO correction for salinity

When a solution and air are in contact and in complete equilibrium (saturated), DO:C[mg/*l*] in the solution, and the oxygen partial-pressure:Ps[MPa] in air are in the following relation:

$$C = Ps/H$$

H[*MPa*/(mg/*l*)] is referred to as Henry's constant, which depends on the composition of the solution. In general, *C* becomes smaller as the salinity in the solution increases, since *H* becomes larger.

A DO sensor is intended to detect *Ps* in theabove expression. Therefore, the DO measurement of an aqueous solution containing salt would be in error if the DO electrode were standardized either on air-saturated pure water or on air. To settle this problem, it is necessary to correct the DO reading based on the salinity of the sample.

Conventional DO meters make this salinity correction by inputting a known salinity value. This poses no problems if the salinity of the sample is known. In practice, however, the salinity of the sample usually not known, unless measured by a device such as the U-10. Therefore, until now, DO meters have not been practical, even if they were provided with a salinity-correcting function.

The U-10 is capable of measuring the salinity of a sample and automatically correcting the DO reading for the amount salinity measured in the sample.

pH

Principle of measurement

The following is the basic equation for obtaining pH:

$$pH = -\log aH^-$$

Where,

aH- : the activity of hydrogen ions

If a thin glass membrane is used to separate two liquids of differing pH values, an electric current will be generated in proportion to the difference between these two pH values. The value of this electrical current, *E(V)* , is shown by the folowing Nernst equation:

$$E = 0.0001983T\,(pH_i - pH_o) + e$$

Where,

T : the temperature of the liquids

pH_i : the pH of the internal liquid (i.e., inside the glass membrane)

pH_o : the pH of the sample liquid (i.e., the iliquid outside the glass membrane)

e : the irregular electrical potential difference

A conventional glass electrode for measuring pH contains a fluid inside the electrode with a pH of 7. If this is used to measure a sample that also has a pH value of 7, the irregular electrical potential difference will be close to 0V. Consequently, when a glass pH electrode is immersed in an acid solution, a positive electric current is generated; when it is immersed in an alkaline solution, a negative electric current is generated.

For actual use in a pH meter, a pair of referance electrodes with extremely stable characteristics is used. These are configured as shown in **Fig. 5**. As shown in **Fig. 5**, it can be seen that the electrical potentials generated in the internal electrodes, *E'* and *E"*, are canceled out by each other, so that the only electrical potential difference obtained is the current generated by the glass membrane, *E*, through the resistance of the membrane, *r*, and transmitted to terminals *G* and *R*.

In pH meters a readout of this voltage between the two terminals is obtained by increasing it with an amplifier. In actual practice, the pH meter is first calibrated using a standard reference solution of known pH, then the pH of the sample liquied is measured.

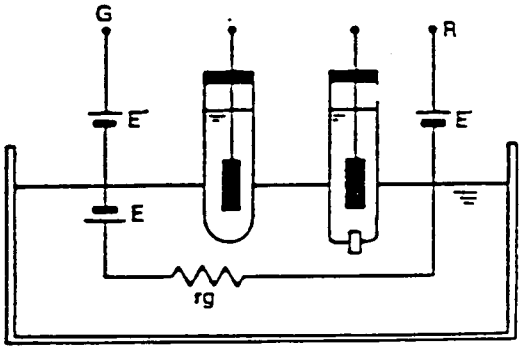


Fig. 5 Principle for Measuring pH

Specifications

pH

Principle	Glass electrode
Range	pH0-14
Resolution	Standard : 0.1pH
	Expanded : 0.01pH
Repeatability	±0.05pH
Temperature compensation	0°-50°C
Readout	LCD
Calibration	1-point auto (Zero)
	Manual 2-point

Temperature of the sample

Principle	Thermistor
Range	0°-50°C
Resolution	Standard : 1°C
	Expanded : 0.1°C
Repeatability	±0.3°C
Temperature compensation	—
Readout	LCD
Calibration	—

DO

Principle	Membrane galvanic cell
Range	0-19.9mg/*l*
Resolution	Standard : 0.1mg/*l*
	Expanded : 0.01mg/*l*
Repeatability	±0.1mg/*l*
Temperature compensation	0°-40°C
Readout	LCD
Calibration	1-point auto (Span)
	Manual 2-point

Conductivity

Principle	4-electrode
Range	0-100ms/cm
Resolution	Standard: 0-1mS/cm : 0.01mS/cm 0-10mS/cm : 0.1mS/cm 10-100mS/cm : 1mS/cm Expanded: 0-1mS/cm : 0.01mS/cm 0-10mS/cm : 0.1mS/cm 10-100mS/cm : 1mS/cm
Repeatability	±1%/F.S. within each measurement range
Temperature compensation	0°-50°C
Readout	LCD
Calibration	1-point auto (Span) Manual 2-point

Turbidity

Principle	Scattered/Transmitted light
Range	0-800 NTU
Resolution	Standard : 10 NTU Expanded : 1 NTU
Repeatability	±3%/F.S.
Temperature compensation	—
Readout	LCD
Calibration	1-point auto (Zero) Manual 2-point

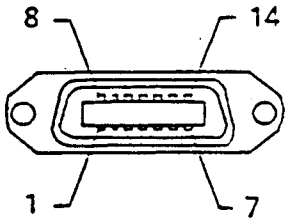
Salinity

Principle	Conversion based on conductivity
Range	0-4%
Resolution	Standard : 0.1% Expanded : 0.01%
Repeatability	±0.1%
Temperature compensation	0°-30°C
Readout	LCD
Calibration	—

Common specification

Data storage	Max. 20 samples
Printer output	Centronics specs.
Power	Battery 9V, with auto power-off function
Operating temperature	0°-45°C
Weight	Main unit: Approx. 400g Probe, with 2-m cable: Approx. 800g

- Output connector pin layout



Pin No.	Name	Pin No.	Name
1	STB	8	DB_8
2	DB_0	9	DB_7
3	DB_1	10	Not used
4	DB_2	11	BUSY
5	DB_3	12	Not used
6	DB_4	13	Not used
7	DB_5	14	GND

Parts List

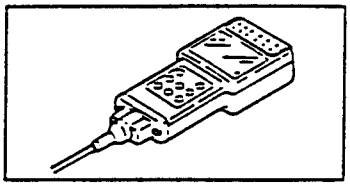
The following expendable parts are available from Horiba for the U-10 Water Checker.

Part name	Model No.	Details	Order P/No.
Probe			9037-0047-00
pH sensor	#7112		9037-0048-00
DO sensor	#7542	Special design for the U-10	9037-0049-00
pH reference sensor		Special design for the U-10	9037-0050-00
Liquid junction (1 pair)	#7210		9037-0051-00
KCl internal solution for ph reference sensor	#330	3.3 mol / *l* gel type, 250 m*l*	9037-0052-00
pH standard solution pH2	100-2		9003-0015-00
pH standard solution pH4	100-4	Special design for U-10 automatic calibration	9003-0016-00
pH standard solution pH7	100-7		9003-0017-00
pH standard solution pH9	100-9		9003-0018-00
Calibration beaker		Special design for U-10 automatic calibration	9037-0053-00

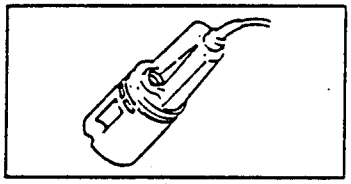
Unpacking the U-10

The following items are included with your U-10 Water Quality Checker.
When you unpack the probe and main unit, confirm that all the other accessories are included as well.

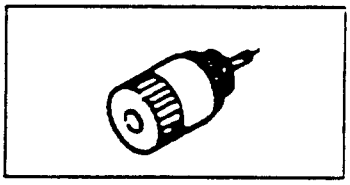
- Main unit



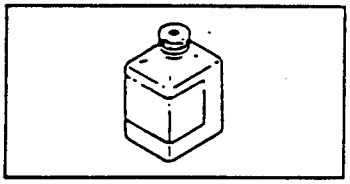
- Probe



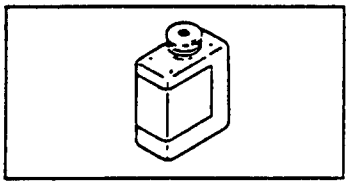
- Dissolved-Oxygen (DO) sensor: 1 unit (boxed)



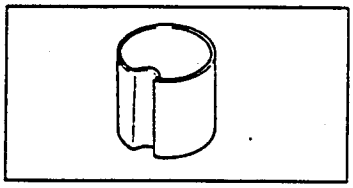
- Standard solution (Phthalate pH standard solution): 1 500 m*l* bottle



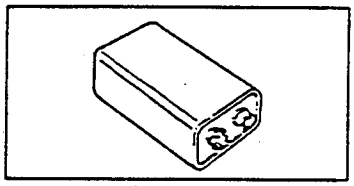
- KCl internal solution for reference sensor: 1 250m*l* bottle



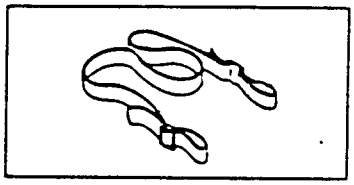
- Calibration breaker



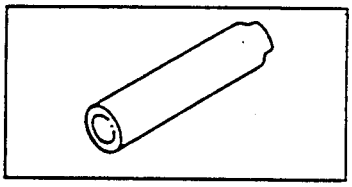
- 9V battery



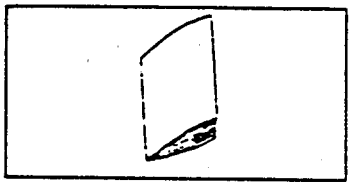
- Carrying strap for main unit strap



- DO sensor tool

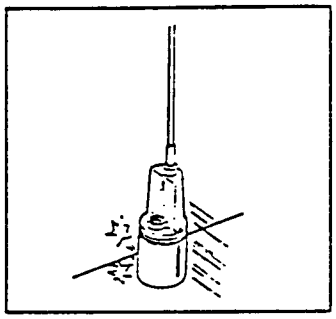


- This Instruction Manual

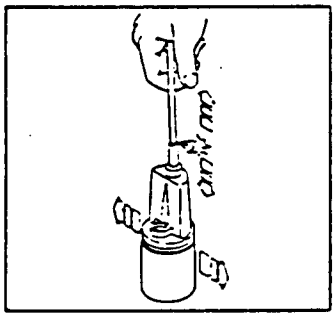


Precautions when using the U-10

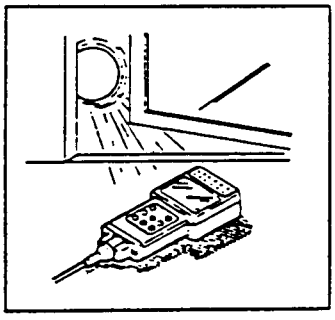
The U-10 Water Quality Checker is carefully designed for trouble-free operation. However, it is a sophisticated electronic instrument, and it can be damaged if used carelessly. Please read the following precautions and observe them when using your U-10 Water Checker.



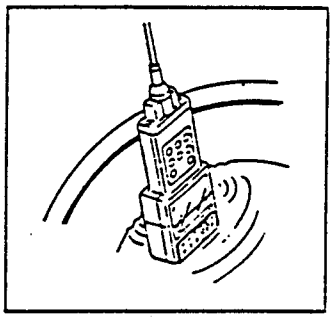
- Do not swing or jerk the probe by its cable.
- Do not subject the cable connector to stress by pulling or stretching it.



- Do not drop the either the U-10 probe or main unit. Never subject either component to sudden impact.

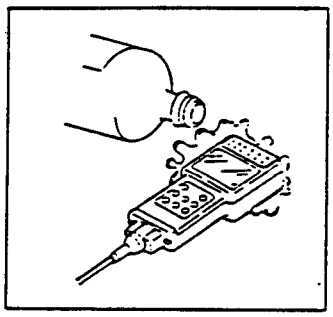


- Do not store the U-10 where may be exposed to prolonged direct sunlight. Never leave the U-10 inside a vehicle with the windows closed.



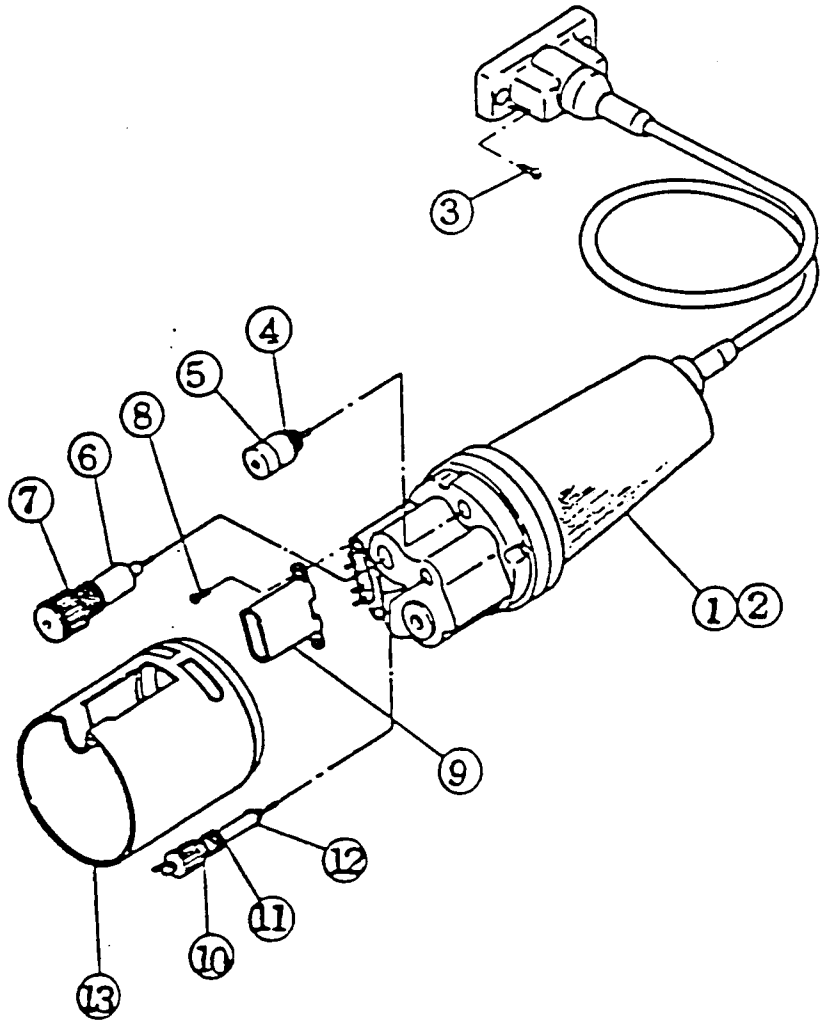
- Never immerse the main unit directly in water.

  The main unit is water-resistant and may be safely used in the rain; however, it is not of waterproof construction. Immersing the main unit in water or any other liquid can damage the internal electronic circuits



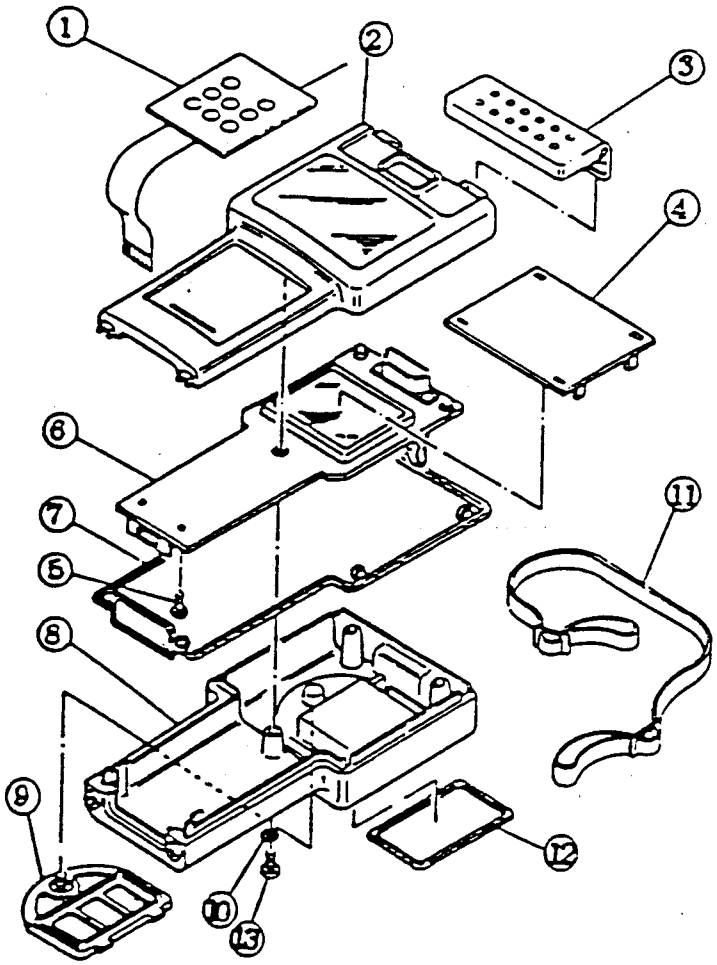
- Never allow any organic solvent to come in contact with either the probe or the main unit. This includes such liquids as methylethyl ketone (MEK) and acetone.

  (The probe is made of polyphenylene ether (PPE); the main unit case is acrylic resin.)



PARTS LIST U-10 SENSOR Drawing No. S410157-03

No.	HII P/N	Description
1.	362177	Sensor assembly with 2 meter cable
2.	362283	Sensor assembly with 10 meter cable
3.	362193	Screw, panhead - J1SB1111 M3X 6(S-ZN3)
4.	362194	O-ring - NOK S 11.2(SI)
5.	362174	DO Tip - U-10 sensor
6.	362175	Reference Tip - U-10 sensor
7.	362195	O-Ring, S18 - NOK S18 FPM
8.	362196	Screw, panhead - M3-6L SUS304
9.	362197	Cond guard - U-10 sensor
10.	360249	O-Ring, P9 - B2401 P9 FPM
11.	362176	PH Tip - U-10 sensor
12.	380169	O-Ring , P5 - B2401 P5 FPM
13.	362198	Protecting tube - U10 Sensor



PARTS LIST U-10 METER for Drawing No. S410156-03

No.	HII P/N	Description
1.	362181	Sheet Switch - Water checker U-10
2.	3612182	Case assembly, top - U-10
3.	362183	PRT Cover - U-10Meter
4.	362184	Window, LCD - U-10 H357887-01
5.	362185	Tapping screws, M3X 6(S-ZN3)
6.	362186	PCB Assembly
7.	362187	Case packing - U-10 meter
8.	362188	Case assembly, bottom
9.	362189	Cover assembly, BAT - U-10
10.	362190	Seal washer - U-10 Meter
11.	362191	Meter strap - U-10 20X1300 T=1.8
12.	362192	Battery packing - U-10 meter
13.	362193	Screw, panhead J1SB1111 M3X 6(S-ZN3)

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7E

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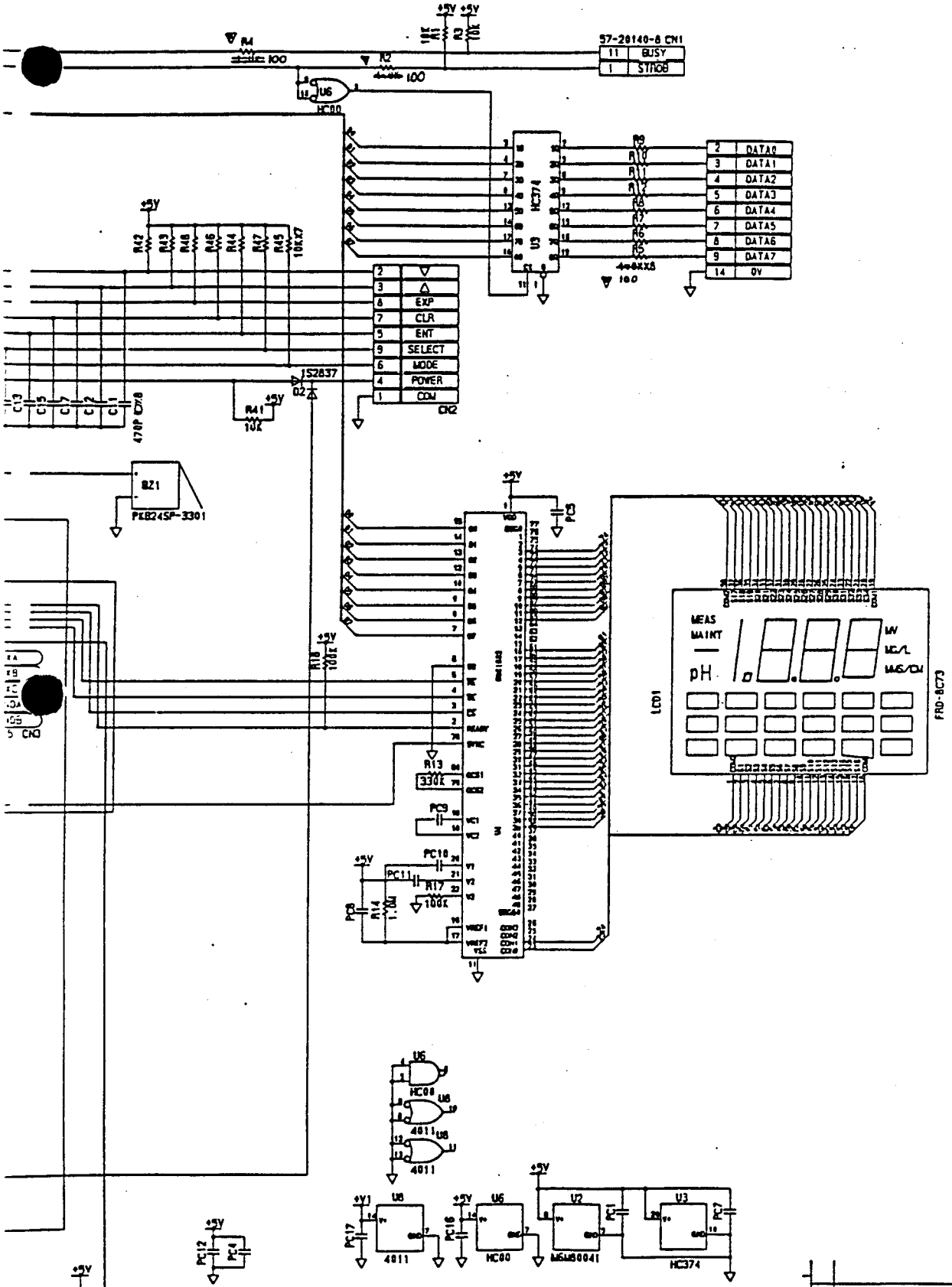
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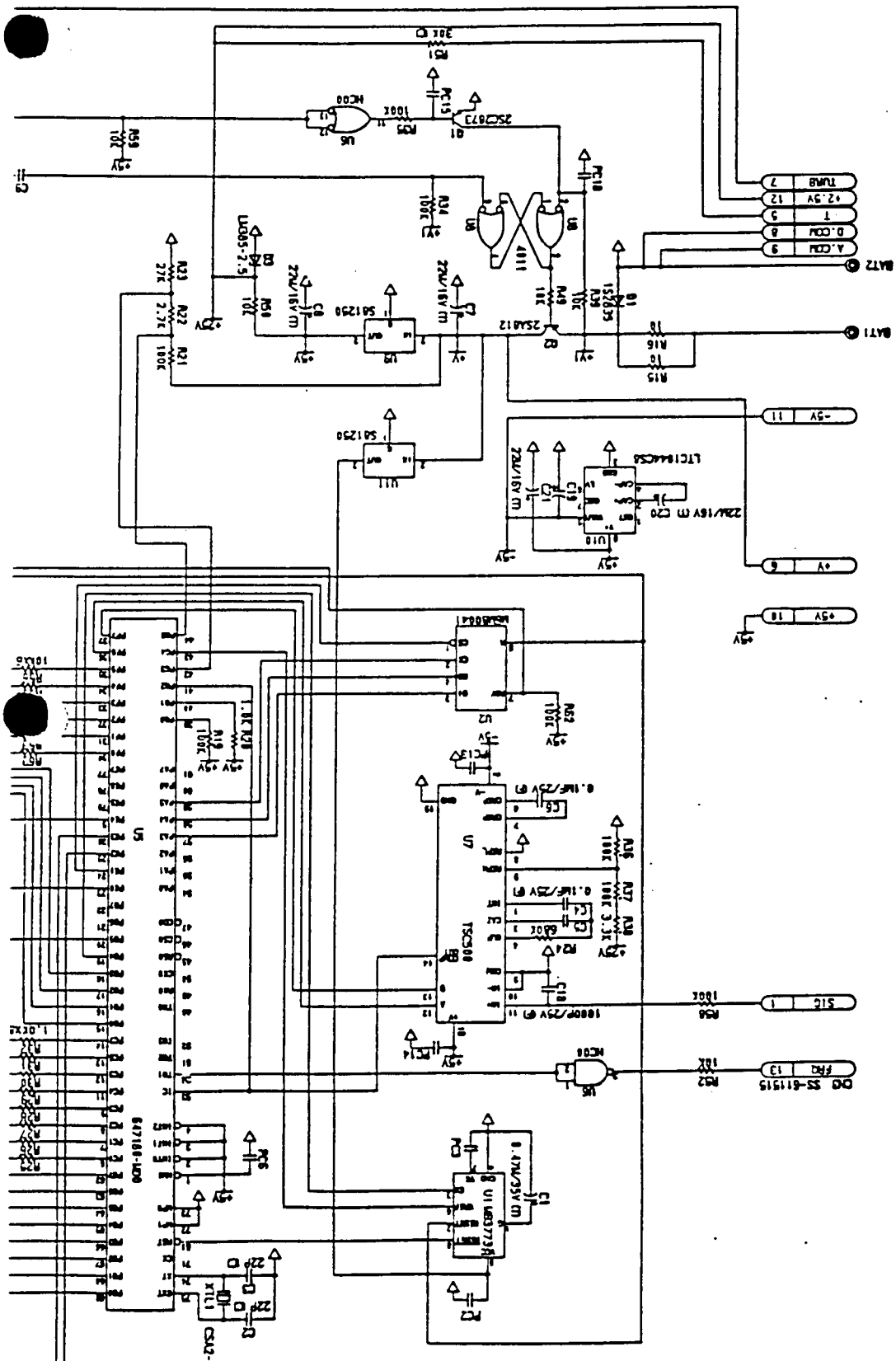


NO.	SPEC.	PARTS.NO.	NOTES

NAME U-10 (メイン) U-10

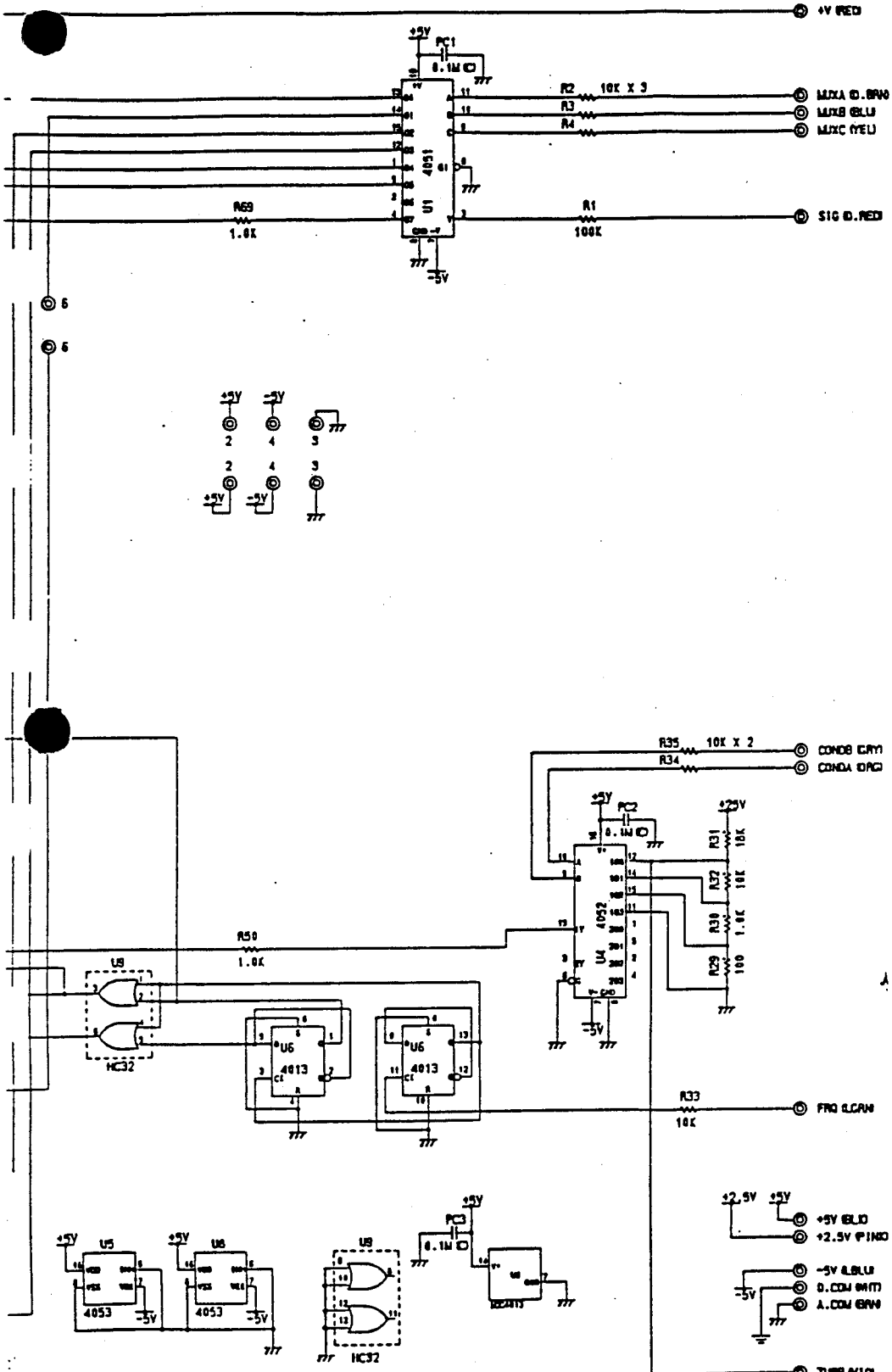
CIRCUIT DIAGRAM

REVISED			SCALE	CAD DRAWING NO.
DRAWN	CHECKED	APPROVED	~	A. V234424
J. Hasegawa	T. Hasegawa	H. Ohkawa	DATE	



CAD DRAWING NO. V234424 A.

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NO.	SPEC.	PARTS NO.	NOTES

NAME UPRE-1, UPRE-2 U-10

CIRCUIT DIAGRAM

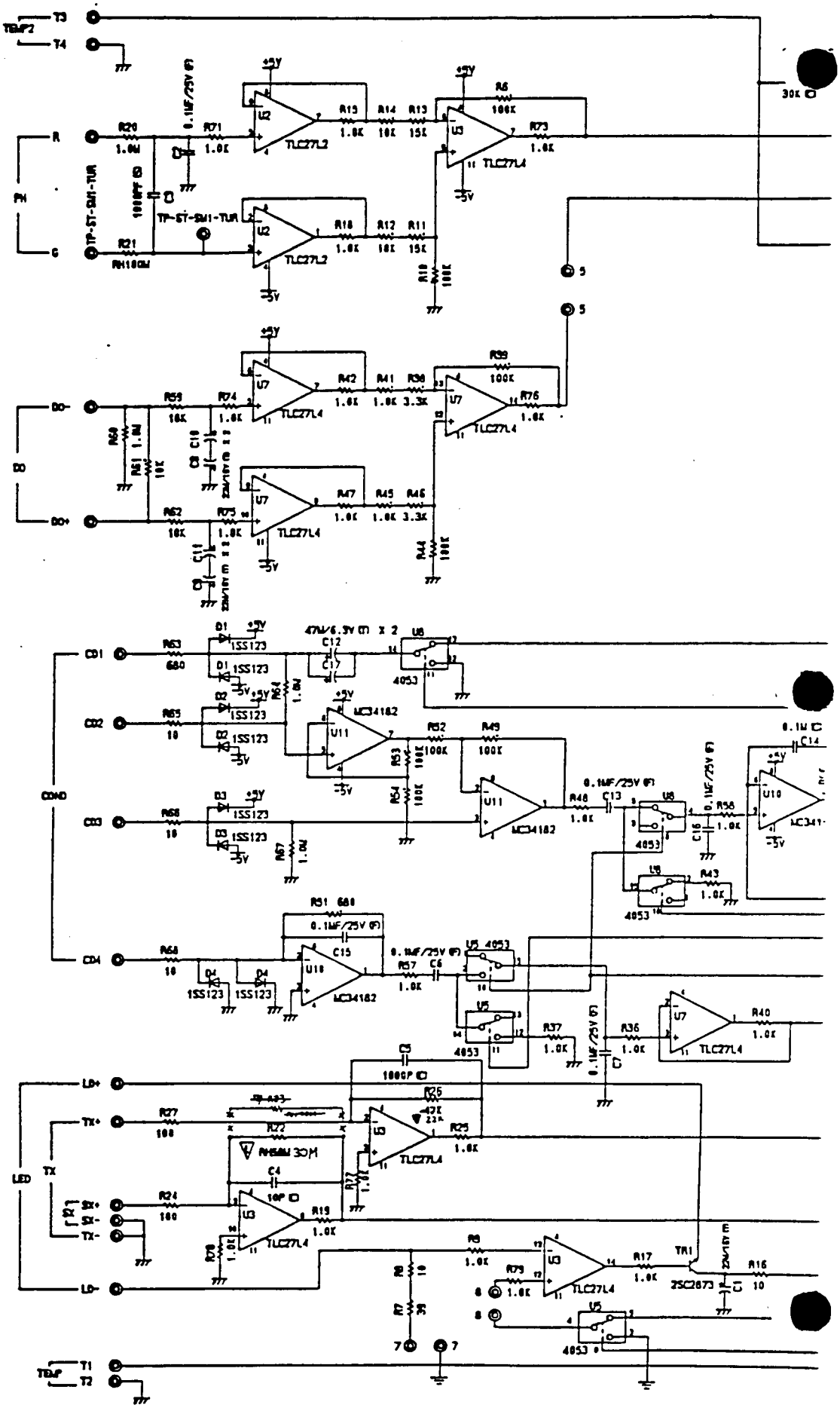
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SCALE ~

DATE 1996. 7. 12

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ORION

230A, 250A, 290A
Instrument Manual

HAZCO Services, Inc.

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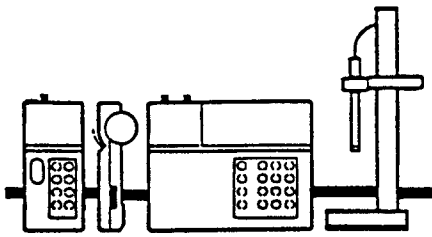
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Chapter I. Introduction

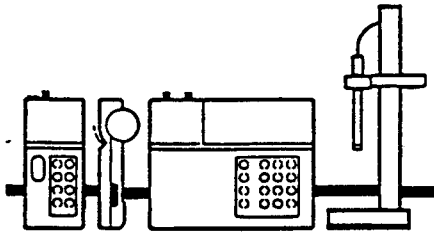
Orion's Portable Meters are compact, battery operated and microprocessor controlled for all measurement needs. All meters feature a custom digital LCD display which simultaneously displays temperature along with measurement results. Ideal for field, plant, or laboratory use each meter is lightweight and designed to fit comfortably in the hand. A flip stand allows easy use in the lab.

The model 230A is a pH meter which features autocalibration and automatic temperature compensation.

The model 250A has all the features of the 230A plus a millivolt and relative millivolt mode, and RS232-C output for use with the Orion 900A printer or other serial peripherales.

The model 290A adds concentration measurements and an internal datalogging function to make a truly versatile meter for pH or ISE analysis.

This manual contains instructions for all three meters. See the calibration and measurement section for details on your particular meter. The general information section contains descriptions of hardware which pertain to all meters. The Temperature Compensation and Troubleshooting sections contain information applicable to all meters.



Chapter II. General Information

General Description

Orion's Portable Meters have a large custom LCD display and keypad with tactile and audible feedback. Designed for one-handed operation each features an electrode clip to attach electrode directly to meter and molded grip area. (Electrode clips included in Portable Meter Starter Kit, Orion Cat. No. 0PBLSK)

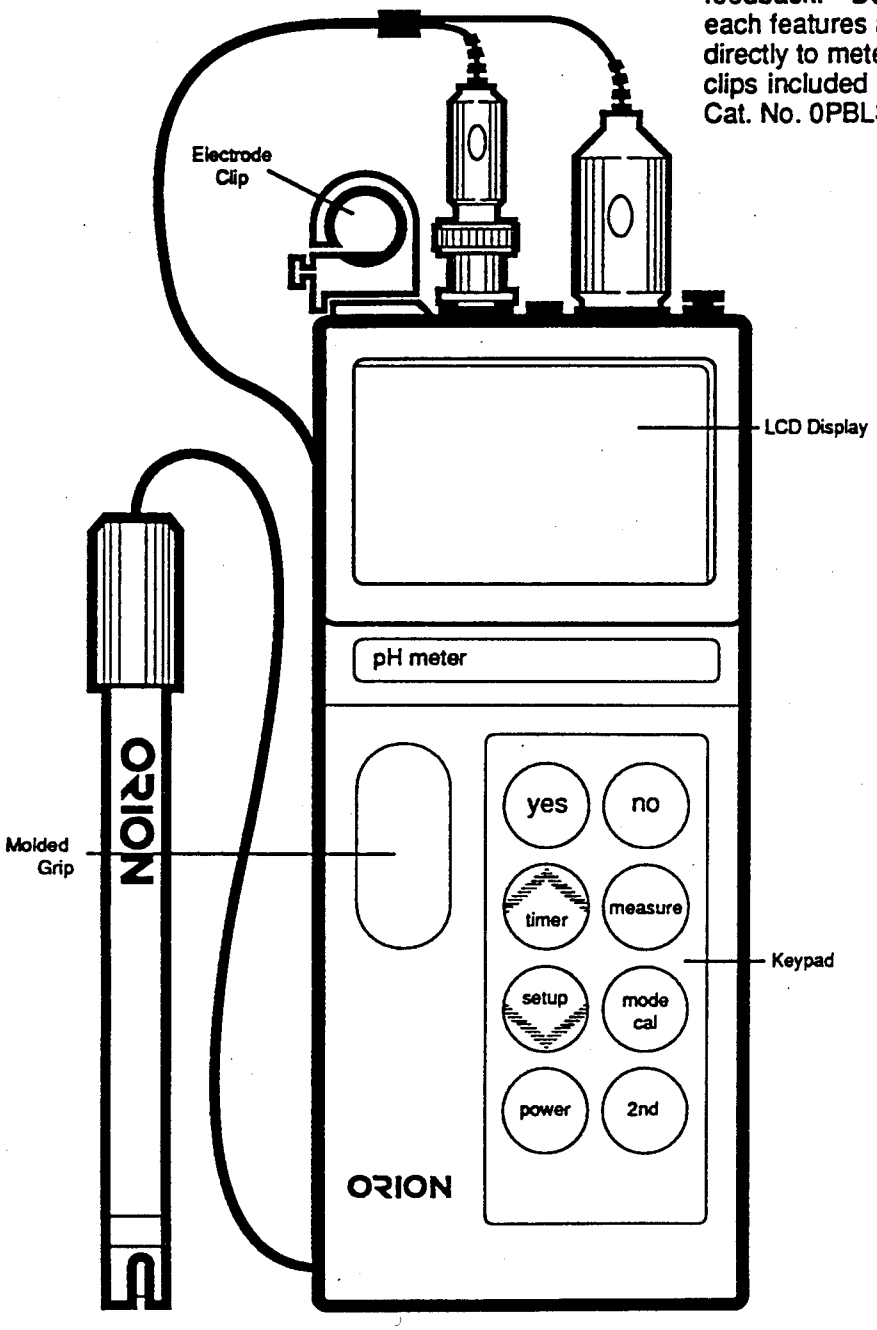


Figure 1

Top Panel

1. **Electrode Connections:** Accepts BNC connecter from combination or sensing electrode(s) (1A), A separate pin tip (1B) accepts a reference electrode.

2. **ATC Probe Jack:** Accepts thermistor type Automatic Temperature Compensation probe with DIN connecter.

3. **Line Converter Jack:** Accepts an AC line converter for use without batteries.

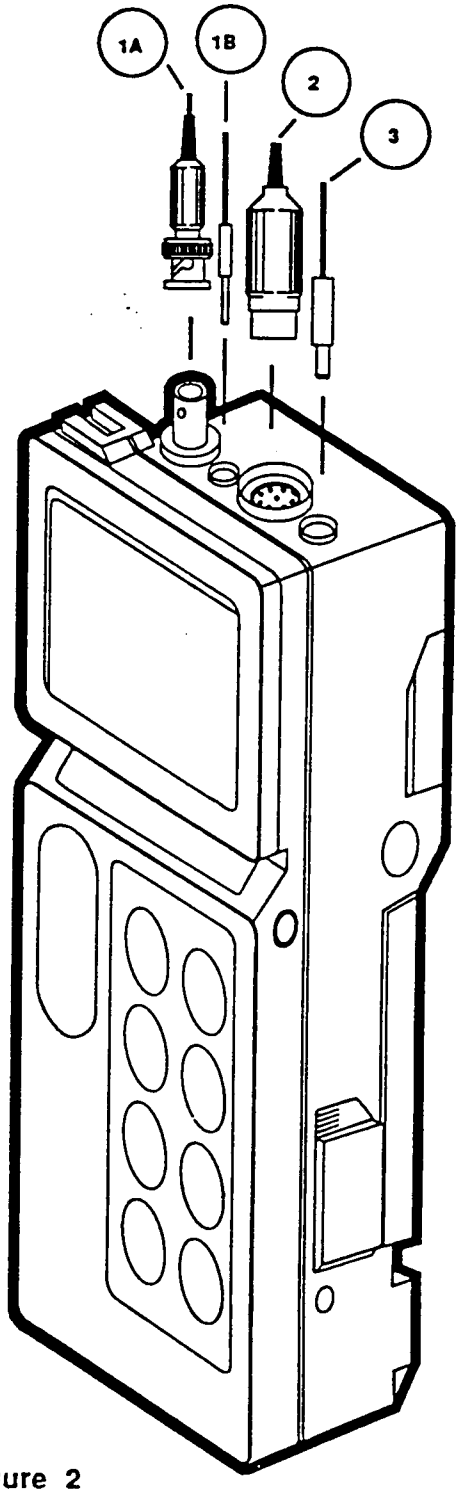


Figure 2

Rear Panel

1. **Battery Compartment:** Accepts one 9 V battery, either alkaline or lithium.
2. **Setup Menu Label:** Identifies setup parameters and corresponding I.D. codes.
3. **Electrode Clip:** Attaches an electrode directly to the meter for one handed operation.
4. **Electrode Storage Compartment:** Stores electrode in between measurements. Compartment can contain electrode storage solution to keep electrode moist and ready for use.
5. **Cable Management:** The cable(s) from the electrode(s) will slide under the left side of the storage compartment.

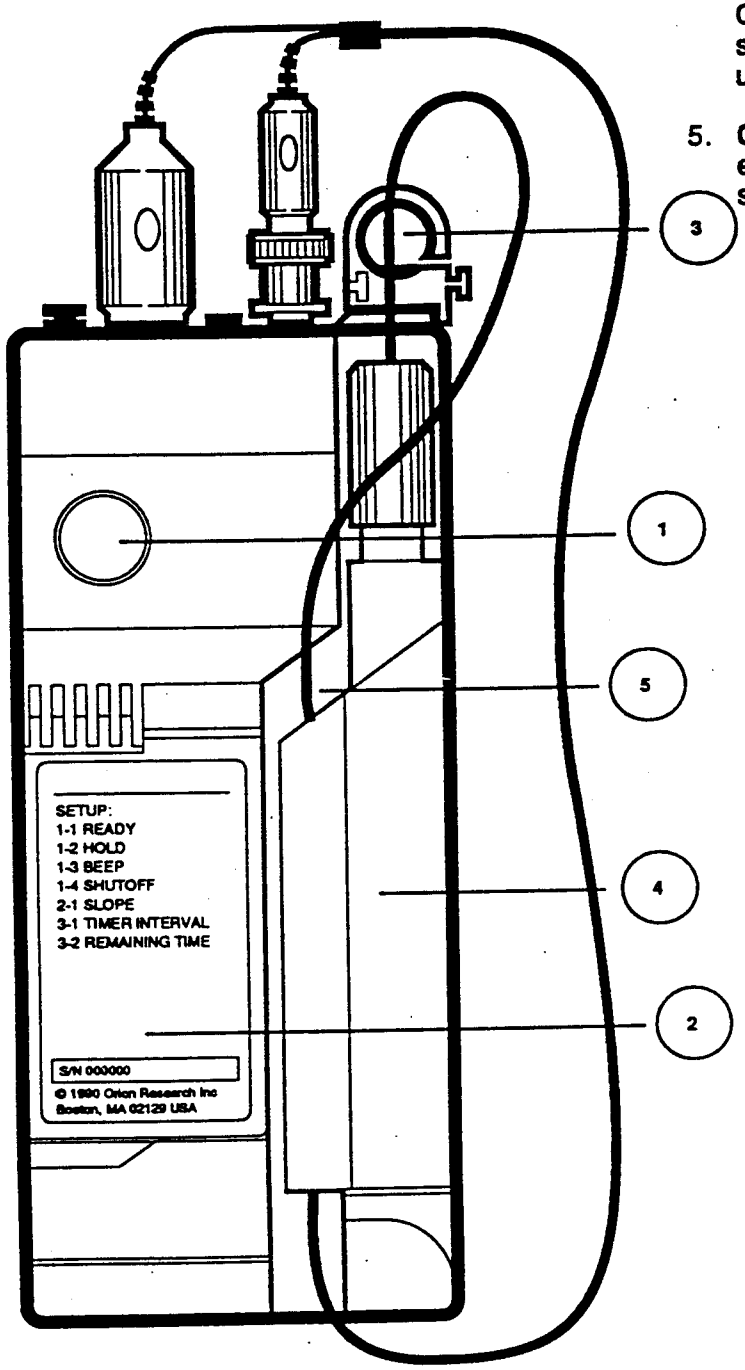


Figure 3

Electrode Clip

The electrode clip allows easy one-handed dip and read operation. Two or more electrodes may be joined together and then attached directly to the meter.

1. Slide electrode clip onto electrode.
2. If using two electrodes slide second electrode clip into opening on the first electrode clip.
3. Attach electrode(s) to meter by sliding clip from left to right into meter until securely seated.

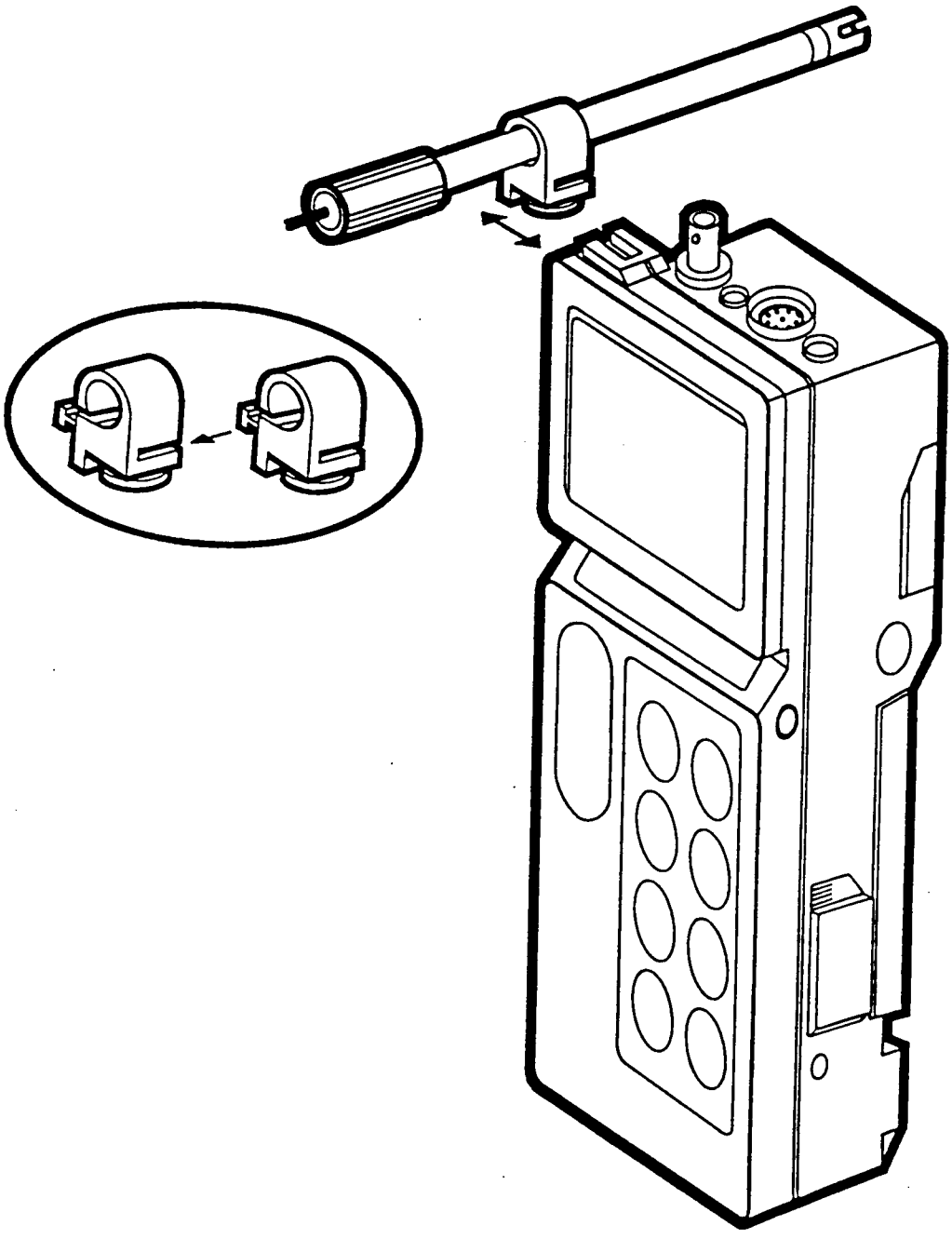


Figure 4

Electrode Storage Compartment

The electrode storage compartment provides a convenient place for electrode storage between measurements and in the field. Add a few drops of pH electrode storage solution Orion Cat No. 910001 to the storage compartment cap to ensure your electrode will be ready for use. The entire compartment is removable for easy cleaning.

The left hand side of the compartment (when the meter is turned over and facing down) provides a space for the electrode cables. Slide the cable underneath the edge of the compartment.

1. With the meter facing down slide the compartment to the right to remove.
2. Rinse with distilled or deionized water.
3. Replace compartment by lining up pins on meter with slides on electrode storage compartment then slide to the left until firmly in place.

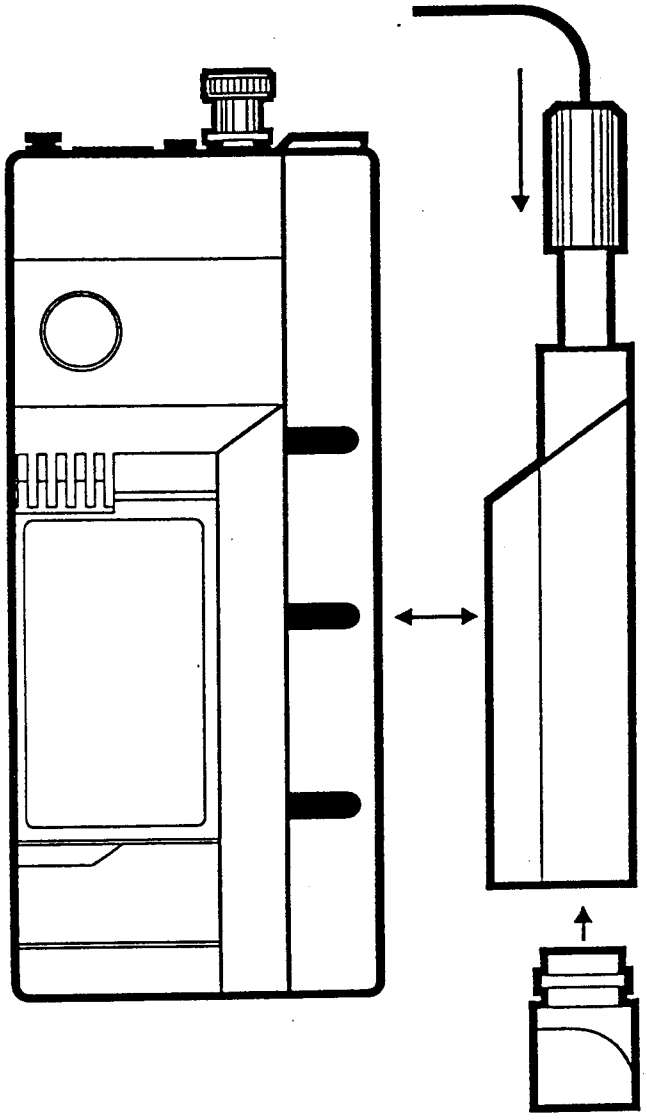


Figure 5

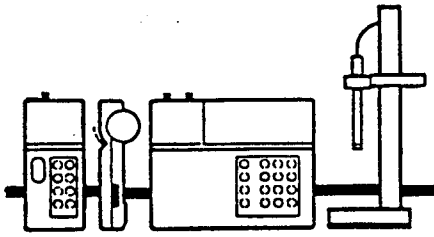
RS232-C Interface

Both the Model 250A and 290A have an RS232-C interface for use printers or serial peripherales.

The **Model 250A** has a **one way Interface** for communication with the Orion 900A printer or other device. The instrument can send (but not receive) information via this port.

The **Model 290A** has a **bi-directional Interface** for communication with printers or computers. The instrument can send or receive information using this port.

The **Model 900A** printer is battery operated and attaches directly to either meter making a compact package for field measurement and recording. See printer manual, part no. 213377-001



Chapter III. Instrument Setup

Power Source

The Orion Portable Meters operate on either one 9 V alkaline battery, one 9 V lithium battery, or an AC line adapter. The estimated battery life is 50 hours of continuous operation for an alkaline battery and 100 hours of continuous operation for a lithium battery. Insert battery as described below or plug in the line adapter.

Battery Installation

1. Open battery compartment by pushing closure up. This is most easily accomplished by using a coin (such as a dime) and inserting it into the slot on the side of the meter.

2. Insert battery pushing gently until it locks in place. Ensure polarity is correct as shown in the battery compartment.

3. Replace battery compartment cover.

NOTE: After replacing the battery recalibrate. Without the battery installed or meter plugged into line power the meter loses calibration data and other information in memory. To prevent loss of data in the field turn meter off if the low battery signal comes on. Check and replace batteries regularly prior to field use.

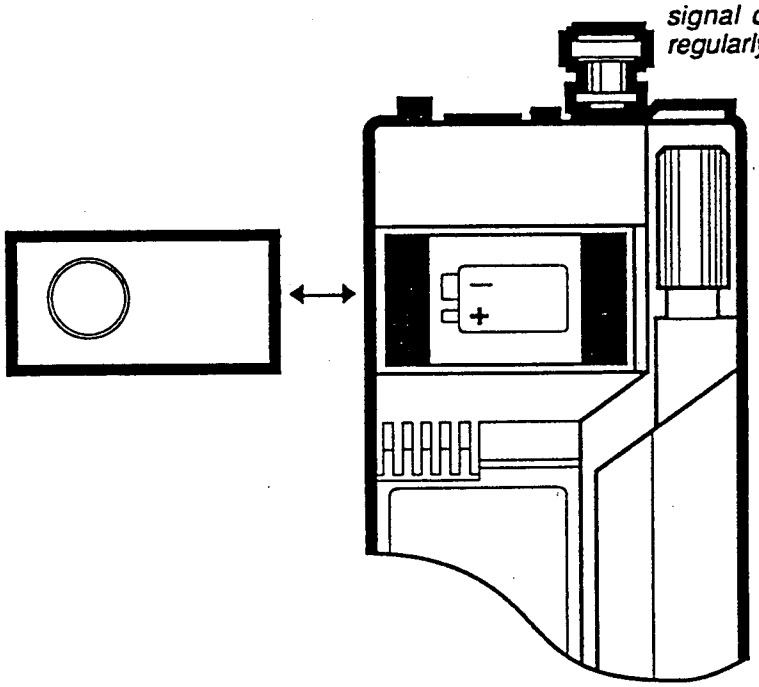


Figure 6

Power Up and Checkout

1. Attach BNC Shorting Plug (Orion Cat. No. 090045) to BNC connector on top of meter.

2. Press power key to turn meter on.

3. If *battery* indicator remains on replace battery or use line adapter.

4. Press the POWER key to turn meter off.

5. Press the POWER key and *quickly* press the YES key to start the self-test. (Alternatively, press and hold the yes key while pressing the power key). The instrument automatically performs electronic and hardware diagnostic tests. See the explanation in the self-test section of the trouble shooting guide, page 47, for a more detailed explanation.

6. After code 7 a "0" will appear on the display. Press each key (the numeric digits will change).

   Note: All keys must be pressed within 10 seconds to complete test 7.

7a. **Model 230A**: After the keypad test the meter will shut off.

7b. **Model 250A or Model 290A**: After the keypad test the meter will turn off then back on again. After completing the self-test the meter will resume normal operations

8. If any problems are found during self-test the meter will display the operator assistance code until acknowledged. Check the trouble-shooting section on page 47.

Electrode Connections

(See Figure 7.)

Orion Triode

Attach Orion TRIODE electrode by sliding the BNC connector onto the sensor input then push down and turn clockwise to lock into position. Slide the DIN connector into the ATC jack until it is firmly seated.

Other Electrodes

Attach electrodes with BNC connectors to sensor input by sliding connector onto input, pushing down and turning clockwise to lock into position. Connect reference electrodes with pin tip connectors by pushing connector straight into reference input.

Note: If using a combination electrode with a BNC connector the reference pin-tip is not used.

ATC Probe

Attach the ATC probe to the ATC jack by sliding the connector straight on until firmly in place. The connector has a special sealing mechanism to prevent moisture from penetrating the meter which is engaged when the connector is properly attached.

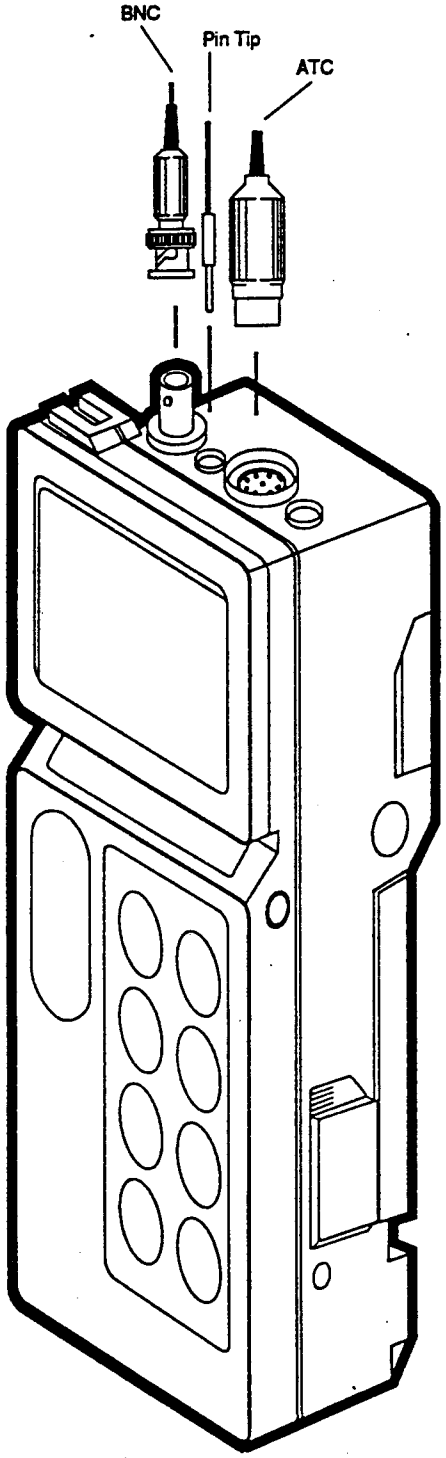
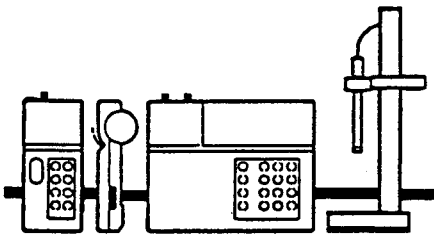


Figure 7



Display (Model 230A)

1. **Operating Mode** — Indicates instrument operating mode.
   - ***SETUP*** — *Indicates meter is in setup mode. Used to define operating parameters*
   - ***CALIBRATE*** — *Indictates the meter is in calibration mode. Accessed by pressing the cal key.*
   - ***MEASURE*** — *Indicates the meter is in measurement mode, accessed by pressing the measure key.*
2. **Main Field** — Displays pH readings, electrode slope and other significant information.
3. **ON/OFF** — Indicates if a particular feature is active or not in the SETUP menu.
4. **Lower Field** — Displays temperature in degrees Celsius. The °C designation is displayed when temperature is displayed.
5. **ATC** — Displayed when a temperature probe is attached.
6. **2nd** — Displayed when the 2nd key has been pressed, indicating the meter is ready to perform a second function.
7. **READY** — Displayed when the electrode signal has stabilized. The Ready function may be turned on or off in the setup menu.
8. **HOLD** — Displayed when the pH reading is frozen after reaching stability in measure mode. The HOLD feature may be turned on or off in the SETUP menu
9. **TIMER** — Displayed when the timer function has been activated.
10. **BAT.** — Displayed when the battery is low and needs to be replaced.

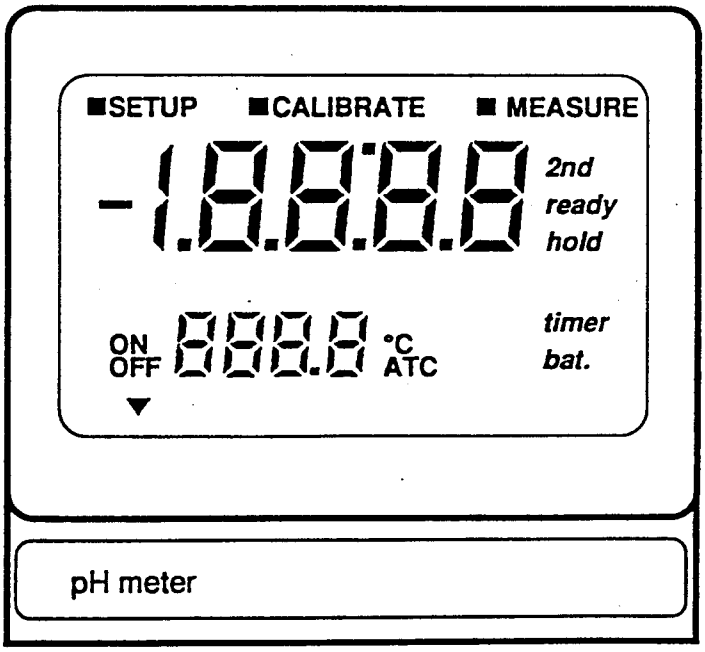


Figure 8

Keypad (Model 230A)

(See Figure 9)

Primary Functions

yes Press to enter a value during calibration or setup. May also be used to scroll through the setup menu without changing any parameters.

no Press to cancel a change to a parameter before entering.

measure Press for sample analysis. Instrument will remain in measure mode until another key is pressed. Press to unlock hold.

cal Press to start calibration. Meter automatically advances to measure after the calibration is complete.

2nd Press to access second functions: timer or setup menu.

Λ Press to increase value.

V Press to decrease value

power Press to turn meter on or off.

Second Functions

All second functions are accessed by first pressing the **2nd** key.

timer Press to start the timer. When the preset time has elapsed the instrument will beep for 1 minute (or until a key is pressed).

setup Press to access the setup menu. This is used for setting instrument operating parameters.

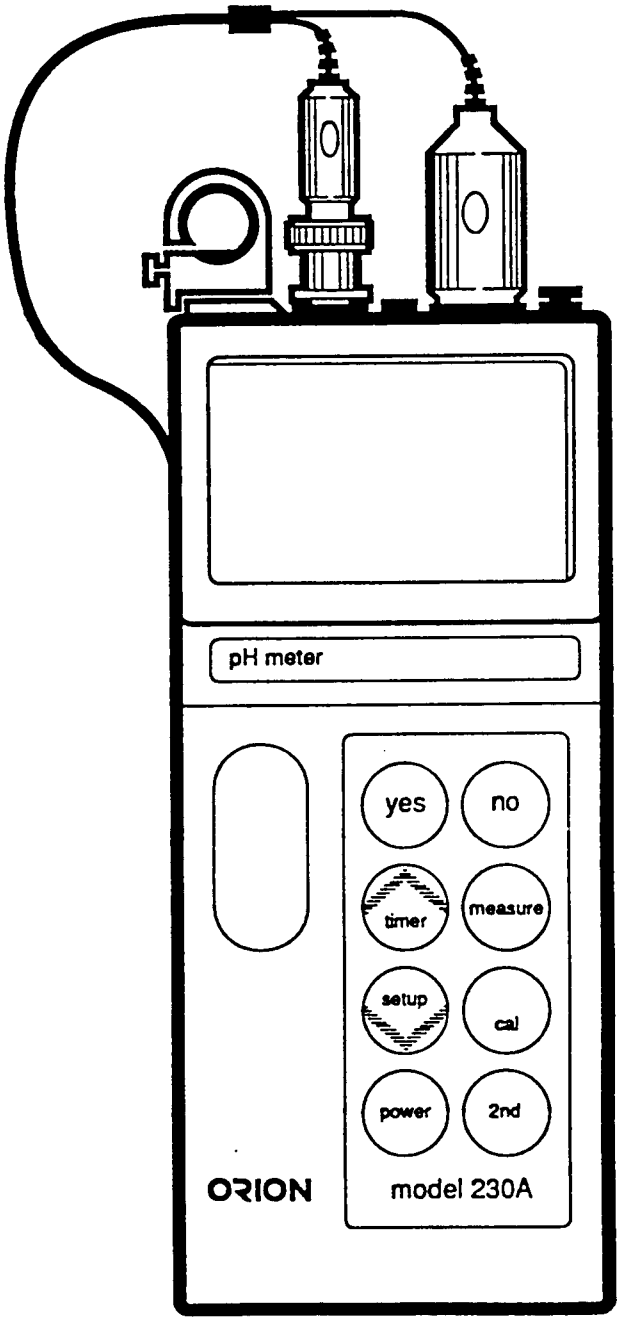


Figure 9

Checkout Procedure (Model 230A)

Note: To change a value press one of the ^ v keys. The first digit will flash, continue scrolling until the first digit equals the correct value then press YES. The second digit will flash. Scroll to the correct value then press YES and continue for each digit.

1. Perform the self-test as described on page 10. After the self check is complete, press the power key to turn meter on. Press measure. Main display should read a steady 7.00 ±0.02. If not follow steps 1a through 1c.

   a. Press **cal**, when the display flashes 7.00 press **yes**.

   b. Press **measure**. The main display should read 100.0 with the legend SLP in the lower display. If so, press yes.

   c. If not, scroll until the display reads 100.0 then press **yes**. The meter advances to **measure** and the display should now read a steady 7.00.

2. The meter is now ready for use with a pH electrode. Remove the shorting plug.

SETUP Menu (Model 230A)

The SETUP menu is used to identify and change instrument operating parameters. While in SETUP the **yes** key is used to scroll through the menu without changing any parameters. To change a parameter press one of the scroll keys, **^ v**, then **yes** to enter. Pressing **no** reverts the parameter to its former state (if done before entering the new setting).

To enter the SETUP menu press **2nd** then **setup**. 1-1 and READY will be displayed. The on or off indicator will flash indicating the current status. Press yes to accept and continue through the menu. Press a scroll key, **^ v**, to change. After changing a setting press **yes** to enter.

To change a numeric value press the **^** or **v** key. The first digit will start flashing, scroll until the first digit is the desired value then press **yes**. The second digit will flash, scroll until the desired value is displayed then Press **yes**. Continue in this manner until all digits have been changed to the desired value.

Scroll through the SETUP menu accepting or changing parameters as desired. To exit the SETUP menu press **cal** to begin the CALIBRATION sequence or **measure** to analyze samples.

The following parameters are accessed in the setup menu.

1-1 **READY**	Turning READY on will cause the ready indicator to be displayed when the electrode signal is stable. It is always on during calibration and when hold is turned on. The default setting is on.
1-2 **HOLD**	Turning HOLD on will cause the display to freeze during sample measurements when the electrode signal is stable. Press the measure key to unlock HOLD during analysis. The default setting is off.

1-3 **BEEP**	Turning BEEP on will cause an audible signal to sound when a key is pressed, when the electrode signal is stable (on ready), and when an operator assistance code is displayed. The default setting is on.
1-4 **AUTOSHUTOFF**	Turning AUTOSHUTOFF on will cause the meter to turn off if no keys have been pressed for 10 minutes. This feature will save battery life. The default setting is on.
2-1 **SLOPE**	Allows review of electrode slope in memory at any time. Value cannot be changed in the SETUP menu.
3-1 **TIMER INTERVAL**	Used to set the timer interval. The maximum interval that can be set is 23 hours, 59 minutes, and 59 seconds. The minimum interval is five (5) seconds. When the TIMER INTERVAL code, (3-1), is displayed the current interval hours setting is first displayed in the main field (H 00). Press **yes** to accept current setting or scroll to desired value then press **yes** to enter. Next the current interval minutes:seconds will be displayed. Press **yes** to accept or change to desired value then press **yes**. The default setting is five seconds.
3-2 **TIME REMAINING**	Allows review of the time remaining before the TIMER is set to go off. If the timer has not been activated 00:00 will be displayed.

Calibration and Measurement Procedures (Model 230A)

pH Measurements

A one or two buffer calibration should be performed before pH is measured. It is recommended that a two buffer calibration using buffers that bracket the expected sample range be performed at the beginning of each day to determine the slope of the electrode. This serves the dual purpose of determining if the electrode is working properly and storing the slope value in memory. Perform a one buffer calibration every two hours to compensate for electrode drift.

Prior to calibration, scroll through the setup menu and ensure all parameters are set correctly for the analysis you want to perform.

There are two ways of calibrating the 230A Meter; autocalibration or manual calibration. Following are descriptions and instructions for each method.

Autocallbration

Autocalibration is a feature of the Model 230A Meter that automatically recognizes the buffers 7.00, 4.01, and 10.01 within a range of ± 0.5 pH units. During calibration the user waits for a stable pH reading. Once the electrode is stable the meter automatically recognizes and displays the temperature corrected value for that buffer. Pressing YES enters the value into memory.

Note: Do not scroll when using autocalibration.

The 230A Meter compares actual values to theoretical values to determine if the buffer is within range. Results greater than ± 0.5 pH units from the theoretical value will trigger an operator assistance code. For best results, it is recommended that an ATC probe be used. If an ATC probe is not used, all samples and buffers should be at the same temperature or use manual temperature compensation. See page 43.

Autocalibration with Two Buffers

1. Connect electrode(s) to meter. Choose either 4.01 and 7.00, or 7.00 and 10.01 buffers, whichever will bracket your expected sample range.

2. Place electrode(s) into either 4.01, 7.00, or 10.01 buffer.

3. Press **cal**. CALIBRATION is displayed above the main readout and P1 is displayed in the lower field. P1 indicates that the meter is ready for the first buffer. When the electrode is stable the READY prompt will be displayed and the temperature- corrected value for the buffer is displayed. Press **yes**. The display will remain frozen for two seconds then P2 will be displayed in the lower field indicating the meter is ready for the second buffer.

4. Rinse electrode(s) and place in second buffer. Wait for a stable pH display and press **yes**. After the second buffer value has been entered the electrode slope will be displayed. SLP appears in the lower field while the actual electrode slope (in percent) appears in the main field.

   The meter automatically advances to the measure mode. MEASURE is displayed above the main field.

5. Rinse electrodes, place into sample. Record pH and temperature directly from the meter display.

Autocalibration with One Buffer

1. Connect electrode(s) to meter. Select one buffer, either 4.01, 7.00, or 10.01 whichever most closely approximates the expected sample pH.

2. Place electrodes into the buffer and press **cal**. CALIBRATE will be displayed above the main field and P1 will be displayed in the lower field.

3. Wait for a stable reading (the display will flash) and press **yes**. The display will remain frozen for two seconds then P2 will be displayed in the lower field.

4. Press **measure**. SLP will be displayed in the lower field and the electrode slope in memory will be displayed in the main field. Press **yes** or if necessary enter the correct electrode slope determined by a two point calibration. Then press **yes**. If slope value is unknown enter 100.0 or perform a two buffer calibration.

5. Rinse electrodes and place into sample. Record pH and temperature directly from the meter display.

Manual Calibration

To calibrate with buffers other than 4.01, 7.00, or 10.01, use the manual calibration technique. The calibration sequence is the same as autocalibration except buffer values are scrolled in.

Note: For manual calibration you must use the scroll keys otherwise the meter assumes you are performing an autocalibration. Even if the buffer value displayed is correct you must press a scroll key to start the editing process. Then press yes to accept each digit.

For best results it is recommended that an ATC probe be used. If an ATC probe is not used, all samples and standards should be at the same temperature or use manual temperature compensation. See page 43.

Manual Calibration with Two Buffers

1. Connect electrode(s) to meter. Choose two buffers that will bracket your expected sample range.

2. Place electrode(s) into the first buffer.

3. Press **cal**. CALIBRATE will be displayed above the main readout and P1 will be displayed in the lower field.

4. Wait for a stable pH display then press the Λ or V key. The first digit will start flashing. Scroll until the correct value appears in the first digit, press **yes**. The second digit will start flashing. Scroll until the correct value appears, then press **yes**. Continue in this manner until all digits have been correctly entered.

   The display will remain frozen for two seconds, then P2 will be displayed in the lower field indicating the meter is ready for the second buffer.

5. Rinse electrode(s) and place into second buffer. Wait for a stable pH display then enter the correct value as described above.

6. The electrode slope (in percent) is then displayed in the main field with SLP in the lower field. The meter automatically advances to MEASURE mode.

7. Rinse electrode(s) and place into sample. Record pH and temperature directly from the meter display.

Manual Calibration with One Buffer

1. Connect electrode(s) to meter. Choose a buffer which most closely approximates the expected sample pH. Place electrode(s) into buffer.

2. Press **cal**. CALIBRATE will be displayed above the main field and P1 will be displayed in the lower field.

3. Wait for a stable pH display then enter the correct buffer value. To enter a value press the Λ or V key. The first digit will flash, continue pressing the scroll key until the desired value is displayed. Press YES to accept. Continue for each digit. When the correct buffer value is displayed press YES to enter.

4. The P2 prompt will be displayed in the lower field. Press **measure**.

5. The slope prompt, SLP, will now be displayed in the lower field and the electrode slope (in percent) will be displayed in the main field. Press **yes** to enter the current electrode slope or scroll in a new value then press **yes**.

   The meter automatically advances to MEASURE mode.

6. Rinse electrode(s) and place into sample. Read sample pH directly from the meter display. Sample temperature is displayed in the lower field.

Dissolved Oxygen Measurements (Model 230A)

Dissolved oxygen measurements are displayed in ppm when the ORION Model 97-08 Dissolved Oxygen Electrode is used with the ORION Model 230A Meter. Follow these instructions for preparing the meter and calibrating the electrode.

1. Connect the Model 97-08 to meter and leave electrode mode switch "OFF".

2. Disconnect ATC probe.

   Note: ATC probe must not be connected to the meter.

3. Turn the HOLD feature (1-2) off.

4. Press **measure**. Using the scroll keys change the temperature value to 25.0°C.

5. Press the **cal** key. Enter the value 7.00 and press **yes**.

6. Press the **measure** key. The slope prompt, SLP, will be displayed in the lower field. Enter 100.0 and press **yes**.

   The meter will automatically enter MEASURE mode.

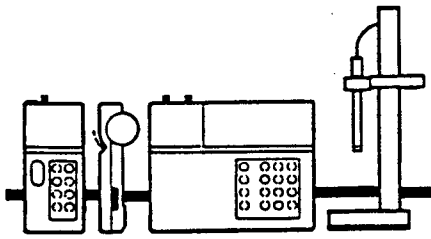
7. Turn the mode switch on the electrode to BT CK. Good battery operation is indicated by a reading of 13.40 or greater on the meter.

8. Turn the mode switch on the electrode to ZERO. Use the zero calibration control to set the meter to read 0.00.

9. Insert the reservoir (funnel) into a BOD bottle containing enough water to just cover the bottom. Insert the electrode, making sure that the electrode tip is not immersed in the water and does not have water droplets clinging to the outside of the membrane. Let stand approximately 30 minutes to ensure water saturation of air in the BOD bottle. This bottle should be used for storage between measurements.

10. Turn the electrode mode switch to the AIR position. If measurements are being made at sea level use the AIR calibration control on the electrode to set the pH meter reading to the prevailing barometric pressure in mm Hg(divided by 100). If the barometric pressure is unknown, if the elevation is above sea level or if the sample has a salinity greater than 2 parts per thousand, consult **Table 1** found in the *Model 97-08 Instruction Manual* to obtain the correct AIR setting.

11. Turn the electrode mode switch to H_2O for sample analysis.



Display (Model 250A)

1. **Operating Mode** — Indicates instrument operating mode.
   - ***SETUP*** — *Indicates meter is in SETUP mode. Used to define operating parameters.*
   - ***CALIBRATE*** — *Indictates meter is in calibration mode, accessed by pressing 2nd then cal key.*
   - ***MEASURE*** — *Indicates the meter is in measurement mode, accessed by pressing the measure key.*
2. **Main Field** — Displays pH, millivolts, or relative millivolts depending on the meter operating mode.
3. **ON/OFF** — Indicates if a particular feature is active or not in the SETUP menu.
4. **Lower Field** — Displays temperature in degrees Celsius. The °C designation is displayed when temperature is displayed.
5. **ATC** — Displayed when a temperature probe is attached.
6. **2nd** — Displayed when the 2nd key has been pressed, indicating the meter is ready to perform a secondary function.
7. **READY** — Displayed when the electrode signal is stable. The READY function may be turned on or off in the SETUP menu.
8. **HOLD** — Displayed when the pH reading is frozen after reaching stability in measure mode. The HOLD feature may be turned on or off in the SETUP menu
9. **TIMER** — Displayed when the timer function has been activated.
10. **BAT.** — Displayed when the battery is low and needs to be replaced.
11. **Mode Indicator** — Designates instrument measurement mode either pH, millivolts (mV), or Relative millivolts (Rel mV).

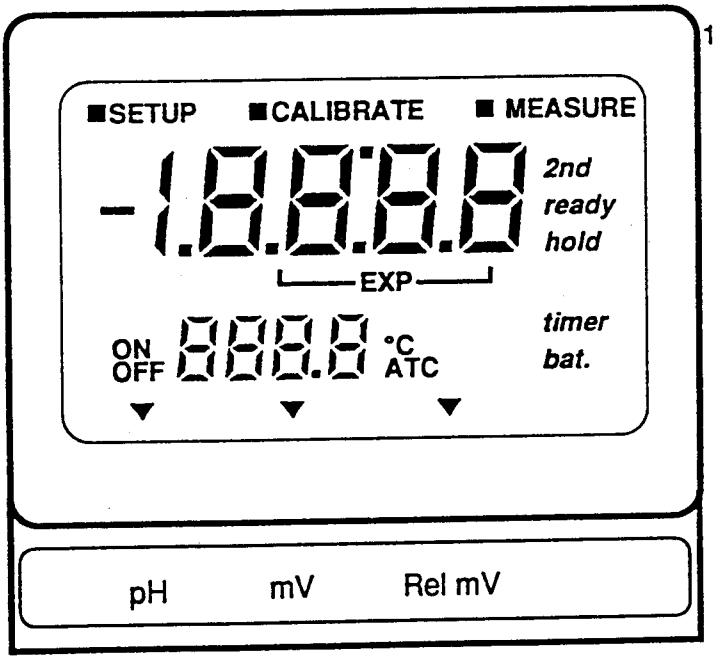


Figure 10

Keypad (Model 250A)

(See Figure 11)

Primary Functions

yes Press to enter a value during calibration or setup. May also be used to scroll through the setup menu without changing any parameters.

no Press to cancel a change to a parameter before entering.

measure Press for sample analysis. Instrument will remain in measure mode until another key is pressed. Press to unlock HOLD.

mode Press to change measurement modes. The options are pH, mV, or REL mV.

2nd Press to access second functions, cal, timer, setup or print.

Λ Press to increase value.

V Press to decrease value.

power Press to turn meter on or off.

Second Functions

All second functions are accessed by first pressing the 2nd key.

cal Press to start calibration. Meter automatically advances to MEASURE after the calibration is complete.

timer Press to start the timer. When the preset time has elapsed the instrument will beep for 1 minute (or until a key is pressed).

print Press to print display data.

setup Press to access the setup menu. This is used for setting instrument operating parameters.

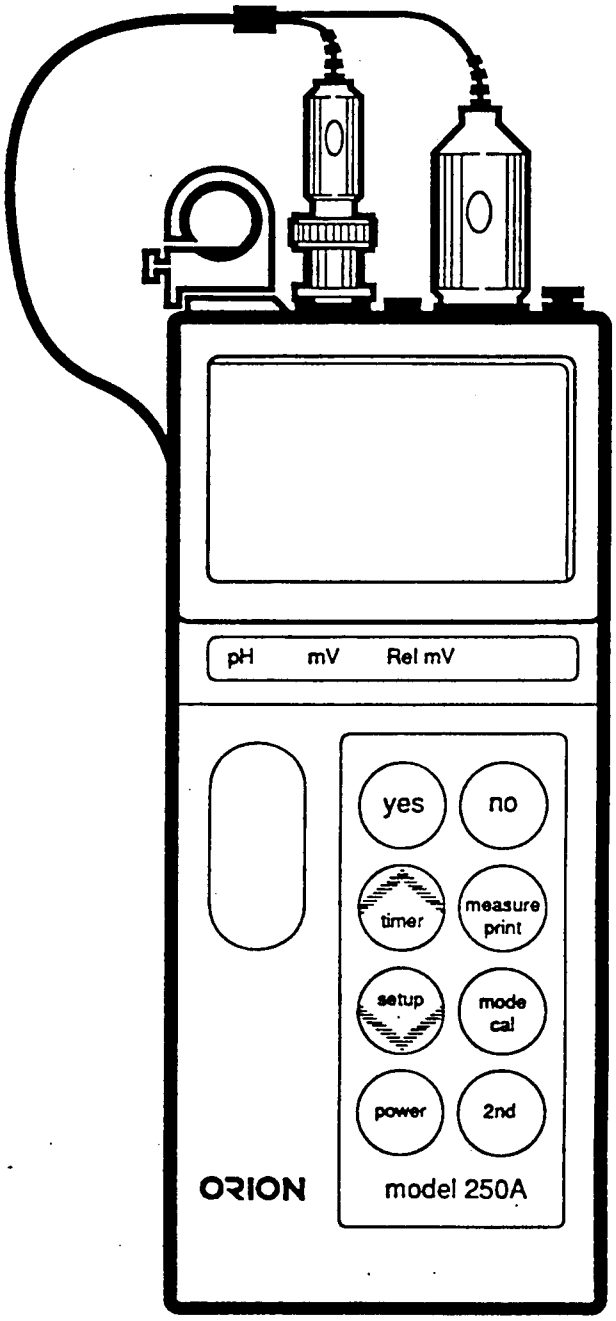


Figure 11

Checkout Procedure (Model 250A)

1. Perform the self test as described on page 10.

   Note: To change a value press one of the ^ v keys. The first digit will flash, continue scrolling until the first digit equals the correct value then press YES. The second digit will flash. Scroll to the correct value then press YES. When all digits have been changed press YES to enter the new value.

2. After the self-test the meter will be in MEASURE mode indicated by the legend MEASURE on the display.
   a. Press the mode key until pH mode indicator is displayed. Main display should read a steady 7.00 ±0.02. Press 2nd CAL and when the display flashes 7.00 press YES.

   b. Press MEASURE. The main display should read 100.0 with the legend SLP in the lower display, if so, press YES. If not scroll until the display reads 100.0 then press YES.

   c. The meter advances to MEASURE and the display should read a steady 7.00.

3. Press the mode key to enter millivolt mode. 0.0 ± .1 should be displayed.

4. Press mode key to enter REL mV mode. 0.0 ± .1 should be displayed. If not press **2nd cal** then press YES to enter the value 0.0. Display should read a steady 0.0.

5. After steps 1 through 4 have been successfully completed the meter is ready for use with electrodes. Remove the shorting plug.

SETUP Menu (Model 250A)

The setup menu is used to identify and change instrument operating parameters. In setup the **yes** key is used to scroll through the menu without changing any parameters. To change a parameter press one of the scroll keys, **^ v**, then **yes** to enter. Pressing **no** reverts the parameter to its former state (if done before entering the new parameter).

To enter the **setup** menu press **2nd** then **setup**. 1-1 and READY will be displayed. The on or off indicator flashes indicating the current status. Press **yes** to accept and continue through the menu. Press a scroll key, **^ v**, to change. After changing a setting press **yes** to enter.

To change a numeric value press the **^** or **v** key, the first digit will start flashing. Scroll until the first digit is the desired value then press **yes**. The second digit will flash, scroll until the desired value is displayed then press **yes**. Continue in this manner until all digits have been changed to the desired value then press **yes** to enter the new value.

Scroll through the SETUP menu accepting or changing parameters as desired.

To exit the SETUP menu, press **2nd cal** to begin the calibration sequence or **measure** to analyze samples.

The following parameters are accessed in the setup menu.

1-1	**READY**	Turning READY on will cause the ready indicator to be displayed when the electrode signal is stable. The default setting is on.
1-2	**HOLD**	Turning HOLD on will cause the display to freeze during sample measurements when the electrode signal is stable. Pressing measure unlocks hold and returns the meter to live displays during sample measurement. The default setting is off.
1-3	**BEEP**	Turning BEEP on will cause an audible signal to sound on ready, when a key is pressed, and when an operator assistance code appears. The default setting is on.
1-4	**AUTO-SHUTOFF**	Turning AUTO-SHUTOFF on will cause the meter to turn off if no keys have been pressed for 10 minutes. This feature will save battery life. The default setting is on.
2-1	**SLOPE**	Allows review of electrode slope in memory at any time. The slope value cannot be changed in the setup menu.
2-2	**RESOLUTION**	Allows selection of either 0.1 or 0.01 pH resolution. Press the scroll key to change the resolution, then press **yes** to enter and continue through the menu. The default setting is 0.01.
2-3	**ISO-POTENTIAL POINT**	Use to change the isopotential point for a particular pH electrode. In pH mode the default value is 7.00.
2-4	**RESET**	Sets all the calibration data and setup options to factory default values. This is particularly useful during trouble shooting or starting with a fresh electrode. To RESET press the Λ scroll key, the ON will flash and the beeper will ring rapidly. Press **yes** to reset. Press **no** to cancel.
3-1	**TIMER INTERVAL**	Used to set the timer interval. The maximum interval that can be set is 23 hours, 59 minutes, and 59 seconds. The minimum interval is five (5) seconds. When the TIMER INTERVAL code, 3-1, is displayed the current interval hours setting is displayed in the main field (H 00). Press YES to accept or scroll to change then press **yes** Next the current interval minutes: seconds will be displayed (00:00). Press **yes** to accept current setting or scroll to desired value then press **yes** to enter. The default setting is five (5) seconds.
3-2	**TIME REMAINING**	Allows review of the time remaining before the TIMER is set to go off.

3-3	**SET REAL TIME**	Used to set the actual time of day. The meter uses a 24-hour clock. When the code 3-3 is displayed in the lower field, the current time (hours: minutes) is displayed in the main field. If correct press **yes** to accept otherwise change as required and press **yes** to enter the new time.
3-4	**SET DATE**	Used to set the current date. When the code 3-4 is displayed in the lower field, the current date (month:day) is displayed in the main field. Press **yes** to accept or change the date as needed then press **yes** to enter. Next the current year is displayed. Press **yes** to accept or change as required then press **yes** to enter.
5-1	**PRINT MODE**	Sets the print mode. When 5-1 is displayed in the lower field the current print mode is displayed in the main field. The options are: 1-Manual Print, indictates no automatic output to the printer and the user may print on command by pressing the **print** key; 2-Print on Ready, the meter will send information to the printer whenever the electrode signal reaches stability; 3-Print on a timed interval, printing occurs at a preset timed interval. Use the scroll keys to change the setting, then press **yes** to enter the new setting. The default setting is 1; print on command.
5-2	**SET PRINT INTERVAL**	Used to set the timed print interval. The maximum print interval is 23 hours, 59 minutes and 59 seconds. The minimum print interval is 5 seconds. When the code 5-2 is displayed in the lower field, the current print interval hours will flash in the main display. Press **yes** to accept or change using the scroll keys, then press **yes** to enter. Next the print interval minutes:seconds will be displayed in the main field. Press **yes** to accept or change, then press **yes** to enter the new setting. The default setting is 1 minute.

Note: Setup functions 2-1 Slope, 2-2 Resolution, and 2-3 Isopotential Point are only accessed in pH mode.

pH Measurements

A one or two buffer calibration should be performed before pH is measured. It is recommended that a two buffer calibration using buffers that bracket the expected sample range be performed at the beginning of each day to determine the slope of the electrode. This serves the dual purpose of determining if the electrode is working properly and storing the slope value in the memory Perform a one buffer calibration every two hours to compensate for electrode drift.

Prior to calibration scroll thorugh the SETUP menu and ensure all parameters are set properly for the analysis you want to perform. Select the resolution desired and verify the isopotential point is set correctly for the electrode.

There are two ways of calibrating the 250A Meter; autocalibration or manual calibration. Following are descriptions and instructions for each method.

Autocalibration

Autocalibration is a feature of the Model 250A Meter that automatically recognizes the buffers 7.00, 4.01, and 10.01 with a range of ± 0.5 pH units. During calibration the user waits for a stable pH reading. Once the electrode is stable, the meter automatically recognizes and displays the temperature-corrected value for that buffer. Pressing **yes** enters the value in memory.

Note: Do not scroll when using autocalibration.

The 250A Meter compares actual values to theoretical values to determine if the buffer is within range. Results greater than ±0.5 pH units from the correct value will trigger an operator assistance code. For best results, it is recommended that an ATC probe be used. If an ATC probe is not used, all samples and buffers should be at the same temperature or use manual temperature compensation.

Autocalibration with Two Buffers

1. Connect electrode(s) to meter. Choose either 4.01 and 7.00, or 7.00 and 10.01 buffers, whichever will bracket your expected sample range.

2. Press the **mode** key until the pH mode indicator is displayed.

3. Place electrode(s) into either 4.01, 7.00, or 10.01 buffer.

4. Press **2nd cal**. CALIBRATION is displayed above the main field and the time and date of the last calibration are displayed. After a few seconds P1 is displayed in the lower field. P1 indicates that the meter is ready for the first buffer and a value has not yet been entered. When the electrode is stable, READY will be displayed and the temperature-corrected value for the buffer is displayed. Press **yes**. The display will remain frozen for two seconds, then P2 will be displayed in the lower field indicating the meter is ready for the second buffer.

5. Rinse electrodes and place in second buffer. Wait for a stable pH display and press yes.

   After the second buffer value has been entered the electrode slope will be displayed. SLP appears in the lower field with the actual electrode slope in percent in the main field.

   The meter automatically advances to the measure mode. MEASURE is displayed above the main field.

6. Rinse electrodes, place into sample. Record pH directly from the main meter display and temperature from the lower field.

Autocalibration with One Buffer

1. Connect electrode(s) to meter. Select one buffer, either 4.01, 7.00, or 10.01, whichever most closely approximates the expected sample pH.

2. Press the **mode** key until the pH mode indicator is displayed.

3. Place electrodes into the buffer and press **2nd cal**. CALIBRATE will be displayed above the main field and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed in the lower field.

4. Wait for a stable reading (the display will flash) and press **yes**. The display remains frozen for two seconds then P2 is displayed in the lower field.

5. Press **measure**. SLP will be displayed in the lower field and the electrode slope in memory in the main field. If necessary enter the correct electrode slope determined by a two point calibration and press **yes**. If slope value is unknown enter 100.0 or perform a two buffer calibration.

6. Rinse electrodes and place into sample. Read the pH directly from the main display and temperature from the lower field.

Manual Calibration

To calibrate with buffers other than 4.01, 7.00, or 10.01, use the manual calibration technique. The calibration sequence is the same as autocalibration except buffer values are manually entered using the scroll keys.

For best results it is recommended that an ATC probe be used. If an ATC probe is not used, all samples and standards should be at the same temperature or use manual temperature compensation. See page 43.

Manual Calibration with Two Buffers

1. Connect electrode(s) to meter. Choose two buffers that will bracket your expected sample range.

2. Press the **mode** key until the pH mode indicator is displayed.

3. Place electrode(s) into the first buffer.

4. Press **2nd cal**. CALIBRATE will be displayed above the main readout and the time since the last calibration will be displayed. After a few seconds P1 will be displayed in the lower field.

5. Wait for a stable pH display then press the ^ or v key. The first digit will start flashing. Scroll until the correct value appears in the first digit, press **yes**. The second digit will start flashing. Scroll until the correct value appears in the second digit, press **yes**. Continue in this manner until all digits have been correctly entered.

   The display remains frozen for two seconds then P2 is displayed in the lower field indicating the meter is ready for the second buffer.

6. Rinse electrode(s) and place into second buffer. Wait for a stable pH display then enter the correct value as described above.

   The electrode slope is then displayed in the main field with SLP in the lower field. The meter automatically advances to MEASURE mode.

7. Rinse electrode(s) and place into sample. Record pH and temperature directly from the meter display.

Manual Calibration with One Buffer

1. Connect electrode(s) to meter. Choose a buffer which most closely approximates the expected sample pH. Place electrode(s) into buffer.

2. Press the **mode** key until the pH mode indicator is displayed

3. Press **2nd cal**. CALIBRATE will be displayed above the main field and the time since the last calibration will be displayed. After a few seconds P1 will be displayed in the lower field.

4. Wait for a stable pH display then enter the correct buffer value.

   To enter a value press the Λ or V key. The first digit will flash, continue pressing the scroll key until the desired value is displayed. Press **yes** to accept. Continue for each digit.

5. The P2 prompt will be displayed in the lower field. Press MEASURE.

6. The slope prompt, SLP, will now be displayed in the lower field and the electrode slope will be displayed in the main field. Press **yes** to enter the current electrode slope or scroll in a new value then press **yes**.

   The meter automatically advances to measure mode.

7. Rinse electrode(s) and place into sample. Read sample pH directly from the meter display. Sample temperature is displayed in the lower field.

Millivolt Measurements

The Model 250A Meter can be used to measure absolute or relative millivolts. The millivolt modes are useful when performing potentiometric titrations or preparing calibration curves. Detailed instructions for any ORION electrode are given in the electrode instruction manual. Titration instructions are included in the ORION Redox Electrode (Model 96-78 or 97-78) Instruction Manual, or in standard analytical chemistry texts.

Absolute Millivolts

Absolute millivolts are displayed with 0.1 mV resolution in the range of -1600.0 to +1600.0 mV.

Access the absolute millivolt mode by pressing the **mode** key until the mV mode indicator is displayed.

Relative Millivolts

Relative millivolts are displayed to 0.1 mV resolution over the range of -1999.9 to +1999.9 mV. (Absolute millivolt range ± 1600.0 mV)

1. Select the relative millivolt mode by pressing the **mode** Key until the Rel mV mode indicator is displayed.

2. Set the relative millivolt offset by pressing **2nd cal**. CALIBRATE will be displayed and the current absolute millivolts will be displayed in the main field.

3. Once the signal is stable the meter displays 0.0. Use the scroll keys to set the desired reading or leave the setting at 0.0. Press **yes** to enter. The meter automatically returns to MEASURE and all Relative millivolt measurements will be based on the offset.

Dissolved Oxygen Measurements (Model 250A)

Dissolved oxygen measurements are displayed in ppm when the ORION Model 97-08 Dissolved Oxygen Electrode is used with the ORION Model 250A Meter. Follow these instructions for preparing the meter and calibrating the electrode.

1. Connect the Model 97-08 to meter and leave electrode mode switch "OFF".

2. Disconnect ATC probe.

   Note: ATC probe must not be connected to the meter.

3. Press the **mode** key until the pH mode indicator is displayed.

4. Turn the hold feature (1-2) off.

5. Press **measure**. Using the scroll keys change the temperature value to 25.0°C.

6. Press **2nd cal**. Enter the value 7.00 and press **yes**.

7. Press the **measure** key. The slope prompt, SLP, will be displayed in the lower field. Enter 100.0 and press **yes**.

   The meter automatically enters the measure mode.

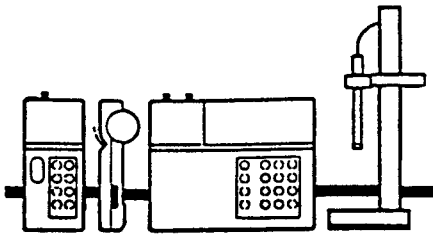
8. Turn the mode switch on the electrode to BT CK. Good battery operation is indicated by a reading of 13.40 or greater on the meter.

9. Turn the mode switch on the electrode to ZERO. Use the zero calibration control to set the meter to read 0.00.

10. Insert the reservoir (funnel) into a BOD bottle containing enough water to just cover the bottom. Insert the electrode, making sure that the electrode tip is not immersed in the water and does not have water droplets clinging to the outside of the membrane. Let stand approximately 30 minutes to ensure water saturation of air in the BOD bottle. This bottle should be used for storage between measurements.

11. Turn the electrode mode switch to the AIR position. If measurements are being made at sea level use the AIR calibration control on the electrode to set the pH meter reading to the prevailing barometric pressure in mm Hg(divided by 100). If the barometric pressure is unknown, if the elevation is above sea level or if the sample has a salinity greater than 2 parts per thousand, consult **Table 1** found in the *Model 97-08 Instruction Manual* to obtain the correct AIR setting.

12. Turn the electrode mode switch to H_2O for sample analysis



Display (Model 290A)

1. **Operating Mode** — Indicates instrument operating mode.
   - ***SETUP*** — *Indicates meter is in setup mode. Used to define operating parameters.*
   - ***CALIBRATE*** — *Indicates meter is in calibration mode. Accessed by pressing **2nd cal**.*
   - ***MEASURE*** — *Indicates meter is in measurement mode. Accessed by pressing the **measure** key.*
2. **Main Field** — Displays pH, millivolts, relative millivolts or concentration depending on the meter measurement mode.
3. **ON/OFF** — During SETUP on/off indicates if a particular feature is active or not.
4. **Lower Field** — Displays temperature in degrees Celsius. The °C designation is displayed when temperature is displayed.
5. **ATC** — Displayed when a temperature probe is attached.
6. **2nd** — Displayed when the 2nd key has been pressed, indicating the meter is ready to perform a secondary function.
7. **READY** — Displayed when the electrode is stable. READY may be turned on or off in the SETUP menu.
8. **HOLD** — Displayed when the reading is frozen after reaching stability. The HOLD feature may be turned on or off in the SETUP menu.
9. **TIMER** — Displayed when the timer function has been activated.
10. **BAT.** — Displayed when the battery is low and needs to be replaced.
11. **Mode Indicator** — Designates instrument operating mode either pH, millivolts (mV), Relative millivolts (Rel mV), or Concentration (conc).

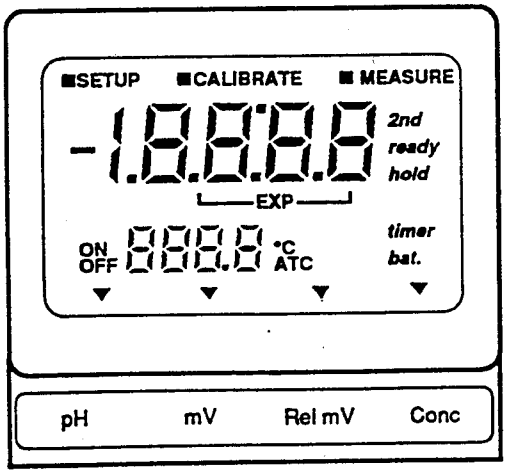


Figure 12

Keypad

(See Figure 13)

Primary Functions

yes Press to enter a value during calibration or setup. May also be used to scroll through the setup menu without changing any parameters.

no Press to cancel to change to a parameter before entering.

measure Press for sample analysis. Instrument will remain in measure mode until another key is pressed. Press to unlock hold during sample analysis.

mode Press to change operating modes. The options are pH, mV, REL mV, or Concentration.

2nd Press to access second functions, cal, timer, setup, or print.

∧ Press to increase value.

∨ Press to decrease value.

power Press to turn meter on or off.

Second Functions

All second functions are accessed by first pressing the 2nd key.

cal Press to start calibration.

timer Press to start the timer. When the preset time has elapsed, the instrument will beep for 1 minute (or until a key is pressed).

setup Press to access the setup menu. This is used for setting instrument operating parameters.

print Press to print current display data and/or to enter data into the internal datalogger. Selection of either option or both can be made in the setup menu. At the end of each calibration all data is printed automatically. (Pressing print during calibration will cause data from the previous cal to be printed until the calibration sequence is completed.)

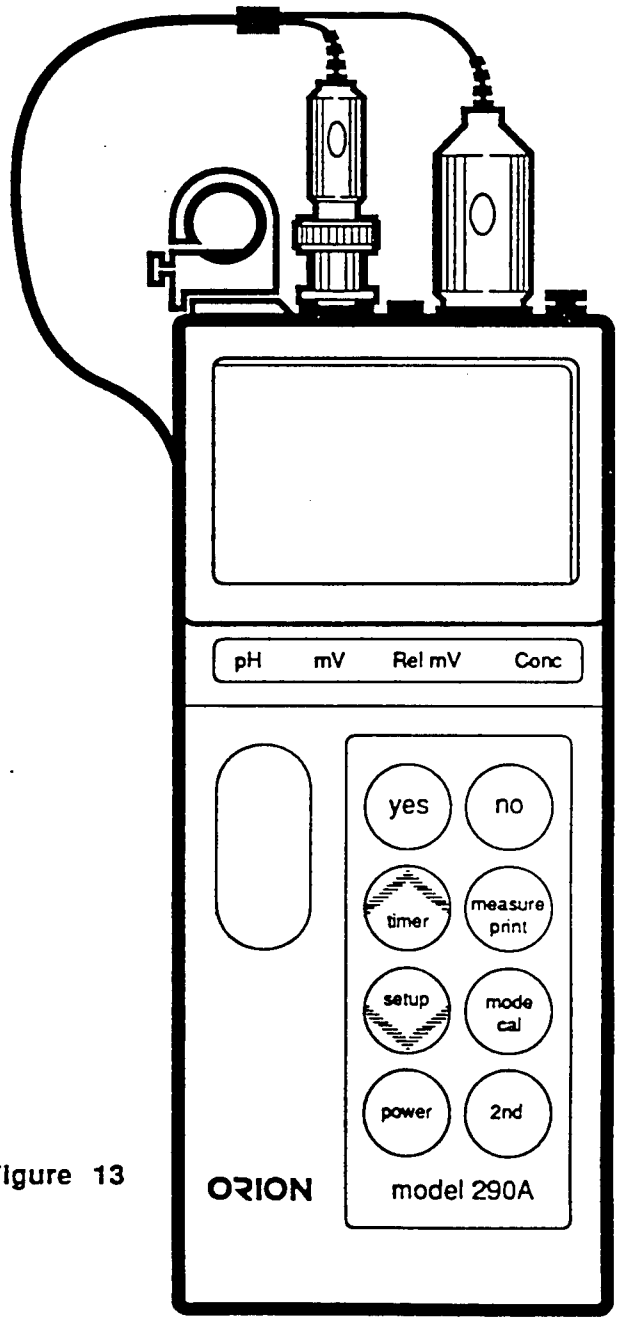


Figure 13

Checkout Procedure

1. Perform the self-test as described on page 10.

   Note: To change a value press one of the ^ v keys. The first digit will flash, continue scrolling until the first digit equals the correct value then press **yes**. *The second digit will flash. Scroll to the correct value then press* **yes**. *When all digits have been changed press* **yes** *to enter the new value.*

   Note: If this is the first time this proceedure has been performed the reading should be 6.997 ± .02

2. After completing the self check the meter will be in MEASURE mode. The legend MEASURE will be displayed.
   a. Press the mode key until the pH mode indicator is displayed. Main display should read a steady 7.00 ±0.02.
   b. If not, press **2nd cal**. The display will flash 7.00, press **yes**.
   c. Press **measure** the main display should read 100.0 with the legend SLP in the lower display. If so press **yes**.
   d. If not scroll until the display reads 100.0 then press **yes**. The meter advances to MEASURE and the display should now read a steady 7.00.

3. Press the **mode** key to enter millivolt mode. Display should read 0.0 ±.01.

4. Press mode key to enter REL mV mode. Display should read 0.0 ±.01. If not press **2nd cal** then press **yes** to enter the value 0.00. The meter will return to measure mode.

5. Press the mode key until the concentration mode indicator is displayed. Display should read 1.00.

   Note: If this is the first time this proceedure has been performed the reading should be 0.996.

   a. If not press **2nd cal** At the P1 prompt press **yes** to enter 1.00.
   b. Press **measure**. SLP and 59.2 should be displayed. If so, press **yes**.
   c. If not enter 59.2. Meter automatically returns to measure mode and display should read a steady 1.00.

6. After successfully completing steps 1 through 5 the meter is ready for use with electrodes. Remove the shorting plug.

SETUP Menu (Model 290A)

The setup menu is used to identify and change instrument operating parameters. While in setup the **yes** key is used to scroll through the menu without changing any parameters.

To enter the setup menu press **2nd** then **setup**. 1-1 and READY will be displayed. The on or off indicator flashes indicating the current status. Press **yes** to accept and continue through the menu. Press a scroll key, ^ v, to change. After changing a setting press **yes** to enter. Pressing **no** reverts the parameter to its former state (if done before entering the new setting).

To change a numeric value press the ^ or v key, the first digit will start flashing, scroll until the first digit is the desired value then press **yes**. The second digit will flash, scroll until the desired value is displayed then press **yes**. Continue in this manner until all digits have been changed then press **yes** to enter the new value.

Scroll through the SETUP menu accepting or changing parameters as desired.

To exit the SETUP menu press **2nd cal** to begin the calibration sequence or **measure** to analyze samples.

The following parameters are accessed in the setup menu.

1-1	**READY**	Turning READY on will cause the ready indicator to be displayed when the electrode signal is stable. The default setting is on.
1-2	**HOLD**	Turning HOLD on will cause the display to freeze during sample measurements when the electrode signal is stable. The default setting is off. Press the measure key to unlock HOLD during analysis
1-3	**BEEP**	Turning BEEP on will cause an audible signal to sound on ready, when a key is pressed, and when an operator assistance code occurs. The default setting is on.

1-4	**AUTO-SHUTOFF**	Turning AUTO-SHUTOFF on will cause the meter to turn off if no keys have been pressed for 10 minutes. This feature will save battery life. The default setting is on.
2-1	**SLOPE**	Allows review of electrode slope in memory at any time. Value cannot be changed in the setup menu.
2-2	**RESOLUTION**	Allows selection of resolution. For pH choose from 0.1 to 0.01 to 0.001. Press the scroll key to change the resolution then press **yes** to enter and continue through the menu. In Concentration mode, select 1,2 or 3 significant digits. Example: pressing the scroll key changes the concentration value from 19900 → 19000 → 1000 → 19900. Select the number of digits desired then press **yes** to enter. The default setting is .001 for pH and 3 digits for concentration.
2-3	**ISO-POTENTIAL POINT**	Use to change the iso-potential point for a particular pH electrode. In pH mode the default value is 7.000. The isopotential point may not be changed in any other mode.
2-4	**RESET**	Allows all the setup options and calibration data to be set to factory default values. This is particularly useful during troubleshooting or prior to calibrating with a new electrode. To RESET press a scroll key, the ON will flash and the audio signal will ring rapidly. Press **yes** to reset.

Note: Setup function 2-3 Isopotential Point is only accessible in pH mode. SETUP Functions 2-1 Slope and 2-2 Resolution are only accessible in pH and concentration modes.

3-1	**TIMER INTERVAL**	Used to set the timer interval. The maximum interval that can be set is 23 hours, 59 minutes, and 59 seconds. The minimum interval is five (5) seconds. When the TIMER INTERVAL code, (3-1), is displayed the current interval hours setting will be displayed in the main field. Press **yes** to accept or scroll to change then press **yes**. Next the current interval minutes:seconds will be displayed. Press **yes** to accept current setting or scroll to desired value then press **yes** to enter. The default setting is five (5) seconds.
3-2	**REMAINING TIME**	Shows time remaining before timer is set to ring.
3-3	**SET REAL TIME**	Used to set the time of day. The meter uses a 24 hour clock. When the code 3-3 is displayed in the lower field the current time (hours:minutes) will be displayed in the main field. If correct press yes to accept otherwise change as required and press yes to enter.
3-4	**SET DATE**	Used to set the current date. When the code 3-4 is displayed in the lower field the current date (month:day) is displayed in the main field. Press **yes** to accept or change the date as needed then press **yes** to enter the new date.
4-H	**HIGH ALARM LIMIT**	Used to set the high alarm limit for the current measurement mode. When the reading exceeds the set limit the alarm will ring. The maximum limits are 19.999 for pH, 19900 for concentration, +1600.0 mV, and +1999.9 relative millivolts. To change the current setting use the scroll keys then press **yes** to enter.

4-L **LOW ALARM LIMIT**

Used to set the low alarm limit for the current measurement mode. When the reading falls below the set limit the alarm will ring. The minimum limits are -2.000 pH, 0.0 for Concentration, -1600.0 mV, and -1999.9 for relative millivolts. To change the low limit use the scroll keys then press **yes** to enter.

5-1 **PRINT MODE**

Sets the print mode. When 5-1 is displayed in the lower field the current print mode will flash in the main field. The options are:

1. Manual Print, indicates no automatic output to the printer and the user may print on command by pressing **2nd print**;
2. Print on READY, the meter will send information to the printer whenever the electrode signal is stable;
3. Print on a timed interval, printing occurs at user selected timed intervals.

Use the scroll keys to change the setting then press **yes** to enter the new setting. The default setting is 1 PRINT on command.

5-2 **SET PRINT INTERVAL**

Used to set the timed print interval. The maximum print interval is 23 hours, 59 minutes, and 59 seconds. The minimum print interval is five (5) seconds. When the code 5-2 is displayed in the lower field the current print interval hours will flash in the main display indicated by an H in the leftmost position. Press **yes** to accept or change using the scroll keys then press **yes** to enter. Next the print interval minutes:seconds will be displayed in the main field. Press **yes** to accept or change then press **yes** to enter the new setting. The default setting is (1) one minute.

6-1 **DATA-LOGGER MODE**

Sets the datalogger mode. Up to 25 points may be stored in memory at any one time. The four options are:

0-Off, when 0 is selected no datalogging of any kind will take place.
1-Manual datalog, no automatic output to the datalogger will occur, the user presses the **2nd print** key to log data;
2-Datalog on ready, data-logging occurs when the electrode signal is stable (on ready);
3-Timed datalog, data-logging occurs at a preset timed interval.

When the code 6-1 is displayed in the lower field the current datalogger mode will flash in the main display. Use the scroll keys to change then press YES to enter the new choice. The default setting is 0; OFF.

6-2	**DATALOG INTERVAL**	Sets the timed datalogger interval. The maximum interval is 23 hours, 59 minutes, and 59 seconds. The minimum interval is five (5) seconds. When the code 6-2 is displayed in the lower field the current datalogger interval hours are displayed in the main field indicated by an H in the left position. Use the scroll keys to change the setting then press **yes** to enter. Next the current datalogger interval minutes:seconds will be displayed in the main field. Use the scroll keys to change the setting, then press **yes** to enter. The default setting is (5) seconds.
6-3	**TRANSFER DATA**	Use this setting to transfer data from the datalogger to a printer or a computer. When the code 6-3 is displayed the OFF will flash, to transfer the data press a scroll key until ON is displayed. Then press YES. Once the data has been transferred the meter advances to the next setup option.

Note: Down loading the data does not clear the memory. To clear memory see step 6-4 below.

6-4	**CLEAR DATA**	This function clears all data from the datalogger memory. When the code 6-4 is displayed the OFF will flash. To clear the data press a scroll key until ON is displayed. The alarm will ring rapidly to indicate the memory is about to be erased. Press **yes** to clear.

Calibration and Measurement Procedures (Model 290A)

pH Measurements

The model 290A can perform up to a five (5) point pH calibration. Either autocalibration, manual calibration, or a combination of the two may be used.

A one, two, or multi-point calibration should be performed using fresh buffers before pH is measured. It is recommended that a minimum of a two point calibration using buffers that bracket the expected sample range be performed at the beginning of each day to determine the slope of the electrode. This serves the dual purpose of determining if the electrode is working properly and storing the slope value in memory Perform a one buffer calibration every two hours to compensate for electrode drift. Use a fresh aliquot of one of the calibration buffers.

Note: If a three or more point calibration is being used recalibrate using all buffers.

Prior to calibration scroll through the setup menu and ensure all parameters are set properly for the analysis you want to perform. Select the resolution desired and verify the isopotential point is set correctly for the electrode.

There are two ways of calibrating the 290A Meter, autocalibration or manual calibration. Following are descriptions and instructions for each method.

Autocalibration

Autocalibration is a feature of the Model 290A Meter that automatically recognizes five buffers 1.68, 4.01, 7.00, 10.01, and 12.46 within a range of ±0.5 pH units. During calibration the user waits for a stable pH reading. Once the electrode is stable the meter automatically recognizes and displays the temperature corrected value for that buffer. Pressing **yes** enters the value in memory.

Note: Do not scroll when using autocalibration.

The 290A Meter compares actual values to theoretical values to determine if the buffer is within range. Results greater than ± 0.5 pH units from the correct value will trigger an operator assistance code. For best results, it is recommended that an ATC probe be used. If an ATC probe is not used, all samples and buffers should be at the same temperature or use manual temperature compensation.

Manual Calibration

To calibrate with buffers other than 1.68, 4.01, 7.00, 10.01, or 12.45 use the manual calibration technique. The calibration sequence is the same as autocalibration except buffer values are scrolled in. To enter a value press the Λ or V key. The first digit will flash, continue pressing the scroll key until the desired value is displayed. Press **yes** to accept. Continue for each digit. When the correct buffer value is displayed press **yes** to enter.

Note: For manual calibration you must use the scroll keys otherwise the meter assumes you are performing an autocalibration. Even if the buffer value is correct you must press a scroll key to start the editing process. Then press yes to accept each digit.

For best results, it is recommended that an ATC probe be used. If an ATC probe is not used, all samples and standards should be at the same temperature or use manual temperature compensation. See page 43.

Multipoint pH Calibration

Up to a five (5) point multipoint calibration can be performed on the 290A. Both autocalibration and manual calibration may be used within the same calibration curve. For example autocalibration may be used with the 1.68, 7.00, and 10.01 buffers while manual calibration would be used with 3.78 and 9.18 buffers.

The instrument uses a point to point calibration scheme, i.e. the meter stores in memory the different electrode slopes for each portion of the calibration curve. When measuring in a particular region of the curve the electrode slope for that region is employed in the calculation of sample pH. The electrode slope displayed after calibration is an average slope for all the segments of the entire calibration curve. Use of this scheme increases accuracy in the different regions of the calibration curve. However, the electrode slope may be lower than normal, especially if buffers from the pH extremes ≤2.00 or ≥12.00 are used.

It is recommended that automatic temperature compensation be used. If not, all buffers and samples should be at the same temperature or use manual temperature compensation. See temperature compensation section, page 43.

Calibration With 2 or More Buffers.

Prior to calibration set the resolution to the desired level, check the isopotential point, and change any parameters in the setup menu.

1. Select and prepare the buffers to be used. A maximum of five buffers may be used.

2. Press the **mode** key until the pH mode indicator is displayed.

3. Place electrodes into the first buffer.

4. Press **2nd cal**. CALIBRATE and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed in the lower field indicating the meter is ready for the first buffer.

5. Wait for a stable pH reading.

   If using autocalibration press **yes**. If not manually enter the value using the scroll keys then press **yes**. To enter a value press the Λ or V key. The first digit will flash, continue pressing the scroll key until the desired value is displayed. Press **yes** to accept. Continue for each digit. When the correct buffer value is displayed press **yes** to enter.

   The P2 prompt is then displayed for the second buffer.

6. Rinse electrodes and place into second buffer. Wait for a stable reading and enter the correct buffer value then press **yes**. The P3 prompt for the third buffer will be displayed.

7. Continue in this manner until all buffers have been entered. If using less than five buffers press **measure** once all the buffers you are using have been entered. The electrode slope will then be displayed with the prompt SLP in the lower field. If using five buffers the meter automatically advances to MEASURE once the buffers have been entered.

8. Rinse electrodes and place into sample. Record pH and temperature directly from the meter display.

One Buffer Calibration

1. Connect electrode(s) to meter. Choose a buffer which most closely approximates the expected sample pH. Place electrode(s) into buffer.

2. Press the **mode** key until the pH mode indicator is displayed

3. Place electrodes in the buffer.

4. Press **2nd cal**. CALIBRATE and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed in the lower field.

5. Wait for a stable pH display (display will flash).

   If using autocalibration press **yes**. If not manually enter the value using the scroll keys. To enter a value press the ^ or v key. The first digit will flash, continue pressing the scroll key until the desired value is displayed. Press **yes** to accept. Continue for each digit.

6. The P2 prompt will be displayed in the lower field. Press **measure**.

7. The slope prompt, SLP, will now be displayed in the lower field and the electrode slope will be displayed in the main field. Press **yes** to enter the current electrode slope or scroll in a new value then press **yes**.

   The meter automatically advances to measure mode.

8. Rinse electrode(s) and place into sample. Read sample pH directly from the meter display. Sample temperature is displayed in the lower field.

Concentration Measurements

A one, two, or multi-point calibration should be performed before concentration is measured. It is recommended that a two point standard calibration be performed at the beginning of each day and every time electrodes are changed to determine the slope of the electrode. This serves the dual purpose of determining if the electrode is working properly and storing the slope value in memory. Perform a calibration with one standard every two hours to compensate for possible electrode drift. Use a fresh aliquot of one of the standards used for calibration.

Note: When calibrating with 3 or more standards, repeat the calibration using fresh aliquots of all standards.

During calibration always use the most dilute standard first. The 290A will automatically recognize slope direction (i.e. will recognize anion or cation electrodes).

Up to a five point calibration may be performed on the 290A. The instrument uses a point to point calibration scheme, i.e. the meter stores in memory the different electrode slopes for each portion of the calibration curve. When measuring in a particular region of the curve the electrode slope for that region is employed in the calculation of sample concentration. The electrode slope displayed after calibration is the average slope for all the segments of the entire calibration curve. Use of this scheme increases accuracy in the different regions of the calibration curve however the electrode slope may be lower than normal, especially if standards close to the electrode limit of detection are used in the calibration.

Blank correction occurs automatically when three or more standards are used. This feature automatically calculates and corrects for background levels of the species of interest. The standards used for calibration do not need to include a blank. This improves results as typical blanks contain low levels of the species to be measured and hence are unstable and difficult to measure accurately. To take advantage of this feature select 3 or more standards for calibration. If the profile of the calibration curve does not indicate a background level of ion concentration then blank correction will not be invoked and the standard point to point scheme will be used.

During calibration to enter a new concentration value you must use the scroll keys. Each digit is edited in turn (similar to a multifunction watch with LCD display). First set the decimal point, then edit each digit of the display. Keep in mind that there are 4.5 digits and a polarity sign.

Any convenient units of concentration units can be used, for example: molarity, ppm, % etc.

All standards and samples should be at the same temperature. In concentration mode the temperature probe is used for temperature measurements only and does not provide temperature corrected concentration measurements.

Prior to calibration set the number of significant digits required in the setup menu. Check the other parameters and verify each is set appropriately for your measurement procedures.

Calibration with Two or More Standards

1. See electrode instruction manual for electrode preparation, required solutions and any special requirements.

2. Prepare the standards. The standards should bracket the expected sample range and be in the same concentration units.

3. Add ionic strength adjustor, or pH adjustor, as recommended in the electrode instruction manual.

4. Connect electrode(s) to the meter. Press the **mode** key until the CONC mode indicator is displayed.

5. Place electrodes into the least concentrated standard.

6. Press **2nd cal**. CALIBRATE and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed indicating the meter is ready for the first standard.

7. When the reading is stable use the scroll keys to enter the value of the standard. To enter a value, press the Λ or V key. The value will flash. Press the key again and the decimal point will flash. Position the decimal then press yes. The first digit will flash. Scroll to the desired value then press yes. Continue for each digit on the display. There are 4 1/2 digits plus a polarity sign and decimal point. The display will freeze for three seconds then P2 will be displayed in the lower field.

8. Rinse electrodes and place into second standard. When the reading is stable enter the value of the standard. The reading will freeze for three seconds then P3 will be displayed in the lower field indicating the meter is ready for the third standard.

9. If using only two standards press **measure**. The electrode slope will be displayed for a few seconds then the meter will advance to MEASURE mode.

   If more than two standards are to be used continue entering standards as described above. When all standards have been entered press **measure**. The meter displays the electrode slope for three seconds then advances to MEASURE. After five standards have been entered the meter automatically displays slope then advances to MEASURE.

10. Rinse electrodes and place into sample. Wait for a stable reading, then record concentration directly from the main meter display. Temperature is displayed in the lower field.

Calibration with One Standard

1. See electrode instruction manual for electrode preparation, required solutions and any special requirements.

2. Prepare a standard which best approximates the expected sample concentration.

3. Add ionic strength adjustor, or pH adjustor, as recommended in the electrode instruction manual.

4. Connect electrode(s) to the meter and press the **mode** key until the CONC mode indicator is displayed.

5. Place electrodes into the standard.

6. Press **2nd cal**. CALIBRATE and the time and date of the last calibration will be displayed. After a few seconds P1 will be displayed in the lower field indicating the meter is ready for the standard.

7. Wait for a stable reading. Enter the value of the standard. The display will freeze for a few seconds then P2 will be displayed in the lower field.

8. Press **measure**. The electrode slope in memory will now be displayed in the main field and SLP will be displayed in the lower field. If correct press **yes** to enter and advance to measure otherwise enter the correct electrode slope.

9. Rinse electrode(s) and place into sample. Record sample concentration from the main meter display and temperature from the lower display.

Millivolt Measurements

The Model 290A Meter can be used to measure absolute or relative millivolts. The millivolt modes are useful for potentiometric titrations and preparing calibration curves. Detailed instructions for any ORION electrode are given in the electrode instruction manual. Titration instructions are included in the ORION Redox Electrode (Model 96-78 or 97-78) Instruction Manual, or in standard analytical chemistry texts.

Absolute Millivolts

Absolute millivolts are displayed with 0.1 mV resolution in the range of -1600.0 to +1600.0.

Access the absolute millivolt mode by pressing the **mode** key until the mV mode indicator is displayed.

Relative Millivolts

Relative millivolts are displayed to 0.1 mV resolution over the range of -1999.9 to +1999.9 (Absolute millivolt range of ±1600.0 mV).

1. Select the relative millivolt mode by pressing the **mode** Key until the Rel mV mode indicator is displayed.

2. Set the relative millivolt offset by pressing **2nd cal**. CALIBRATE will be displayed and the current absolute millivolts will be displayed in the main field.

3. When the reading is stable 0.0 will flash. If this is correct press **yes**. Otherwise use the scroll keys to set the desired mV value for the solution. Press **yes** to enter. The meter automatically returns to MEASURE and all Relative millivolt measurements will be based on the offset.

Dissolved Oxygen Measurements

Dissolved oxygen measurements are displayed in ppm when the ORION Model 97-08 Dissolved Oxygen Electrode is used with the ORION Model 290A Meter. Follow these instructions for preparing the meter and calibrating the electrode.

1. Connect the Model 97-08 to meter and leave electrode mode switch "OFF".

2. Disconnect ATC probe.

   Note: ATC probe must not be connected to the meter.

3. Press the **mode** key until the pH mode indicator is displayed.

4. Turn the hold feature (1-2) off.

5. Press **measure**. Using the scroll keys change the temperature value to 25.0°C.

6. Press the **2nd cal** key. Enter the value 7.00 and press **yes**.

7. Press the **measure** key. The slope prompt, SLP will be displayed in the lower field. Enter 100.0 and press **yes**.

   The meter automatically enters the MEASURE mode.

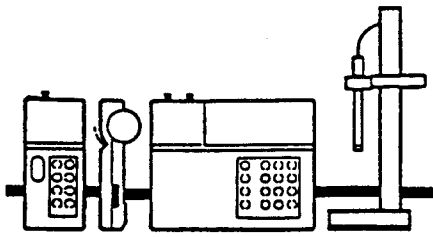
8. Turn the mode switch on the electrode to BT CK. Good battery operation is indicated by a reading of 13.40 or greater on the meter.

9. Turn the mode switch on the electrode to ZERO. Use the zero calibration control to set the meter to read 0.00.

10. Insert the reservoir (funnel) into a BOD bottle containing enough water to just cover the bottom. Insert the electrode, making sure that the electrode tip is not immersed in the water and does not have water droplets clinging to the outside of the membrane. Let stand approximately 30 minutes to ensure water saturation of air in the BOD bottle. This bottle should be used for storage between measurements.

11. Turn the electrode mode switch to the AIR position. If measurements are being made at sea level use the AIR calibration control on the electrode to set the pH meter reading to the prevailing barometric pressure in mm Hg(divided by 100). If the barometric pressure is unknown, if the elevation is above sea level or if the sample has a salinity greater than 2 parts per thousand, consult **Table 1** found in the *Model 97-08 Instruction Manual* to obtain the correct AIR setting.

12. Turn the electrode mode switch to H_2O for sample analysis.



Chapter VII. Temperature Compensation

pH measurements on the Orion portable meters may be made with either Automatic Temperature Compensation (ATC) or Manual Temperature Compensation.

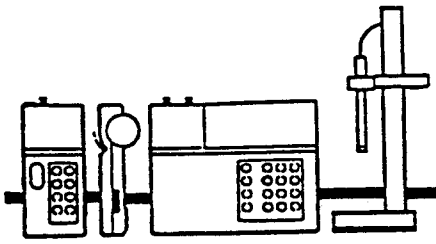
For Automatic Temperature Compensation a temperature probe must be used. Live temperature readings will be displayed in the lower field along with the °C and ATC legends. Temperature corrected pH values will be displayed in the main field.

Disconnect the temperature probe when performing Manual Temperature Compensation. Temperature values can be entered manually while in MEASURE mode using the scroll keys. The value will be displayed in the lower field. Temperature corrected pH values based on the manually entered temperature will be displayed in the main field.

To calibrate using manual temperature compensation all buffers must be at the same temperature. While in measure mode scroll in the temperature value of the buffer(s). Then start the calibration sequence. Follow calibration instructions for your meter. After calibration varying sample temperatures may be entered while in measure mode by using the scroll keys.

The maximum temperature display for either automatic or manual temperature compensation is 105.0°C. The minimum temperature is -5.0°C.

For the **model 250A** and **model 290A** there is no temperature compensation for any mode other than pH. The temperature display in mV, relative mV, and concentration modes reflect the sample temperature only.



Chapter VIII. Use of 250A & 290A with Printers and Computers

The 250A can send information to a printer or other serial peripheral using the RS232-C output. The 290A can be used with either computers or printers and can be controlled remotely from an RS232 communication device. The RS232-C output on the 290A is bi-directional.

The following information can be used to interface the meter to your printer or computer.

Baud rate: 1200.

Eight data bits, no parity.

One start bit, one stop bit.

METER	PIN	PRINTER
RXD	2	
TXD	3	RXD
DSR	4	
SIG GND	5	SIG GND
DTR	6	
RTS	7	
CTS	8	RTS

Jumper 4 + 6 together.

Use ORION Cable, Cat. No. 0ACBL0

Remote Control

The model 290A can be remotely controlled from an RS232 communication device or PC. After making the physical connection between your meter and computing device type REM then enter into your computer to establish communication. The following are the remote control commands

command	function or meaning
+	increase value, scroll up
-	decrease value, scroll down
cal	calibrate
disp	display LCD image
exit	exit remote control
help	displays help menu
meas	measure
mode	change modes
n	no
off	shut down, turn off
setup	setup, go to setup menu
timer	timer, start timer
y	yes
rem	remote log in
mp	prints value, mode, and temperature
pr	print/datalog

Note: help and rem are not displayed in the help menu.

This is an example of a program written in basic which monitors the meter for pH data every five seconds and prints the data if the pH value is less than five.

```
      REM HANDLE ALL SYSTEM ERRORS
      ON ERROR GOTO ERRHANDLE
      CLS
      CLOSE #2
      REM SET THE PARAMETERS FOR THE RS232 PORT
      OPEN "COM1:1200, N, 8, 1" FOR RANDOM AS #2
      REM MAKE SURE WE ARE NOT CURRENTLY LOGGED ON
      GOSUB EXITRC
      PRINT #2, "rem":REM SEND THE LOG ON COMMAND
      INPUT #2, S$:REM FILTER OUT INCOMING
            INFORMATION
      INPUT #2, S$
      INPUT #2, S$
      WHILE 1
        LOGT = TIMER + 5:REM SETUP LOG TIMER
        WHILE (TIMER < LOGT)
          KP$ = "":REM CHECK FOR USER REQUEST TO EXIT
          KP$ = INKEY$: IF KP$ = "E" OR KP$ = "e" THEN GOTO
          ENDPROG

        WEND
        GOSUB CHECKPH:REMCHECK CURRENT READING
        IF (PH <5) THEN GOSUB LOGDATA

      WEND

ERRHANDLE:
      PRINT "SYSTEM ERROR ENCOUNTERED. . ."
      PRINT ERR          :REM INDICATE SYSTEM ERROR CODE

ENDPROG:
      GOSUB EXITRC
      LPRINT "END OF PROGRAM."
      CLOSE #2

      END

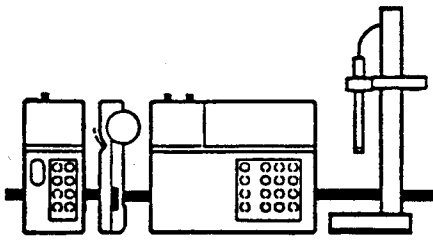
CHECKPH
      PRINT #2, "mp"  :REM SEND THE mp COMMAND TO READ
                       THE CURRENT PH VALUE
      INPUT #2, S$    :REM FILTER OUT INCOMING
                       INFORMATION

      INPUT #2,S1$    :REM CAPTURE CURRENT PH READING
      INPUT #2,S$     :REM FILTER OUT INCOMING
                       INFORMATION
      INPUT #2, S$
      PH = VAL(S1$)   :REM CONVERT THE RECEIVED PH STRING
                       TO VALUE
      RETURN

LOGDATA:
      S$ = ""         :REM CLEAR STRING BUFFER
      PRINT #2, "pr"  :REM SEND THE pr COMMAND TO PRINT
                       THE PH, MV, TEMP AND DATE
      INPUT #2, S$
      FOR I = 1 TO 8
        INPUT #2, S$
        LPRINT S$     :REM DIVERT OUTPUT TO PRINTER

      NEXT I
      RETURN

EXITRC:
      PRINT #2, "exit" :REM LOG OFF
      INPUT #2, S$
      INPUT #2, S$
      RETURN
```



Chapter IX. Troubleshooting

Self-Test

During the self-test the meter will display various codes corresponding to the section of the instrument being checked. If any problems are found an operator assistance code corresponding to the test that failed will be displayed. Note the code and Press any key to continue. See table 1 under operator assistance codes. Should an operator assistance code appear during self test check to make sure the shorting cap is securely attached then repeat the test. If the problem persists contact ORION's Product Service Department at 1-800-225-1480.

During the self test the meter displays 7E57 in the main field and the number of the test in the lower field. Additional meter displays occur depending on the test being performed.

Note: Ensure shorting cap is on prior to self-test.

TEST		FUNCTION/DISPLAY SEQUENCE
Test #1	**Segment Display**	Checks meter display. Ensure all segments are lit.
Test #2	**RAM Check**	Verifies the external RAM is functioning properly.
Test #3	**External Input**	Checks the electrode input channel. The shorting plug must be on for this test to pass properly.
Test #4	**Internal Check**	Internal function test.
Test #5	**Internal Reference**	Checks the internal reference on the meter.
Test #6	**Ground Reference**	Checks the meter ground.
Test #7	**Keypad Test**	Checks that the keypad is functioning properly. During this test all keys must be pressed at the 0 prompt. Press each key. As each key is pressed a number corresponding to each key is displayed. When all keys have been pressed the ready is turned on. If no keys are pressed or there is a problem with a key the meter will recognize an error and display E-7. Press yes to continue.
Test #8	**Autoshutoff Test**	Checks the meter autoshutoff feature. The display clears then the meter shuts off. The 230A remains off. After 5 seconds the model 250A and 290A turn on again and resume normal operation.

Note: If any operator assistance codes appear, make a note of each then press yes to continue.

Operator Assistance Code

Operator Assistance Codes are used to inform the user of an out of range value or meter problem. The following tables outline the operator assistance codes available in the portable meter series.

The meter has a self test circuit which verifies proper electronic operation. During self test a special series of codes, E-00 through E-08 indicate a problem with the meter hardware. See Table I. Should one of these codes appear contact ORION's Product Service Department at 1-800-225-1480.

Table I
Self Test Operator Assistance Codes .

E-2	Ram Check Error
E-3	Input Channel Error: Check to make sure the shorting cap is securely in place on the input connector and repeat self-test.
E-4	Internal Check
E-5	Internal Reference Error
E-6	Ground Test Error
E-7	Internal Keypad Error: Press each key while in self test, if code persists contact ORION Product Service Group
E-8	Instrument Shutdown Error

The Operator Assistance Codes E-20 through E-32 alert the user to a potential problem while calibrating or measuring. Several steps can be taken to eliminate the problem in each case. If the code persists after trying the suggested remedies contact ORION Product Service Group.

Table II

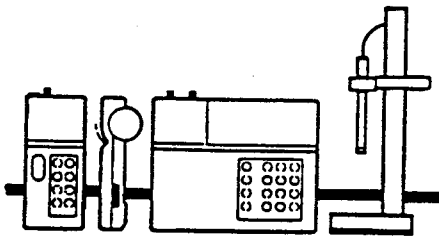
E-20	out of range pH, mV, Rel mV, or conc out of range	1. If this occurs when electrodes are out of solution, code will disappear when electrodes, are returned to solution. 2. Verify electrodes are properly connected. 3. Sample may be out of range, check a buffer or standard. 4. Check slope value. On the 250A or 290A check the isopotential point setting. 5. Recalibrate using fresh buffers or standards. 6. Check that ATC probe is connected properly and make sure temperature is within -5.0 to 105.0°C.

E-21	ABR error pH autocalibration error	Electrode voltage being measured is > ±0.5 pH units from the nominal value for the pH buffer 1. Verify buffer is either 1.68*, 4.01, 7.00, 10.01, or 12.45*. (290A only*) 2. Press any key and recalibrate that point using fresh buffer 3. Clean electrodes and refill reference electrode. Recalibrate. 4. Perform a manual calibration. Some electrodes may operate outside of the range for pH autocalibration. This may be more evident as an electrode ages and is normal.
E-22	Calibration Standard Error	The millivolts being measured are the same for two different standards or buffers. 1. Press any key to acknowledge. 2. Check that two different standards or buffers are being used and that the correct one is being measured. 3. Make fresh standards or buffers and repeat the last calibration point or the entire calibration.
E-23	Bad Slope	pH electrode slope not in the range of 80% to 120% 1. Press any key to acknowledge and repeat calibration using fresh buffers. 2. Clean electrodes and refill reference electrode. 3. Refer to electrode instruction manual for instructions on how to checkout electrode operation.
E-26	Datalog Full	The datalogger is full and cannot store any more points. A maximum of 25 points may be stored. 1. Transfer data to a printer or computer. 2. Clear the data from memory. Go to 6-4 in the setup menu and press yes. Once the data has been cleared additional points may be logged.

E-27	Data Transfer Error.	There is a problem in transferring data from the datalogger on the 290A to a printer or computer. 1. Check to make sure the printer or other device is securely plugged into the RS232-C port on the right hand side of the meter. 2. Check to make sure your printer or computer is on and ready to receive information from the meter. 3. Check your cable to make sure it matches the pin configuration provided on page 45. Use Orion Cat. No. 0ACBL0 for IBM PC or compatible devices.
E-29	Printer Error; Model 250A and 290A only.	The meter is sending information to a printer and there is no printer plugged into the meter or the printer is not turned on. 1. Plug in the printer and turn it on. 2. If no printer is available select manual print in the setup menu.
E-31	Bad Value	A value has been entered which is not within the exceptable range for that function. 1. Press any key to acknowledge the error. 2. Re-enter a new value within the allowable range. Exceptable values are as follows: **pH;** -2.00 to +19.999. **pH slope;** 80% to 120% **timer interval;** 5 seconds to 23 hours, 59 minutes and 59 seconds **relative millivolts;** -1999.9 to +1999.9 (250A and 290A) **concentration;** 0.000 to 19900 (290A)
E-32	Blank Error. Model 290A only. The meter is unable to calculate a blank value.	This error occurs during a 3 or more point calibration when one solution has been defined as zero concentration and the actual concentration of the blank is substantially greater than the standard with the third highest concentration. This can also occur during a one or two point calibration if one of the standards is defined as zero. 1. Check to make sure electrodes were placed in the proper standards and blank solution and recalibrate. 2. Repeat calibration using fresh blank and standards. 3. Recalibrate using two standards of known concentration other than zero.

Troubleshooting Guide

MALFUNCTION	POSSIBLE CAUSE	REMEDY
No Display	No power to meter	Press the power key. Check to ensure battery is inserted correctly and polarity signs match. Replace batteries if operating on battery power. Check that the line converter is plugged in securely.
	Autoshutoff may be turned on.	When the Autoshutoff feature is on the meter will automatically shut down if no keys have been pressed within 10 minutes. Press the power key to turn the meter on. If this feature is not desired turn autoshutoff off. Go to 1-4 in the setup menu and change the setting.
Erratic Readings or Reading Out of Range	Meter or electrode failure	Follow the meter check out procedure which pertains to your meter. Check electrode operation by following the instructions in the electrode instruction manual.
Trouble Calibrating in Autocalibration	Some electrodes may operate outside the limits of ± 0.5 pH units	Perform a manual calibration. Check temperature and slope then repeat calibration. Buffers used may be out of specification. Repeat calibration using buffers from a fresh lot.



Chapter X. Instrument Warranty

These warranty programs go into effect for listed products when purchased by the user after July 1, 1989. These warranties supersede all previous Orion product warranties.

Orion warranty covers failures due to manufacturer's workmanship or material defect from the date of purchase by the user. User must return the warranty card to Orion and retain proof of purchase. Warranty is void if product has been abused, misused, or repairs attempted by unauthorized persons.

A Return Authorization Number must be obtained from Orion Laboratory Products Service before returning any product for in-warranty repair, replacement or credit.

Laboratory pH, pH/ISE Meters & Sage Pumps are warranted to be free from defects in material and workmanship for a period of twelve (12) months from the date of purchase by the user or eighteen (18) months from date of shipment from Orion, whichever is earlier, provided when used under normal laboratory conditions and in accordance with the operating limitations and maintenance procedures in the instruction manual and when not having been subjected to accident, alteration, misuse, or abuse.

In the event of failure within the warranty period, Orion, will, at Orion's option, repair or replace product not conforming to this warranty, or will refund the purchase price of the non-conforming product. There may be additional charges, including freight, for warranty service performed in some countries. For service, call Orion (or its authorized dealer outside North America). Orion reserves the right to ask for proof of purchase, such as the original invoice or packing slip.

Economy Line Electrodes are warranted to be free from defects in material and workmanship for a period of three (3) months from date of purchase by customer or six (6) months from date of shipment from Orion, whichever is earlier. If the electrode fails for any reason (including breakage), except abuse, provided the electrode is not used in solutions containing silver, sulfide, perchlorate, or hydrofluoric acid; or in solutions more than 1 molar in strong acid or base at temperatures above 50°C, and providing the electrode is used at room temperature (use at extreme temperatures can shorten electrode life). For service, Orion (or its authorized dealer outside North America) will replace product not conforming to this warranty or refund the purchase price of the nonconforming product.

Ion-selective Electrodes and pH Electrodes (excluding the Economy Line electrodes) are warranted to be free from defects in material and workmanship for a period of twelve (12) months from the date of purchase by the customer or eighteen (18) months from date of shipment from Orion, whichever is earlier, except this warranty does not cover etching of the sensing elements of Models 94-17, 96-17, 97-17, and 94-06 or the breakage of non-Economy Series pH electrodes. 93 Series sensing modules are warranted to give six (6) months of operation if placed in service before the date indicated on the package, except the nitrate sensing modules are warranted to give thirty (30) days of operation if placed in service before the date indicated on the package. Replacement parts for the 92 and 95 Series electrodes and the 97-08 electrode (O-rings, membranes, filling solution, etc.) are warranted to be free of defects in material and workmanship for thirty (30) days from the date of shipment from Orion.

All other ORION pH electrodes, temperature probes, and compensators are warranted for one year from date of purchase.

ORION Meter and Electrode Accessories carry an "out-of-box" warranty. Should they fail to work when first used, contact Orion immediately for replacement.

Should ORION Solutions of Buffers be unusable when first "out-of-box," contact Orion immediately for replacement.

Series 100 Conductivity Meters and Series 800 Dissolved Oxygen Meters and Dissolved Oxygen Probes are warranted to be free from defects in material and workmanship for a period of twenty-four (24) months from the date of purchase by the user or thirty (30) months from the date of shipment from Orion, whichever is earlier; provided when used under normal laboratory conditions and in accordance with the operating limitations and maintenance procedures in the instruction manual and when not having been subjected to accident, alteration, misuse or abuse. Conductivity cells carry a one year warranty (warranty does not include coverage for broken glass cells once placed in use) from date of purchase. Dissolved Oxygen Probe Membranes carry an "out of box" warranty.

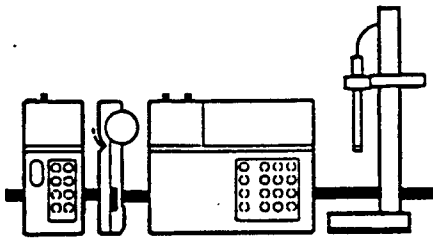
Series 100 Conductivity Cells are warranteed for one year (warranty does not cover breakage of glass cells once placed in use) from date of purchase by the user or eighteen (18) months from Date of Shipment from Orion, whichever is earlier.

Series 800 Dissolved Oxygen Probe Membranes are warranted against "out-of-box" failure.

THE WARRANTIES DESCRIBED ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER STATUTORY, EXPRESS OR IMPLIED INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND ALL WARRANTIES ARISING FROM THE COURSE OF DEALING OR USAGE OF TRADE. THE BUYER'S SOLE AND EXCLUSIVE REMEDY IS FOR REPAIR OR REPLACEMENT OF THE NON-CONFORMING PRODUCT OR PART THEREOF, OR REFUND OF THE PURCHASE PRICE, BUT IN NO EVENT SHALL ORION (ITS CONTRACTORS AND SUPPLIERS OF ANY TIER) RELIABLE TO THE BUYER OR ANY PERSON FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHETHER THE CLAIMS ARE BASED IN CONTRACT, IN TORT (INCLUDING NEGLIGENCE), OR OTHERWISE WITH RESPECT TO OR ARISING OUT OF THE PRODUCT FURNISHED HEREUNDER.

Representations and warranties made by any person, including its authorized dealers, representatives, and employees of Orion which alter or are in addition to the terms of this warranty shall not be binding upon Orion unless in writing and signed by one of its officers.

REMEMBER: For in- or out-of-warranty repair or service, contact Orion Product Service. Product Service will issue a Return Authorization (RA) for all warranty services. You must have an Orion RA prior to returning/forwarding any product to Orion.

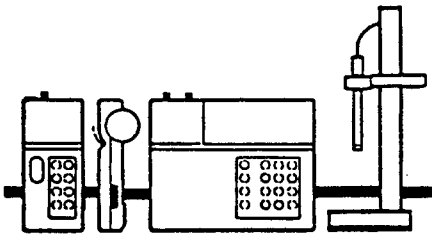


Chapter XI. Repair and Service

A Return Authorization Number must be obtained from Orion Laboratory Product Service Department before returning any product for in-warranty or out-of-warranty repair, replacement, or credit.

Consult your authorized Orion dealer, or:

ORION RESEARCH INCORPORATED
The Schrafft Center
529 Main Street, Boston, Massachusetts 02129
TELEPHONE 617-242-3900 or 1-800-225-1480
TELEX 4430019
FAX 617-242-7885
Outside of North America contact your authorized Orion dealer.



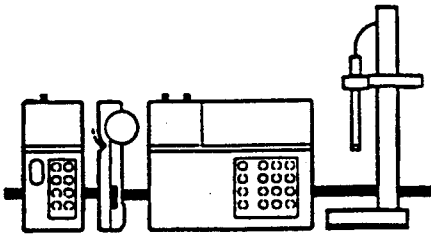
Chapter XII. Notice of Compliance

Warning: This meter may radiate radio frequency energy and if not installed and used properly, that is in strict accordance with the manufacturer's instructions, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a commercial environment. Operation of the meter in a residential area may cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

Note: To meet or exceed FCC Compliance ORION supplied wall adaptors must be used with these products.

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la class A prescrites dans le Règlement sur le brouillage radioélectrique édicté par le ministère des Communications du Canada.



Chapter XII. Ordering Information

Orion Cat. No.	Description
0230A0	Model 230A Portable pH/Temperature Meter. Includes Orion Triode combination pH and ATC electrode.
0250A0	Model 250A Portable pH/Temperature/mV Meter. Includes Orion Triode combination pH and ATC electrode.
0290A0	Model 290A Portable pH/ISE/Temperature/mV Meter. Includes Orion Triode combination pH and ATC electrode.
0PBLSK	Starter Kit for Portable Meters, includes Rugged Carrying Case, Electrode Holder and Stand, one each of Electrode Storage Solution 2 oz., two each of pH 4 Buffer Solution, 2 oz., pH 7 Buffer Solution, 2 oz., and pH 10 Buffer Solution, 2 oz., one 150 mL plastic beaker, and two electrode clips.
0900A0	Portable Printer for Orion Meters. Includes rechargeable battery and one roll of printer paper.
0900A1	Portable Printer for Orion Meter. Same as above except 220 V.
0ACBL0	RS232 Interface Cable for use with computers IBM PC or compatible devices.
915700	ORION Triode 3 in 1 Combination pH/ATC Probe for ORION A Series Meters
917005	ATC Probe for ORION A Series Meters
8102BN	Ross Combination Glass pH Electrode
8172BN	Ross SURE-FLOW Combination Glass pH Electrode
8165BN	Ross SURE-FLOW Epoxy-Body Combination pH Electrode
8175BN	Ross SURE-FLOW Semi-Micro Epoxy-Body Combination pH Electrode
090070	Electrode Holder and Stand
020125	Line Converter, 110V
020130	Line Converter, 220V
910104	pH 4 Buffer Solution, 475 ml
910107	pH 7 Buffer Solution, 475 ml
910110	pH 10 Buffer Solution, 475 ml
910001	pH Electrode Storage Solution, 475 mL
212843-001	Electrode clip
213945-A01	Electrode Storage Compartment

Note: A wide selection of Ion Selective Electrodes and other replacement parts are available. Contact Orion or your local authorized distributor for more information.

SPECIFICATIONS

	230A	250A	290A
pH range	-2.00 to 19.99	-2.00 to 19.99	-2.000 to 19.999
resolution	0.01	0.01/0.1	0.001/0.01/0.1
relative accuracy	±0.02	±0.02	±0.005
slope	80% to 120%	80% to 120%	80% to 120%
concentration range			0.000 to 19900
resolution			± one least significant digit
relative accuracy			±0.5% of reading
millivolt range		-1600.0 to +1600.0	-1600.0 to +1600.0
resolution		0.1 mV	0.1 mV
relative accuracy		0.2 mV or±0.05% of ΔE whichever is greater	0.2 mV or ±0.05% of ΔE whichever is greater
relative millivolt range		-1999.9 to +1999.9	-1999.9 to +1999.9
resolution		0.1 mV	0.1 mV
relative accuracy		0.2 mV or ±0.05% of ΔE whichever is greater	0.2 mV or ±0.05% of ΔE whichever is greater
temperature	-5.0 to 105.0°C	-5.0 to 105.0°C	-5.0 to 105.0°C
resolution	0.1°C	0.1°C	0.1°C
relative accuracy	±1.0°C	±1.0°C	±1.0°C
display	Custom LCD	Custom LCD	Custom LCD
inputs	BNC, pin tip, ATC, power	BNC, pin tip, ATC, power	BNC, pin tip, ATC, power, RS232-C
outputs		RS232-C	RS232-C
power requirements	one 9V alkaline battery, or one 9V lithium battery, or line adapter for either 110 or 220 VAC, 50/60 Hz wall outlet		
input impedance	>10^{12} ohms		
instrument drift	< 50 microvolts/°C		
input bias current	< ± 1 picoamp at 25°C and < ± 4 picoamps over full operating range		
environmental requirements	5 to 45 °C and 5 to 85% relative humidity, non-condensing		
meter dimensions	8.08 x 3.26 x 1.90 inches		
case	Dust and Splash Resistant, Chemical Resistant		

GA90

Infra-Red Gas Analyser
Instrument Manual

HAZCO Services, Inc.

Operating Manual

Infra-red Gas Analyser

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Warning

The Geotechnical Instruments (U.K.) Ltd. GA 1.1 Gas Analyser Unit is not yet certified to any BASEEFA standards - it therefore is NOT classified as intrinsically safe.

The Readout must NOT be used in confined areas (e.g. basements, mines, sewers, manholes, enclosed buildings, etc...) or any area that could be considered potentially hazardous.

It is vital that this instruction be followed absolutely, since any instrument which is not classified as intrinsically safe could cause an explosion resulting in serious injury or death.

BASEEFA approval is being sought and it is envisaged that later models will be classified as intrinsically safe.

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Introduction - General

The Infra-Red Gas Analyser has been designed to obtain accurate data on the concentrations of the main constituents of Landfill gas - Methane, Carbon Dioxide and Oxygen. In addition, an electronic pressure transducer can be fitted in order to measure atmospheric pressure at the time of analysing a gas sample.

The unit is capable of storing 1750 sets of readings (1 set = 3 gas concentrations plus atmospheric pressure) together with the date and time that they were obtained. Facilities for viewing and deleting readings are also provided. Readings may be downloaded to an IBM or compatible computer via an integral RS232C interface.

The outer case is constructed from moulded glass reinforced plastic, making the unit light but robust. It is environmentally sealed and may be used in severe weather conditions.

The Infra-Red Gas Analyser has been developed with the user very much in mind. The membrane switch panel has audio feedback and a series of menus are presented to the operator - thus permitting interaction with ease.

The unit is also fitted with an automatic power-off device in order to conserve power. Thus if no key is pressed for 15 minutes then the unit will automatically switch itself off (no stored readings will be lost).

The unit is supplied complete with the following accessories -

Carrying Strap

Sampling Probe

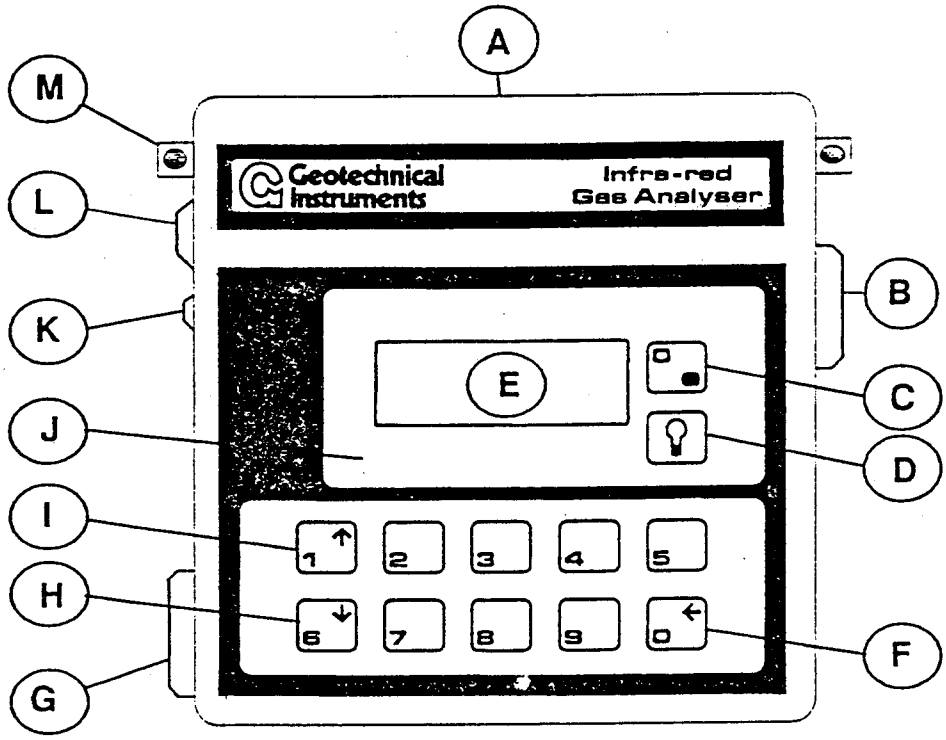
1m (3ft) of Sampling Tube

In line Water Trap with Spare Filter

Spare Inlet Filter

Battery Charger and Lead

Operating Manual



Infra-red Gas Analyser

A - GRP Outer case
B - Inlet port and replaceable filter
C - On/Off key
D - Backlight key (Not operational)
E - Graphic LCD
F - Exit key - press once. Rubout key - keep pressed
G - Exhaust port
H - Cursor down
I - Cursor up
J - Membrane panel
K - 4 pin charging socket
L - 7 pin RS232C socket
M - Carrying strap attachments

Maintenance

Operating Manual
Although the Infra-Red Gas Analyser is very easy to control, we strongly recommend that this Operating Manual is read prior to use.

Servicing
The unit will have been electronically and functionally tested before it leaves our factory and in order to keep the unit in perfect working order we recommend that it is returned to us at six monthly intervals for routine servicing, maintenance and calibration.

Cleaning
The polycarbonate membrane panel may be wiped clean with soapy water and a damp cloth if required. We do not recommend any other cleaning agents.

Sunlight
The unit should not be left out in direct sunlight for long periods of time as this will raise the temperature inside the case which could cause damage to components.

Dustcaps
Always replace the protective dust caps on the sockets and on any leads.

Filter
It is important that the replaceable filter (fitted inside the inlet port) is regularly changed. It should be replaced -

If the aspirator pump has difficulty in drawing a sample of gas into the unit (indicated by an continuous warning note and a Flow Fail message on the screen).

If the filter has been allowed to become wet (also maybe indicated by an audible warning note and Flow Fail indicator).

The filter is changed as follows -

Remove the Sampling Tube from the Gas Analyser by carefully pulling the tube from the Inlet nozzle.

The filter inlet nozzle is removed by inserting a suitable coin in the groove cut into the nozzle end and turning in an anti-clockwise direction. When the nozzle is removed, the old filter will be attached to the rear of the nozzle. This filter can be removed by using your fingers.

Carefully locate a new filter onto the rear of the nozzle, ensuring it is firmly located. It is important that only genuine Geotechnical Instruments (U.K.) Ltd filters are used with the Gas Analyser or the performance and safety of the unit may be at risk. When the new filter is in position, carefully replace the nozzle in the Gas Analyser and using the coin in the groove, turn until it is finger tight.

Storage
If the unit is to be stored for a long period, the internal batteries should be fully charged prior to storage and then checked and charged every 2 months during storage. **Failure to do this may cause damage to the batteries**

Important
Although the Infra-Red Gas Analyser is housed in a rugged environmentally sealed case, it must be noted that it is an advanced scientific instrument and should be treated as such.

Battery Charging
Please follow these instructions carefully

The internal battery of the Infra-red Gas Analyser is comprised of a series of Nickel-Cadmium cells with a maximum output of 8.4volts D.C.

It must only be charged with a Geotechnical Instruments Battery Charger (provided with the unit).

It is important that the battery is not overcharged, as this could result in damage to one or more of the cells.

There is a linear relationship between battery capacity used and the required charging time. Reference to paragraph 1.2.1 of this Manual shows how to determine the available battery capacity.

The following table should be strictly adhered to.

Available Capacity without pump (see Paragraph 1.2.1)	Maximum Charging Time
6.6 hours	Nil hours
6.0	2.0
5.0	4.0
4.0	6.0
3.0	8.0
2.0	10.0
1.0	12.0
0.0	14.0

Note: The above Table applies to all Gas Analysers with "supply = 100" marked on their serial number plate.

The battery charger is fitted with two lights -

Red/orange Neon - indicates the mains power is on.

Green L.E.D. - indicates that charging is in process.

Note this light will not diminish with charging time and is not to be used as an indication of the charge state of the Gas Analyser.

The green light will only go out if the 4 pin connector is removed from the Gas Analyser when the mains supply is on. Thus it is important to be aware of the exact charging time required and avoid leaving the charger and Gas Analyser connected for excessive periods.

Battery Capacity
If the readout unit is repeatedly given small "top-up" charges, the battery capacity can be reduced resulting in an incorrect available capacity display. To restore the battery to full capacity, totally discharge the unit and then charge for a full 14 hour period.

Battery Shut-off
A circuit within the Gas Analyser continuously monitors the battery voltage. If the battery voltage falls below a pre-determined level the unit will automatically shut itself off in order to prevent memory loss. If the unit shuts itself off when the battery display shows capacity still available, then the unit requires a full charge of 14 hours to restore the battery to its maximum level.

Automatic Power-off
The unit is also fitted with an automatic power-off device in order to conserve power. Thus if no key is pressed for 15 minutes then the unit will automatically switch itself off (no stored readings will be lost).

Calibration Check
It is important to check the accuracy of the Gas Analyser periodically in order to ensure continued reliability. To perform a Calibration Check you will need -

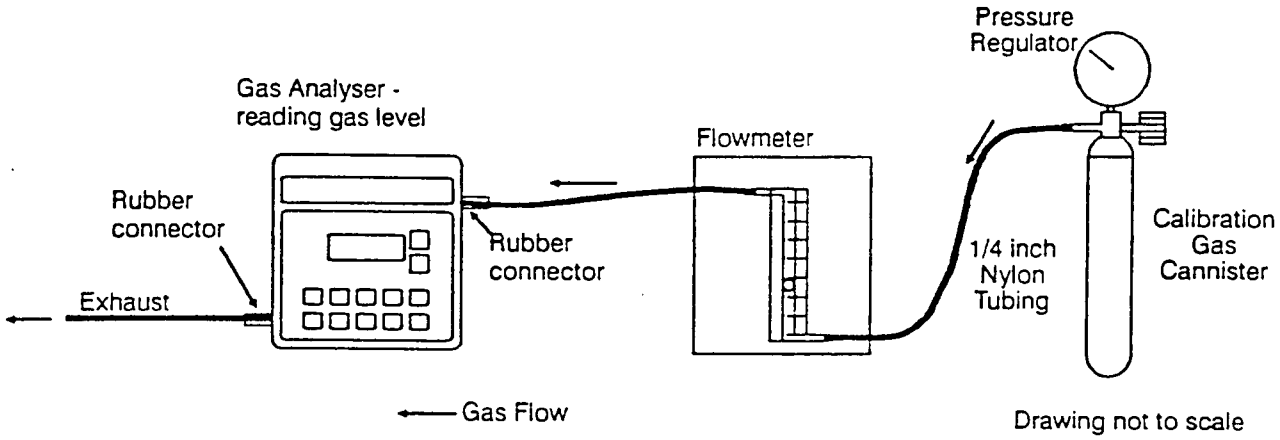
Equipment
1. A cannister of Calibration Gas fitted with a pressure regulator capable of regulating in the range 0 - 10psi. This is a pre-prepared mixture of gases, of which the important constituents are Methane and Carbon Dioxide at known percentages. The cannister must be fitted with suitable connectors for the 1/4inch nylon tubing.

2. A Flowmeter, capable of measuring in the range 60 - 600cc per minute maximum and fitted with suitable connectors for the 1/4inch nylon tubing.3. Three 600mm lengths of 1/4inch Type 11 nylon tubing.

4. Two 50mm long rubber tubing connectors, 3/16inch I.D. x 1/8inch wall thickness, for connecting the nylon tubing to the inlet and exhaust ports of the Gas Analyser.

All this equipment is available from Geotechnical Instruments Ltd. Other types of tubing can be used but the connections must be airtight and secure.

Calibration Procedure
1. Connect the Calibration Gas cannister to the flowmeter and the flowmeter to the gas Analyser using two lengths of the 1/4inch nylon tubing. The third length of nylon tubing is to provide an exhaust outlet for the Calibration Gases. The two 50 mm lengths of rubber tubing are to push onto the inlet and exhaust nozzles of the analyser and then insert the nylon tubing inside the rubber tubing for a secure connection.
This diagram shows the arrangement -



2. Prior to flowing any gas the readout unit must be auto-zeroed as descibed in section 1.3.

3. Allow the Calibration Gas to flow into the sampling chamber at a rate of no more than 300cc per minute maximum and at a maximum pressure of 5psi.

4. Switch on the Gas Analyser and follow the **Read Gas Level** operation (see Section 2, page 22), **but do not use the pump facility to draw the calibration gas** into the analyser or the calibration check will be inaccurate.
When the display has stabilised the readings should correspond to the known percentages of the Calibration Gas within the tolerances given in the table below.

IMPORTANT SAFETY PROCEDURES: The Calibration Gas used must be a Regulated Supply with a restricted flow rate of 300cc per minute maximum. Always use a low pressure of less than 5p.s.i. No high pressures are to be used.

The exhaust tubing must emerge in a well vented area. Ensure there are no leaks in the tubing and connections otherwise explosive gas concentrations could occur.

No naked lights and No Smoking are allowed in the area of calibration testing.

If the readings do not generally correspond with the Calibration Gas percentages, within the tolerances, then the Gas Analyser should be returned to Geotechnical Instruments for re-calibration.

Concentration	Typical Accuracy		
	CH_4% by Volume	CO_2% by Volume	O_2% by Volume
0-5% (LEL CH4)	± 0.5%	± 0.5%	± 1.0%
5-15% (UEL CH4)	± 1.0%	± 1.0%	± 1.0%
5-100% (30%	± 3.0%	± 3.0%	± 1.0%

Note: If a Barometric Sensor option is not fitted then an additional error of 1.0% of reading, per 10 mbar difference, between original calibration pressure and the pressure during checking could be obtained.

Starting Up

Switch on at the Gas Analyser by pressing the **red key** ("C" on the illustration, page 5). The Warning Display will appear thus -

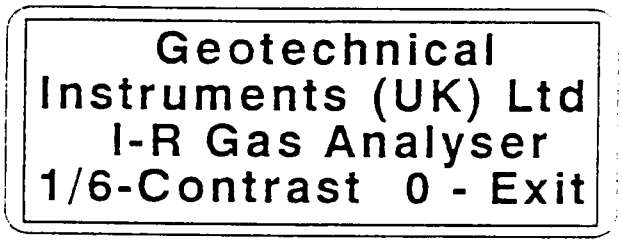


The Gas Analyser is not yet certified to any BASEEFA standards , therefore it is NOT classified as intrinsically safe. The Readout must not be used in confined areas (e.g. basements, mines, sewers, manholes, enclosed buildings, etc...) or any area that could be considered potentially hazardous.

It is vital that this instruction be followed absolutely, since any instrument which is not classified as intrinsically safe could cause an explosion resulting in serious injury or death.

BASEEFA approval is being sought and it is envisaged that later models will be classiified as intrinsically safe.

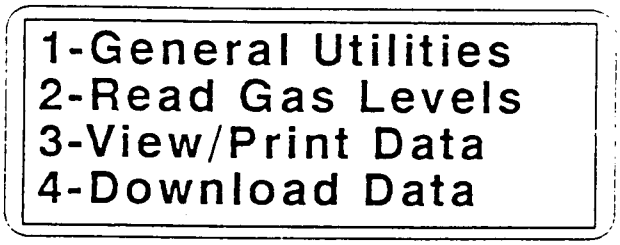
After **5** seconds, the Warning Display will be replaced by the Title Display -



Display contrast can now be adjusted as follows.

Press **key 1** to increase contrast and press **key 6** to decrease contrast.

The new setting of contrast will remain in the memory of the unit, even when it is switched off. When the desired level of contrast has been selected press **key 0** to continue. When **key 0** is pressed, the **Main Menu** will appear.



The main purposes of each of the options are as follows.

1. General Utilities
This option allows the operator to -
check that the internal clock is operating correctly
check that the battery is charged
check that the alarm levels are set as required
auto-zero the unit
check that there is sufficient storage capacity available in memory.

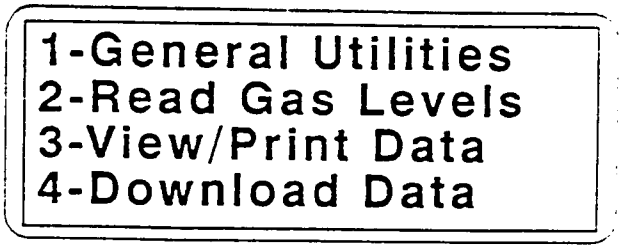
2. Read gas Levels
Allows the operator to obtain and store readings of gas concentrations. Also allows control of data logging functions (where option is fitted).

3. View/Print Data
Allows scanning of all readings stored in the memory and also enables hard copies to be printed.

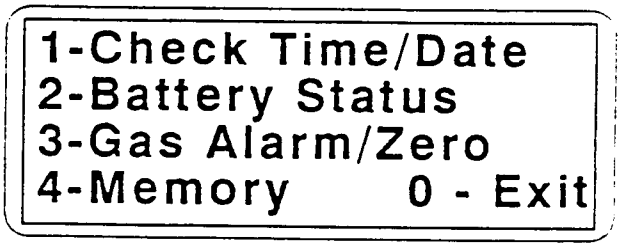
4. Download Data
Enables stored readings to be downloaded to any IBM or compatible computer for archiving and processing.

1. General Utilities

This part of the manual describes how to enter pre-set information which will be stored in the memory of the Gas Analyser. It also indicates how to check the status of the battery and the memory.
From the **Main Menu**



Press **key 1** to reveal the **General Utilities Menu** thus -

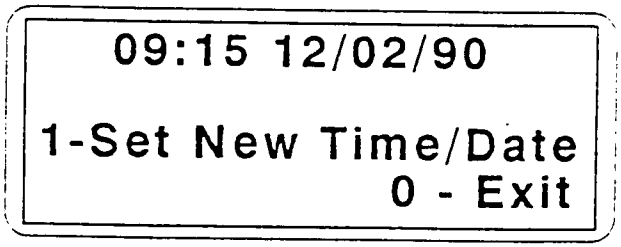


1.1 Check Time/Date

1.1.1 The gas sampler contains a real time clock and calendar which is powered by an internal secondary battery pack. These functions are maintained even when the unit is switched off.

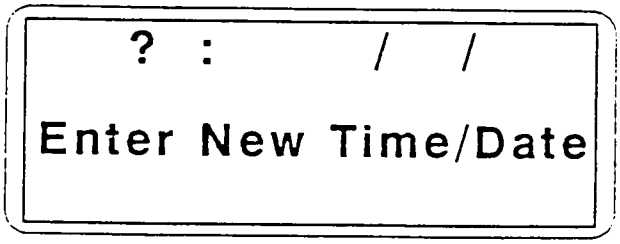
When readings are stored, then the time and date will also be stored automatically. Both the clock and calendar are preset to U.K. time during manufacture. We advise that you check that the settings correspond with local time prior to use as follows -

1.1.2 From the **General Utilities Menu**, press **key 1**. The screen will then display the current time and date -



1.1.3 If the time and date are correct, press **key 0** to return to the **General Utilities Menu**.

1.1.4 If they require resetting, press **key 1**. The following screen will appear



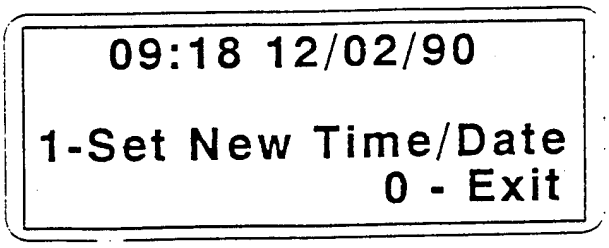
1.1.5 The new time and date should be entered as prompted by the question mark in the format.

Hours:Minutes Days/Months/Years

Use two digits for each part of the entry (e.g. **08 = August**) and make use of the **rubout key (key 0, keep it pressed)** to correct any errors.

1.1.6 If an attempt is made to enter an impossible time/date, it will not be accepted - the complete entry must be recommenced.

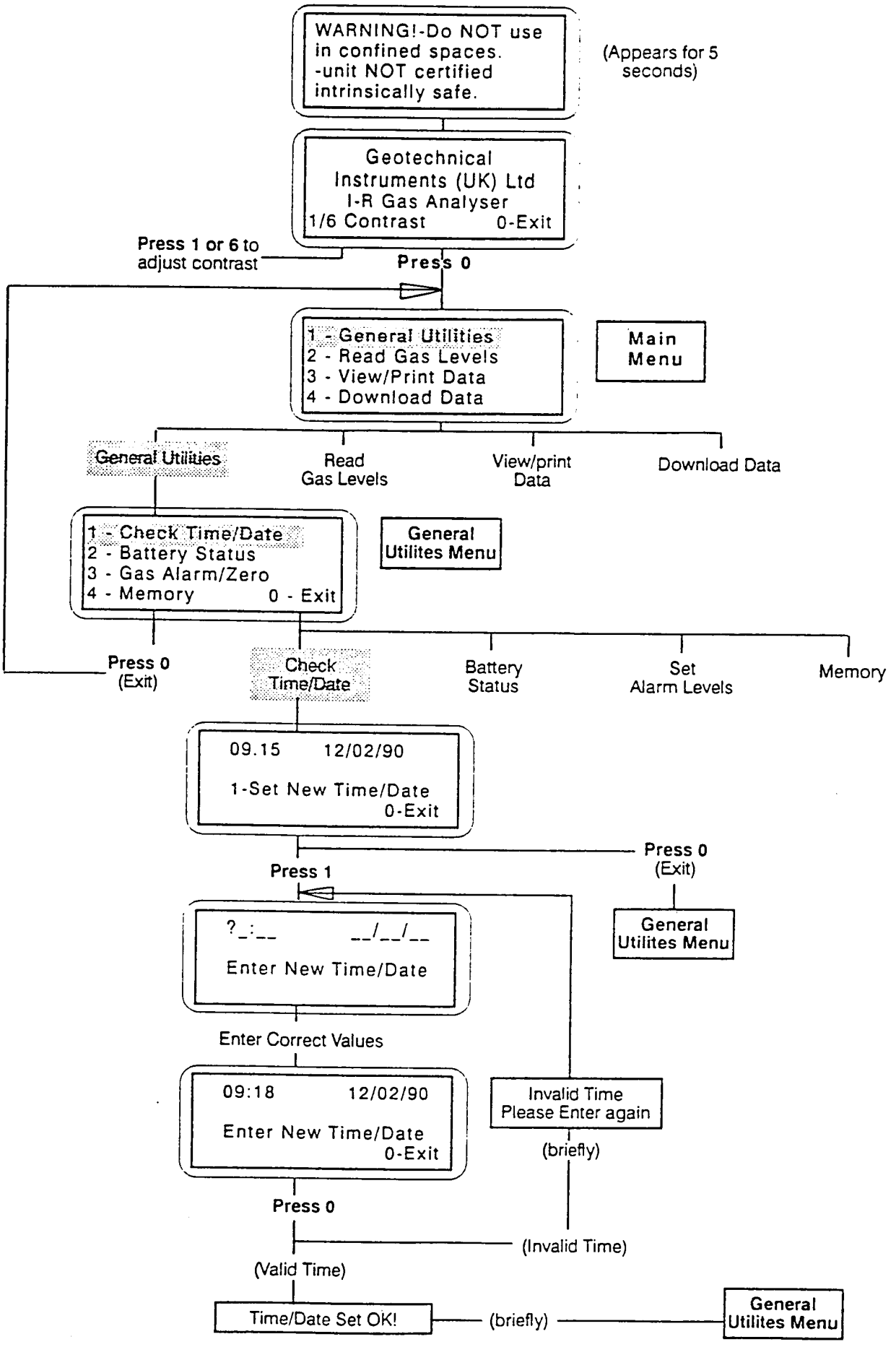
1.1.7 When the complete time/date has been entered, the message **0 - Exit** will appear on the screen thus -



1.1.8 Now pre. J and the message

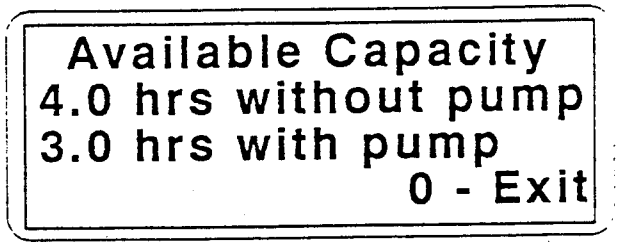
Time/Date Set OK!

will appear briefly, prior to the **General Utilities Menu** being redisplayed.


WARNING!-Do NOT use in confined spaces. -unit NOT certified intrinsically safe.
(Appears for 5 seconds)
Geotechnical Instruments (UK) Ltd
I-R Gas Analyser
1/6 Contrast 0-Exit
Press 1 or 6 to adjust contrast
Press 0
1 - General Utilities
2 - Read Gas Levels
3 - View/Print Data
4 - Download Data
Main Menu
General Utilities
Read Gas Levels
View/print Data
Download Data
1 - Check Time/Date
2 - Battery Status
3 - Gas Alarm/Zero
4 - Memory 0 - Exit
General Utilites Menu
Press 0 (Exit)
Check Time/Date
Battery Status
Set Alarm Levels
Memory
09.15 12/02/90
1-Set New Time/Date
0-Exit
Press 0 (Exit)
Press 1
General Utilites Menu
?_:__ __/__/__
Enter New Time/Date
Enter Correct Values
09:18 12/02/90
Enter New Time/Date
0-Exit
Invalid Time Please Enter again
(briefly)
Press 0
(Invalid Time)
(Valid Time)
Time/Date Set OK!
(briefly)
General Utilites Menu

1.2 Battery Status

1.2.1 From the **General Utilities Menu**, select **key 2 (Battery Status)**. The following screen will appear -



1.2.2 The Gas Analyser is powered by an internal rechargeable 8.4volt Nickel-Cadmium battery. This is sufficient to provide power for approximately

6.6 hours without use of the aspirator pump

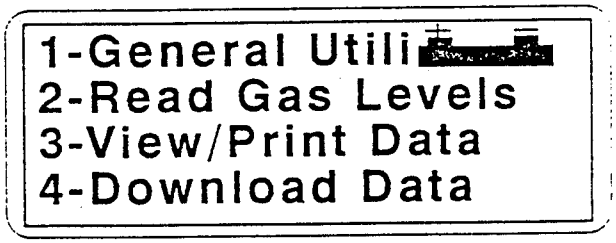
5.0 hours if the pump is used normally.

A counting device monitors the charge state of the battery and interprets this information to give time estimates of the available battery capacity with and without use of the aspirator.

1.2.3 If **key 0** is pressed, the operator will be returned to the **General Utilities Menu.**

1.2.4 When the available battery capacity has dropped to 10% of a full charge, a battery low symbol will appear at the top right hand corner of the screen, irrespective of the display at that time.

For example, if the **Main Menu** was being displayed, the screen would change to -



1.2.5 When this symbol first appears, battery capacity will be sufficient to operate the unit for approximately

30 mins without using the pump

20 mins with normal use of pump.

It is therefore imperative that the battery is recharged as soon as possible.

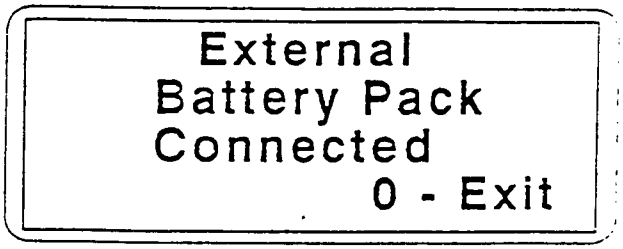
1.2.6 The unit is charged via a 4 pin socket on the left-hand side of the case. Only Geotechnical Instruments chargers should be used with the Gas Analyser.

1.2.7 Please ensure that Battery Charging Instructions (given on page 7) are followed very carefully. It is vital that overcharging is not allowed to occur.

1.2.8 Please note that the Gas Analyser is fitted with an Automatic Power-off device in order to conserve power. Thus if no key is pressed for 15 minutes, the unit will automatically switch itself off (no stored readings will be lost if this occurs).

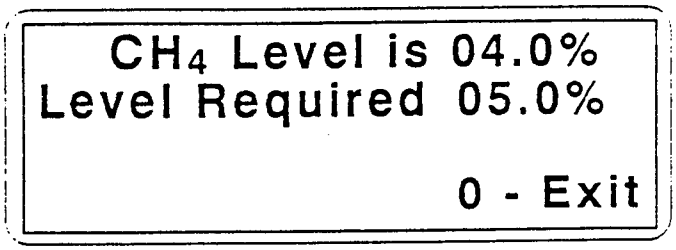
1.2.9 If an external Battery Pack has been connected to the charging socket of the unit, the appearance of the screen shown in **paragraph 1.2.1** will be prevented.

In this case, if **key 2 (Battery Status)** is selected from the General Utilities menu then this screen will be displayed.



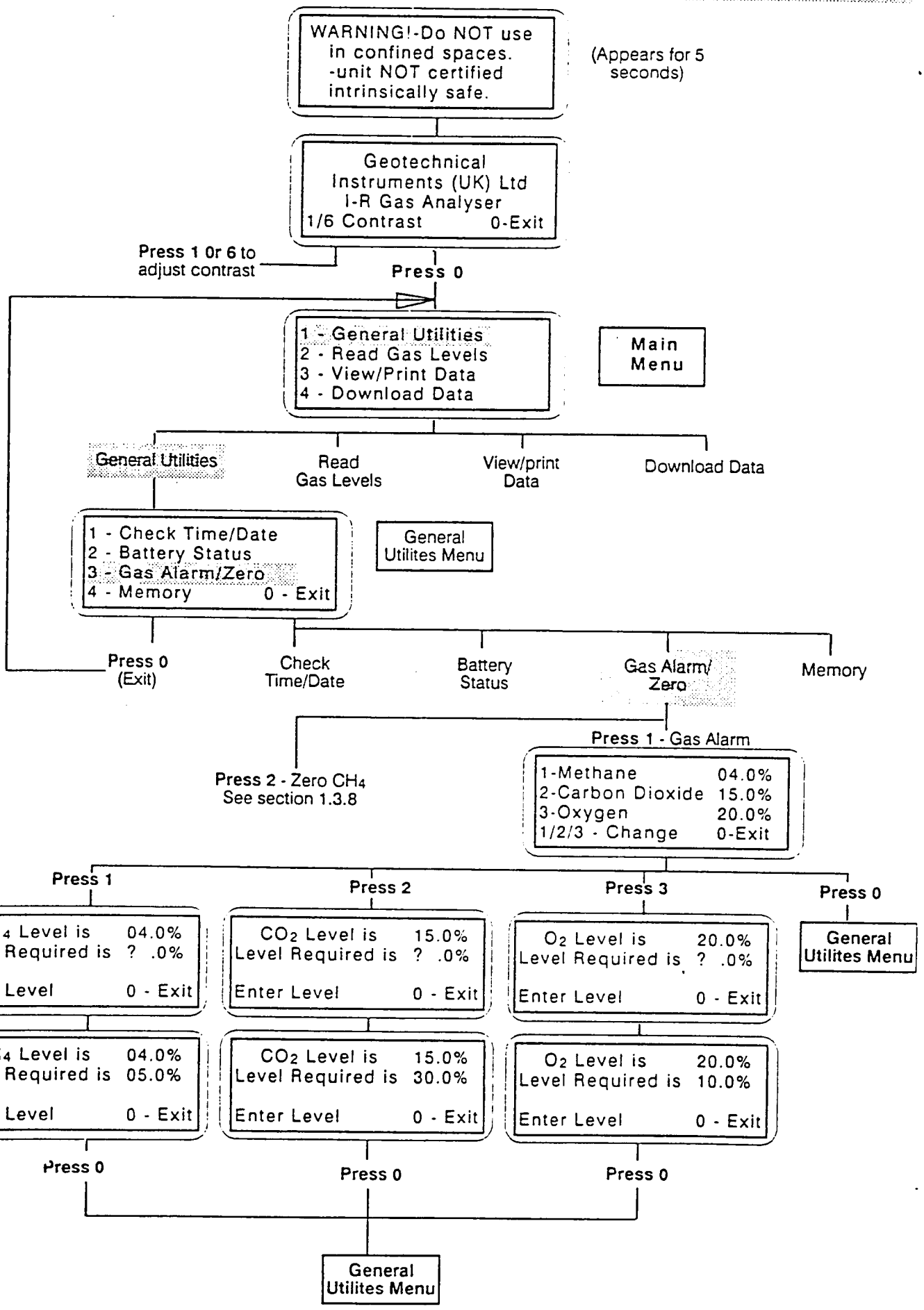
Again, pressing **key 0 - Exit** will return the operator to the **General Utilities Menu.**

1.3.5 When the new level has been correctly entered, the screen will change to -



1.3.6 If **key 0** is now pressed, the operator will be returned to the **General Utilities Menu.**

1.3.7 Any of the alarm levels may be altered at any time in this manner.


WARNING!-Do NOT use in confined spaces. -unit NOT certified intrinsically safe.
(Appears for 5 seconds)
Geotechnical Instruments (UK) Ltd
I-R Gas Analyser
1/6 Contrast 0-Exit
Press 1 0r 6 to adjust contrast
Press 0
1 - General Utilities
2 - Read Gas Levels
3 - View/Print Data
4 - Download Data
Main Menu
General Utilities
Read Gas Levels
View/print Data
Download Data
1 - Check Time/Date
2 - Battery Status
3 - Gas Alarm/Zero
4 - Memory 0 - Exit
General Utilites Menu
Press 0 (Exit)
Check Time/Date
Battery Status
Gas Alarm/ Zero
Memory
Press 1 - Gas Alarm
Press 2 - Zero CH4 See section 1.3.8
1-Methane 04.0%
2-Carbon Dioxide 15.0%
3-Oxygen 20.0%
1/2/3 - Change 0-Exit
Press 1
Press 2
Press 3
Press 0
CH4 Level is 04.0%
Level Required is ? .0%
Enter Level 0 - Exit
CO2 Level is 15.0%
Level Required is ? .0%
Enter Level 0 - Exit
O2 Level is 20.0%
Level Required is ? .0%
Enter Level 0 - Exit
General Utilites Menu
CH4 Level is 04.0%
Level Required is 05.0%
Enter Level 0 - Exit
CO2 Level is 15.0%
Level Required is 30.0%
Enter Level 0 - Exit
O2 Level is 20.0%
Level Required is 10.0%
Enter Level 0 - Exit
Press 0
Press 0
Press 0
General Utilites Menu

1.3.8. Zero CH_4

The Analyser should have its Methane zero level checked, and be auto-zeroed if necessary, prior to taking readings at the start of each day. It is not practical to attempt to auto-zero the CO_2 channel because a Nitrogen calibration gas would need to be flushed through the Analyser for a prolonged period prior to zeroing.

Please note that the normal **Read Gas Levels** Screen as shown in section 2.1 will not display negative readings, it will display "00.0", however the auto-zero screen **will** display a negative reading. Therefore it is important that the Analyser "zero" is checked using the auto zero screen and not the normal reading screen.

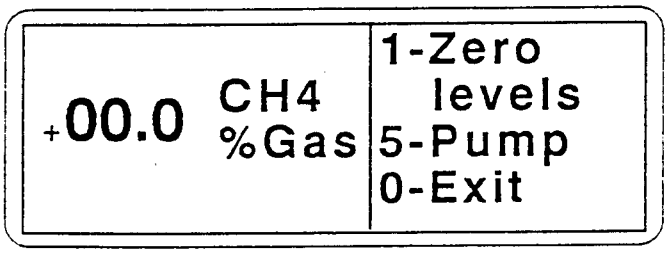
Ensure that the Analyser is cleared of any Methane at the time of zeroing. The Analyser should not be auto-zeroed near a Landfill site because there may be Methane in the surrounding atmosphere.

When you perform the auto-zeroing operation the Analyser will re-calculate 16 calibration points and store the revised data in its memory. The Analyser does not need to be auto-zeroed every time it is switched on because it remembers its revised calibration even after it is switched off.

If the internal battery is allowed to discharge totally, indicated by the message "memory lost" at switch-on, any revised zero settings will be lost and the Analyser will revert to its de-fault zero settings.

1.3.9 **To auto-zero the Analyser**
Press **key 2** from the Gas Alarm/Zero menu, the following screen will appear -

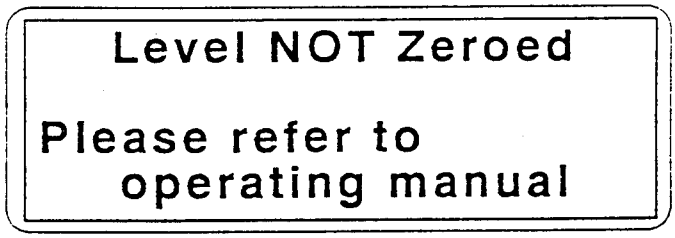
Note: + and - values can be displayed with this screen.



When you press **Key 1 - Zero Levels**, the Analyser will auto-zero. The following message wil be displayed before you are returned to the screen above -

CH_4 Zeroed !

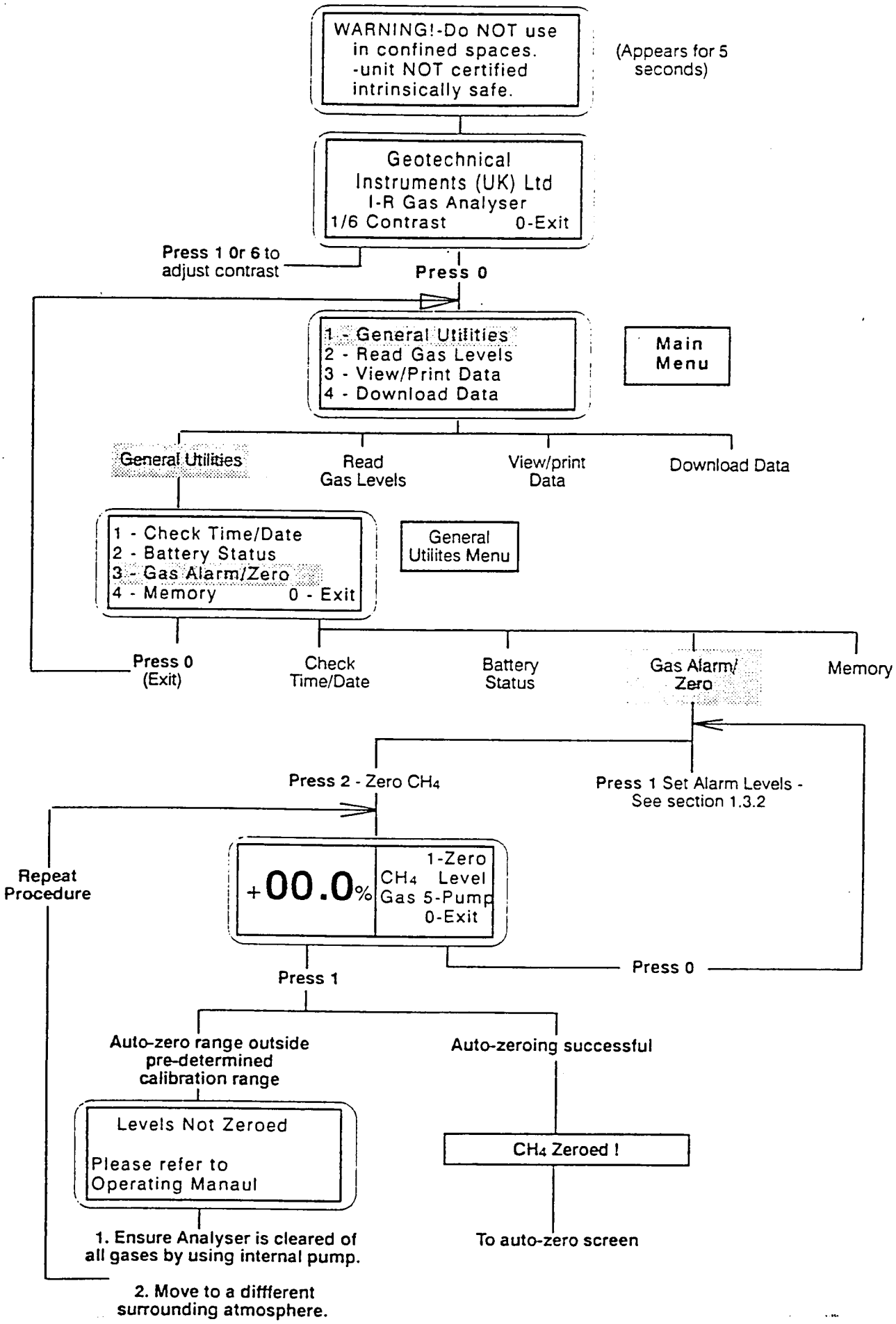
1.3.10 If the Analyser cannot auto-zero, the following screen will display -



The main reason for this is because the Analyser is trying to auto-zero to a level which is outside the pre-determined range set when the unit was first calibrated at the factory.

To rectify this, first ensure the Analyser is cleared of all gas residues which could be affecting the zero level. Use the Analysers pump to clear internal parts and ensure the surrounding atmosphere is not affecting the level by moving to a different area.

If the Analyser continues to fail in auto-zeroing then the unit must be returned to Geotechnical Instruments for checking.

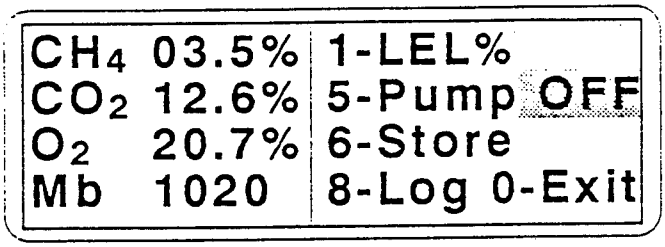

WARNING!-Do NOT use in confined spaces. -unit NOT certified intrinsically safe.
(Appears for 5 seconds)
Geotechnical Instruments (UK) Ltd
I-R Gas Analyser
1/6 Contrast 0-Exit
Press 1 0r 6 to adjust contrast
Press 0
1 - General Utilities
2 - Read Gas Levels
3 - View/Print Data
4 - Download Data
Main Menu
General Utilities
Read Gas Levels
View/print Data
Download Data
1 - Check Time/Date
2 - Battery Status
3 - Gas Alarm/Zero
4 - Memory 0 - Exit
General Utilites Menu
Press 0 (Exit)
Check Time/Date
Battery Status
Gas Alarm/ Zero
Memory
Press 2 - Zero CH4
Press 1 Set Alarm Levels - See section 1.3.2
Repeat Procedure
+00.0%
1-Zero CH4 Level
Gas 5-Pump
0-Exit
Press 1
Press 0
Auto-zero range outside pre-determined calibration range
Auto-zeroing successful
Levels Not Zeroed
Please refer to Operating Manaul
CH4 Zeroed !
1. Ensure Analyser is cleared of all gases by using internal pump.
To auto-zero screen
2. Move to a diffferent surrounding atmosphere.

2. Read Gas Levels

This section instructs the operator on the methods of obtaining data - both manually and by automatic data logging.

2.1 Manual Operation

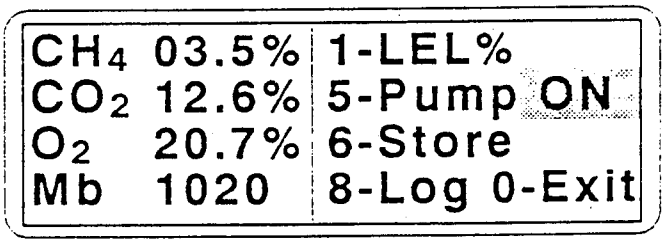
2.1.1 From the **Main Menu**, press **key 2 - Read Gas Levels**. Note: the aspirator pump will be in the **OFF** position and the readings shown on the display will not represent the gas required until the pump has drawn a sample into the sampling chamber. For the first 30 seconds a row of asterix will be displayed before the first reading appears. If the asterix symbols remain at the CH_4 location after the initial 30 seconds then the Analyser is outside the acceptable negative zero range and requires auto-zeroing (see section 1.3).



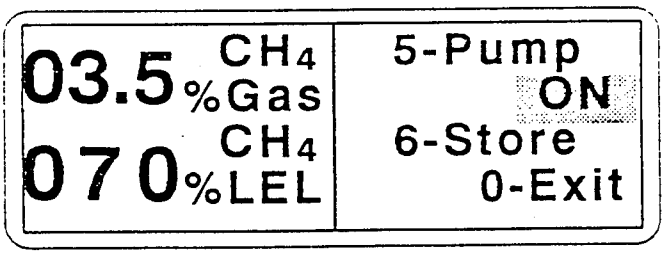
2.1.2 The left-hand side of the display shows the current gas concentrations being analysed by the unit together with the current atmospheric pressure. Please note that the data logging option, concentration of Oxygen and the reading of atmospheric pressure will <u>not</u> be displayed unless these options have been fitted to the particular unit which is being used.

The controls and information on the right hand side of the screen will now be examined in detail.

2.1.3 **1- LEL%.**



If **key 1** is pressed the display will change to show the concentration of methane both in terms of percentage **by volume** and percentage of the **Lower Explosive Limit**.

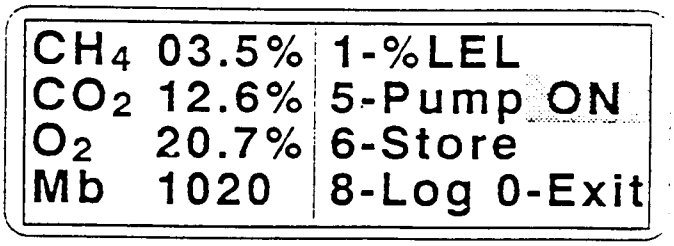


The **Lower Explosive Limit** of Methane is equal to a 5% concentration of Methane by volume in air. (Percentage by volume is termed here as %gas). Thus the following relationships are derived -

For Methane - **1.0% gas = 020.% LEL**
2.0% gas = 040.% LEL
3.0% gas = 060.% LEL
4.0% gas = 080.% LEL
5.0% gas = 100.% LEL.

Therefore in the example given, the display shows **3.5% gas = 70% LEL**. If **key 0-Exit** is pressed, the display will revert to that shown at the beginning of this paragraph.

2.1.4 5 - Pump.



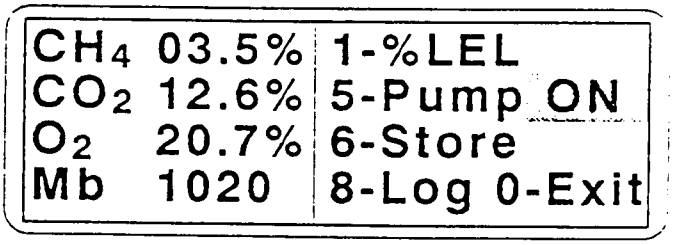
When the sampling probe is located at the required location, pressing **key 5 - Pump** will draw a gas sample into the the readout unit. After approximately 20 - 30 seconds the readings will stabilise to represent the gas concentrations drawn in by the aspirator pump.

To stop the pump, press **key 5 - Pump** again.

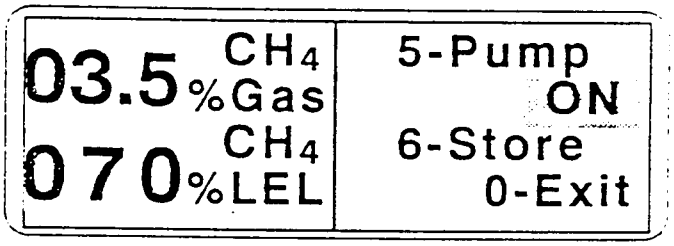
Control of the pump in this manner may be effected whilst either of the foregoing types of screen are being displayed.

2.1.5 6 - Store.

Irrespective of which screen is being shown,

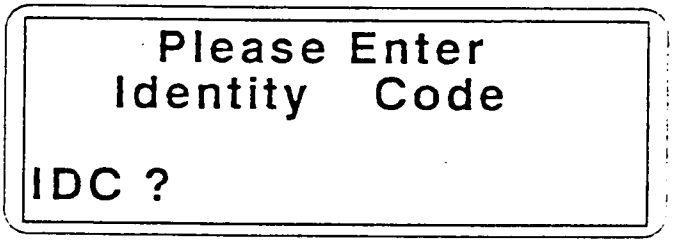


or



If **key 6 - Store** is pressed, readings of all gases will be stored in the memory as follows.

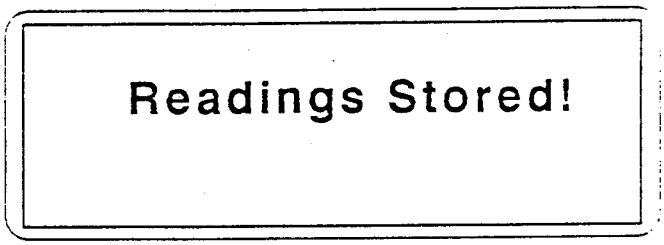
As soon as **key 6** is pressed, the screen will change to -



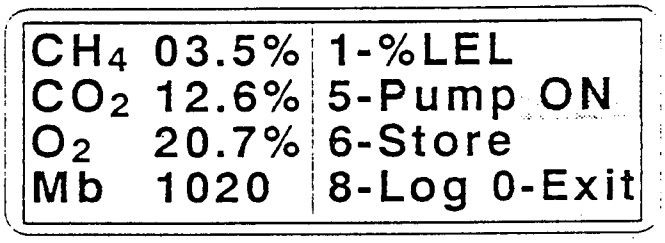
The operator is now being prompted by the question mark to enter an **8 digit code (in 2 sets of 4)** which will identify the set of readings. This could be, for example, the site number or borehole number etc. The **rubout key (key 0, keep it pressed)** may be used to correct any errors. A space is automatically inserted between the first four figures and the second four. When an eight digit code has been correctly entered, the message **0 - Exit** will appear in the lower right hand corner of the screen thus -



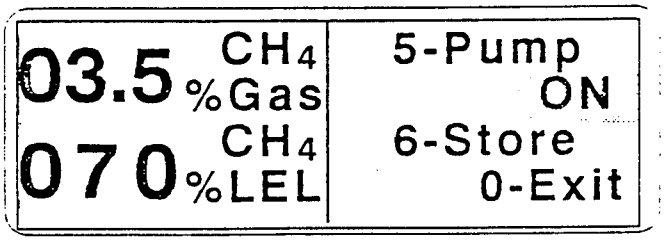
As soon as **key 0 - Exit** is pressed the screen will change to



for a few moments, prior to returning to the relevant display of gas concentrations.



or



2.1.6 **Default Selection of last IDC Code Entered.**

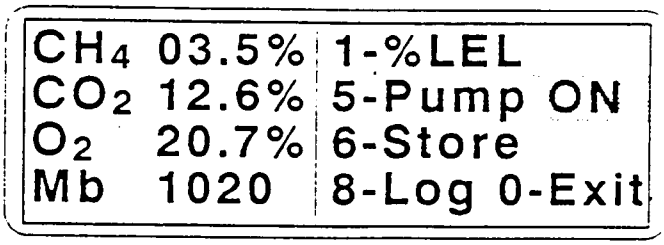
When you take a second reading and chose to store the data with an identity code, the unit will automatically display the first four figures of the last Identity Code entered. This assists you in keeping a sequence of readings related and speeds up the entry of codes.

If the first four figures of the last code entered are not required, then you can delete these using the **Rubout Key (Key 0, keep it pressed to delete)**. Once deleted the first four figures can be replaced with the required code.

This default facility will operate for all the options requiring an identity code to be entered, **View/Print Data** and **Download Data.**

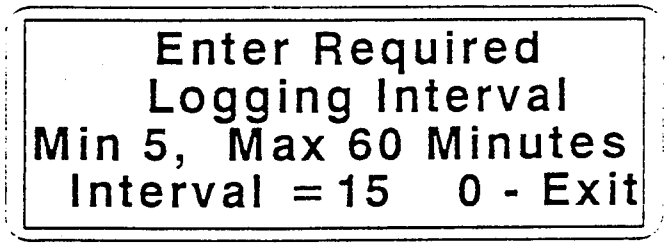
2.1.7 **8 - Log.**
This will be described in detail under **Section 2.2 - Automatic Operation (Data Logging).**

2.1.8 **0 - Exit.**



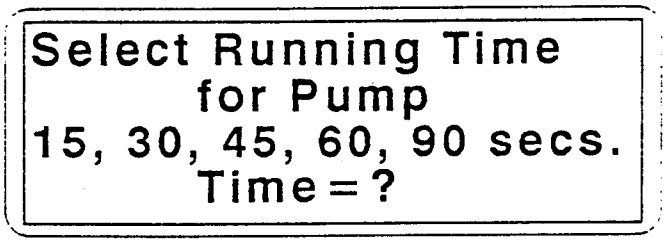
If **key 0 - Exit** is pressed, the operator will be returned to the **Main Menu**. If the aspirator pump is running it will automatically shut down.

2.2.5 When two digits have been entered, the screen will change to -



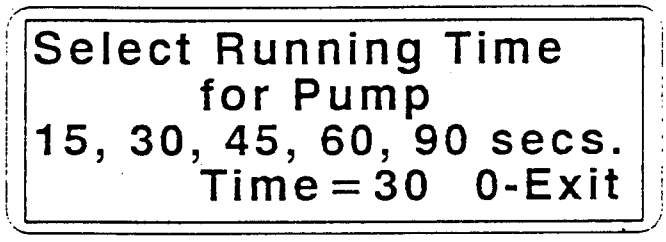
The operator should press **key 0** to confirm the required interval time and then the following display will appear. If the operator attempts to enter an **invalid logging interval**, he will be returned to the screen at the beginning of **paragraph 2.2.4**.

2.2.6



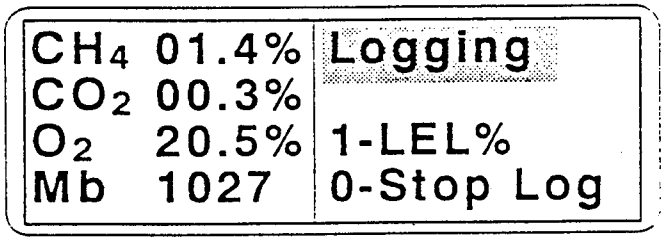
The operator is now being prompted to select and enter the time that the pump will run prior to any reading being logged. Determination of this period should be based on the local conditions - length of tube, gas concentrations etc. The length of pump running time which can be entered is limited to the alternatives shown on the screen.

2.2.7 When two digits have been entered, the screen will change to -



The operator should now press **key 0** to confirm the pump running time. If the entered pump running time is **not one of the available choices**, the display will revert to that shown at the beginning of paragraph **2.2.6** in order that another attempt may be made to enter a valid time.

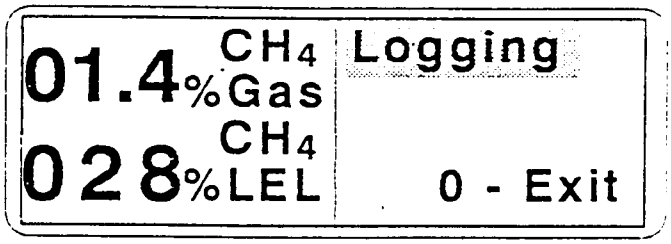
2.2.8 When **key 0 - Exit** has been pressed, the display will confirm that a logging sequence has been initiated thus -



2.2.9 During a logging sequence, the 15 minute "auto power off" facility is inhibited and current data will be displayed for as long as logging is allowed to continue.

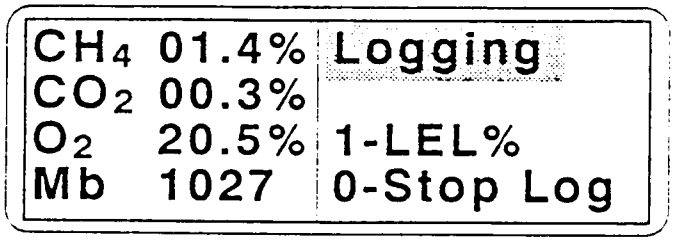
Starting and stopping of the aspirator **pump** will be **automatic** and under the control of the Gas Analyser.

2.2.10 The operator may view concentrations of Methane expressed as a **percentage LEL** without disturbing the logging sequence by pressing **Key 1** whilst the previous screen is displayed, thus -

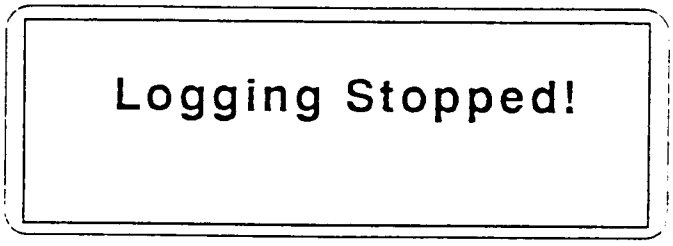


2.1.11 To **stop** a logging sequence, the following procedure should be adopted.

Whilst the above screen is being displayed, press **key 0 - Exit**. The screen described in paragraph 2.2.8 will return.



2.2.12 **Key 0 - Stop Log** should now be pressed and confirmation will be provided by the brief message -



prior to the operator being returned to the **Main Menu**. All data gathered during **data logging** will have been **automatically stored** in the memory of the Gas Analyser.

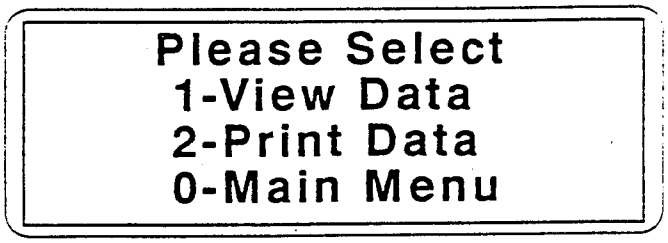
If the readout battery is allowed to totally discharge during logging, then the last few readings should be discarded.

3. View/Print Data

This section of the manual describes how to scan or obtain a hard copy of data which has previously been stored in the memory of the Gas Analyser.

From the Main Menu, press **key 3 - View/Print Data.**

The View/Print Menu will appear



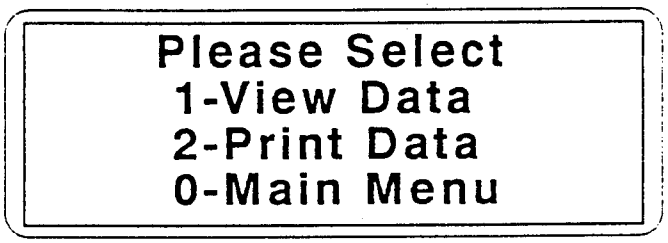
unless no data has been stored, in which case the message



will briefly appear, prior to an immediate return to the Main Menu.

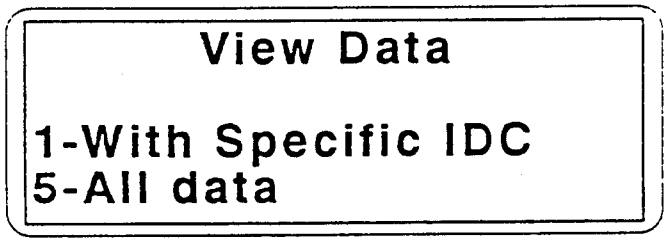
3.1 View Data

3.1.1 From the **View/Print Menu,**



Select **key 1 - View Data.** The following screen will appear.

3.1.2



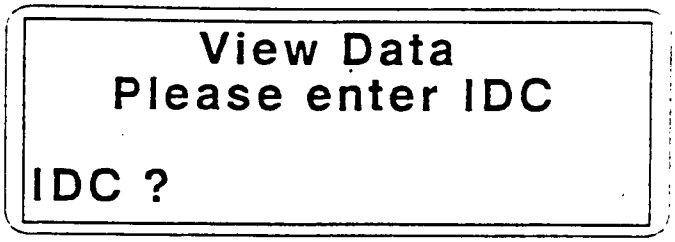
This screen enables the operator to select for viewing only data which has been stored with a specific IDC (Identity Code). All other data will be ignored.

This facility can be used to avoid scanning through irrelevant data if, for example, data from only one borehole or one site is to be examined.

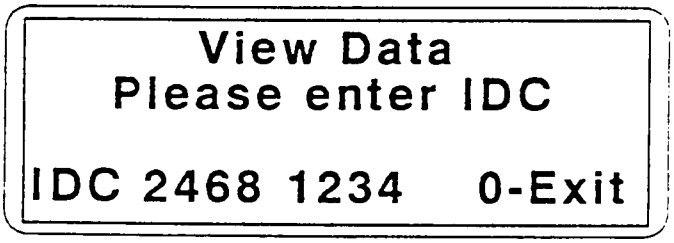
If **key 1 (Specific IDC)** is pressed then only data for the particular IDC chosen will be presented.

If **key 5 (All data)** is pressed, then the entire memory of the Gas Analyser will be presented in chronological order.

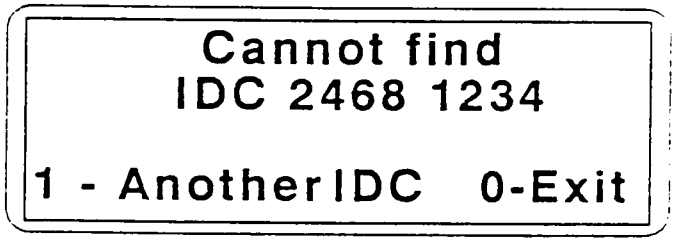
3.1.3 Assuming that only data with a specific Identity Code is required, now press key **1 - With Specific IDC.**



This screen now asks the operator to enter the chosen IDC. The code should be entered as prompted by the question mark. Use the **Rubout Key (Key 0, keep it pressed)** to correct any errors. The unit will display the first four digits of the last IDC entered , which can be deleted if necessary. When eight digits have been entered, the message **"0 - Exit"** will appear in the lower left hand corner of the screen, thus -



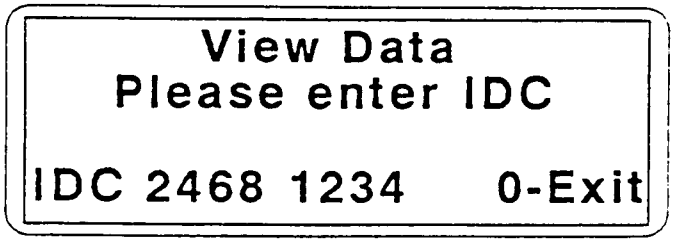
Key 0 - Exit should now be pressed. If data with the entered IDC is not present in the memory of the unit, then the message



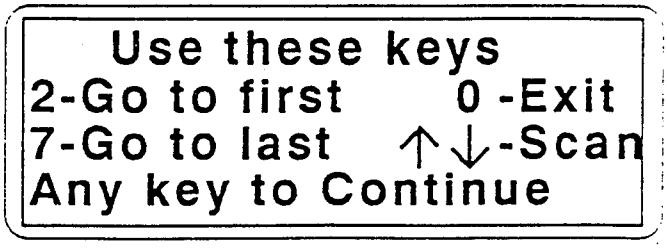
will appear.

3.1.4 If **key 1 - Another IDC** is now pressed, the operator will be returned to the screen in paragraph 3.1.3 for another attempt at entering a valid IDC. If **key 0 - Exit** is now pressed, the operator will be returned to the View/Print Menu.

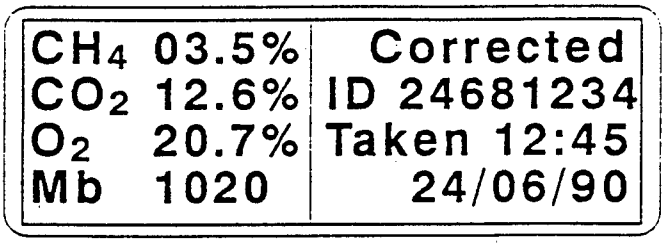
3.1.5 When **key 0 - Exit** is pressed from the screen



and data with the chosen IDC is present in the memory, then a screen describing how to search through will be presented to the operator, thus



The various facilities described in this screen will not be functional until data is being scanned. Thus press any key to continue and a screen similar to the following one will appear



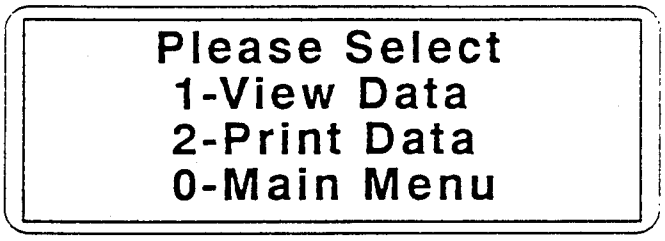
3.1.6 The above screen is chronologically the first data which is available . (If a specific **IDC** was entered, it will be chronologically the first data available which has that **IDC**).

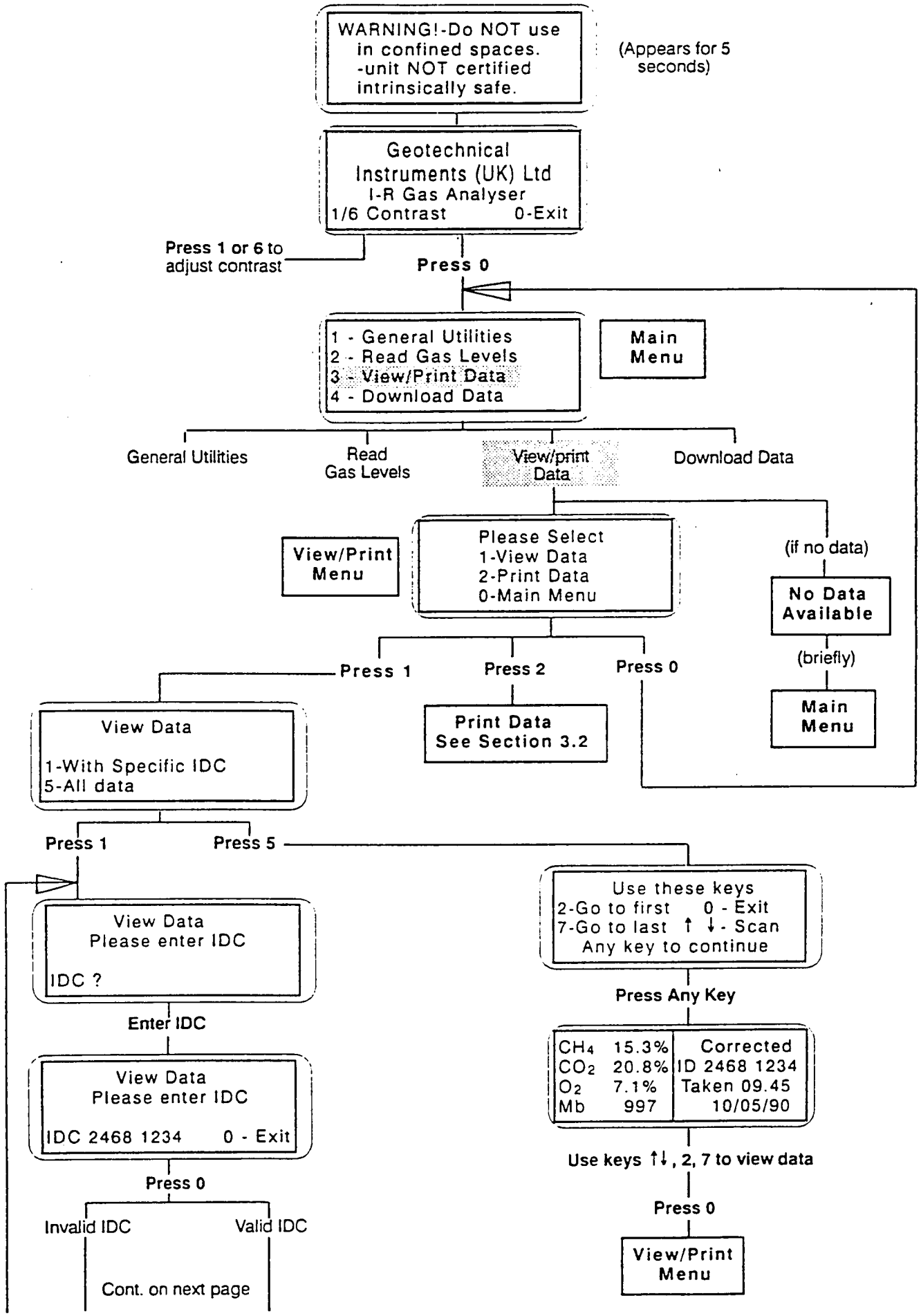
The various concentrations (in terms of percentage gas) of sampled gases are being displayed, together with the Identity Code, and time and date of reading. The data can be searched as follows

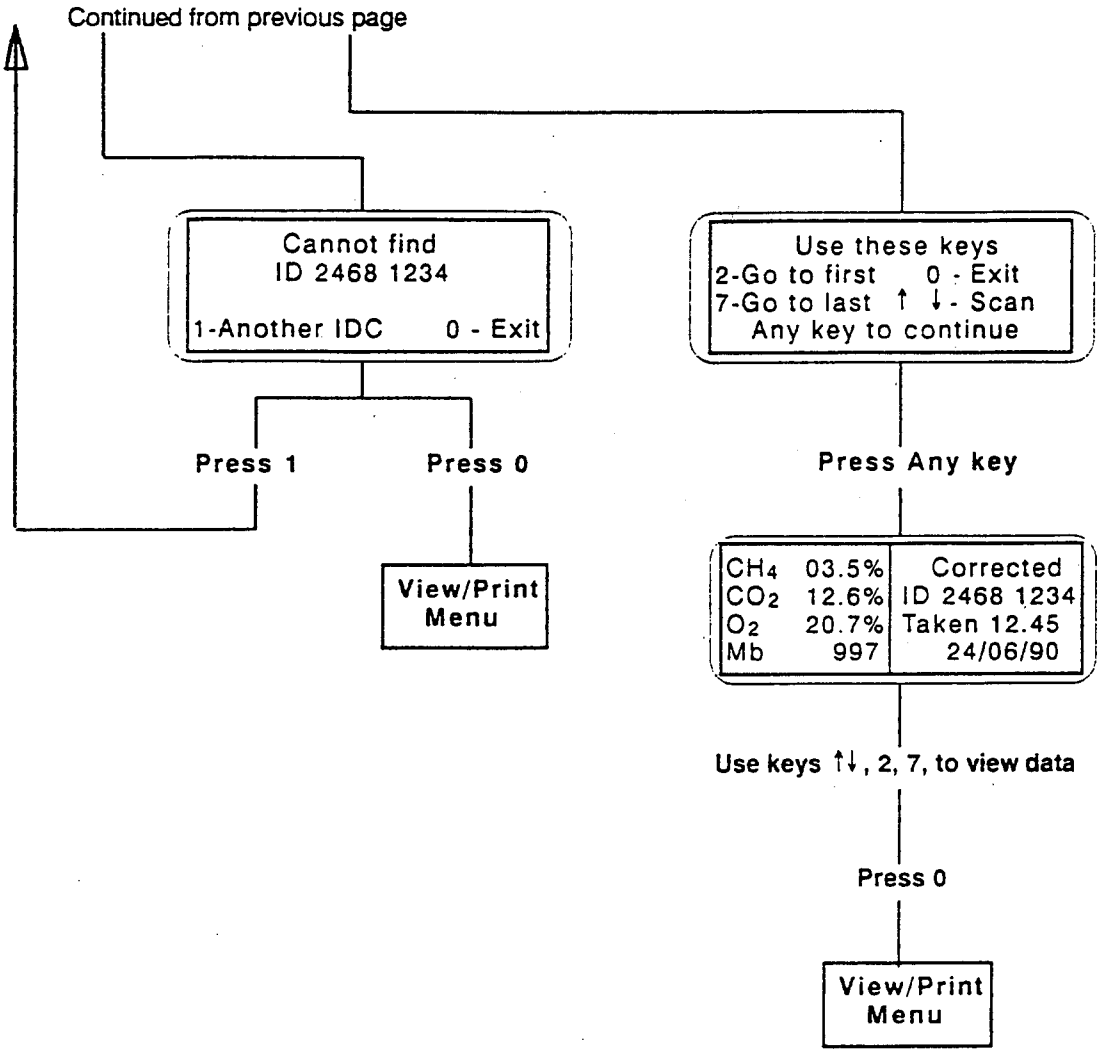
- Press ↓ **(key 6)** to view the next reading in chronological order.
- Press ↑ **(key 1)** to view the previous reading in chronological order.
- Press **key 2** to view the first reading in chronological order.
- Press **key 7** to view the last reading in chronological order.

Please note that unless the particular Gas Analyser which is being used has been fitted with relevant options, then Oxygen percentage and atmospheric pressure may not be displayed.

3.1.7 When all required data has been viewed, press **key 0 - Exit** to return to the View/Print Menu.

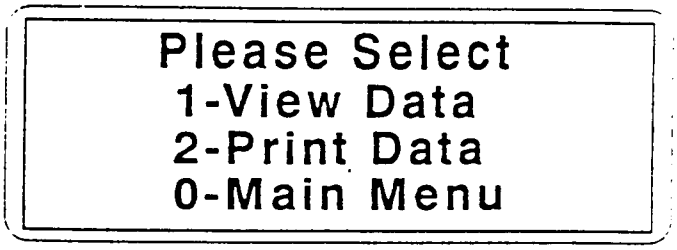



WARNING!-Do NOT use in confined spaces. -unit NOT certified intrinsically safe.
(Appears for 5 seconds)
Geotechnical Instruments (UK) Ltd
I-R Gas Analyser
1/6 Contrast 0-Exit
Press 1 or 6 to adjust contrast
Press 0
1 - General Utilities
2 - Read Gas Levels
3 - View/Print Data
4 - Download Data
Main Menu
General Utilities
Read Gas Levels
View/print Data
Download Data
View/Print Menu
Please Select
1-View Data
2-Print Data
0-Main Menu
(if no data)
No Data Available
(briefly)
Main Menu
Press 1
Press 2
Press 0
Print Data See Section 3.2
View Data
1-With Specific IDC
5-All data
Press 1
Press 5
View Data
Please enter IDC
IDC ?
Enter IDC
View Data
Please enter IDC
IDC 2468 1234 0 - Exit
Press 0
Invalid IDC
Valid IDC
Cont. on next page
Use these keys
2-Go to first 0 - Exit
7-Go to last ↑ ↓- Scan
Any key to continue
Press Any Key
CH4 15.3%
CO2 20.8%
O2 7.1%
Mb 997
Corrected
ID 2468 1234
Taken 09.45
10/05/90
Use keys ↑↓, 2, 7 to view data
Press 0
View/Print Menu


Continued from previous page
Cannot find
ID 2468 1234
1-Another IDC 0 - Exit
Use these keys
2-Go to first 0 - Exit
7-Go to last ↑ ↓ - Scan
Any key to continue
Press 1
Press 0
Press Any key
View/Print Menu
CH4 03.5%
CO2 12.6%
O2 20.7%
Mb 997
Corrected
ID 2468 1234
Taken 12.45
24/06/90
Use keys ↑↓, 2, 7, to view data
Press 0
View/Print Menu

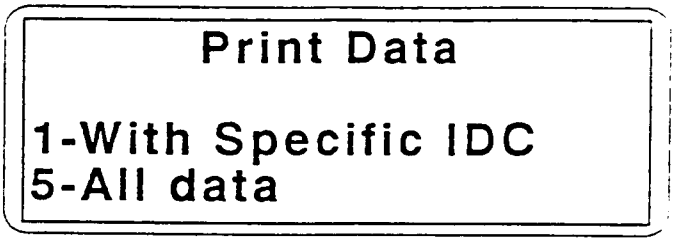
3.2 Print Data

3.2.1 From the View/Print Menu



Select **key 2 - Print Data.** The following screen will appear.

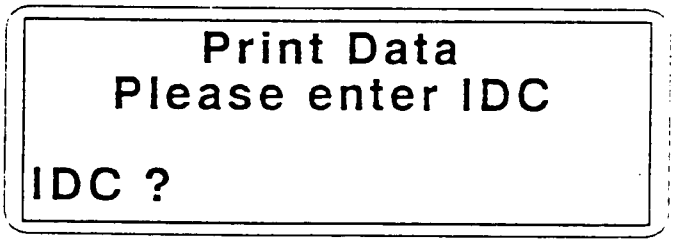
3.2.2



The screen allows the operator to select for printing only data which has been stored with a specific IDC (Identity Code). All data stored with other Identity Codes will be ignored.

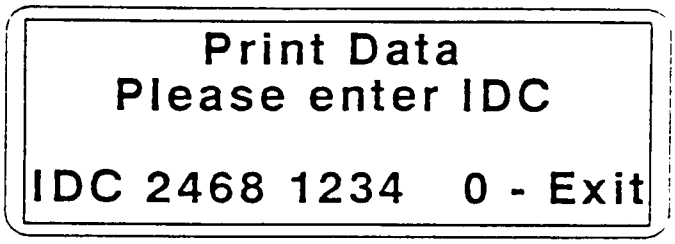
Thus, if **key 1 (Specific IDC)** is pressed then only data with the particular IDC chosen will be printed. If **key 5 (All data)** is pressed, then the entire memory of the Gas Analyser will be printed in chronological order.

3.2.3 Assuming that only data with a specific identity code is required now press **key 1 - With Specific IDC.**

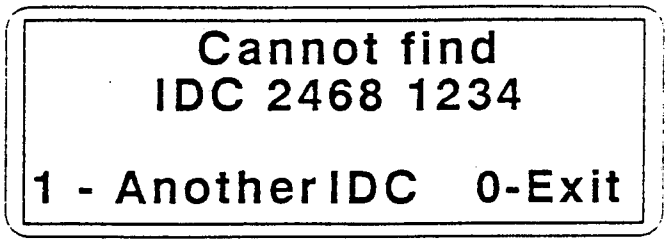


This screen now asks the operator to enter the chosen IDC. The code should be entered as prompted by the question mark. Use the **Rubout Key (Key 0, keep it pressed)** to correct any errors. The unit will display the first four digits of the last IDC entered, which can be deleted if necessary.

3.2.4 When four digits have been entered, the message "**0 - Exit**" will appear in the lower right hand corner of the screen, thus -



Key **0 - Exit** should now be pressed. If data with the entered **IDC** is not present in the memory of the unit, then the message

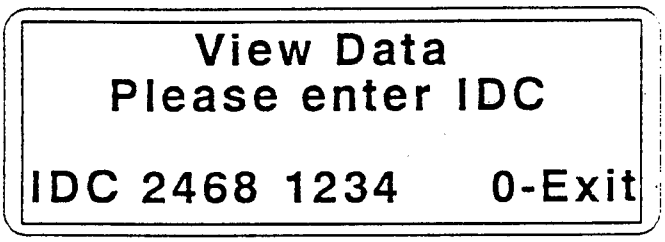


will appear.

3.2.5 If **key 1 - Another IDC** is now pressed, the operator will be returned to the screen in paragraph **3.2.3** for another attempt at entering a valid **IDC**.

If **key 0 - Exit** is pressed, the operator will be returned to the **View/Print Menu**.

3.2.6 When **key 0 - Exit** is pressed from the screen



and data with the chosen IDC is present in the memory, then an attempt will be made to print data.

3.2.7 For printing to occur successfully the following conditions must be satisfied.

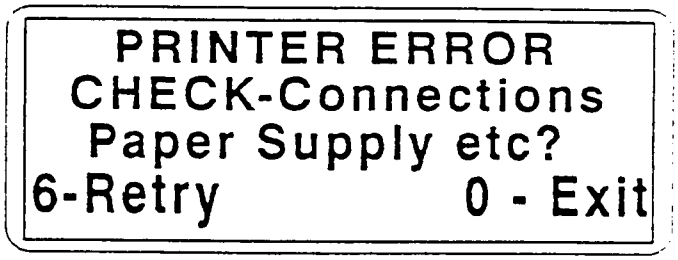
- A printer with a serial interface e.g. **Diconix model 150** must be connected correctly to the communications port of the Gas Analyser.
- Printer Settings - Your printer must be set to these ratings -

Baud Rate	2400
Handshake	RTS/CTS
Parity	None
Data bits	8
Stop bits	1

If you are not sure how to alter your printer settings, please consult your printer manual.

- RS232C Communications Lead - the lead used to connect the Gas Analyser to the printer must be the type supplied by Geotechnical Instruments (UK) Ltd.
- A sufficient supply of continuous fan fold paper must be available and correctly fitted in the printer.

3.2.8 If an attempt at printing is made and the above conditions are not satisfied, then the following message will appear.

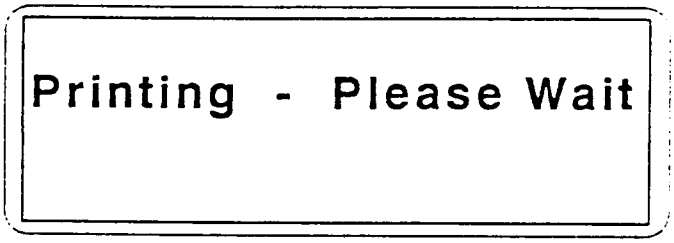


If the attempt at printing is to be aborted, press key **0 - Exit** and the **View/Print Menu** will appear.

3.2.9 If another attempt at printing is to be made, check again that the conditions for printing are fulfilled and then press key 6.

If the conditions are not satisfied the screen in paragraph **3.2.8** will reappear.

If, however, the printing conditions are satisfied, then the message



will be displayed. This message will remain on screen whilst printing is taking place.

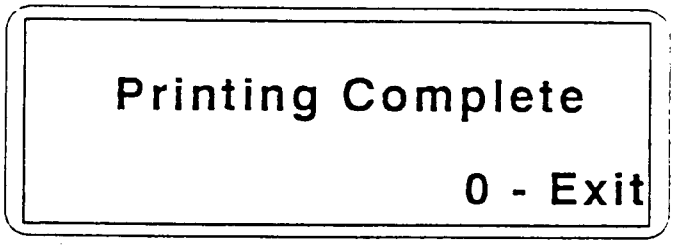
3.2.10 The print format is

Time	Date	IDC	$\%CH_4$	$\%CO_2$	$\%O_2$	Millibar
12:45	24/06/90	2468 1234	03.5	12.6	20.7	1020

If a specific IDC has been selected, the printout will give data in chronological order for that IDC.

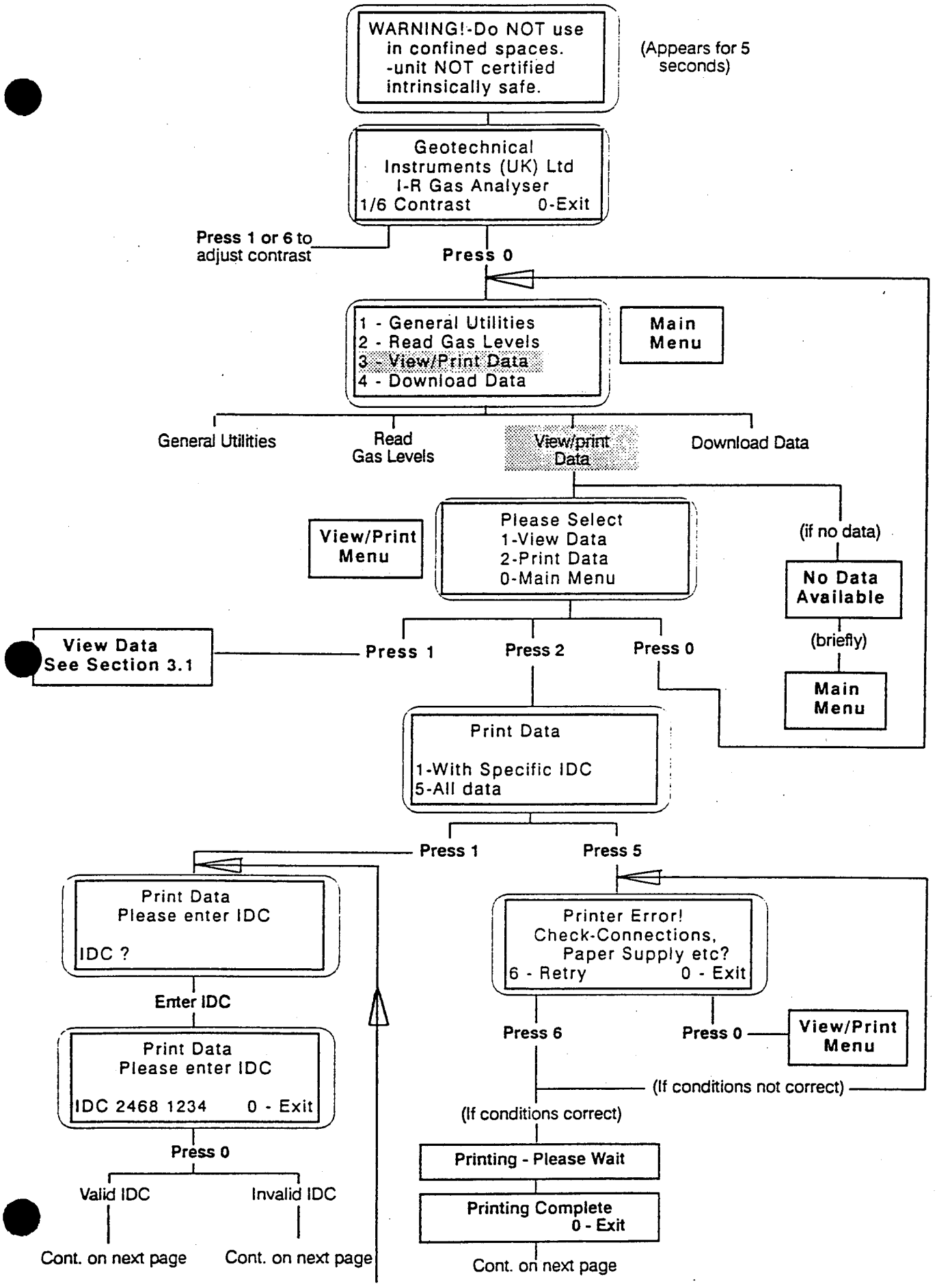
If no IDC has been selected, the printout will be in strict chronological order.

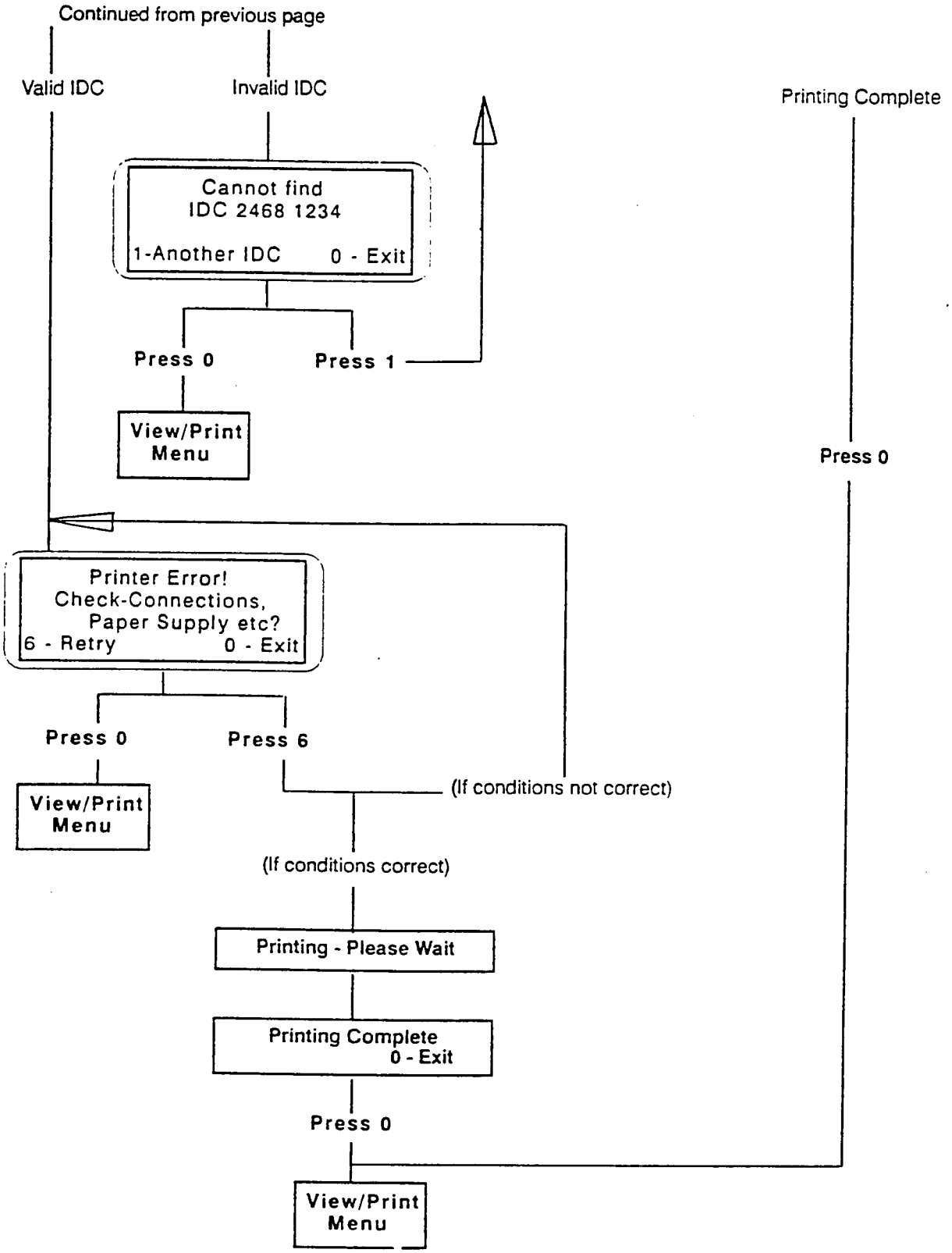
3.2.1 When all relevant data has been printed the message



will appear.

If **key 0 - Exit** is pressed, the **View/Print menu** will re-appear.


WARNING!-Do NOT use in confined spaces. -unit NOT certified intrinsically safe.
(Appears for 5 seconds)
Geotechnical Instruments (UK) Ltd
I-R Gas Analyser
1/6 Contrast 0-Exit
Press 1 or 6 to adjust contrast
Press 0
1 - General Utilities
2 - Read Gas Levels
3 - View/Print Data
4 - Download Data
Main Menu
General Utilities
Read Gas Levels
View/print Data
Download Data
View/Print Menu
Please Select
1-View Data
2-Print Data
0-Main Menu
(if no data)
No Data Available
(briefly)
Main Menu
View Data See Section 3.1
Press 1
Press 2
Press 0
Print Data
1-With Specific IDC
5-All data
Press 1
Press 5
Print Data
Please enter IDC
IDC ?
Enter IDC
Print Data
Please enter IDC
IDC 2468 1234 0 - Exit
Press 0
Valid IDC
Invalid IDC
Cont. on next page
Cont. on next page
Printer Error!
Check-Connections,
Paper Supply etc?
6 - Retry 0 - Exit
Press 6
Press 0
View/Print Menu
(If conditions not correct)
(If conditions correct)
Printing - Please Wait
Printing Complete
0 - Exit
Cont. on next page


Continued from previous page
Valid IDC
Invalid IDC
Printing Complete
Cannot find
IDC 2468 1234
1-Another IDC
0 - Exit
Press 0
Press 1
View/Print
Menu
Press 0
Printer Error!
Check-Connections,
Paper Supply etc?
6 - Retry
0 - Exit
Press 0
Press 6
View/Print
Menu
(If conditions not correct)
(If conditions correct)
Printing - Please Wait
Printing Complete
0 - Exit
Press 0
View/Print
Menu

4. Download Data

This section of the manual describes how to download data stored in the memory of the Gas Analyser to a suitable IBM PC or compatible computer that is running Geotechnical Instruments Universal Download Software (UNI_DOWN).

This software accepts the data from the Gas Analyser in **binary format** and converts it into **ASCII format (refered to as CSV in the UNI_DOWN program)** which is then suitable for importing into most popular spreadsheet programs e.g. LOTUS 1-2-3 or SuperCalc. For more information, consult your spreadsheet program manual on importing different file formats.

Note: for users of spreadsheet programs the correct file importing option is defined on the screen as "Numbers".

4.1 Download Data Operation

To achieve successful downloading of data it is advisable to be familiar with the operation of the UNI_DOWN software program you are running on the computer. Please refer to the relevant section of the operating manual supplied with the software in conjunction with this manual. In addition, the computer provides on-screen help when you proceed with the operation.

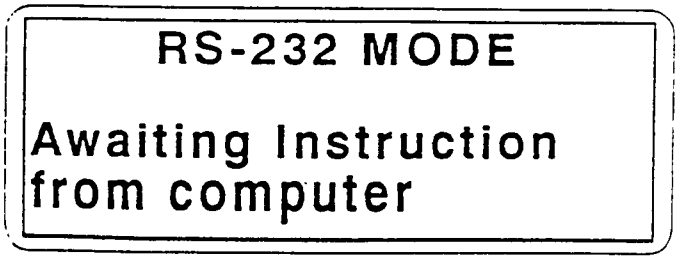
The download function allows you to download all data in the Gas Analyser memory or selected data only. Selected data is chosen by specifying either the 8 digit identity code or the time/date of the reading.

4.1.1 Turn on the computer and load the UNI_DOWN software program. The following screen will appear on your computer -

Universal Download Program (version 4.6 14/11/90 IBM PC/XT/PS2)	
Details: This option allows data to be transferred from GA 90 Hand Held Gas Readouts. Data is stored in a form suitable for import into most popular spreadsheets. See manual for details on the "Numbers" format.	Select 1...DTM/VWR 2...INTERROGATOR 3...INCLINOMETER 4...GAS READOUT
Geotechnical Instruments (UK) Ltd. Leamington Spa, Warwickshire. CV31 3NR.	
Use cursor keys to select. Press RETURN to complete. Press ESC to abort.	

4.1.2 Turn on the Gas Analyser and connect to the computer with a RS-232 lead. This lead can be supplied by Geotechnical Instruments manufactured to your particular computer connection port specification.

From the main menu press key **4 - Download Data** , the following screen will appear on the Gas Analyser for the duration of the download operation (see over page) -

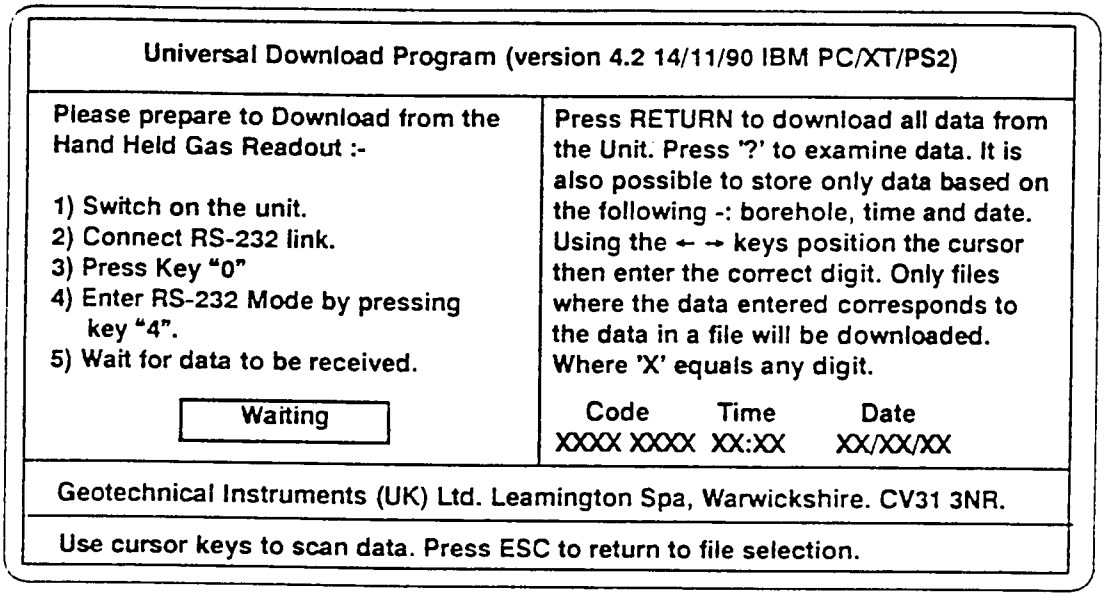


4.1.2 From the computer select option **4 GAS READOUT** and press the Return key of your computer. The computer will then download data to its memory, during this process a countdown of readings will be displayed briefly on the right hand side of the computer screen -

Readings Downloaded

00150

When all data is in the memory of the computer, **but not yet stored to disc**, the following screen will appear -



4.1.3 The UNI_DOWN program now provides you with the option to store to disc **all data or selected data**. In addition, by pressing the **"?" key** of your computer you can view all the data downloaded from the Gas Analyser.

To **Store all data**, simply press the Return key on the computer.

To **Store selected data** based on the identity code or time/date, use the computer keys ← → to position the highlighted cursor over the **X** characters and enter the desired code or time/date. If you do not need to enter an identity code but only the **time or date**, then leave the **X** characters in place (and vice versa if you do not require an entry for the time or date).

When you have decided which data is to be stored to disc, selected data or all data, press the **Return** key on your computer and the storing to disc process will commence.

4.1.4 When the storing process has finished the following screen will appear on your computer. This screen requests you to input a filename to identify the readings.

Universal Download Program (version 4.2 14/11/90 IBM PC/XT/PS2)	
Please prepare to Download from the Hand Held Gas Readout :- **1) Switch on the unit.** **2) Connect RS-232 link.** **3) Press Key "0"** **4) Enter RS-232 Mode by pressing key "4".** **5) Wait for data to be received.**	**Press RETURN to download all data from the Unit. Press '?' to examine data. It is also possible to store only data based on the following -: borehole, timeand date. Using the ← → keys position the cursor then enter the correct digit. Only files where the data entered corresponds to** **Filename: .....** **Code Time Date** **XXXX XXXX XX:XX XX/XX/XX**
Geotechnical Instruments (UK) Ltd. Leamington Spa, Warwickshire. CV31 3NR.	
Press RETURN to complete. Press ESC to abort.	

4.1.5 The filename can be up to 8 characters long, plus 3 for an extension of your choice. In addition, you can type in a directory path before the filename to locate the data file wherever you like in the memory of your computer.

Note: It is advisable to use the conventional extension **".PRN"** if you want to import the data files into most popular spreadsheets.

For example -

C:\GASREAD\SECT12\FILEABC1.PRN

The filename and directory path chosen must not exceed 30 characters.

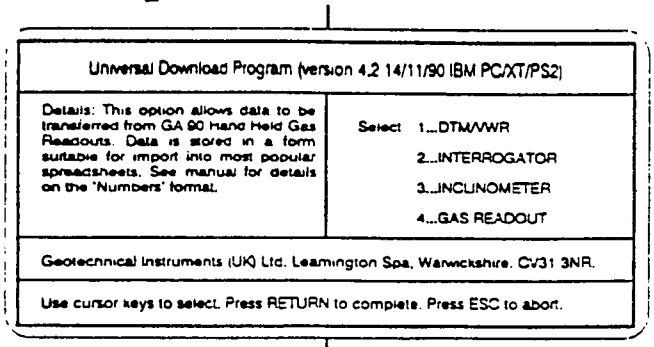
When you have completed the filename and directory path, pressing the **Return** key of your computer stores the data on your computer. The computer screen will return to the screen shown in paragraph **4.1.2** ready to download more selected data if required.

If you have completed downloading all the necessary data and wish to disconnect the Gas Analyser from the computer, press the computer **ESC** key and the program will return to the first screen shown in paragraph **4.1.1.**

The Gas Analyser can now be disconnected and the screen will return to the main menu.

Computer Operation

Turn on your computer and load UNI_DOWN software



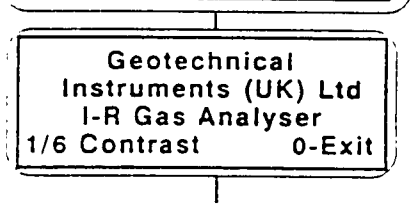
Select option 4 - Gas Readout

Gas Analyser Operation

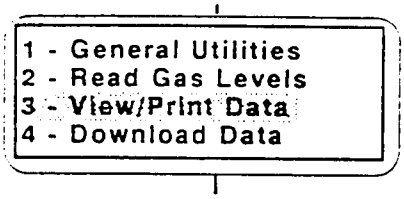
Turn on the Gas Analyser and connect to the computer using a suitable RS-232 lead.

(Appears for 5 seconds)



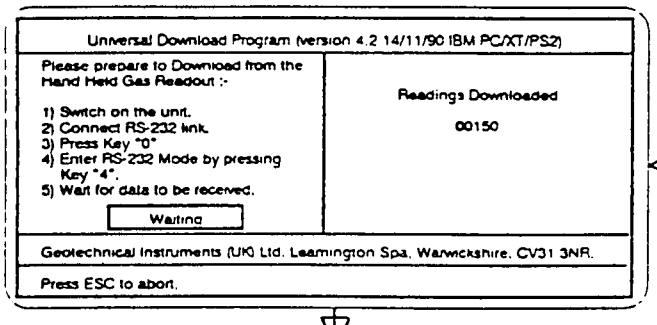


Press 0

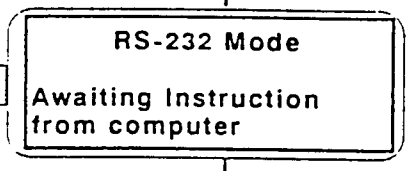


Press 4

When key, 4 - Download Data, is pressed control of Gas Analyser is taken over by computer and data is downloaded - the readings total will accumulate on the right hand side of the computer screen.



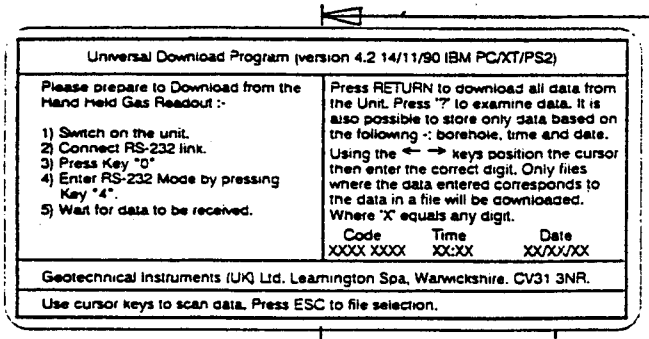
Downloading Data



Cont. on next page

Continued from previous page

Downloading is now complete, but data is not yet stored to disc - choose to store all data or selected data to disc.

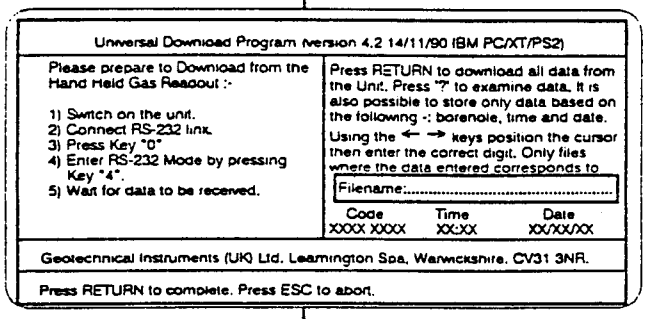


Press ? - to view the data downloaded (but not yet stored to disc)

Press Return to store all data to disc.

Enter specific identity code and or time/date to store selected data. Press Return to enter.

Enter Filename with extension (and directory path if required).



Press Enter

Data Stored to disc

Select more data for storing to disc.

Press ESC key to return to main menu and disconnect Gas Analyser. This completes the download operation.

Continued from previous page

1 - General Utilities
2 - Read Gas Levels
3 - View/Print Data
4 - Download Data