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Cathodic Protection Diagnostic Computer Program for Sacrificial and Impressed Current Systems: Overview and User's Manual

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The total cost of corrosion at Army facilities is a significant percentage of maintenance and repair budgets. Corrosion in underground gas piping is particularly costly because pipe damage is difficult to determine or assess until a leak occurs. Cost-effective maintenance of underground gas piping and other structures requires that cathodic protection (CP) systems operate properly and that some measure of current and projected pipe condition be available. To meet this requirement, data on CP systems must be constantly monitored, and CP faults indicated by the data must be correctly recognized and interpreted. The CP Diagnostic computer program helps meet the recordkeeping, analysis, and maintenance requirement of sacrificial and impressed current cathodic protection systems.

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FOREWORD

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The work was conducted by the Engineering and Materials Division (EM) of the U.S. Army Construction Engineering Research Laboratory (USACERL). The Principal Investigator was Dr. Ashok Kumar. The software was developed by Kim Reinke of Argus Systems, Urbana, Illinois. The technical assistance provided by Mr. Malcolm McLeod, Mr. Ivan Leef, and Mr. Thomas Spoerner of the USAEHSC and by Mr. Vincent Hock, USACERL, was invaluable to the successful completion of this work. Dr. Paul A. Howdyshell is acting Chief, USACERL-EM. The USACERL technical editor was Mr. William J. Wolfe, Information Management Office.

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CATHODIC PROTECTION DIAGNOSTIC COMPUTER PROGRAM FOR SACRIFICIAL AND IMPRESSED CURRENT SYSTEMS: OVERVIEW AND USER'S MANUAL

1 INTRODUCTION

The total cost of corrosion at Army facilities is a significant percentage of maintenance and repair budgets. Corrosion of underground gas piping, underground storage tanks, and water storage tanks is particularly costly because the presence and extent of damage are difficult to determine until a leak occurs. The normal approach taken by Army Directorates of Engineering and Housing (DEHs) to leak maintenance is therefore corrective rather than preventive, to take maintenance measures only after a pipe leaks. One effective method to prevent corrosion-induced leaks is the use of cathodic protection. However, cathodic protection systems must be properly maintained to achieve peak effectiveness. Proper maintenance of cathodic protection systems requires recording and evaluating a large amount of data.

The U.S. Army Construction Engineering Research Laboratory (USACERL) has developed a computer-based approach for preventive rather than corrective corrosion mitigation. This approach consists of two computer systems. The Cathodic Protection Diagnostic Computer Program (CP Diagnostic) helps the user maintain the appropriate data on cathodic protection systems and recognize possible malfunctions of these systems. The Gas Piper Computer System (GPIPER)[1] allows the user to maintain detailed data about gas piping, predicts pipe condition, and identifies the pipes that need leak prevention maintenance. This report describes CP Diagnostic.

CP Diagnostic Overview

CP Diagnostic maintains background information about CP systems (e.g., number and type of anodes, date of installation) as well as data from field measurements (e.g., pipe-to-soil potential, rectifier currents and voltages). CP Diagnostic generates reports that present relevant data, emphasizing information that suggests CP system malfunctions. A planned revision to the program will also inform the user of the specific repair needs indicated by the data.

CP Diagnostic is divided into two parts: Sacrificial CP Diagnostic manages information related to Sacrificial CP systems, and Impressed Current CP Diagnostic manages data related to impressed current CP systems. Sacrificial CP Diagnostic has been tested at Fort Riley, Kansas, and Impressed Current CP Diagnostic has been tested at Fort Hood, Texas.[2]

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[1] R. Guglomo, et al., *GPIPER Implementation Guide and User Manual*, Draft Technical Report (U.S. Army Construction Engineering Research Laboratory [USACERL], 1990); Further discussion of GPIPER data entry screens and reports is included in: Ashok Kumar, Margaret Blyth, and Michael Bergenhouse, "Implementation of a Pipe Corrosion Management System," *Proceedings of the National Association of Corrosion Engineers* (San Francisco, 1987).

[2] *Cathodic Protection Module at Fort Riley, Kansas* (Corrpro Companies, Inc., Schaumburg, IL, 28 February 1989); *Cathodic Protection Computer System Impressed Current Field Investigation* (HARCO Technologies Corp., Medina, OH, July 1989).

Both the Sacrificial and Impressed systems are user-friendly programs written in the dBASE III+ programming language and compiled with the Clipper compiler.[3] Because these programs are compiled, the only software required is the program disk(s) supplied. CP Diagnostic operates on an IBM-compatible microcomputer system with 640K of Random Access Memory (RAM). A hard drive is required because of the large amounts of data stored by the program. It supports both color and monochrome monitors. The program can be configured to support most dot matrix and laser printers.

Capabilities of the two parts of CP Diagnostic are discussed later in this chapter. An overview of the data that is required and the reports that are generated is given. For more detail, refer to the figures (located in later chapters) that are noted throughout this overview.

IMPORTANT NOTE: CP Diagnostic stores data for both pipes and tanks. The word "structure" will be used throughout the text to denote both pipes and tanks in general. The words "pipe" and "tank" will only be used if the information being given is specific to either pipes OR tanks. Thus, the word "structure" as used in this text means "pipe and/or tank."

Before the programs themselves are discussed, it is important for the user to understand the criteria that are used to determine whether or not cathodic protection is being achieved on a structure. This understanding is critical to the successful application of CP Diagnostic. The section should be read carefully before the programs are used.

Criteria of Cathodic Protection

Introduction

One of the key functions of CP Diagnostic is to pinpoint malfunctions in CP systems. It is therefore essential to understand the criteria which are used to determine whether or not cathodic protection of a structure is being achieved. No one simple criterion has been accepted by all cathodic protection engineers and that can be practicably measured in the field under all circumstances. Therefore, CP Diagnostic has been designed such that program users may select from several of the criteria currently used by cathodic protection engineers, or they may enter their own criterion as dictated by regulation, management, or experience. For further information on cathodic protection system operation, maintenance, and criteria selection, the reader should consult the references given at the end of this report.

Explanation of Potential Changes

In order to understand the criteria of CP, it is critical to understand the changes that occur in the electrical potential of a structure when the protective current is applied to it. Husock[4] explains:

> It should be noted that cathodic protection when properly applied produces a change in the potential of a structure with respect to a reference electrode placed in the soil in proximity to that structure. The cathodic protection current makes the potential thus measured more negative than the potential was

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[3] dBASE is a registered trademark of Ashton-Tate, Torrence, CA. Clipper is a registered trademark of the Nantucket Corp., Los Angeles, CA.

[4] Husock, Bernard, *Evaluation of Cathodic Protection Criteria*, Report Number ESL TR-79-14 (Headquarters, Air Force Engineering and Services Center [HQAFESC], April 1979), p. 12-14.

before the current was applied, and the amount of change produced is a measure of the effectiveness of the cathodic protection at that location.

The changes in electrical potential of the structure (with respect to a copper-copper sulfate reference electrode) that occur when the cathodic protection current is applied are depicted graphically in Figure 1-1. Before current is applied, the structure is at its original or "native" potential. When the current is applied, there is a change in potential in the negative direction at the instant the current is turned on. As the current is continuously applied over an extended period of time, the potential tends to increase negatively because of polarization. According to Husock, "polarization of a structure is a phenomenon which occurs over a long time period and a structure may not be entirely polarized even after the cathodic protection system has been in operation for many months." If the current is interrupted after the structure has polarized, the potential becomes less negative at the instant of turn-off. The potential then begins to decay, or depolarize, back to the original or native potential.

CP Criteria

The guidance typically used by corrosion engineers concerning the criteria of cathodic protection is contained in two Recommended Practices (RPs) published by the National Association of Corrosion Engineers (NACE): RP-01-69, "Control of External Corrosion on Underground or Submerged Metallic Piping Systems," and RP-02-85, "Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems." Although there are some differences in wording between the two

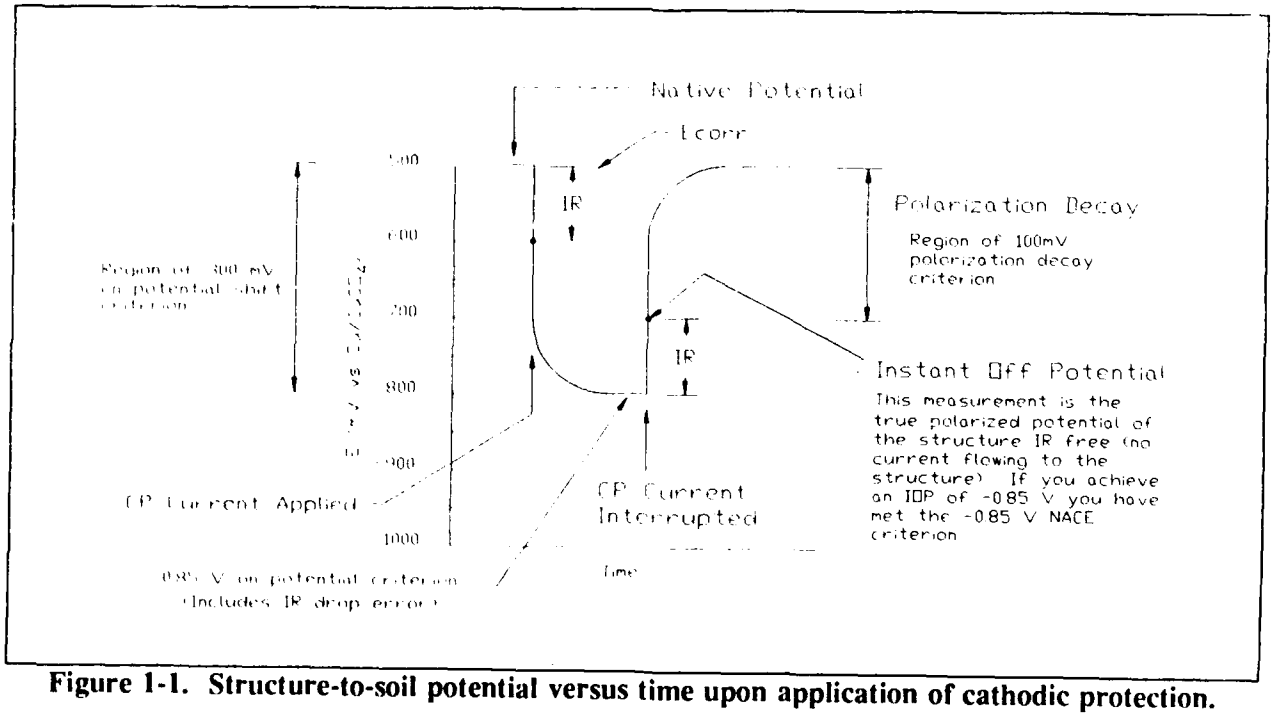

Figure 1-1. Structure-to-soil potential versus time upon application of cathodic protection.

RPs due to the different structures that are being described, the content is essentially the same. Refer to Figure 1-1 for a graphical representation of the criteria below, taken from NACE RP-01-69:[5]

6.1 Introduction

6.1.1 This section lists criteria for cathodic protection which, when complied with either separately or collectively, will indicate that adequate cathodic protection of a metallic piping system in its electrolyte has been achieved.

6.2 General

6.2.1 The objective of using cathodic protection is to control the corrosion of metallic surfaces in contact with electrolytes.

6.2.2 The selection of a particular criterion for achieving this objective depends, in part, upon past experience with similar structures and environments wherein the criterion has been used successfully.

6.2.3 The criteria in Section 6.3 have been developed through laboratory experiment or have been empirically determined by evaluating data obtained from successfully operated cathodic protection systems. It is not intended that persons responsible for corrosion control be limited to these criteria if it can be demonstrated by other means that the control of corrosion has been achieved.

6.2.4 Voltage measurements on pipelines are to be made with the reference electrode located on the electrolyte surface as close as practicable to the pipeline. Such measurements on all other structures are to be made with the reference electrode positioned as close as feasible to the structure surface being investigated. Consideration should be given to voltage (IR) drops other than those across the structure-to-electrolyte boundary, the presence of dissimilar metals, and the influence of other structures for valid interpretation of voltage measurements. [Note: RP-02-85 adds the following at this point: Measurements made with a reference electrode located on blacktop pavement or concrete slab may be in error.]

6.2.5 No one criterion for evaluating the effectiveness of cathodic protection has proved to be satisfactory for all conditions. Often a combination of criteria is needed for a single structure.

6.3 Criteria

6.3.1 For steel and cast iron structures:

6.3.1.1 A negative (cathodic) voltage of at least 0.85 volt as measured between the structure surface and a saturated copper-copper sulfate reference electrode contacting the electrolyte. Determination of this voltage is to be made with the protective current applied.

6.3.1.2 A minimum negative (cathodic) voltage shift of 300 millivolts, produced by the application of protective current. The voltage shift is measured between the structure surface and a stable reference electrode contacting the electrolyte. This criterion of voltage shift does not apply to structures in contact with dissimilar metals.

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[5] "Control of External Corrosion on Underground or Submerged Metallic Piping Systems," Recommended Practice RP-01-69 (National Association of Corrosion Engineers [NACE], Houston, TX, 1983 revision), p. 6-7.

6.3.1.3 A minimum negative (cathodic) polarization voltage shift of 100 millivolts measured between the structure surface and a stable reference electrode contacting the electrolyte. This polarization voltage shift is to be determined by interrupting the protective current and measuring the polarization decay. When the current is initially interrupted, an immediate voltage shift will occur. The voltage reading after the immediate shift shall be used as the base reading from which to measure polarization decay. . . .

6.3.2 For aluminum structures:

6.3.2.1 A minimum negative (cathodic) voltage shift of 150 millivolts, produced by the application of protective current. The voltage shift is measured between the structure surface and a stable reference electrode contacting the electrolyte. (See precautionary notes in 6.3.2.3 and 6.3.2.4.)

6.3.2.2 A minimum negative (cathodic) polarization voltage shift of 100 millivolts measured between the structure surface and a stable reference electrode contacting the electrolyte. This polarization voltage is to be determined by interrupting the protective current and measuring polarization decay. When the current is initially interrupted, and immediate voltage shift will occur. The voltage reading after the immediate shift shall be used as the base reading from which to measure polarization decay. (See precautionary notes in 6.3.2.3 and 6.3.2.4.)

6.3.2.3 PRECAUTIONARY NOTE - Excessive Voltages: Notwithstanding the alternative minimum criteria in 6.3.2.1 and 6.3.2.2, aluminum, if cathodically protected at voltages more negative than -1.20 volts measured between the structure surface and a saturated copper-copper sulfate reference electrode contacting the electrolyte and compensated for the voltage (IR) drops other than those across the structure-electrolyte boundary, may suffer corrosion as the result of the build-up of alkali on the metal surface. A voltage more negative than -1.20 volts should not be used unless previous test results indicate no appreciable corrosion will occur in the particular environment.

6.3.2.4 PRECAUTIONARY NOTE - Alkaline Soil Conditions: Since aluminum may suffer from corrosion under high pH conditions and since application of cathodic protection tends to increase the pH at the metal surface, careful investigation or testing should be made before applying cathodic protection to stop pitting attack on aluminum structures in environments with a natural pH in excess of 8.0.

6.3.3 For copper structures:

6.3.3.1 A minimum negative (cathodic) polarization voltage shift of 100 millivolts measured between the structure surface and a stable reference electrode contacting the electrolyte. This polarization voltage shift is to be determined by interrupting the protective current and measuring the polarization decay. When the current is initially interrupted, an immediate voltage shift will occur. The voltage reading after the immediate shift shall be used as the base reading from which to measure polarization decay.

Army guidance on the criteria of cathodic protection is given in the following publications:

- TM 5-811-7 *Electrical Design, Cathodic Protection*
- CEGS 16640 "Cathodic Protection System (Sacrificial Anode)"
- CEGS 16641 "Cathodic Protection System (Steel Water Tanks)"
- CEGS 16642 "Cathodic Protection System (Impressed Current)."

CEGS 16640[6] and CEGS 16642[7] refer to the three criteria described above from NACE RP-01-69. TM 5-811-7[8] refers to the -0.85 volt criterion as set forth in the NACE RP.

Guidance for steel water tanks is somewhat different because disbonding of the interior coating due to excessive protective current must be mitigated. For steel water tanks, CEGS 16641[9] states:

> 3.4.1. Minimum - The criterion of protection shall be a negative voltage of at least minus 0.85 volt as measured between the tank and a saturated copper-copper-sulphate reference electrode. Determination of the voltage shall be made with the cathodic protection system in operation.
>
> 3.4.2 Maximum - In order to mitigate disbonding of the interior coating in the tank, potential between a copper-copper-sulphate reference electrode and the tank shall not be more negative than minus 1.1 volt measured with the electrode located between 1/4 and 1/2 inch away from the steel surface but not touching it.

Understanding the IR Drop

The NACE criteria state that the IR drop shall be considered when measurements are interpreted. According to Myers[10] "only polarization provides cathodic protection. No protection is provided by the the voltage drops other than those across the structure-to-electrolyte boundary." Figure 1-1 shows the region of the potential versus time curve which is considered to be the IR drop. There are two IR drops that are referred to: the soil IR drop and the metal IR drop. Husock[11] defines and explains these IR drops and offers suggestions for considering them in the interpretation of structure-to-soil potentials. (Note: "E" in the following description refers to the absolute value of the measured structure-to-soil potential.)

> It is the IR drops in the soil $(IR)_S$ and metal of the pipeline $(IR)_M$ that must be considered as shown in Figure 1-2 and the following equation:
>
> $$E = E_P + (IR)_M + (IR)_S$$
>
> where:
>
> E_P = the pipe-to-soil potential which exists between a hypothetical reference electrode immediately adjacent to the pipe surface and a metallic contact to the pipe close to the reference electrode.

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[6] "Cathodic Protection System (Sacrificial Anode)," Guide Specification for Military Construction, Electrical, Section 16640 (U.S. Army Corps of Engineers [USACE], December 1988), p. 8-9.

[7] "Cathodic Protection System (Impressed Current)," Guide Specification for Military Construction, Electrical, Section 16642 (USACE, March 1989), p. 11-12.

[8] *Electrical Design, Cathodic Protection*, Technical Manual (TM) 5-811-7 (Headquarters, Department of the Army [HQDA], 22 April 1985), p. 2-1.

[9] "Cathodic Protection System (Steel Water Tanks)," Guide Specification for Military Construction, Electrical, Section 16641 (USACE, February 1989), p. 12.

[10] Myers, J.R., *Cathodic Protection Acceptance Criteria - A Guide for Directorate of Engineering and Housing (DEH) Inspectors*, Contractor Report (USACERL, 1988), p. 88-89.

[11] Husock, p. 37-47.

$(IR)_S$ = Voltage (IR) drop in soil between the hypothetical reference electrode placed immediately adjacent to the pipe surface and the actual position of the reference electrode placed at grade (or other location).

$(IR)_M$ = Voltage (IR) drop in pipe (often referred to as metal IR drop) between a point of metallic contact close to the reference electrode and the actual point of contact to the structure ... .

Both of these IR drops are an inherent part of the potential which is measured. On coated pipe, soil IR drop is not usually significant, but it can be considerable on bare pipes especially in higher resistivity soils. Metal IR drops, particularly where there is substantial line current, must be considered on all lines, both coated and bare, particularly where there is some distance between the contact point and the reference electrode location.

In the application of the NACE potential criterion (i.e., -0.85V for steel), regardless of structure material, the potential must be interpreted as a polarized value. Structure-to-electrolyte measurements for comparison to the chosen criterion must be free of IR drop error. Sometimes this can be achieved by placing the reference electrode immediately adjacent to the structure or, alternatively, by measuring the potential instantaneously after the cathodic protection current is interrupted (sometimes called "instant off" potentials).

The IR drop also affects the potential shift criteria (i.e., 100 mV polarization voltage shift and 300 mV potential shift). According to the 100 mV criterion, if the corrosion potential is polarized electronegatively by at least 100 mV, protection is considered to be achieved. To apply this criterion it is necessary to record structure corrosion potentials prior to the energization of the cathodic protection system and then to measure polarized potentials at the same locations after the cathodic protection system has been

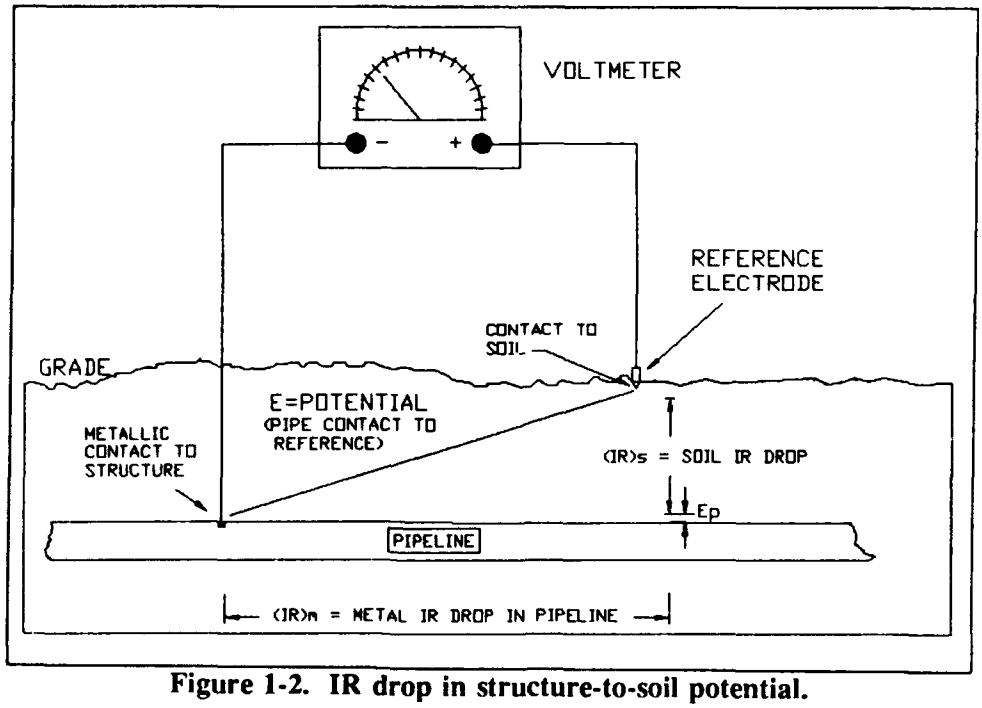

Figure 1-2. IR drop in structure-to-soil potential.

placed in operation. Since polarization is a function of time, it is sometimes advantageous, especially on bare structures, to allow the cathodic protection system to operate for a period of time before conducting the potential survey. It is imperative that all potentials measured after energization be free of IR drop so that a valid comparison to the native potentials can be made. If baseline corrosion potential data were not recorded prior to energization, the cathodic protection system can be turned off to allow the structure to depolarize so that the baseline data can be obtained. This has the disadvantage that the structure could remain unprotected for an extended period of time.

The 300 mV potential shift criterion should be used with extreme caution, because the IR drop is not considered or corrected for in its measurement. The magnitude of the IR drop error, and, consequently, the magnitude of structure polarization, are both unknown. When the IR drop is large (i.e., 200 mV or greater) and the corresponding polarization component is small (i.e., less than 100 mV), then the 300 mV shift criterion could be invalid.

Selection of a Criterion

As stated in NACE RP-01-69, no one criterion for evaluating the effectiveness of cathodic protection has proved to be satisfactory for all conditions. The selection of the criterion to be used should be made carefully, preferably with the assistance of a corrosion engineer who has expertise in cathodic protection. To select the proper criterion for a particular situation, it is important to understand each criterion and its limitations. If the results obtained with the particular criterion selected indicate that the level of cathodic protection on the structure does not meet that criterion, we do not have the freedom to impulsively select another criterion which may be more easily met. The criterion must be appropriate for the application.

Each of the criteria described above has advantages and disadvantages which affect its applicability to a given situation. Table 1, which has been reproduced from Husock,[12] summarizes the appropriate uses for each criterion. For further details, the reader should consult ESL TR-79-14.

Application to CP Diagnostic

CP Diagnostic has been designed to give the user considerable flexibility in selecting the criterion to be used in determining whether or not cathodic protection is being achieved at a given test site. CP Diagnostic uses the criterion selected to generate the Trouble Readings report. This report will list all of the test sites which do not meet the selected criterion. Note that in order to use the 300 millivolt and 100 millivolt shift criteria, the program requires the native potentials at the test site.

CP Diagnostic offers the following criteria selections:

[1] -0.85 Volt Criterion: This is the criterion described in NACE RP-01-69, paragraph 6.3.1.1. CP Diagnostic will compare the "on" potentials that are input into the field measurements table (Figures 2-23 and 3-30) with -0.85 volt as referenced to a $Cu/CuSO_4$ reference cell. Those test sites with "on" potentials that are less negative than -0.85 volt will be listed in the Trouble Readings Report.

[2] 300 Millivolt Shift Criterion: This is the criterion described in NACE RP-01-69, paragraph 6.3.1.2. CP Diagnostic will compare the "on" potentials that are input into the field measurements

[12] Husock, p. 49.

Table 1

Summary of Cathodic Protection Criteria

Criteria: Characteristics	-0.85 Volt	300 Millivolt Voltage Shift	100 Millivolt Polarization Shift	-0.85 Volt Instant Off
Frequency of use	Most often used	2nd most often used	Seldom used	Rarely used
Readings taken with CP current:	On	Off and on	Off and on then off	Off
Ease of field use	Easiest	Somewhat more difficult	Not easy	Suitable
Suitable for use in stray current areas	Yes	No	No	No
Must consider IR drop	Yes	Yes	No	No
Primarily used on	Well-coated structures	Bare structures	Bare structures	Well-coated structures
Can also be used when interconnected with	Copper	Aluminum or galvanized steel	Aluminum or galvanized steel	Copper

table (Figures 2-23 and 3-30) with the native potentials that are entered in the test site background data (Figures 2-17 and 3-25). Test sites with "on" potentials that are at least 300 mV more negative than the native potential will meet this criterion. All other test sites will be listed in the Trouble Readings Report.

[3] 100 Millivolt Shift Criterion: This is the criterion described in NACE RP-01-69, paragraph 6.3.1.3. CP Diagnostic will compare the "instant off" potentials that are input into the field measurements table (Figures 2-23 and 3-30) with the native potentials that are input into the test site background screen. Test sites with "instant off" potentials that are at least 100 mV more negative than the native potential will meet this criterion. All other test sites will be listed in the Trouble Readings Report.

[4] -0.85 Volt "Instant Off" Criterion: This criterion will compare the readings that are input into the "instant off" potential column with -0.85 volts. Those test sites with instant off potentials that are less negative than -0.85 volt will be listed in the Trouble Readings Report.

[5] User-Specified Criterion: This option allows the user to input minimum and maximum threshold "on" potentials. However, the program will not allow any threshold "on" potential to be less negative than -0.85 volt. Those test sites with "on" potentials that do not fall within the user-specified range will be listed in the Trouble Readings Report.

Sacrificial CP Diagnostic Overview

The Sacrificial CP Diagnostic System consists of the Sacrificial CP Diagnostic Program (SCP), a number of support files, and one or more Cathodic Protection data bases. The Cathodic Protection Diagnostic Program and all required support files are provided on the system distribution disk. The user creates CP data bases to hold background information and field data concerning cathodic protection systems for underground gas pipes, underground storage tanks, and water storage tanks. Data is analyzed and information is retrieved from the databases through a series of reports. One of the key functions of SCP is determining whether or not a system meets the criteria for cathodic protection as described above.

SCP provides menu-driven data-entry screens allowing the user to add new structures, anodes, and test sites to the data base, edit the information already in the data base, and record new data collected in the field. The types of information recorded may be classified as either background information or field measurements. Each datum, whether of the background information or the field measurements, is directly associated with a structure, anode bed, or test site. Structures, anode beds, and test sites are interrelated as well. A structure may be associated with many anode beds (those which protect it) and may have many associated test sites in the data base. An anode bed is associated with one test site, and a test site is associated with (provides field measurement points for) one structure. An anode bed is therefore associated with one structure. This description summarizes the relationships within the data; we now give a more detailed description of the data.

Background Information

Background information such as pipe section or tank ID, physical dimensions, location, coating information, soil information, and current requirements is stored for each pipe section or tank. The user enters values for all fields except Surface Area and Total Current Required – CP Diagnostic computes the values for these fields based on the user-entered data. Pipe Surface Area A_P in square feet (ft^2)* is computed as:

$$A_P = 3.14 * D_P * L_P \qquad \text{[Eq 1]}$$

where:

D_P = pipe diameter (ft)
L_P = pipe length (ft)

Tank surface area A_T (ft^2) is computed as:

$$A_T = 3.14D_T * (L_T + 0.5D_T) \qquad \text{[Eq 2]}$$

where

D_T = tank diameter (ft)
L_T = tank length (ft)

*1 ft = 0.305 m; 1 sq ft = 0.093 m^3.

CP Diagnostic computes Total Current Required (I_{req}) for both pipes and tanks as:

$$I_{req} = A * i * (1 - CE) \qquad \text{[Eq 3]}$$

where:

A = surface area of pipe (A_P) or tank (A_T) (ft^2)
i = required current density in milliamperes/sq ft (mA/ft^2)
CE = coating efficiency (expressed as a decimal fraction).

Test site background information consists of information that can be entered when a test site (i.e., test station or test point) is installed or first recorded in CP Diagnostic. A test station is a collection of one or more measurement points, usually wires, that is designed for the purpose of allowing structure-to-soil potentials, or other values that indicate the effectiveness of a CP system, to be measured. A test point is any other location at which measurements can be taken, such as a riser for a gas service line to a house. This is explained in greater detail in a later chapter of this manual. Test site background information includes data such as test site description and location, natural potential, and number of wires. This data is expected to change only infrequently or to remain unchanged during the life of the CP system. It can be easily modified; however, previously recorded data is replaced by any new data. Old data is not saved for historical information. Information that is expected to change periodically, for which all values should be kept (such as periodic measurements of structure-to-soil potentials), is recorded on a field measurement screen discussed later.

In addition to the test site background information (Figure 2-17), anode bed background information and initial potential and anode current measurements are recorded. Sacrificial CP Diagnostic provides space to record pipe-to-soil potential measurements both when the anodes are connected and when they are disconnected. Though new potential and anode current measurements are entered in field measurement screens, initial measurements are stored with the background information.

Background information regarding the anodes associated with a test site is also recorded when the CP system is initially installed, or when CP Diagnostic is first used with the system, and is expected to remain relatively static. The anode background information data entry screen is shown in Figure 2-19. Initial anode current outputs are also recorded with this background information (Figure 2-20).

Finally, information regarding repairs may be stored with the background information. The date, type, and cost of any repair to a pipe section may be recorded with the background information of that pipe section. Repair information is entered using the data entry screen shown in Figure 2-21.

Field Collection Data

Collection of field data for Sacrificial CP Diagnostic is done periodically at the test sites. The program stores the collected readings over time so that an accurate performance history of the CP system is maintained. Figure 2-23 displays a test site field collection data entry screen for potential measurements. The program provides space to enter both potential measurements collected with the anodes connected and potential measurements collected with the anodes disconnected. While a test point generally requires only one or two potential measurements (for anodes connected and disconnected), a test station may have an arbitrary number of measurement points for potentials. Therefore, the test site data entry screen provides multiple rows for recording measurements.

Figure 2-24 displays a test site field collection data entry screen for anode currents. The number of anode current output terminals is taken from the anode background data for the anode bed associated with the test site. If no anode bed is associated with the test site or 0 is recorded for the number of anode current output terminals, the test site field collection data entry screen for anode currents will not appear.

Reports

Sacrificial CP Diagnostic generates (1) reports that analyze data and (2) reports that simply retrieve information from the databases. Sacrificial CP Diagnostic can generate the following reports:

1. Field Collection Forms: A user of Sacrificial CP Diagnostic may record field data on data collection forms, which are organized by structure ID. A data collection form lists all test sites associated with a structure, and contains a description of each test site. The forms may be used to collect the anode current outputs and pipe-to-soil potentials for each measurement point at each test site. Data may then be entered into Sacrificial CP Diagnostic from the data collection forms.

2. Trouble Readings Report: This report identifies all test sites with readings that do not meet the user-specified criterion for proper cathodic protection. The criteria that are available in CP Diagnostic are discussed in the "Criteria of Cathodic Protection" section above. The report prints every reading taken after a user-specified date. The user also has the option of printing all such readings for the entire history of the CP system.

3. Structure Listing: This report provides a listing of all structures in the data base. It gives the structure ID and its location. It is useful as a concise description of the overall pipe and tank inventory.

4. Structure Master Listing: This report displays the background information for each structure recorded in the data base, providing a more detailed description of the pipes and tanks than does the structure listing.

5. Field Collection Report: This report gives a complete listing of all field data collected at all test sites during a user-specified time period. For each test site, the listing includes the date and result of each potential or anode current measurement or dielectric evaluation.

6. System History Report: This report lists dates and descriptions of repairs that have been performed and dates and locations of field measurements that have been taken during the life of the system. The listing is in chronological order.

7. Test Sites Not Collected: This report prints the identifiers of all test sites from which field data has not been collected over a user-specified time period (a range of dates).

8. Repair History: This report prints the contents of the repair database including repair date, failure type, repair length, and cost of repair. The repairs are listed by year and annual repair costs are totalled. This report can be printed for one structure or for all structures in the database.

9. Anode Current Output Drop: This report plots the anode current outputs over time for any anode current output terminal that has experienced a significant drop in current during a user-specified time period. A significant drop in anode current output is defined to be a drop of at least 10 percent between any two readings (they need not be consecutive) or a drop of any amount over three consecutive readings (that is, two consecutive drops of any amount).

Impressed Current CP Diagnostic Overview

The Impressed Current Cathodic Protection (CP) Diagnostic System provides data base management and diagnostics for underground pipes, underground tanks, and elevated water storage tanks that are protected by an impressed current cathodic protection system. The Impressed Current Cathodic Protection Diagnostic System consists of the Impressed Current CP Diagnostic Program (ICP), a number of support files, and one or more cathodic protection data bases. ICP and all support files are provided on the distribution disk. The user creates the CP data bases to hold information about the cathodically protected structures being maintained.

As in the sacrificial program, the user creates CP databases to hold background information and field information concerning cathodic protection systems for underground gas pipes, underground storage tanks, and water storage tanks. Data is analyzed and information is retrieved from the databases through a series of reports.

The types of data maintained for an impressed current CP system are similar to those for a sacrificial CP system, with two major differences. For an impressed current CP system, information about the rectifiers is recorded, and measurements of data about rectifier operation should be taken regularly to ensure that the rectifiers are providing appropriate current to the anodes. The relationships between the types of data maintained by Impressed Current CP Diagnostic are similar to those for Sacrificial CP Diagnostic, with the following modifications and additions. Anode currents are measured at junction boxes rather than at test sites. A junction box is associated with exactly one anode bed, and every anode bed is associated with a junction box. A rectifier may be associated with (supply current to) many junction boxes, and therefore many anode beds, but a junction box and anode bed are associated with only one rectifier. A rectifier also may be associated with (help protect) many structures. A structure may be associated with (partially protected by) many rectifiers. While it remains true that a test site is associated with exactly one structure, notice that because anode beds are directly associated with junction boxes instead of test sites, and because a junction box is associated with a rectifier which may help protect many structures, an anode bed may be associated with (help protect) many structures.

Data Entry

There are three basic differences between the data entry screens of Sacrificial CP Diagnostic and Impressed Current CP Diagnostic, caused by the presence of rectifiers for impressed current CP systems. First, Impressed Current CP Diagnostic contains additional background information data entry screens, for rectifier background information (Figures 3-12 and 3-13). All the data for this screen are user-entered except Rectifier Efficiency, which is computed based on user input according to Equation 4:

$$\text{Rectifier Efficiency} = 100 * (I_{DC}V_{DC} / I_{AC}V_{AC}) \qquad \text{[Eq 4]}$$

where:

I_{DC} = DC Current
V_{DC} = DC Voltage
I_{AC} = AC Current
V_{AC} = AC Voltage.

The second difference between the data entry screens of the parts of CP Diagnostic is that Impressed Current CP Diagnostic maintains field collection data for rectifiers (Figure 3-31), in addition to that for

test sites. This data may be used to ensure that a rectifier is continuing to operate properly. As with other field collection data, this information is associated with a collection date. The user may store and access this data to gain a history of the rectifier's operation.

A final difference between the data entry screens within CP Diagnostic is that the impressed current program refers to the "on" potential and the "instant off" potential instead of "connected" and "disconnected" potentials. This difference is seen in all of the potential measurements tables.

Reports

Impressed Current CP Diagnostic provides the same reports described for Sacrificial CP Diagnostic. Some reports are slightly modified to include relevant information about rectifiers. Impressed Current CP Diagnostic also provides two additional reports that give information about rectifiers:

1. Rectifier Master Listing: This listing prints the background information for each rectifier recorded in the data base.

2. Rectifier History Report: This report prints all field collection data recorded for each rectifier. The user may specify a range of dates for the report, which then provides only field measurements collected during the requested range of dates.

Mode of Technology Transfer

It is anticipated that the CP Diagnostic Program will be forwarded to the Engineering and Housing Support Center (EHSC) at Fort Belvoir, VA, for program maintenance, support, and distribution.

2 USER'S MANUAL FOR THE SACRIFICIAL SYSTEM

Introduction

The Sacrificial CP Diagnostic program is a user-friendly recordkeeping and diagnostic program for cathodic protection systems that use sacrificial anodes. Background and field data is stored in several database files. The program provides information through a series of reports. The purpose of this chapter is to give detailed instructions on the operation of the program. All of the program options will be explained. The user will be guided through the steps of preparing data for input into the program, installing the program on the computer, configuring the program, creating databases, entering background and field data, and generating reports. A sample implementation specification for the sacrificial CP Diagnostic system is included in Appendix A.

Steps for Implementing and Using Sacrificial CP Diagnostic

Initial Implementation

In general, these steps will need to be performed just once, unless modifications are made to the CP system or to the protected structures that would change the background information.

1. Divide the CP system and protected structures into components as described below in "Preparing Data for Input Into the Program."

2. Collect background data about the components as described in "Preparing Data for Input Into the Program." This will probably require a field survey to verify the information. If a field survey is done, the first set of field data (structure-to-soil potentials, anode current outputs, and dielectric conditions) should be collected at this time.

3. Install and configure the program as described under MAIN MENU OPTION 4 - System Utility.

4. Create databases in which to input the CP system data as described under MAIN MENU OPTION 3 - Database Administration.

5. Input background data into the databases as described under MAIN MENU OPTION 1 - Data Entry and Modifications, Submenu Option [1] - Add/Edit Structure/Test Site/Anode Background Data.

6. If the first set of field data was collected, enter it into the field collection database as described under MAIN MENU OPTION 1 - Data Entry and Modifications, Submenu Option [2] - Add/Edit Test Site Field Collection Data. If you wish to store field collection data that was collected in the past, you may enter it also.

7. Generate the reports of interest as described under MAIN MENU OPTION 2- Database Related Reports.

Periodic Collection of Field Data

1. Generate field collection forms as described under MAIN MENU OPTION 2 - Database Related Reports, Submenu Option [1] - Field Collection Forms.

2. Collect field data.

3. Input field data into program as described under MAIN MENU OPTION 1 - Data Entry and Modifications, Submenu Option [2] - Add/Edit Test Site Field Collection Data.

4. Generate the reports of interest as described under MAIN MENU OPTION 2 - Database Related Reports.

Preparing Data for Input Into the Program

Overview

Before the program can be used, data concerning the CP system and the structure that it protects must be compiled. All following sections of this manual assume that this data has been compiled and is ready to input into the program. Each system component will be given its own unique identification number. Appendix G contains a chart which shows the relationships between system components. It will be helpful to refer to it while you are reading this section. A record in the database will be created for each component and data about it will be collected and entered into the record. All of the records will be stored in the program database files. It is recommended that you obtain maps and/or drawings that show as much detail as possible about the system and the protected structures.

Defining the Protected Structures

Sacrificial CP Diagnostic recognizes two types of protected structures: underground pipes (such as gas distribution pipes) and underground storage tanks. A piping network is defined as a collection of "pipe sections." Each pipe section will have its own individual record in the database in which the information associated with it will be stored. For a system of tanks, each tank will have its own individual record in the database which contains the data associated with it.

To define a piping network, it is essential to have a map of it. Pipe sections are identified by the Pipe ID and the Section ID. The system is divided up into pipes, and each pipe is assigned a Pipe ID. Each pipe is then divided up into sections, and each section is assigned a Section ID. Therefore, a section is a subdivision of a pipe and an individual pipe may consist of many sections. A "pipe section" is the length of pipe referred to by the combination of the Pipe ID and the Section ID. A pipe section should have a consistent diameter, material of construction, coating type and quality, date of installation, and required current density along its entire length. Soil resistivity should also remain fairly consistent along the length of the section, although this is not critical to the program output. With these criteria in mind, divide the piping network up into pipes and pipe sections. Develop an identification system that fits the needs of your installation. The Pipe ID may be up to 10 characters (letters and/or numbers) in length. The Section ID may be up to 4 characters in length. For example, a gas main that serves several barracks might be given a Pipe ID of "BARRACKS" and Section ID's of 1, 2, 3, etc. A gas main that serves the 3600 Block might be given a Pipe ID of "3600BLOCK" and Section ID's of 1, 2, 3, etc. The location of each pipe section should be marked on the map. The data required for each pipe section is shown in

Figure 2-13. In addition to this data, mark and note the location of isolation joints. Isolation joints associated with a pipe section are numbered consecutively starting with 1. You may wish to use the Pipe Section Background Data Sheet in Appendix B to help organize and compile the data. Complete one form for each pipe section. This data is then ready to input into CP Diagnostic.

To define a system of tanks, assign a Tank ID (up to 10 characters) to each tank. Figure 2-14 shows the data that is required for each tank. You may wish to use the Underground Storage Tank Background Data Sheet in Appendix B to help organize and compile the data. Complete one form for each tank. In addition, if the piping associated with the tank is cathodically protected, an underground piping record (as described in the preceding paragraph) may be created for it. This data is then ready to input into CP Diagnostic.

Defining the Cathodic Protection System

CP Diagnostic defines the sacrificial CP system itself as a collection of "test sites." Each test site is associated with a protected structure (pipe or tank). Each test site has one or more anodes associated with it.

We should first clarify the definitions of "test site," "test station," and "test point" as they will be used in this document. "Test site" is used in CP Diagnostic as a generic term for "test stations" and "test points." Thus, a test site may be either a "test station" or a "test point." A test station is a collection of one or more measurement points, usually wires, that is designed for the purpose of allowing structure-to-soil potentials and/or anode current outputs to be measured. Many test stations contain a wire connected to each nearby structure and another connected to a copper-copper-sulfate ($Cu\text{-}CuSO_4$) half-cell in the soil. We can use these wires to measure structure-to-soil potentials without digging up the structure. The same test station may contain terminals for anodes or groups of anodes of an anode bed that protects the structure. At each terminal, the current flowing between the protected structure and the anodes connected to the terminal may be measured. A test point is any other location at which we are able to take measurements of interest. For example, a riser for a gas service line to a house is a useful test point. Because the riser is above ground, we can measure the structure-to-soil potential easily. In addition, a riser should have a dielectric, or isolation, joint to electrically isolate the house piping from the gas service line. Therefore, at such a test point we would also like to measure the potential across the dielectric, to ensure that it is working properly.

To define the CP system, assign a test site ID to each test site associated with each structure in the system. The use of symbol conventions will make this easier. For example, test stations might be labelled TS1, TS2, etc.; riser test points might be labelled R1, R2, etc.; and valve test points might be labelled V1, V2, etc. Isolation joints must also be represented as test sites since they will be tested to ensure that they are working properly. Recall that isolation joints were numbered consecutively beginning with 1 when the protected structures were defined above. To remain consistent with this, it is suggested that this number that was previously assigned to the joint should be used when inputting it into the test site data section. To identify it as an isolation joint test site, the number might be prefaced with an I. Often, isolation joints are located at risers at which potential measurements may also be taken. In this situation, the isolation joint number might be prefaced with RI to denote it as an isolation joint that is also a riser test point. Since the test site chart allows the entry of both potentials and dielectric conditions, all of the data for risers with isolation joints may be entered on one screen. Only riser test points without isolation joints would be named R1, R2, etc.

The test sites should be marked on the system map. Each test site will contain one or more locations at which to perform potential measurements and may contain one or more locations at which to perform current measurements. The data required for each test site is shown in Figures 2-17 through 2-20. Test site information requirements for pipes and tanks are identical. Information describing the test site itself and the anode bed associated with it are needed. In addition, structure-to-soil potentials for each potential measurement point of the test site should be collected in the field and recorded at the time the program is implemented. Dielectric conditions (i.e., good, short, none) should be determined and recorded. Also, anode current outputs are to be collected in the field and recorded. If initial potentials and anode currents are available (i.e., potentials and currents that were measured when the CP system was installed) they should also be recorded. Guidance for conducting field measurements can be found in Air Force Manual (AFM) 85-5.[13] You may wish to use the Test Site Background Data Sheet in Appendix B to help organize and compile the data. This data is then ready to be input into the CP Diagnostic program.

Installing Sacrificial CP Diagnostic

The Sacrificial Cathodic Protection Diagnostic System is distributed on a single disk that contains the following files:

SCHEMAA.DBF	SCHEMAW.DBF
SCHEMAB.DBF	SCHEMAY.DBF
SCHEMAD.DBF	SCHEMAZ.DBF
SCHEMAI.DBF	GSI.DBF
SCHEMAM.DBF	DB.DBF
SCHEMAR.DBF	SCP.EXE
SCHEMAT.DBF	INSTSCP.BAT
SCHEMAU.DBF	

Before doing anything with the distribution disk you should make a backup copy of the disk using the DOS "DISKCOPY" command. If you are not familiar with the DOS operating system or the "DISKCOPY" command, please consult your DOS manual.

As stated in Chapter 1, CP Diagnostic operates on an IBM-compatible microcomputer system with 640K of Random Access Memory (RAM). A hard drive is required because of the large amounts of data stored by the program. It supports both color and monochrome monitors. The program can be configured to support most dot matrix and laser printers.

First, check your CONFIG.SYS file to see if it contains the statement:

FILES=50

If this statement is not in the CONFIG.SYS file, you must add it. If there is a FILES statement, but the number is less than 50, you must change it to 50. Consult your DOS manual for assistance. If the FILES=50 statement is not in your CONFIG.SYS file, CP Diagnostic will not run properly.

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[13] *Maintenance and Operation of Cathodic Protection Systems*, Air Force Manual (AFM) 85-5 (Headquarters, U.S. Air Force, 1982).

IMPORTANT: In the installation procedure that follows:

A: refers to the letter designation of the floppy disk drive from which you are installing the program.

C: refers to the letter designation of the hard drive on which you are installing the program.

Your disk drives may or may not be designated by the letters A: and C:. If not, substitute the appropriate letters for A: and C:.

To install the Sacrificial Cathodic Protection Diagnostic System on a hard disk, place the backup disk into the floppy disk drive of your computer. You will see the DOS prompt "C:>" to which you will enter the following command "A:". The DOS prompt will now read "A:>" to which you will respond "INSTSCP A: C:". Your screen should show:

C:> A:
A:> INSTSCP A: C:

(Note: the C:> and A:> portions of the commands are DOS prompts and are not user-entered.) The "INSTSCP" program creates a directory named SCP on the hard disk and copies all the files needed to run the Sacrificial Cathodic Protection Diagnostic System to the SCP directory. After the "INSTSCP" program has finished, the system is ready to use. Remember to store the distribution and back-up disks in a safe place.

Starting the Sacrificial CP Diagnostic System

Before starting the Sacrificial Cathodic Protection Diagnostic System, you need to access the directory and drive containing SCP and its support files. If you have just installed the program, you are already in the correct directory. If not, you will need to change to the SCP directory. For example, if the Sacrificial Cathodic Protection Diagnostic System was installed on drive C, the following commands access the drive and directory containing SCP.

A:> C:
C:> CD\SCP

(Note: The A:> and the C:> are DOS prompts and are not user-entered commands.) The program is then started by entering the command SCP at the DOS prompt. As the program starts, it displays an opening screen that lists the program authors. Press any key to continue. After the opening screen is cleared the program displays either the MAIN MENU screen or a MISSING FILE(S) error screen. If the error screen appears, make a note of the missing file(s), copy them from your backup disk, and restart the program.

Diagram of Program Flow

To assist you with navigating throughout the Sacrificial CP Diagnostic Program, a diagram showing the program flow is included in Appendix C. This diagram consists of five sheets labelled A through E. All menus and menu options in the diagrams are cross-referenced with their descriptions in the main text

of this manual. Cross references are given in brackets { } and consist of a letter and a number. The letter refers to the sheet of the diagram on which the option or menu appears. For example, in the text below, the cross-reference {A1} appears after the title "Main Menu Overview." To locate this in the diagram, turn to Appendix C and find sheet A. Block {A1} is located at the top of sheet A. By using the diagrams and the cross-references, you can easily determine your location in the program at any time.

General Rules for Operating the Menus

CP Diagnostic is a menu-driven, user-friendly program. There are two basic rules that apply to the operation of ALL menus throughout the program.

1. Menu options are selected by (1) typing the number of the option, or (2) moving the selection bar to the desired option and pressing <Enter>. Once an option is selected, the program either executes the option or displays a message about its failure to perform the option.

2. The <Esc> key can be used to move back to the previous menu or program screen.

About Passwords

Certain sections of the CP Diagnostic program are password-protected to reduce the chance of unauthorized persons editing or deleting your data. There are three passwords which you may set: the add/edit password, the delete password, and the general system information password. The add/edit password is used to control access to the "Add/ Edit Structure/ Test Site/ Anode Data" option and the "Add/ Edit Test Site Field Collection Data" options of the ADD/ MODIFY/ DELETE menu. The delete password is used to control access to all options which allow deletion of structures, test sites, or entire databases. The general system information password is used to control access to the "System Utility" option of the MAIN MENU. Procedures for setting these passwords will be discussed in the "System Utility" section.

A particular password only needs to be entered once during a program run. For example, once you enter your delete password, you will be allowed access to all "delete" options until you exit the program. You will not be prompted for the password every time you attempt to access a "delete" option, even if you have performed other program operations in the meantime. After you exit the program and then restart it, you will be prompted for the passwords again.

Most of the instructions for each program option described in this manual are written with the assumption that the password necessary to access the option has not yet been entered. If you have, in fact, entered the password during your current working session, disregard the references to the password screens.

MAIN MENU Overview {A1}

The MAIN MENU screen (Figure 2-1) illustrates a number of features of SCP's user interface. The menu displays an informative header across the top of the screen containing three information boxes: the File Box, the Banner Box, and the Version Box. The File Box (top left of the screen) displays the name of the active Cathodic Protection data base. The Banner Box (top middle of the screen) displays the name

of the program, the current location in the program, and a short description of the active CP data base. The program Version Box (top right of the screen) displays SCP's version number. The current date and time are displayed below the file and version boxes to complete the program's header. On a color monitor, the color of the header provides the following additional information:

- RED All Error Screens
- WHITE The MAIN MENU and Secondary Menu Screens
- CYAN All Other Menu or Option Screens.

The Sacrificial Cathodic Protection Diagnostic Program is operated from the MAIN MENU (Figure 2-1). The MAIN MENU has five options. The following sections of this manual describe each of the program's MAIN MENU and secondary menu options in detail.

MAIN MENU Option 1 (Data Entry & Modification) and Option 2 (Data Base-Related Reports) are ordered before Options 3 and 4 in the MAIN MENU because they are used most often. Most of your work in the Sacrificial Cathodic Protection Diagnostic System will be done through Options 1 and 2. However, there are several procedures which you must perform initially when using CP Diagnostic for the first time. You must configure the program for your hardware using MAIN MENU Option 4. You must then create and/or select a database for use using MAIN MENU Option 3. Thus, MAIN MENU Option 4 will be discussed first, followed by Option 3. Options 1 and 2 will be discussed last.

MAIN MENU Option 4 — System Utility {A8}

This option is used to configure CP Diagnostic for your hardware and to set passwords (Figure 2-2). If passwords have not yet been set, the General System Information screen (Figure 2-2) {A9} will appear immediately after this option is selected. If passwords have been set, you will be prompted to enter your general system information password. Type your password and press <Enter>. Your password will not be displayed on the screen as you type it.

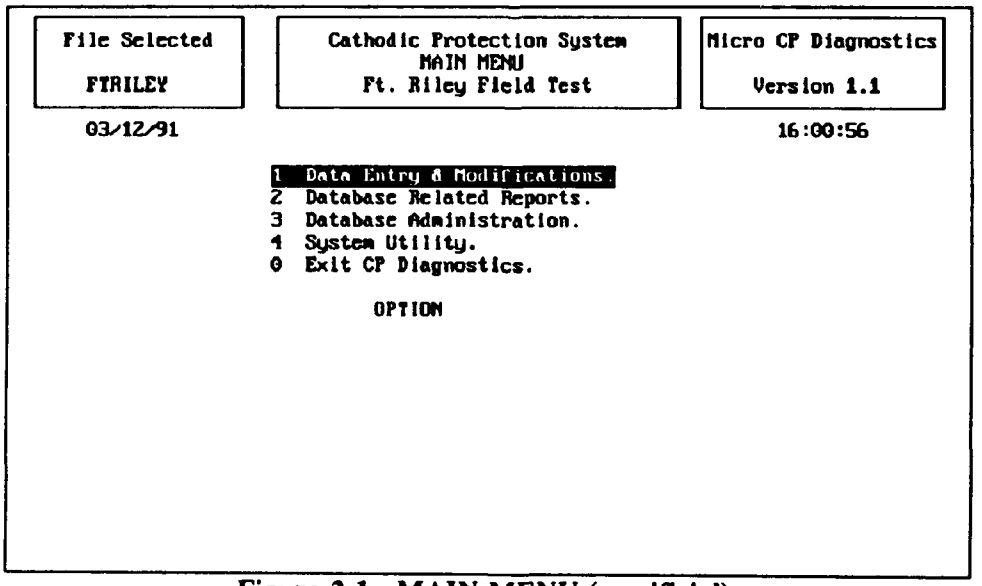

Figure 2-1. MAIN MENU (sacrificial).

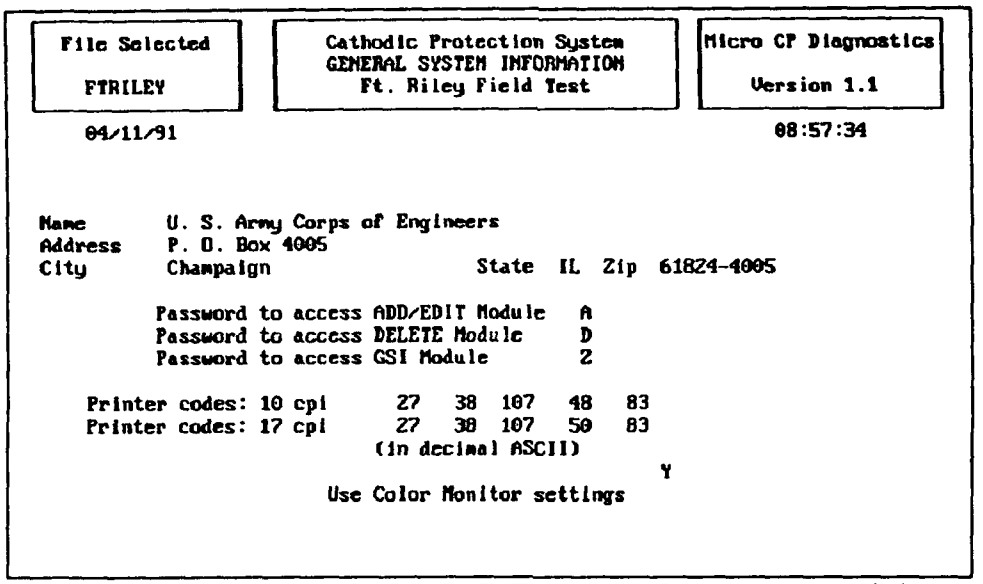

Figure 2-2. GENERAL SYSTEM INFORMATION screen (sacrificial).

Enter your name (or the installation's name) and address in the top portion of the screen.

As discussed previously, each of the three kinds of data manipulation—add/edit data, delete data, and edit general system information (system utility)—has its own password. Passwords may be up to six characters in length. Enter the desired passwords in the appropriate location. Once you enter a password for the GSI (system utility) module, you will not be able to access this screen again without it. Thus, it is critical that you commit the passwords to memory or write them down.

The printer codes are needed to configure CP Diagnostic for your printer so that the reports print correctly. The printer codes are entered in decimal ASCII. Consult your printer manual to determine the codes needed to switch your printer to compressed mode and enter them as the 17-characters-per-inch codes. Next, determine the codes needed to cancel compressed mode and enter these as the 10-character-per-inch codes.

The monitor setting controls whether or not CP Diagnostic screens appear in color. If you have a color monitor, enter "Y" after the "Use Color Monitor Settings?" prompt. If you do not have a color monitor, enter "N".

CP Diagnostic is now configured for your hardware. These settings will be stored by the program. You will only need to repeat this setup procedure if you wish to change the passwords or if you use the program with a different printer or a different monitor type. To return to the MAIN MENU, hit <Esc> or press <Enter> on the "Use Color Monitor Settings" field.

MAIN MENU Option 3 – Data Base Administration {A6}

The Data Base Administration option of the MAIN MENU is used to manipulate the database files that are stored by CP Diagnostic. Databases can be added (created), selected for use, deleted, and reindexed using this option. When the Data Base Administration option is selected, the DATA BASE ADMINISTRATION MENU screen (Figure 2-3) {A7} will appear.

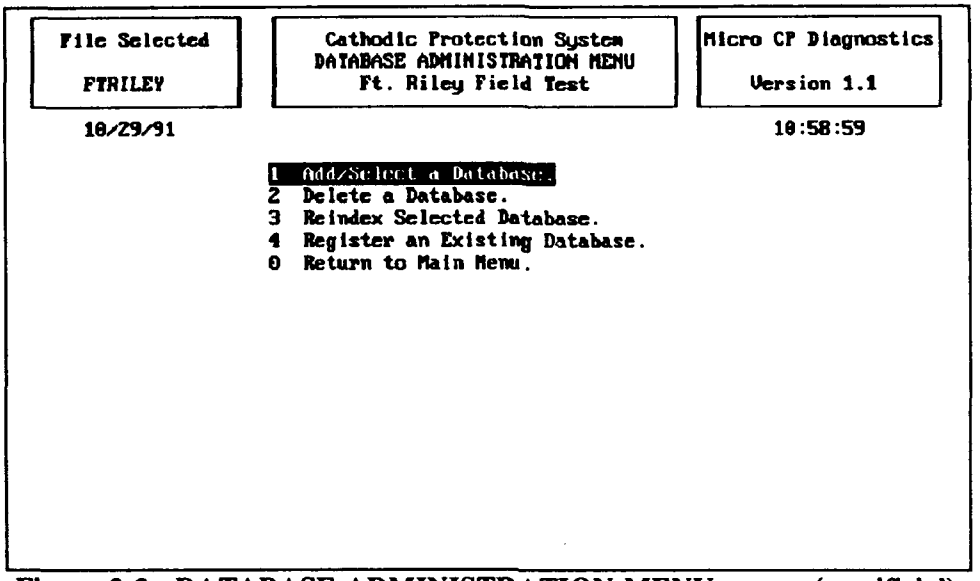

Figure 2-3. DATABASE ADMINISTRATION MENU screen (sacrificial).

DATA BASE ADMINISTRATION MENU Option 1 – Add/Select a Data Base {E1}

This option allows you to (1) add (create) a new database, or (2) select an existing database for use. This option also alerts you if files are missing from a database that you are attempting to select. Note that if you are using CP Diagnostic for the first time, you will need to add a database before entering any data.

The Sacrificial Cathodic Protection Diagnostic System can maintain many separate CP data bases. The amount of information stored is limited only by the available space on the hard disk. You may wish to store all of your data in one database, or you may wish to divide it up into several databases. Storing data in more than one database is advantageous when you have a large amount of data or when you are maintaining data for more than one installation. Each CP data base is given a one- to seven-character name within the Sacrificial Cathodic Protection Diagnostic Program. The program creates a series of disk files to store the information for each of the databases that is created. The names of the disk files consist of the one- to seven-character database name plus a single character. For example, the disk files for the CP database HOOD would have the following names:

HOODA.DBF	Anode current background data for the CP database HOOD
HOODB.DBF	Anode current field data for the CP database HOOD
HOODD.DBF	Test site field data for the CP database HOOD
HOODI.DBF	Isolation joint locations for the CP database HOOD
HOODM.DBF	Pipe section background data for the CP database HOOD
HOODR.DBF	Repair information for the CP database HOOD
HOODT.DBF	Test site and anode background data for the CP database HOOD
HOODU.DBF	Underground storage tank background data for the CP database HOOD
HOODW.DBF	Test site wire background data for the CP database HOOD
HOODY.DBF	Test site field comments for the CP database HOOD
HOODZ.DBF	Anode current field comments for the CP database HOOD

When you choose the Add/Select a Data Base option from the Data Base Administration Menu, the SELECTING A DATA BASE screen will appear (Figure 2-4). This screen lists all the Cathodic Protection data bases (if any) that have been entered into the Sacrificial Cathodic Protection Diagnostic System.

To ADD (Create) a New Database: {E2} As stated above, you will need to do this if you are using the program for the first time. To create a CP data base, simply type a one- to seven-character name for it at the "Database" prompt of the SELECTING A DATA BASE screen and press <Enter>. IMPORTANT. The database name must not include any spaces. For example, TEST DB would not be an acceptable database name. In addition, the database name *must* begin with a *letter*. The name must be different from the other existing database names. When a database name is entered that does not already exist in the program, the CREATING A DATA BASE screen appears. This screen asks you if you want to create a new CP data base. If you answer no <N>, you are returned to the DATABASE ADMINSTRATION MENU, and the currently selected data base is not changed. If you answer yes <Y>, a new CP data base (with the name that you have specified) is added to the system. Before the new data base is created, it must be given a description. The program prompts for a short (up to 20-character) description of the data base. The data base files are then created, the data base is automatically selected, and you are returned to the DATABASE ADMININSTRATION MENU.

To SELECT an Existing Database for Use: {E3} All CP data bases that have been previously entered into the system are listed in the "selecting a database" screen. If there are many CP data bases on the disk, the list may contain multiple pages. The <PgUp> and <PgDn> keys may be used to page through multiple-page listings of Cathodic Protection data base files. To select one of the listed databases for use, type its name at the "Database" prompt and press <Enter>. To exit the SELECTING A DATA BASE screen without changing the currently active CP data base, use <Esc>. After the data base is selected, its name and description are placed in the program's header, and you are returned to the DATABASE ADMINSTRATION MENU.

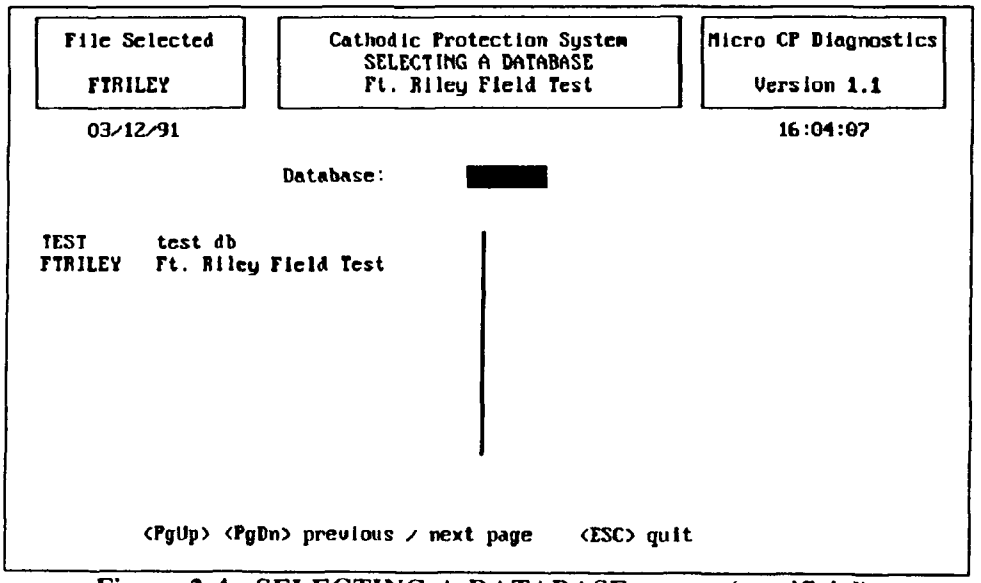

Figure 2-4. SELECTING A DATABASE screen (sacrificial).

Note that if this is not the first time you have used the program, the data base that was in use the last time the program was run remains active when the program is started again and does not need to be activated with the Data Base Administration option.

If Some Files Are Missing from the Selected Database: Occasionally all or some of the disk files of a Cathodic Protection data base may be missing. This can occur, for example, if you delete the files using DOS and forget to remove the CP data base name from SCP. The MISSING FILE(S) Screen also appears when the program is started using an incomplete or missing data base. When this occurs, the MISSING FILE(S) Screen (Figure 2-5) appears. To use the incomplete data base, note the names of the missing file(s). Press any key to return to the DATABASE ADMINISTRATION MENU. Leave SCP, copy the file(s) from a backup disk, and restart SCP.

DATA BASE ADMINISTRATION MENU Option 2 – Delete a Data Base {E4}

The Delete a Database option allows you to remove data base files from your hard drive. After you select this option, enter your "delete" password when prompted. The SELECTING A DATABASE screen will appear. Select a database to delete and type its name at the prompt. Next, the DELETE A DATA BASE screen will appear (Figure 2-6). It will display the name of the data base that you have selected in the lower left hand corner of the screen and will ask you if you really wish to delete all the records associated with this data base.

If you do not wish to delete the selected database, press <N> or <Enter> at the prompt to return to the DATABASE ADMINISTRATION MENU.

If you wish to delete all records of the data base from your hard disk and the SCP program, press the <Y> at the prompt. It is recommended that you make a backup of the files on a disk before proceeding with the delete option. DELETED DATA BASE FILES CANNOT BE RECALLED.

After the files are deleted, press any key when prompted to return to the DATABASE ADMINISTRATION MENU.

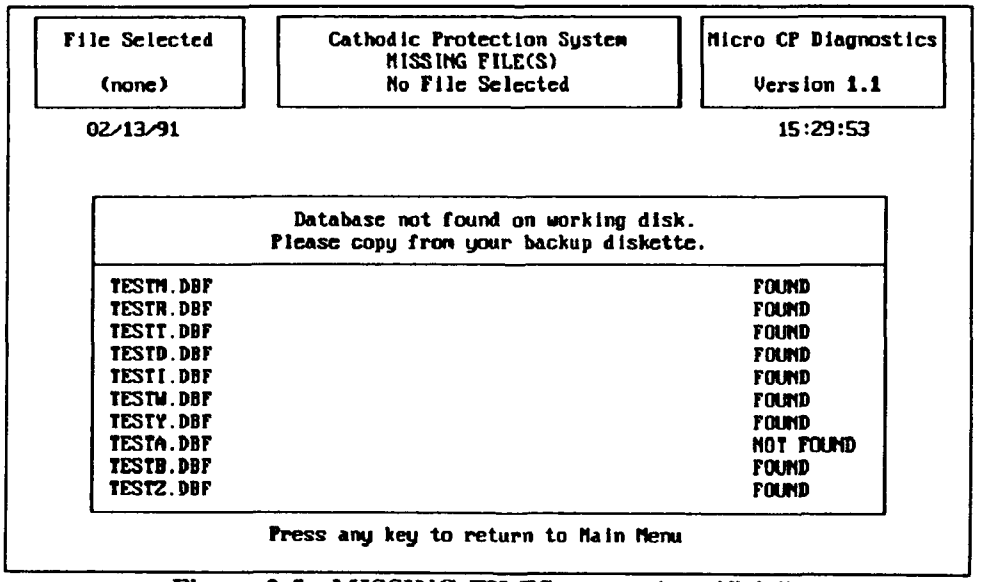

Figure 2-5. MISSING FILES screen (sacrificial).

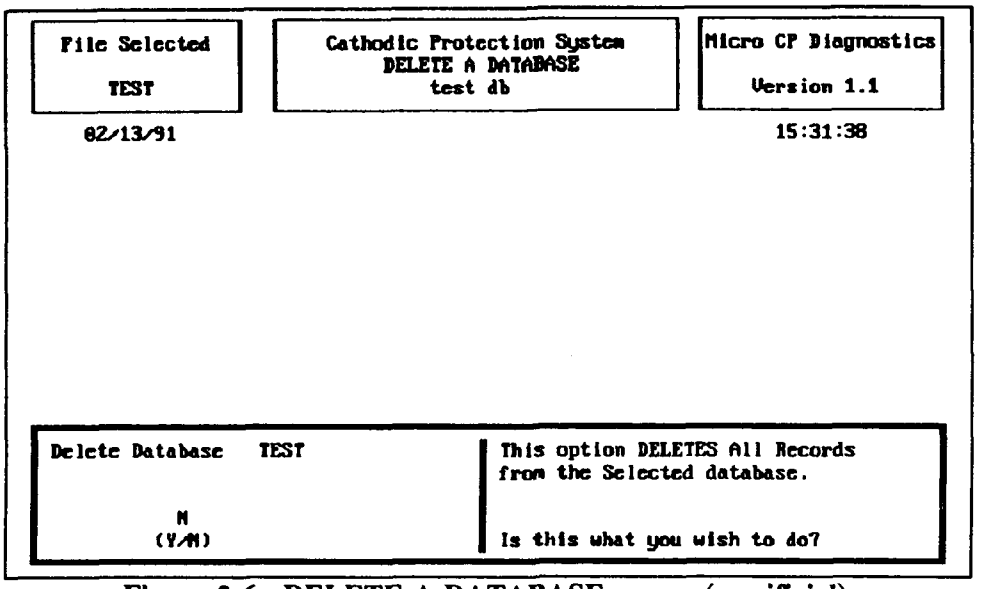

Figure 2-6. DELETE A DATABASE screen (sacrificial).

DATA BASE ADMINISTRATION MENU Option 3 – Re-Index a Data Base {E5}

This option will create new index files for the current data base. The index is used in searching files for particular records and must exist in order for the program to operate properly. Re-indexing data base files from time to time will help the system run faster. If, over a period of time, many operations have been performed such as adding or deleting records, re-indexing will help speed your work by "cleaning up" the index. This option should also be used if the index files are accidentally erased.

You will be asked if you want to rebuild the index for the currently selected data base (Figure 2-7). If this is what you want to do, press <Y> for YES. After indexing is complete, press any key to return to the DATABASE ADMINISTRATION MENU. If this is not what you want to do, press <N> for NO. The program will return to the DATA BASE ADMINISTRATION menu.

DATABASE ADMINISTRATION MENU Option 4 - Register on Existing Database {E6}

It is possible that existing CP data bases will not be listed in the SELECTING A DATA BASE Screen's data base list. For example, this occurs if you install a new version of SCP on a computer with existing CP data bases. Before these data bases can be selected for use, they must be "registered" with the program so that it recognizes their existence. To "register" an existing data base with the system, type its name at the "Database" prompt of the SELECTING A DATA BASE Screen. The MISSING FILE(S) Screen (Figure 2-5) will list any files of the data base that may be missing. If any of the data base files are missing, note their names, exit the program, and copy them from a backup disk, then restart the SCP program, and select the data base. If no files are missing, the MISSING FILE(S) Screen is supplemented with the message that the data base is being added to the system. You are then prompted to enter a new description for the data base. After you enter the description, the new database becomes the current database in use, and you are returned to the MAIN MENU.

DATA BASE ADMINISTRATION MENU Option 0 - Return to Main Menu {E7}

This option returns you to the Main Menu of Sacrificial CP Diagnostic.

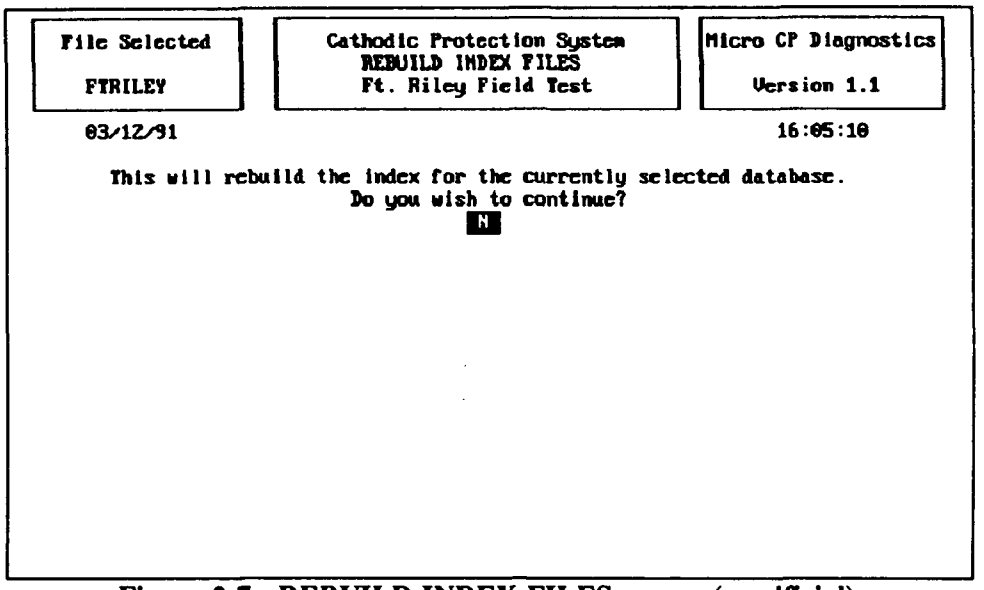

Figure 2-7. REBUILD INDEX FILES screen (sacrificial).

MAIN MENU Option 1 -- Data Entry and Modification {A2}

The Data Entry and Modification option of the MAIN MENU is used to create and update information about cathodic protection systems in the currently active CP data base. A CP data base must be active (selected) before this option can be used. If no CP data base is active when you select the Data Entry and Modification Option, the SELECTING A DATABASE screen will appear. Type the name of the database that you wish to work with at the prompt. If you attempt to exit the SELECTING A DATABASE screen before typing a database name, the program displays the error message:

"You Must Have A Data Base In Use!"

You will not be allowed to exit this screen without selecting a database.

After you have selected the Data Entry & Modification option and have an active database, the ADD/MODIFY/DELETE MENU {A3} will appear. You will notice that the ADD/ MODIFY/ DELETE MENU Screen displays five options (Figure 2-8). Select the desired option in the usual manner.

General Rules for Data Entry and Modification

CP system data is entered via a series of screens, each of which contains a series of prompts followed by blank spaces, or "fields," in which the data is to be entered. There are several general rules that apply throughout all of the Data Entry and Modification screens.

1. Enter data in each field by typing your response and pressing the <Enter> key. The cursor then moves to the next field.

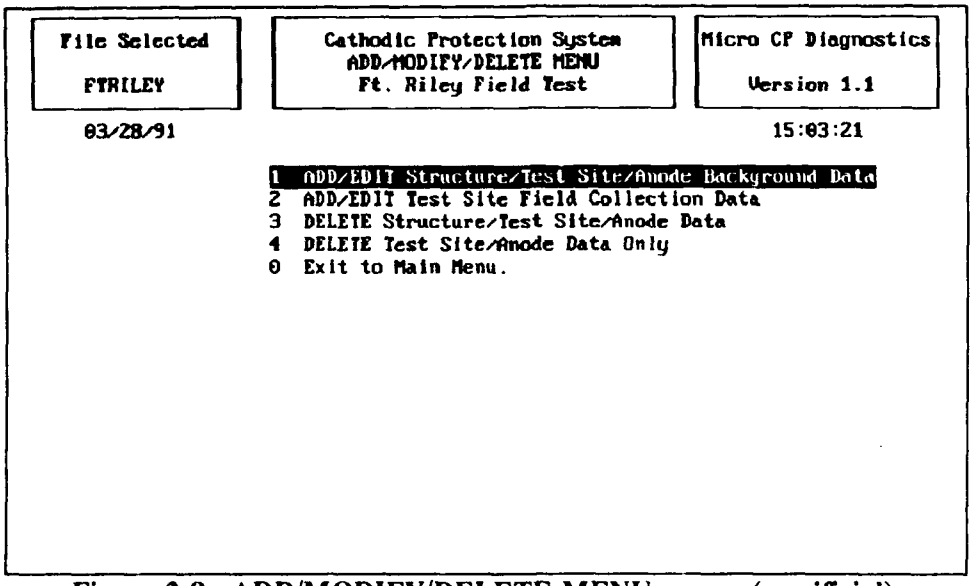

Figure 2-8. ADD/MODIFY/DELETE MENU screen (sacrificial).

2. If the information for a field is not available, press <Enter> to bypass that field and move the prompt to the next field. The former field will be left blank. If the information for that field becomes available at a later date, it may be entered into the program at that time.

3. The backspace and delete keys may be used to correct mistakes in data entry. The backspace key will erase the character immediately to the left of the cursor. The delete key will erase the character at the cursor.

4. The insert key may be used to toggle between insert mode and typeover mode.

5. The left and right arrow keys may be used to move the cursor within the field that you are currently editing.

6. The up arrow key may be used to move to the field above the one you are currently in and the down arrow key may be used to move to the field below it.

ADD/MODIFY/DELETE MENU Option 1 – ADD/EDIT Structure/Test Site/Anode Data {B1}

This option allows you to enter new structures, test sites, and anode beds with the associated data, into the system, and allows you to edit data for existing structures, test sites, and anode beds.

After you choose this option, the ENTER ADD/EDIT PASSWORD screen (Figure 2-9) will appear. At the prompt, type your add/edit password and press <Enter>. The password will not be displayed on the screen as you type it.

After you enter the password, the STRUCTURE TYPE SPECIFICATION screen (Figure 2-10) will appear. You will be asked whether you are editing pipe section records or tank records. Type your response at the prompt. The appropriate STRUCTURE IDENTIFICATION screen will appear. Figure 2-11 shows the pipe section identification screen. Figure 2-12 shows the tank identification screen.

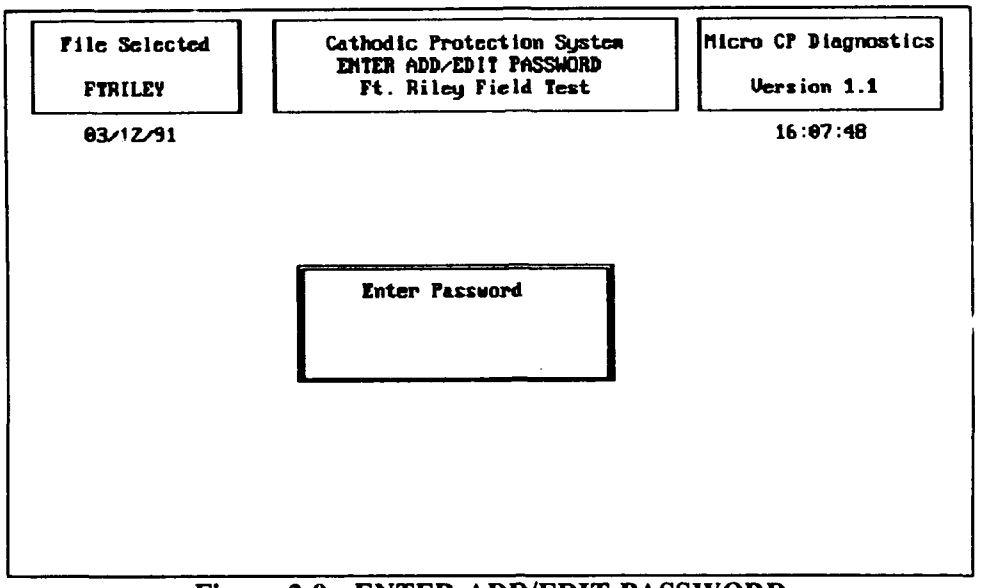

Figure 2-9. ENTER ADD/EDIT PASSWORD screen (sacrificial).

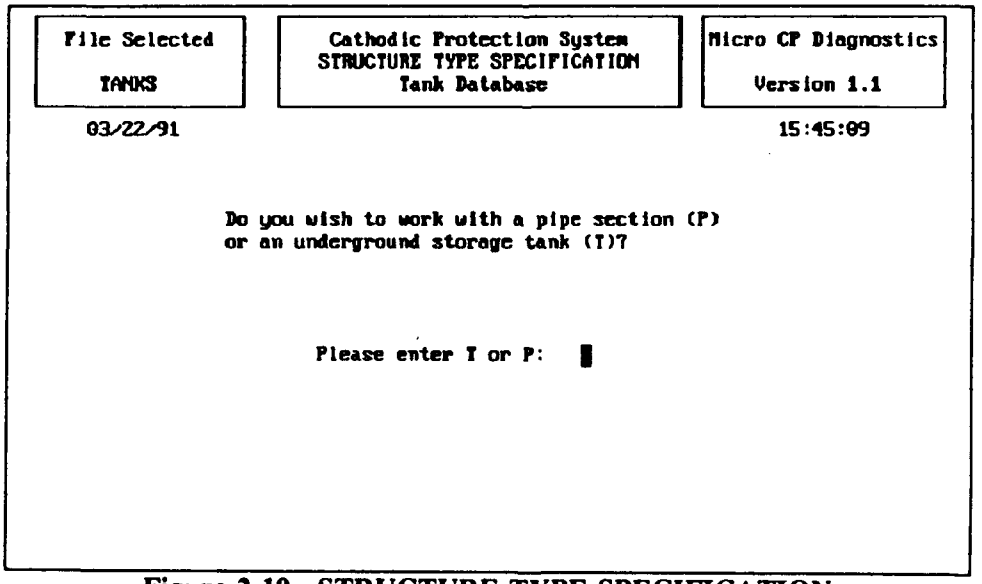

Figure 2-10. STRUCTURE TYPE SPECIFICATION screen (sacrificial).

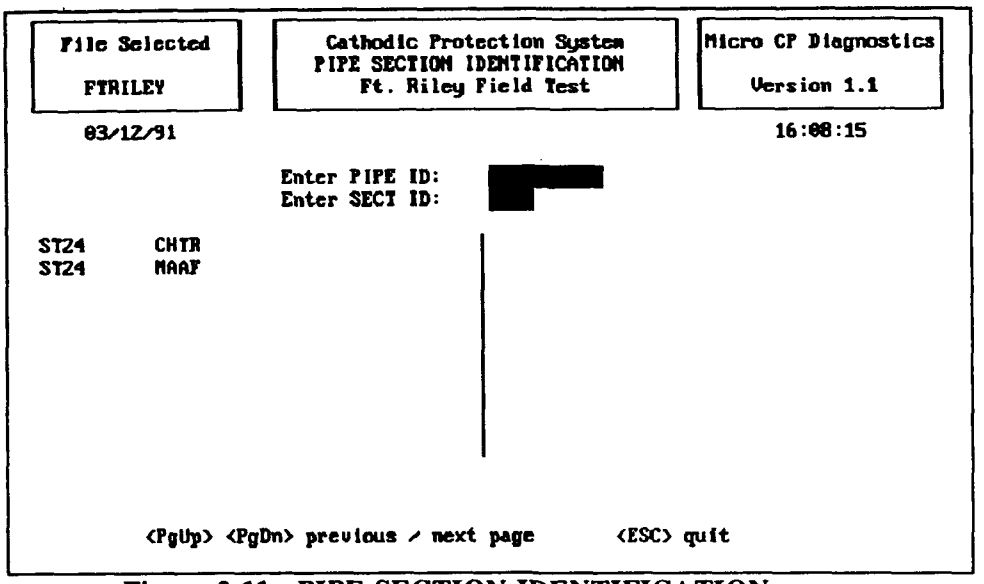

Figure 2-11. PIPE SECTION IDENTIFICATION screen (sacrificial).

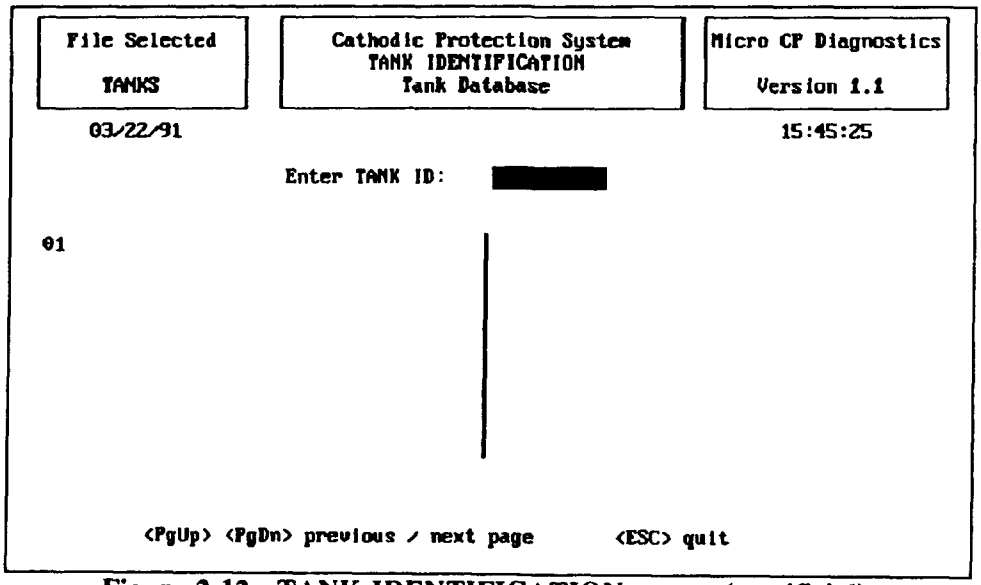

Figure 2-12. TANK IDENTIFICATION screen (sacrificial).

If you wish to edit an existing record, consult the list of structure ID's shown on the screen. This is a complete list of the identification numbers of previously entered structures. The <PgUp> and <PgDn> keys are used to scroll through the pages of the list. To select an existing pipe section record for editing, type the PIPE ID (up to 10 characters) exactly as it appears in the list at the prompt and press the <enter> key to move the prompt to SECT ID. Enter the four-character section identification number at the prompt and press <Enter>. To select an existing tank record for editing, enter the TANK ID (up to 10 characters) exactly as it appears in the list of existing structures.

If you wish to create a new record, type a new structure ID at the prompt, following the procedures given in the preceding paragraph for entering structure ID's. The program automatically creates a new record when a structure ID is entered that does not already exist in the program (i.e., does not appear on the list).

After you have entered the Structure ID, the ADD/EDIT BACKGROUND DATA screen (Figure 2-13 for pipes; Figure 2-14 for tanks) will appear. The STRUCTURE/TEST SITE/ANODE DATA submenu {C1} is located at the bottom of the screen and displays a list of four options from which you may choose.

STRUCTURE/ TEST SITE/ ANODE SUBMENU Option 1 – Add/Edit Background Data. {C2} You may add or edit background information about the structure that you have selected by choosing option 1 of the submenu. This is the information that you collected on the Pipe Background Data Sheets or the Underground Tank Background Data Sheets from Appendix B. Add or edit background information by typing the appropriate information at the corresponding prompt on the screen and pressing <Enter> to move to the next prompt. Note that Surface Area and Total Current Required are automatically calculated by the program.

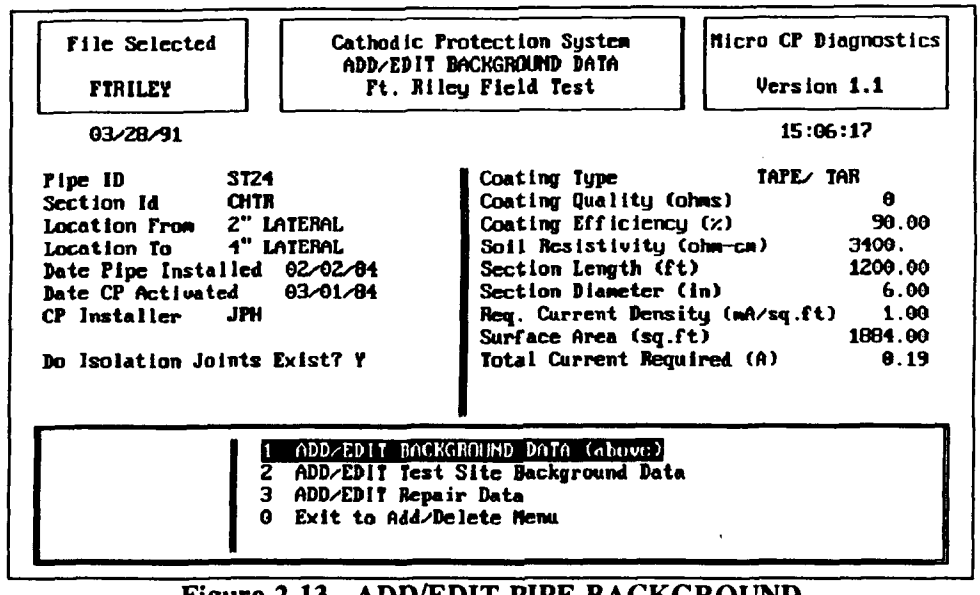

Figure 2-13. ADD/EDIT PIPE BACKGROUND DATA screen (sacrificial).

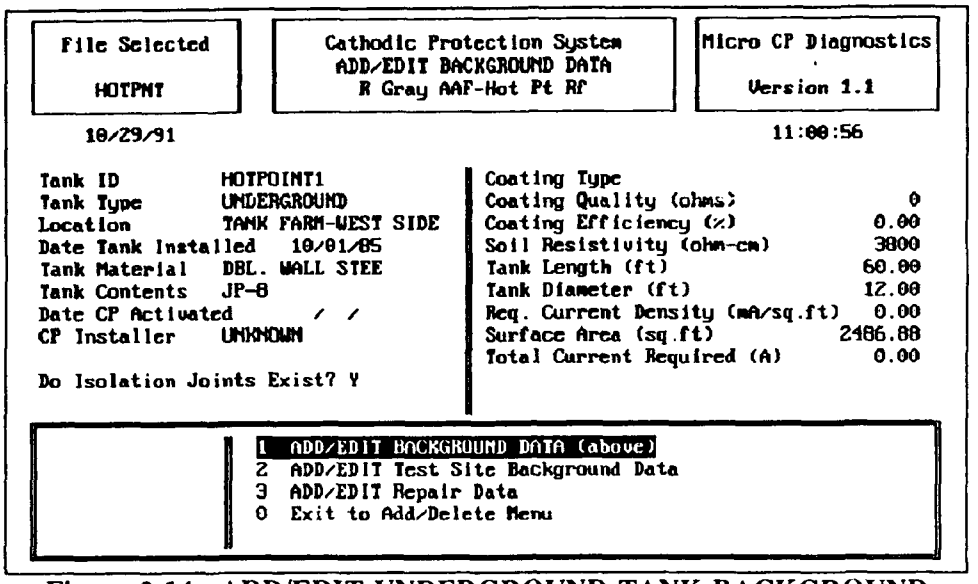

Figure 2-14. ADD/EDIT UNDERGROUND TANK BACKGROUND DATA screen (sacrificial).

To answer the question "Do Isolation Joints Exist?", press either <Y> for Yes or <N> for No. If <Y> is pressed a window will appear at the bottom of the ADD/EDIT BACKGROUND DATA SCREEN asking for the location of the identified isolation joints (Figure 2-15). Enter the location description and press <return>. You may enter as many isolation locations as desired. Use the up/down arrow keys on your keyboard to page through the entered isolation joint locations. When finished, press <Esc> to return to the STRUCTURE/TEST SITE/ANODE DATA submenu.

STRUCTURE/TEST SITE/ANODE SUBMENU Option 2 – Add/Edit Test Site Background Data. {C3} This option allows you to add or modify test site and anode bed background data, initial potentials, initial dielectric conditions, and initial anode currents for the test sites that are associated with the currently selected structure. This option also allows you to add new test sites for the currently selected structure. For a detailed explanation of test sites, see the section in this chapter entitled "Defining the Cathodic Protection System."

When this option is selected, the SCP program will display the TEST SITE IDENTIFICATION screen (Figure 2-16). The TEST SITE IDENTIFICATION screen prompts you to enter a Test Site ID number.

If you wish to edit an existing record, consult the list of test site ID's shown on the screen. This is a complete list of the identification numbers of previously entered test sites for the currently selected structure. The <PgUp> and <PgDn> keys are used to scroll through the pages of the list. To select an existing test site record for editing, type the Test Site ID exactly as it appears in the list at the prompt and press the <Enter> key.

If you wish to create a new test site for the currently selected structure, type a new test site ID at the prompt. The program automatically creates a new record when a Test Site ID is entered that does not already exist in the program (i.e., does not appear on the list).

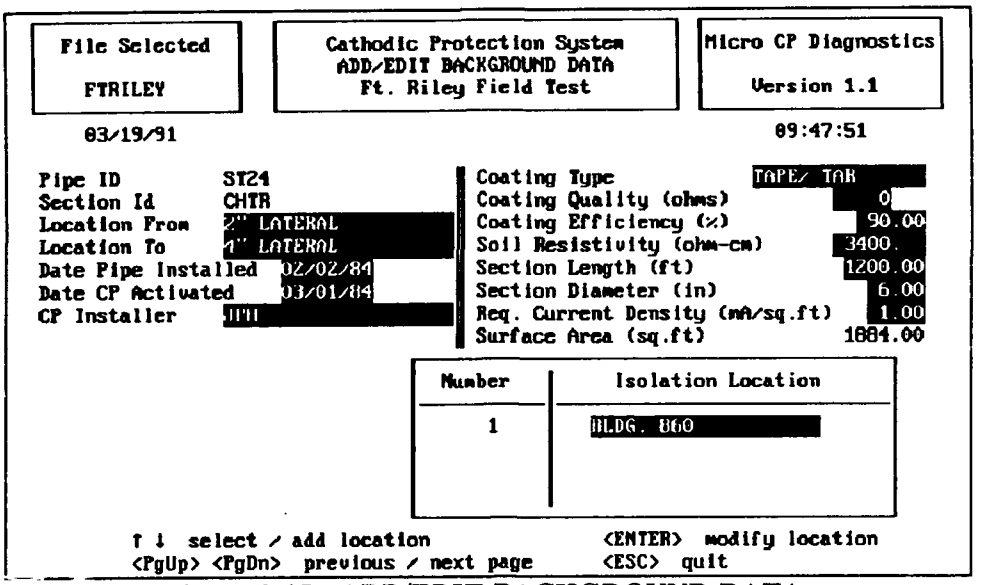

Figure 2-15. ADD/EDIT BACKGROUND DATA (isolation joints-sacrificial).

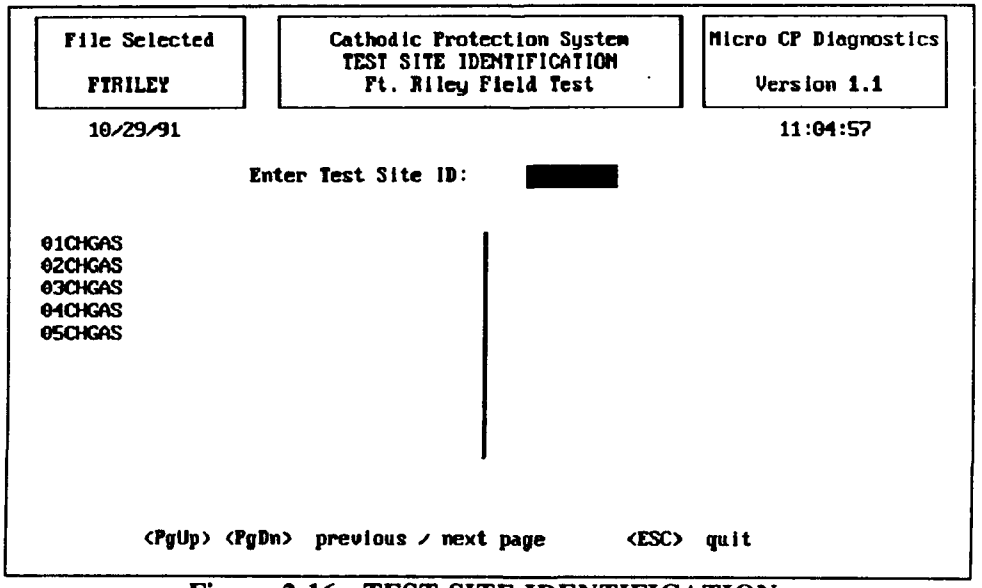

Figure 2-16. TEST SITE IDENTIFICATION screen (sacrificial).

To return to the STRUCTURE/TEST SITE/ANODE submenu without adding or modifying test site data, press the <Esc> key.

After entering the Test Site ID, you will be presented with a sequence of four background information screens related to test sites. The first screen contains fields for general information about the test site. The second screen holds the initial potential values at each of the test site's measurement points and the condition of the isolation joint. The third screen contains information about the anodes in the anode bed associated with the test site, that is, the anode bed that protects the structure whose measurements are taken at the test site. The fourth screen contains initial anode current outputs. Initial measurements refer to those that were taken when the CP system was installed. It is important to note that the initial potentials and currents entered here in the background data section are *not* evaluated when the analytic reports such as Trouble Readings and Anode Current Output Drop are run. These initial measurements provide baseline information only. The reports analyze data entered in the "Field Collection Data" section of the program. To exit any of these screens, press <Enter> through all of the fields on the screen or press <Esc>. Exiting all four screens returns you to the ADD/EDIT BACKGROUND DATA screen and the PIPE/TEST SITE/ANODE DATA submenu. Let us now examine each of the four test site background information screens in more detail.

The first screen in the sequence is the ADD/EDIT TEST SITE DATA screen shown in Figure 2-17. It contains fields for general information about the test site. This is the information that you collected in Part I of the Test Site Background Data Sheets from Appendix B. If the test site you selected is already in the database, the information will be displayed on your screen, ready for you to edit. Otherwise, all fields except structure ID and test site ID will be empty.

The second screen in the sequence, the ADD/EDIT TEST SITE INITIAL POTENTIALS screen (Figure 2-18), will appear after you have pressed <Enter> on the last field of the general information screen. It contains initial values (i.e., from when the CP system was activated) for each structure-to-soil potential measurement point of the test site. This is the information that you collected in the Initial Potentials table of the Test Site Background Data Sheets from Appendix B. Enter only structure-to-soil potentials on this screen. Do not enter other potential measurements or anode current output measurements. For each measurement point of the test site, enter an identifier, e.g., "RED," press <Enter>, then enter the function that the wire serves (e.g., P/S for "Pipe to Soil potential"), and the initial potential value for wire connected and disconnected. Press <Enter> after typing in each field's value. At the end of each line, the prompt will automatically move to the next line. You will be prompted to enter potentials for as many measurement points as you have specified in the "Number of Wires" field on the previous screen. When you have entered information for all of the measurement points, press the <Esc> key to move to the next screen.

The next screen to appear is the ADD/EDIT ANODE DATA Screen (Figure 2-19). Enter the anode information at the prompts. This is the information that you collected in Part II of the Test Site Background Data Sheets from Appendix B.

The last screen to appear is the ADD/EDIT INITIAL ANODE CURRENTS screen (Figure 2-20). This screen will appear after you have pressed <Enter> on the last field of the ANODE DATA Screen. This screen requests the information that you collected in the Anode Current Output table of the Test Site Background Data Sheets. For each terminal, type in the measured *initial* anode current output followed by the <Enter> key. At the end of each line, the prompt will automatically move to the next line. After you have entered information for all of the terminals, press <Esc> to return to the ADD/EDIT BACKGROUND DATA screen and the STRUCTURE/TEST SITE/ANODE submenu.

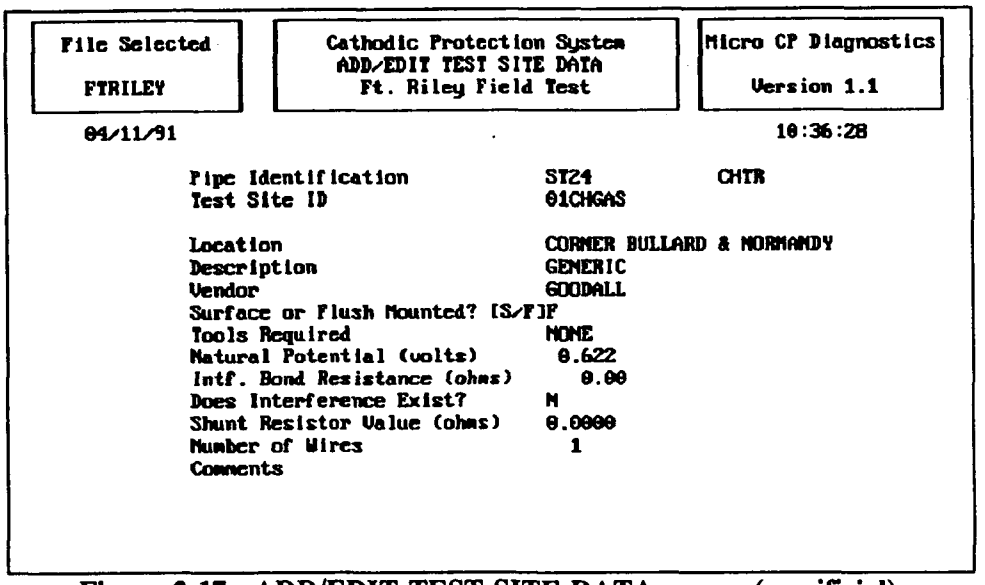

Figure 2-17. ADD/EDIT TEST SITE DATA screen (sacrificial).

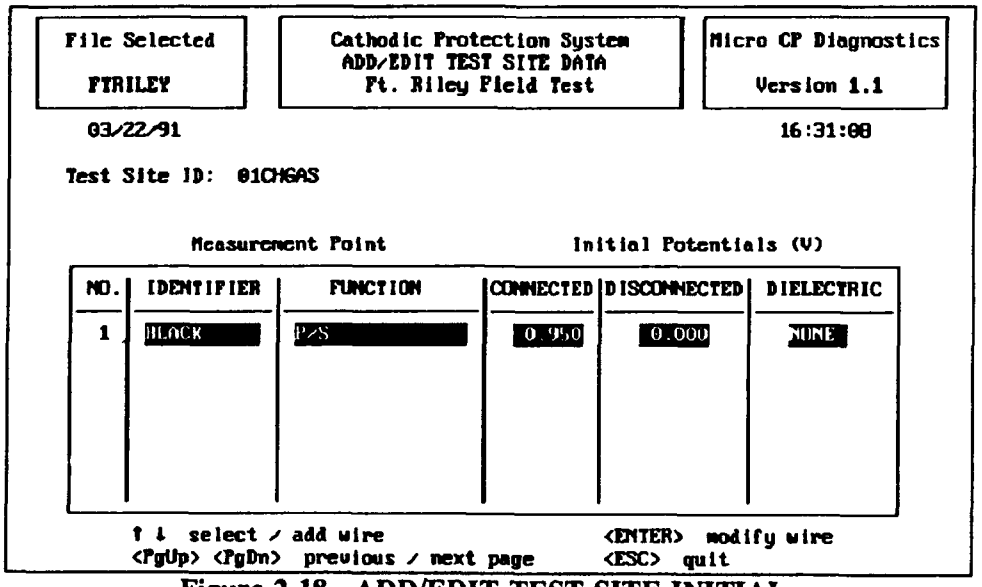

Figure 2-18. ADD/EDIT TEST SITE INITIAL POTENTIALS screen (sacrificial).

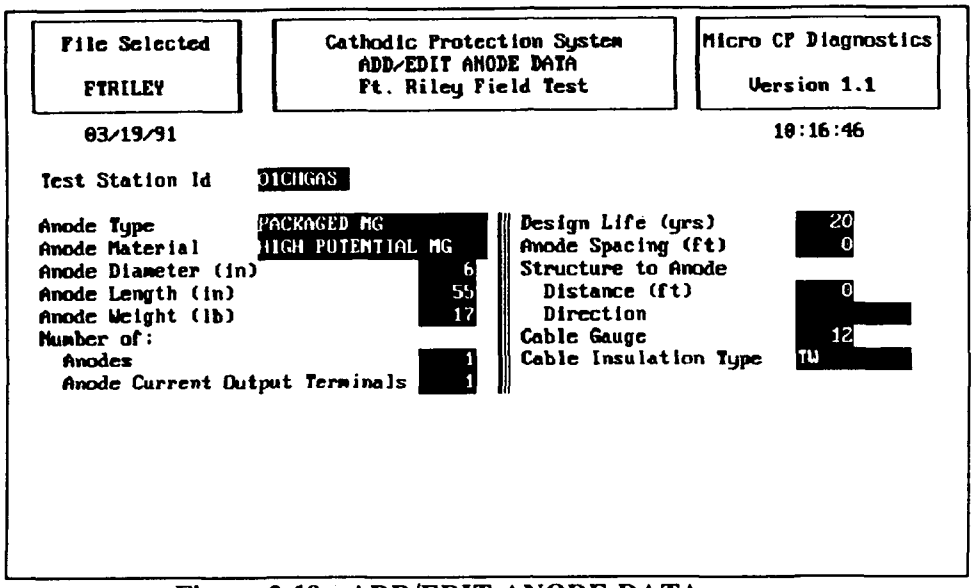

Figure 2-19. ADD/EDIT ANODE DATA screen (sacrificial).

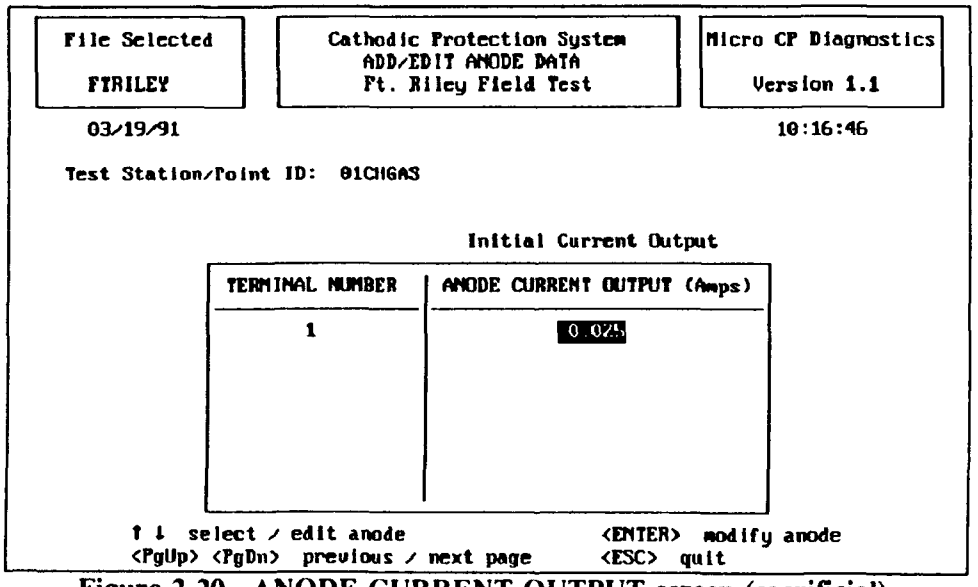

Figure 2-20. ANODE CURRENT OUTPUT screen (sacrificial).

STRUCTURE/TEST SITE/ANODE SUBMENU Option 3 – Add/Edit Repair Data. {C4} To enter information regarding repairs on the currently selected cathodically protected structure, select submenu option 3 at the bottom of the ADD/EDIT BACKGROUND DATA screen. A pop-up screen will appear at the bottom of the ADD/EDIT BACKGROUND DATA screen (Figure 2-21). Enter the repair date at the prompt. If you wish to use the current (default) date that is displayed, simply hit <Enter>. Enter the repair information for the selected structure as prompted. After you enter all of the repair information, the program will remove the pop-up screen and replace it with the ADD/EDIT STRUCTURE/TEST SITE/ANODE DATA submenu.

STRUCTURE/TEST SITE/ANODE SUBMENU Option 0 - Exit to Add/Delete Menu. {C5} This option allows you to exit from the ADD/EDIT BACKGROUND DATA screen. You will first exit to the STRUCTURE IDENTIFICATION screen. If you wish to add or edit background data for a different structure, type its ID as described earlier. If you do not wish to work with another structure, hit <Esc>. This will return you to the ADD/MODIFY/DELETE MENU.

ADD/MODIFY/DELETE MENU Option 2 – ADD/EDIT Test Site Field Collection Data {B2}

The ADD/EDIT Test Site Field Collection Data option allows you to enter potentials and anode currents each time they are gathered in the field. These are the measurements that will be evaluated by the analytic reports. When you select this option, you will be asked to enter your add/ edit password if you have not already done so. After you enter the password, the STRUCTURE TYPE SPECIFICATION screen (Figure 2-10) will appear. You will be asked whether you are editing pipe section records (P) or tank records (T). Type your response at the prompt. The appropriate STRUCTURE IDENTIFICATION screen will appear. Select the structure with which you wish to work in the usual manner. Next, the TEST SITE IDENTIFICATION screen will appear. Enter the ID of the test site with which you wish to work at the prompt.

NOTE: The Test Site ID must already exist; you will not be able to proceed further in this operation if the appropriate background information corresponding to this Test Site ID has not already been

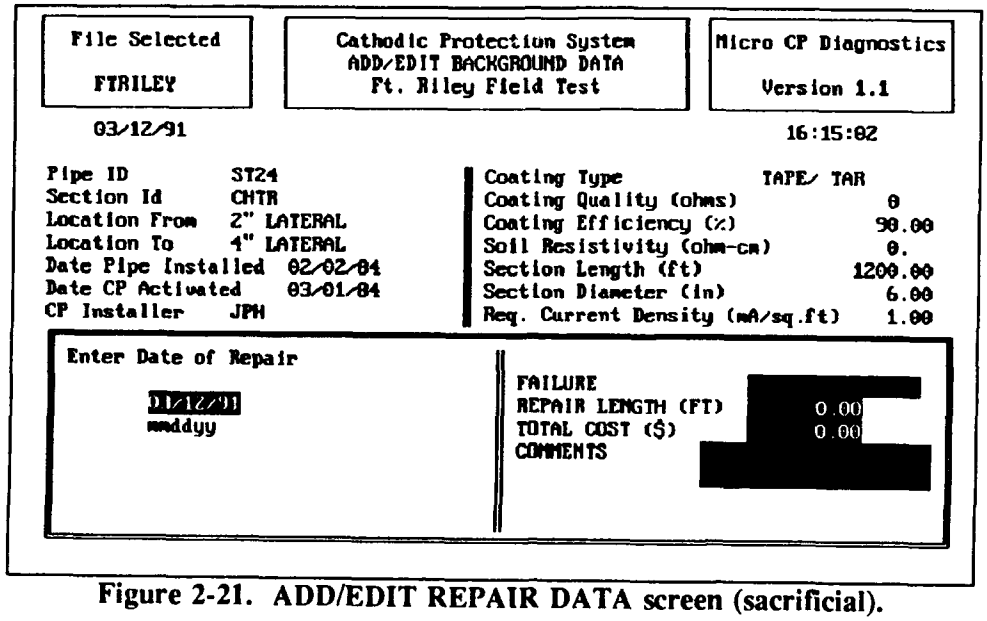

Figure 2-21. ADD/EDIT REPAIR DATA screen (sacrificial).

entered. To enter the appropriate background information, go to the ADD/EDIT BACKGROUND INFORMATION series of screens and enter all available information corresponding to this test site. Once you have done so, you will be able to return to the ADD/EDIT FIELD DATA operation and proceed to add or modify data relevant to the test site.

Next, enter the date on which the field collection data was gathered at the prompt (Figure 2-22). If you wish to use the current (default) date, simply hit <Enter>. Type comments regarding field collection at the prompt. Hit <Enter>. The ADD/EDIT TEST SITE FIELD DATA Screen (Figure 2-23) displays the color and wire function for each wire that you had previously identified under Background Information on the Initial Potentials Screen. If the Test Site is a Test Point, the measurement point may not be a wire, in which case you may disregard the Wire Color field. Enter the collected Connected and Disconnected Potentials for each wire. Enter *only* the structure-to-soil potentials on this screen. Do not enter other potential measurements or anode current output readings. Enter Dielectric Status if the measurement allows you to evaluate a dielectric joint. As usual, press <Enter> to move the prompt to the next location on the screen.

When you are finished entering potentials, hit <Esc>. If the test site provides anode current output data (i.e., if the "Number of Anode Current Output Terminals" field of the test site and anode background information is greater than 0), you will then be prompted to enter anode current data. If you wish to enter anode current data at the test site, then enter the date when prompted, or hit <Enter> to keep the current (default) date. Enter collection comments at the prompt and press <Enter>. The anode current data table will then appear (Figure 2-24). Type the anode current output readings for each terminal of the test site. Press <Enter> after each line. When you are finished entering the current readings, press <Esc> to return to the Test Site Identification screen. If you do not wish to enter anode current data for the test site, simply hit <Enter> repeatedly to bypass the data and collection comments fields and then press <Esc> to return to the Test Site Identification screen. After you return to the Test Site Identification screen, if you wish to edit data for another test site associated with this structure, type its name at the prompt. If you do not wish to edit data for another test site associated with this structure, press <Esc> to return to the

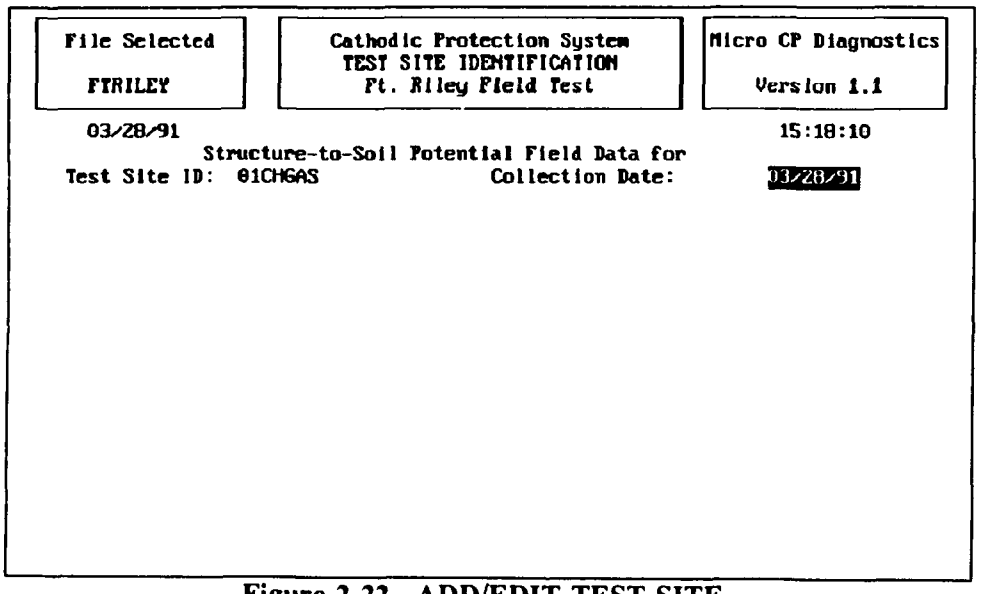

Figure 2-22. ADD/EDIT TEST SITE FIELD DATA screen (sacrificial).

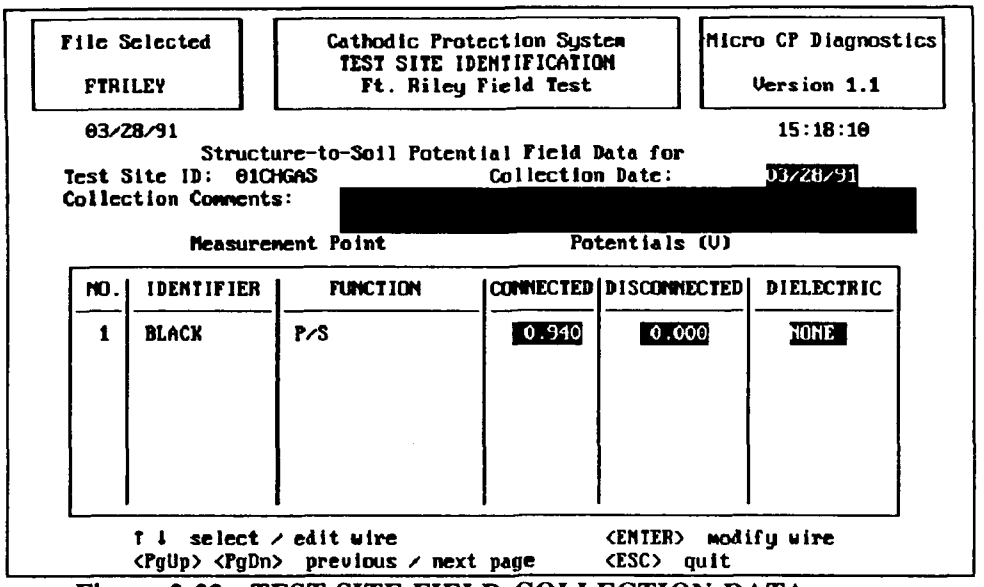

Figure 2-23. TEST SITE FIELD COLLECTION DATA screen with data table (sacrificial).

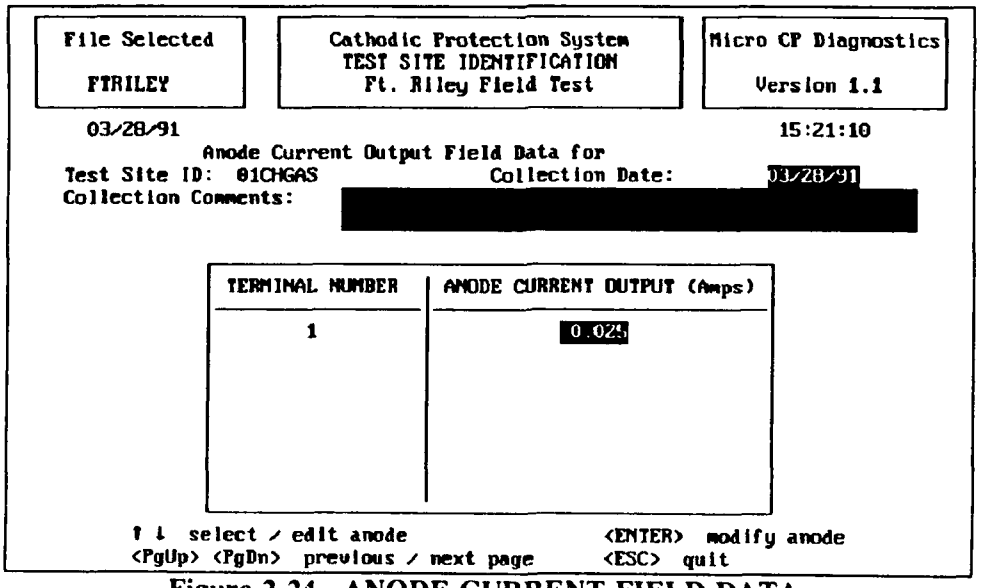

Figure 2-24. ANODE CURRENT FIELD DATA (sacrificial).

Structure Identification screen. Select another structure from the list, or press <Esc> to return to the ADD/ MODIFY/DELETE MENU.

NOTE: Before going to the field to collect Test Site data, print Report Option 1: FIELD COLLECTION FORMS. The wire numbers, colors, and functions will be printed and can then help serve as a reference for collecting potential data.

ADD/MODIFY/DELETE MENU Option 3 – Delete Structure/Test Site/Anode Data {B3}

Use this option to delete the records of an entire structure from the data base, along with ALL associated Test Site records. After you have selected this option, the password screen will appear (Figure 2-25). Enter your DELETE password at the prompt and press <Enter>. The password will not be displayed on the screen as you type it.

After you enter the password, the STRUCTURE TYPE SPECIFICATION screen (Figure 2-10) will appear. You will be asked whether you are deleting pipe section records (P) or tank records (T). Type your response at the prompt. The appropriate STRUCTURE IDENTIFICATION screen will appear. Select the structure with which you wish to work in the usual manner.

After you have entered the Structure ID you wish to delete, the program shows the DELETE PIPE SECTION DATA screen or the DELETE TANK DATA screen (Figure 2-26). This screen displays the structure ID in the upper left-hand corner below the header for your reference. The prompt appears at the bottom left hand corner of the screen. To delete the pipe section records press <Y> for Yes. If you do not wish to delete the pipe section records as well as all associated test site records, press <N> on your keyboard for "No."

An additional warning is posted at the lower right hand corner of the screen. Please carefully consider deletion of pipe section information from the data base. USE THIS OPTION WITH EXTREME

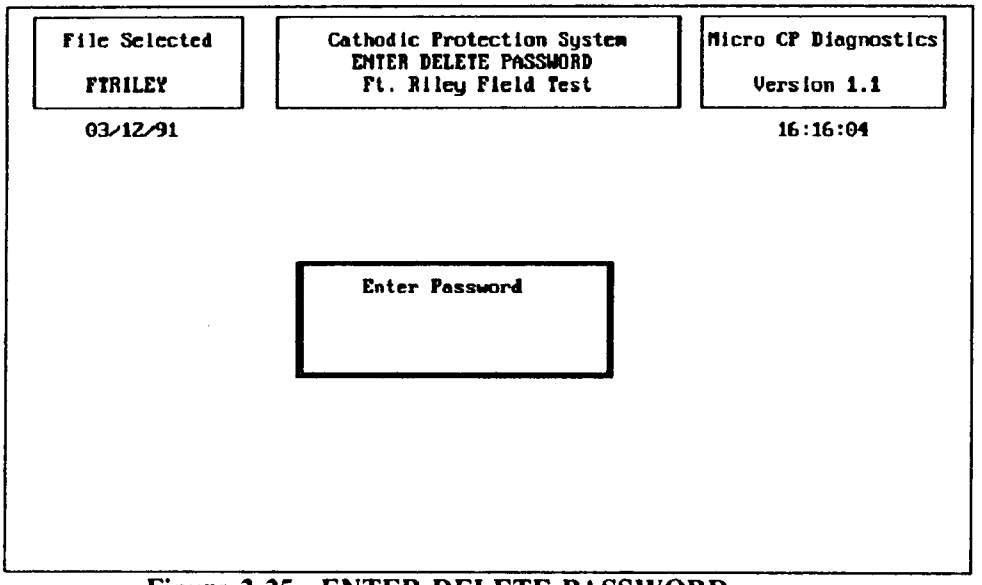

Figure 2-25. ENTER DELETE PASSWORD screen (sacrificial).

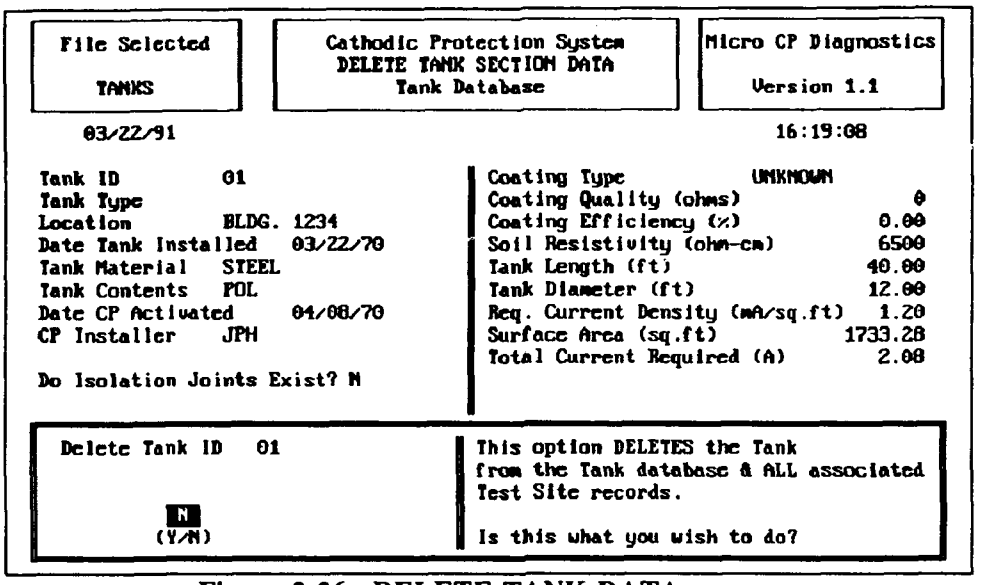

Figure 2-26. DELETE TANK DATA screen (sacrificial).

CARE. THIS OPTION DELETES THE STRUCTURE AND ALL ASSOCIATED TEST SITE RECORDS FROM THE DATA BASE. ONCE THIS INFORMATION IS DELETED, IT CANNOT BE RECALLED.

After you have performed this task, you will be automatically returned to the "ADD/MODIFY/ DELETE MENU."

ADD/MODIFY/DELETE MENU Option 4 – Delete Test Site Data Only {B4}

To delete test site and anode data without deleting the structure data, select option 4 of the ADD/MODIFY/DELETE MENU (Figure 2-8). After this option is selected, you will be asked to enter your delete password. After you enter the password, the STRUCTURE TYPE SPECIFICATION screen (Figure 2-10) will appear. You will be asked whether you are deleting a test site associated with a pipe section (P) or a tank (T). Type your response at the prompt. The appropriate STRUCTURE IDENTIFICATION screen will appear. Select the structure with which you wish to work in the usual manner. Next, the TEST SITE IDENTIFICATION screen (Figure 2-16) will appear. At the prompt, enter the Test Site ID number and press <Enter>.

You will now see the DELETE TEST SITE DATA Screen on your monitor. This screen will automatically display the Structure ID and Test Site identification numbers beneath the banner box (Figure 2-27).

Press <Y> at the prompt to delete the data. All field collection and background data records associated with the selected test site will be deleted (including data about associated anodes). Press <N> if you do not wish to delete the data. Please carefully consider the deletion of this information. ONCE THIS INFORMATION IS DELETED FROM THE DATA BASE, IT CANNOT BE RECALLED.

After you have performed this task, you will be automatically returned to the ADD/MODIFY/ DELETE MENU.

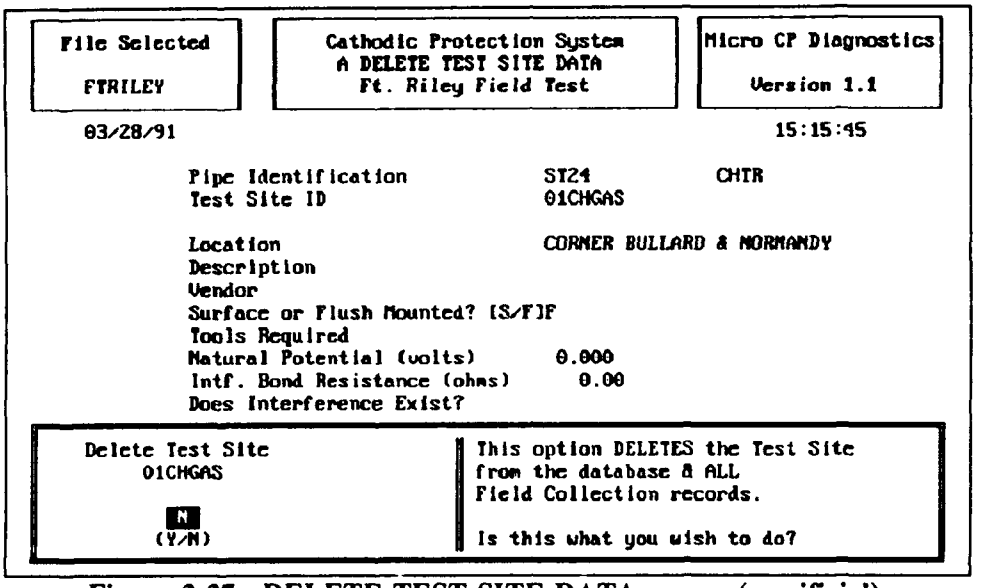

Figure 2-27. DELETE TEST SITE DATA screen (sacrificial).

ADD/MODIFY/DELETE MENU Option 0 - Return to Main Menu {B5}

This option will return you to Sacrificial CP Diagnostic's main menu.

MAIN MENU Option 2 – Data Base-Related Reports {A4}

The Sacrificial CP Diagnostic System's MAIN MENU option 2 allows you to generate reports which retrieve and analyze specific data from the CP databases. After you select option 2 of the MAIN MENU, the REPORT MENU {A5} will appear on your screen. To generate a report, select it from the menu and respond to the prompts. Many of the reports are displayed to the printer only, so make sure that your printer is on and loaded with paper. If you did not already configure CP Diagnostic for your printer by entering the printer control strings on the System Utility screen, be sure to do so before attempting to generate any reports. The reports that can be generated are explained below.

REPORT MENU Option 1 - Field Collection Forms {D1}

This report prints a series of field data collection forms (organized by pipe section) that can be used by the field inspector. A data collection form lists all test sites associated with a pipe section, and contains a description of each test site. The forms may be used to collect the anode current outputs and pipe-to-soil potentials (both with the anodes connected and disconnected) from the measurement points at each test site. Data may then be entered into Sacrificial CP Diagnostic from the data collection forms. To generate the report, select it from the menu. The inspection forms will begin printing as soon as the option is selected from the menu. After the report has printed, you will be returned to the REPORT MENU.

REPORT MENU Option 2 - Trouble Readings Report {D2}

This report identifies all test sites with readings that do not meet the selected criterion for proper cathodic protection. To generate the report, select it from the menu and enter the earliest date that you

REPORT MENU Option 2 - Trouble Readings Report {D2}

This report identifies all test sites with readings that do not meet the selected criterion for proper cathodic protection. To generate the report, select it from the menu and enter the earliest date that you wish the readings to be analyzed at the prompt. Select the criterion that you wish to use from the CP CRITERION MENU (Figure 2-28). The criterion should be selected with extreme care. See Chapter 1 for a detailed discussion and guidance on this subject. The report will begin printing as soon as you select the criterion. The report prints every reading taken after the specified date that does not meet the selected criterion.

REPORT MENU Option 3 - Structure Listing {D3}

This report provides a listing of all structures in the data base. It gives the structure ID and location. It is useful as a concise description of the overall structure inventory. To generate the report, select it from the menu. You will be presented with a screen that asks whether you wish to send the report to the [S]creen, [P]rinter, or [Q]uit. Press the first letter of the option you wish to select. Printer [P] is the default option and may be selected by pressing <Enter>. If you choose to display the report on the screen, press the <Cntl> and <S> keys to stop or start the scrolling of the data that is being displayed. Press any key after the report has been displayed on the screen to return to the REPORT MENU. If you select [Q]uit, you will be returned to the REPORT MENU and the report will not be generated.

REPORT MENU Option 4 - Structure Master Listing {D4}

This report displays the background information for each structure recorded in the data base, providing a more detailed description of the structures than the Structure Listing (Report 3). To generate this report, select it from the menu and respond to the [S]creen, [P]rinter, or [Q]uit prompt as described above for the Structure Listing report. If you choose to display the report on the screen, press the <Ctrl> and <S> keys to stop or start the scrolling of the data that is being displayed. Press any key after the report

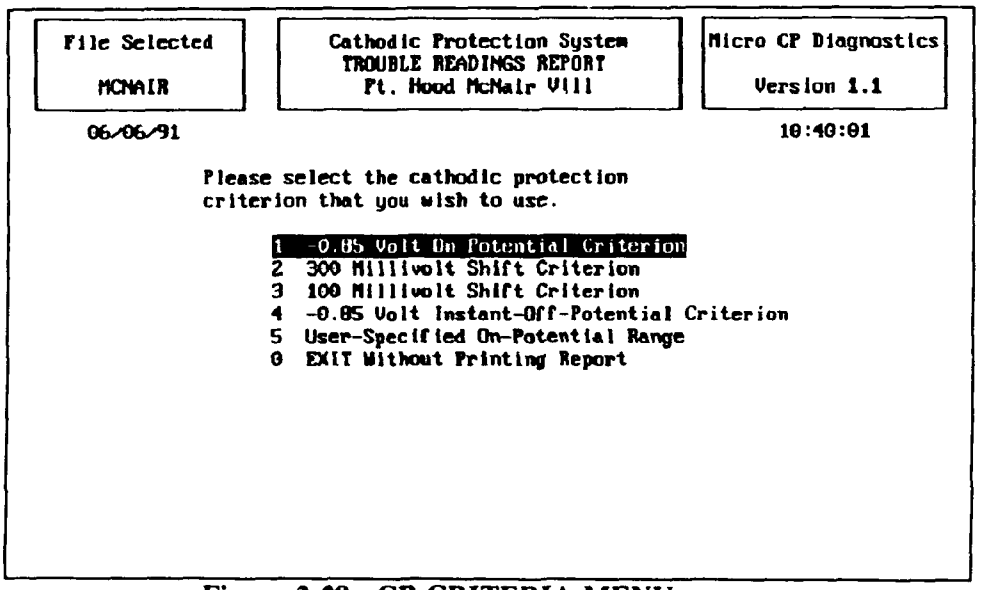

Figure 2-28. CP CRITERIA MENU screen (sacrificial).

has been displayed on the screen to return to the REPORT MENU. If you select [Q]uit, you will be returned to the REPORT MENU, and the report will not be generated.

REPORT MENU Option 5 - Field Collection Report {D5}

This report gives a complete listing of all field data (arranged by test point) collected at all test sites during a user-specified time period. The listing includes dates, potentials, and dielectric status for each test point. To generate the report, select it from the menu, and it will begin printing immediately. After the report is printed, you will be returned to the REPORT MENU screen.

REPORT MENU Option 6 - System History Report {D6}

This report lists dates and descriptions of repairs that were performed and dates and locations that field measurements were taken for all structures throughout the life of the system. The listing is in chronological order. To generate the report, select it from the menu and it will begin printing immediately. After the report is printed, you will automatically be returned to the REPORT MENU screen.

REPORT MENU Option 7 - Test Sites Not Collected {D7}

This report prints the identifiers of all test sites from which field data has not been collected over a specified range of time. To generate the report, select it from the menu and enter the desired range of dates at the prompt. To keep the default (current) date, simply press <Enter>. Respond to the [S]creen, [P]rinter, or [Q]uit option as discussed above. You will be returned to the REPORT MENU after the report is printed.

REPORT MENU Option 8 - Repair History {D8}

This report prints the contents of the repair database including repair date, failure type, repair length, and cost of repair. The repairs are listed by year, and annual repair costs are totalled. This report can be printed for structure or for all structures in the database. To generate the report, select it from the menu. At the prompt, enter a structure ID if you wish to print the report for one structure only, or enter "ALL" if you wish to print the report for all structures in the database. Press <Enter> after you type your selection, and the report will be printed. You will be returned to the REPORT MENU after the report is printed.

REPORT MENU Option 9 - Anode Current Output Drop {D9}

This report identifies the pipe section, test site, and anode current output for any test site that has experienced a drop in the anode current output over time during a user-specified time period. A significant drop in anode current output is defined to be a drop of at least 10 percent between any two readings (they need not be consecutive) or a drop of any amount over three consecutive readings (that is, two consecutive drops of any amount). To generate this report, select it from the menu and enter the earliest and latest reading dates that you wish the report to consider. The report will print immediately after you enter the dates, and you will be returned to the REPORT MENU after the report is printed.

REPORT MENU Option 0 - Return to Main Menu {D10}

This option returns you to the Main Menu screen of Sacrificial CP Diagnostic.

3 USER'S MANUAL FOR THE IMPRESSED CURRENT SYSTEM

Introduction

The Impressed Current CP Diagnostic program is a user-friendly record-keeping and diagnostic program for cathodic protection systems that use impressed current anodes. Background and field data is stored in several database files. The program provides information through a series of reports. The purpose of this chapter is to give detailed instructions on the operation of the program. All of the program options will be explained. The user will be guided through the steps of preparing data for input into the program, installing the program on the computer, configuring the program, creating databases, entering background and field data, and generating reports. A sample implementation specification for the impressed current CP Diagnostic system is included in Appendix D.

Steps for Implementing and Using Impressed Current CP Diagnostic

Initial Implementation

In general, these steps will need to be performed just once, unless modifications are made to the CP system or to the protected structures that would change the background information.

1. Divide the CP system and protected structures into components as described below in "Preparing Data for Input Into the Program."

2. Collect background data about the components as described in "Preparing Data for Input Into the Program." This will probably require a field survey to verify the information. If a field survey is done, the first set of field data (structure-to-soil potentials, anode current outputs, dielectric conditions, and rectifier readings) should be collected at this time.

3. Install and configure the program as described under MAIN MENU OPTION 4 - System Utility.

4. Create databases in which to input the CP system data as described under MAIN MENU OPTION 3 - Database Administration.

5. Input background data into the databases as described under MAIN MENU OPTION 1 - Data Entry and Modifications, Submenu Option [1] - Add/Edit Rectifier/Structure/Test Site Background Data.

6. If the first set of field data was collected, enter it into the field collection database as described under MAIN MENU OPTION 1 - Data Entry and Modifications, Submenu Option [2] - Add/Edit Test Site Field Collection Data. If you wish to store field collection data that was collected in the past, you may enter it also.

7. Generate the reports of interest as described under MAIN MENU OPTION 2 - Database Related Reports.

Periodic Collection of Field Data

1. Generate field collection forms as described under MAIN MENU OPTION 2 - Database Related Reports, Submenu Option [1] - Field Collection Forms.

2. Collect field data.

3. Input field data into program as described under MAIN MENU OPTION 1 - Data Entry and Modifications, Submenu Option [2] - Add/Edit Test Site Field Collection Data.

4. Generate the reports of interest as described under MAIN MENU OPTION 2 - Database Related Reports.

Preparing Data for Input Into the Program

Overview

Before the program can be used, data concerning the CP system and the structure that it protects must be compiled. All of the following sections of this manual assume that this data has been compiled and is ready to input into the program. Each system component will be given its own unique identification number. Appendix E contains a chart which shows the relationships between system components. It will be helpful to refer to it while you are reading this section. A record in the database will be created for each component and data about it will be collected and entered into the record. All of the records will be stored in the program database files. It is recommended that you obtain maps and/ or drawings that show as much detail as possible about the system and the protected structures.

CP Diagnostic defines the impressed current CP system itself as a collection of rectifiers, junction boxes, and "test sites." Each rectifier has one or more junction boxes associated with it. Each junction box has a collection of anodes associated with it. Each rectifier protects one or more structures. In addition, each structure has a collection of "test sites" associated with it.

Rectifiers

Begin collecting data for Impressed Current CP Diagnostic by assigning a Rectifier ID (up to 10 characters) to each rectifier in the CP system. Mark the rectifiers and their ID's on the system map. The background data required for each rectifier is shown in Figure 3-12. You may wish to use the Rectifier Background Data Sheet in Appendix F to help organize and compile the data. Fill out one form for each rectifier.

Junction Boxes and Anode Ground Beds (Underground Structures)

If any of the rectifiers identified in the preceding paragraph protect underground structures, junction box and anode ground bed data must be collected for each. As stated above, each rectifier that protects underground tanks or pipes has one or more junction boxes associated with it. Typically, the junction box contains a series of terminals to which anodes are connected and at which anode currents may be measured. Assign a junction box ID (up to five characters) to each junction box. These ID's should be marked on the system map. Background data as shown in Figure 3-14 is required for the anodes which are connected to the junction box. Anode currents should be measured at each termianl when the program

is implemented. In addition, initial anode current outputs (i.e., those that were mesured when the CP system was installed) should be collected and recorded if they are available. You may wish to use the Ground Bed Data Sheet in Appendix F to help organize and compile this data. Fill out one form for each junction box/ anode ground bed.

Elevated Water Storage Tank Anodes

If any of the rectifiers identified above protect elevated water storage tanks, information concerning the anodes inside the tank must be compiled for each. The data that is required for each rectifier/ water storage tank is shown in Figure 3-16. You may wish to use the Water Tank Anode Background Data Sheet in Appendix F to compile the data. Fill out one form for each rectifier/ water storage tank.

Defining the Protected Structures

The next step in preparing to implement Impressed Current CP Diagnostic is to define and collect data concerning the structures that are protected by each rectifier that was identified previously. Impressed Current CP Diagnostic recognizes three types of protected structures: underground pipes (such as gas distribution pipes), underground storage tanks, and elevated water storage tanks. A piping network is defined as a collection of "pipe sections." Each pipe section will have its own individual record in the database in which the information associated with it will be stored. For a system of tanks, each tank will have its own individual record in the database that contains the data associated with it.

To define a piping network, it is essential to have a map of it. Pipe sections are identified by the Pipe ID and the Section ID. The system is divided up into pipes, and each pipe is assigned a Pipe ID. Each pipe is then divided up into sections, and each section is assigned a Section ID. Therefore, a section is a subdivision of a pipe and an individual pipe may consist of many sections. A "pipe section" is the length of pipe referred to by the combination of the Pipe ID and the Section ID. A pipe section should have a consistent diameter, material of construction, coating type and quality, date of installation, and required current density along its entire length. Soil resistivity should also remain fairly consistent along the length of the section, although this is not critical to the program output. With these criteria in mind, divide the piping network up into pipes and pipe sections. Develop an identification system that fits the needs of your installation. The Pipe ID may be up to 10 characters (letters and/or numbers) in length. The Section ID may be up to four characters in length. For example, a gas main that serves several barracks might be given a Pipe ID of "BARRACKS" and Section ID's of 1, 2, 3, etc. A gas main that serves the 3600 Block might be given a Pipe ID of "3600BLOCK" and Section ID's of 1, 2, 3, etc. The location of each pipe section should be marked on the map. The data required for each pipe section is shown in Figure 3-20. In addition to this data, mark and note the location of isolation joints. Isolation joints associated with a pipe section are numbered consecutively starting with 1. You may wish to use the Pipe Section Background Data Sheet in Appendix F to help organize and compile the data. Complete one form for each pipe section. This data is then ready to input into CP Diagnostic.

To define a system of tanks, assign a Tank ID (up to 10 characters) to each tank. Figure 3-21 shows the data that is required for each underground storage tank. Figure 3-22 shows the data that is required for each elevated water storage tank. You may wish to use the Underground Tank Background Data Sheet or the Water Storage Tank Background Data Sheet from Appendix F to organize and compile the data. Complete one form for each tank. In addition, if the piping associated with the tank is cathodically protected, an underground piping record (as described in the preceding paragraph) may be created for it. This data is then ready to input into the program.

Test Sites

Each protected structure (pipe or tank) has a series of "test sites" associated with it at which structure-to-soil potentials may be measured. We should first clarify the definitions of "test site," "test station," and "test point" as they will be used in this document. "Test site" is used in CP Diagnostic as a generic term for "test stations" and "test points." Thus, a test site may be either a "test station" or a "test point." In an impressed current system, a test station is a collection of one or more measurement points, usually wires, that is designed for the purpose of allowing structure-to-soil potentials to be measured. Many test stations contain a wire connected to each nearby structure and another connected to a copper-copper-sulfate ($Cu\text{-}CuSO_4$) half-cell in the soil. We can use these wires to measure structure-to-soil potentials without digging up the structure. A test point is any other location at which we are able to take measurements of interest. For example, a riser for a gas service line to a house is a useful test point. Because the riser is above ground, we can measure the structure-to-soil potential easily. In addition, a riser should have a dielectric, or isolation, joint to electrically isolate the house piping from the gas service line. Therefore, at such a test point we would also like to measure the potential across the dielectric, to ensure that is working properly.

To define test sites in Impressed Current CP Diagnostic, assign a test site ID (up to eight characters) to each test site associated with each structure in the system. The use of symbol conventions will make this easier. For example, test stations might be labelled TS1, TS2, etc.; riser test points might be labelled R1, R2, etc.; and valve test points might be labelled V1, V2, etc. Isolation joints must also be represented as test sites since they will be tested to insure that they are working properly. Recall that isolation joints were numbered consecutively beginning with 1 when the protected structures were defined above. To remain consistent with this, it is suggested that this number that was previously assigned to the joint should be used when inputting it into the test site data section. To identify it as an isolation joint test site, the number might be prefaced with an I. Often, isolation joints are located at risers at which potential measurements may also be taken. In this situation, the isolation joint number might be prefaced with RI to denote it as an isolation joint that is also a riser test point. Since the test site chart allows the entry of both potentials and dielectric conditions, all of the data for risers with isolation joints may be entered on one screen. Only riser test points without isolation joints would be named R1, R2, etc.

The test sites should be marked on the system map. Each test site will contain one or more locations at which to perform potential measurements. The data required for each test site is shown in Figures 3-25 and 3-26. Test site information requirements for pipes and tanks are identical. Information describing the test site itself and structure-to-soil potentials measured at the time the program is implemented for each potential measurement point of the test site are required. Dielectric conditions (i.e., good, short, none) should be determined and recorded. If "initial" potentials (i.e., those that were measured when the CP system was installed) are available, they should be recorded. Guidance for conducting field measurements can be found in Air Force Manual (AFM) 85-5.[14] You may wish to use the Test Site Background Data Sheet in Appendix F to help organize and compile the data. This data is then ready to be input into the CP Diagnostic program.

[14] AFM 85-5.

Installing Impressed Current CP Diagnostic

The Impressed Current Cathodic Protection Diagnostic System is distributed on a single disk which contains the following files:

SCHEMAA.DBF	SCHEMAI.DBF	SCHEMAN.DBF
SCHEMAB.DBF	SCHEMAJ.DBF	SCHEMAR.DBF
SCHEMAC.DBF	SCHEMAM.DBF	SCHEMAT.DBF
SCHEMAD.DBF	DB.DBF	SCHEMAU.DBF
SCHEMAF.DBF	GSI.DBF	SCHEMAW.DBF
SCHEMAG.DBF	ICP.EXE	SCHEMAX.DBF
SCHEMAH.DBF	INSTICP.BAT	SCHEMAY.DBF

Before doing anything with the distribution disk you should make a backup copy of the disk using the DOS "DISKCOPY" command. If you are not familiar with the DOS operating system or the "DISKCOPY" command, please consult your DOS manual.

As stated in Chapter 1, CP Diagnostic operates on an IBM-compatible microcomputer system with 640K of Random Access Memory (RAM). A hard drive is required because of the large amounts of data stored by the program. It supports both color and monochrome monitors. The program can be configured to support most dot matrix and laser printers.

First, check your CONFIG.SYS file to see if it contains the statement:

FILES = 50

If this statement is not in the CONFIG.SYS file, you must add it. If there is a FILES statement, but the number is less than 50, you must change it to 50. Consult your DOS manual for assistance. If the FILES=50 statement is not in your CONFIG.SYS file, CP Diagnostic will not run properly.

IMPORTANT: In the installation procedure that follows:

A: refers to the letter designation of the floppy disk drive from which you are installing the program.

C: refers to the letter designation of the hard drive on which you are installing the program.

Your disk drives may or may not be designated by the letters A: and C:. If not, substitute the appropriate letters for A: and C:.

To install the Impressed Current Cathodic Protection Diagnostic System on a hard disk, place the backup disk into the floppy disk drive of your computer. You will see the DOS prompt "C:>" to which you will enter the following command "A:". The DOS prompt will now read "A:>" to which you will respond "INSTICP A: C:". Your screen should show:

```
C:> A:
A:> INSTICP A: C:
```

(Note: the C:> and A:> portions of the commands are the DOS prompts and are not user-entered commands.) The INSTICP program creates a directory named ICP on the hard disk and copies all the

files needed to run the Impressed Current Cathodic Protection Diagnostic System to the ICP directory. After the INSTICP program has finished, the system is ready to use. Remember to store the distribution and backup disks in a safe place.

Starting the Impressed Current CP Diagnostic System

Before starting the Impressed Current Cathodic Protection Diagnostic System (ICP), access the directory and drive containing ICP and its support files. If you have just installed the program you are already in the correct directory. If not, you must change to the ICP directory. For example, if the Impressed Current Cathodic Protection Diagnostic System were installed on disk drive C the following commands would access the drive and directory containing ICP:

```
A:> C:
C:> CD ICP
```

(Note: The A:> and the C:> are DOS prompts and are not user-entered.) The program is then started by entering the command ICP at the DOS prompt. As the program starts, it displays an opening screen which lists the program authors. Press any key to continue. After the opening screen is cleared, the program displays either the MAIN MENU screen or a "MISSING FILE(S)" error screen. If the error screen appears, note the missing file(s), copy them from the backup disk and restart the program.

Diagram of Program Flow

To assist you with navigating throughout the Impressed Current CP Diagnostic Program, a diagram showing the program flow is included in Appendix G. This diagram consists of five sheets labelled A through E. All menus and menu options in the diagrams are cross-referenced with their descriptions in the main text of this manual. Cross references are given in brackets { } and consist of a letter and a number. The letter refers to the sheet of the diagram on which the option or menu appears. For example, in the text below, the cross-reference {A1} appears after the title "Main Menu Overview." To locate this in the diagram, turn to Appendix G and find sheet A. Block {A1} is located at the top of sheet A. By using the diagrams and the cross-references, you can easily determine your location in the program at any time.

General Rules for Operating the Menus

Impressed Current CP Diagnostic is a menu-driven, user-friendly program. There are two basic rules that apply to the operation of ALL menus throughout the program.

1. Menu options are selected by (1) typing the number of the option or (2) moving the selection bar to the desired option and pressing <Enter>. Once an option is selected, the program either executes the option or displays a message about its failure to perform the option.

2. The <Esc> key can be used to move back to the previous menu or program screen.

About Passwords

Certain sections of the CP Diagnostic program are password-protected to reduce the chance of unauthorized persons editing or deleting your data. There are three passwords which you may set: the add/edit password, the delete password, and the general system information password. The add/edit password is used to control access to the "Add/ Edit Rectifier/ Structure/ Test Site Data" option and the "Add/ Edit Test Site Field Collection Data" options of the ADD/ MODIFY/ DELETE menu. The delete password is used to control access to all options that allow deletion of rectifiers, structures, test sites, or entire databases. The general system information password is used to control access to the "System Utility" option of the MAIN MENU. Procedures for setting these passwords will be discussed in the "System Utility" section.

A particular password only needs to be entered once during a program run. For example, once you enter your delete password, you will be allowed access to all "delete" options until you exit the program. You will not be prompted for the password every time you attempt to access a "delete" option, even if you have performed other program operations in the meantime. After you exit the program and then restart it, you will be prompted for the passwords again.

Most of the instructions for each program option described in this manual are written with the assumption that the password necessary to access the option has not yet been entered. If you have, in fact, entered the password during your current working session, disregard the references to the password screens.

MAIN MENU Overview {A1}

The MAIN MENU screen (Figure 3-1) illustrates a number of features of the ICP user interface. The menu displays an informative header across the top of the screen. The header contains three information boxes: the File Box, the Banner Box, and the Version Box. The File Box (top left of the screen) displays the name of the active Cathodic Protection data base. The Banner Box (top middle of the screen) displays the name of the program, the current location in the program, and a short description of the active CP data base. The program Version Box (top right of the screen) displays ICP's version number. The current date and time are displayed below the file and version boxes to complete the program's header. On a color monitor the color of the header provides the following additional information:

- RED All Error Screens
- WHITE The MAIN MENU and Secondary Menu Screens
- CYAN All Other Menu or Option Screens

ICP is operated via the MAIN MENU shown in Figure 3-1. The MAIN MENU has five options. The following sections of this manual describe each of the program's main and secondary menu options in detail.

MAIN MENU Option 1 (Data Entry & Modification) and Option 2 (Data Base-Related Reports) are ordered before Options 3 and 4 in the MAIN MENU because they are used most often. Most of your work in the Impressed Current Cathodic Protection Diagnostic System will be done through Options 1 and 2. However, there are several procedures which you must perform initially when using CP Diagnostic for the first time. You must configure the program for your hardware using MAIN MENU Option 4. You

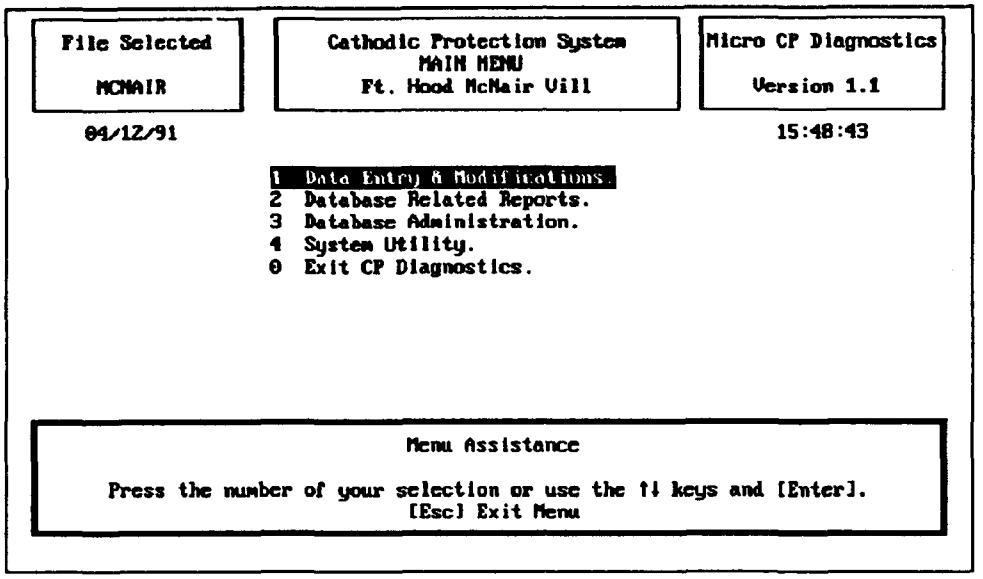

Figure 3-1. MAIN MENU (impressed current).

must then create and/or select a database for use using MAIN MENU Option 3. Thus, MAIN MENU Option 4 will be discussed first, followed by Option 3. Options 1 and 2 will be discussed last.

MAIN MENU Option 4 — System Utility {A8}

This option is used to configure CP Diagnostic for your hardware and to set passwords. If passwords have not yet been set, the General System Information screen (Figure 3-2) {A9} will appear immediately after this option is selected. If passwords have been set, you will be prompted to enter your general system information password. Type your password and press <Enter>. Your password will not be displayed on the screen as you type it. The General System Information screen will appear after you have entered your password correctly.

Enter your name (or the installation's name) and address in the top portion of the screen.

Each of the three kinds of data manipulation—add/edit data, delete data, and edit general system information (system utility)—has its own password. Passwords may be up to six characters in length. Enter the desired passwords in the appropriate location. Note that once you enter a password for the GSI (system utility) module, you will not be able to access this screen again without it. Thus, it is critical that you commit the passwords to memory or write them down in a safe place.

The printer codes are needed to configure CP Diagnostic for your printer so that the reports print correctly. The printer codes are entered in decimal ASCII. Consult your printer manual to determine the codes needed to switch your printer to compressed mode and enter them as the 17-characters-per-inch codes. Next, determine the codes needed to cancel compressed mode and enter these as the 10-character-per-inch codes.

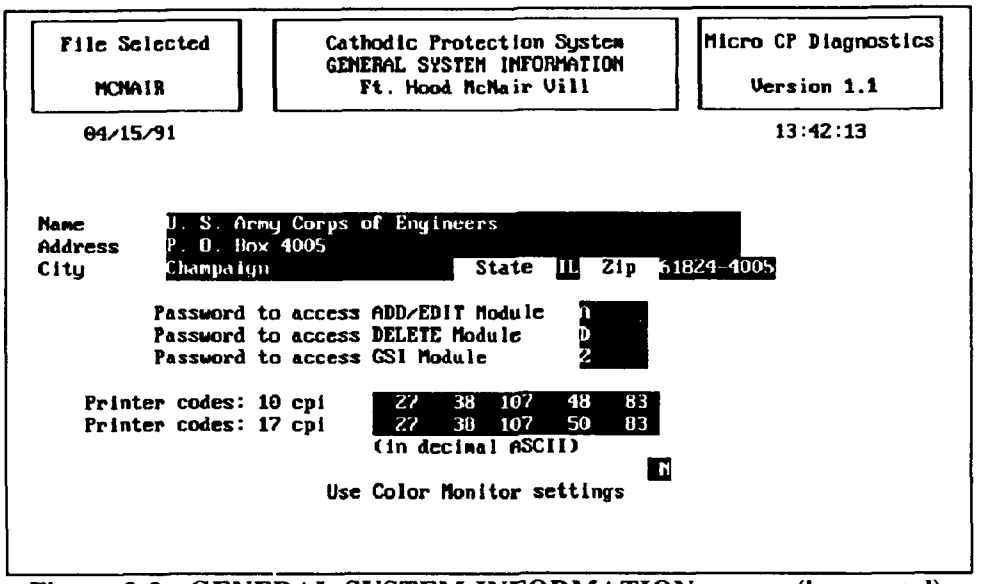

Figure 3-2. GENERAL SYSTEM INFORMATION screen (impressed).

The monitor setting controls whether or not CP Diagnostic screens appear in color. If you have a color monitor, enter "Y" after the "Use Color Monitor Settings?" prompt. If you do not have a color monitor, enter "N".

CP Diagnostic is now configured for your hardware. These settings will be stored by the program. You will only need to repeat this setup procedure if you wish to change the passwords or if you use the program with a different printer or a different monitor type. To return to the MAIN MENU, hit <Esc> or press <Enter> on the "Use Color Monitor Settings" field.

MAIN MENU Option 3 — Data Base Administration {A6}

The Data Base Administration option of the MAIN MENU is used to manipulate the database files that are stored by CP Diagnostic. Databases can be added (created), selected for use, deleted, and reindexed using this option. When you select the MAIN MENU's option 3, the "DATA BASE ADMINISTRATION MENU" screen will appear (Figure 3-3) {A7}.

DATA BASE ADMINISTRATION MENU Option 1 – Add/Select a Data Base {E1}

This option allows you to (1) add (create) a new database, (2) select an existing database for use, or (3) register an existing database file with the program. This option also alerts you if files are missing from a database that you are attempting to select. Note that if you are using CP Diagnostic for the first time, you will need to add a database before entering any data.

The Impressed Current Cathodic Protection Diagnostic System can maintain many separate CP data bases. The amount of information stored is limited only by the available space on the hard disk. You may wish to store all of your data in one database, or you may wish to divide it up into several databases. Storing data in more than one database is advantageous when you have a large amount of data or when you are maintaining data for more than one installation. Each CP data base is given a one- to seven-character name within the Impressed Current Cathodic Protection Diagnostic Program. The program

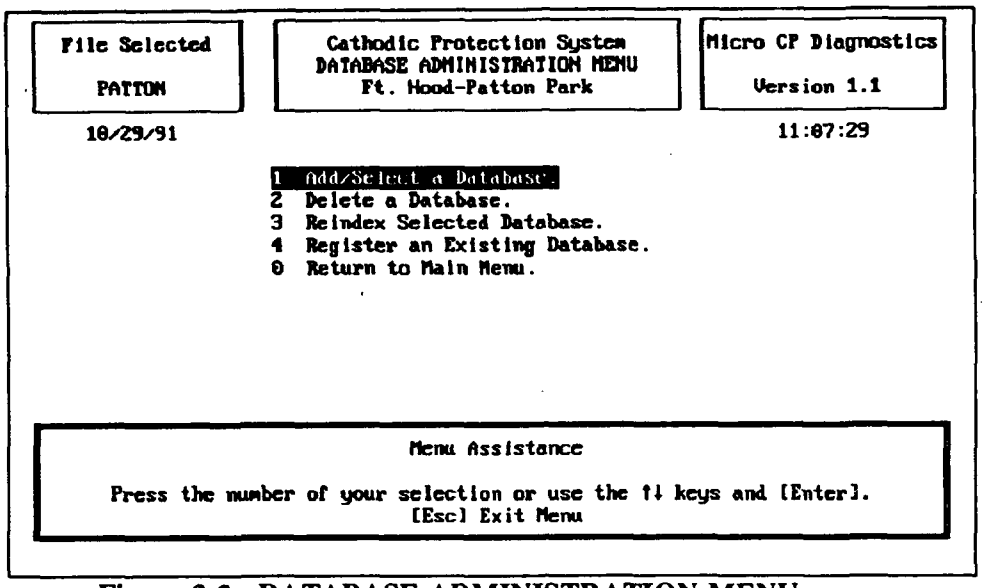

Figure 3-3. DATABASE ADMINISTRATION MENU screen (impressed current).

creates a series of 14 disk files to store the information for each of the databases that is created. The names of the disk files consist of the one- to seven-character database name plus a single character. For example, the disk files for the CP data base HOOD would have the following names:

HOODA.DBF	Junction box field collection comments for the CP data base HOOD
HOODB.DBF	Junction box background file for the CP data base HOOD
HOODC.DBF	Rectifier information file for the CP data base HOOD
HOODD.DBF	Field collection information file for the CP data base HOOD
HOODF.DBF	Rectifier field collection information for the CP data base HOOD
HOODG.DBF	Anode background information for the CP data base HOOD
HOODH.DBF	Water tank information file for the CP data base HOOD
HOODI.DBF	Isolation joint information file for the CP data base HOOD
HOODJ.DBF	Water tank anode background information file for the CP data base HOOD
HOODM.DBF	Pipe section information file for the CP data base HOOD
HOODN.DBF	Junction box and anode field collection file for the CP data base HOOD
HOODR.DBF	Repair information file for the CP data base HOOD
HOODT.DBF	Test site information file for the CP data base HOOD
HOODU.DBF	Underground storage tank information for the CP data base HOOD
HOODX.DBF	A cross-reference file linking pipe sections to a rectifier for CP data base HOOD
HOODY.DBF	Test site field collection comments for the CP data base HOOD

When you choose the Add/Select a Data Base option from the Data Base Administration Menu, the SELECTING A DATA BASE screen will appear (Figure 3-4). This screen lists all the Cathodic Protection data bases (if any) that have been entered into the Impressed Current Cathodic Protection Diagnostic System.

To ADD (Create) a New Database: {E2} As stated above, you will need to do this if you are using the program for the first time. To create a CP data base, simply type a one- to seven-character name for

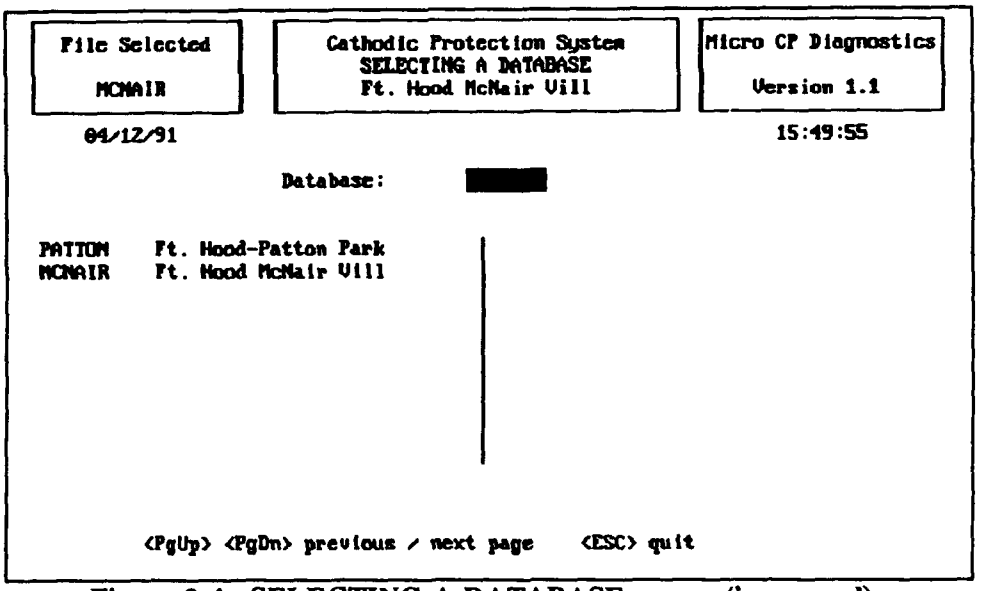

Figure 3-4. SELECTING A DATABASE screen (impressed).

it at the "Database" prompt of the SELECTING A DATA BASE screen and press <Enter>. IMPORTANT! The database name must not include any spaces. For example, TEST DB would not be an acceptable database name. In addition, the database name *must* begin with a *letter*. The name must be different from the other existing database names. When a database name is entered that does not already exist in the program, the CREATING A DATA BASE screen appears. This screen asks you if you want to create a new CP data base. If you answer no <N>, you are returned to the DATABASE ADMINSTRATION MENU, and the currently selected data base is not changed. If you answer yes <Y>, a new CP data base (with the name that you have specified) is added to the system. Before the new data base is created, it must be given a description. The program prompts for a short (up to 20-character) description of the data base. The data base files are then created, the data base is automatically selected, and you are returned to the DATABASE ADMININSTRATION MENU.

To SELECT an Existing Database for Use: {E3} All CP data bases that have been previously entered into the system are listed in the "selecting a database" screen. If there are many CP data bases on the disk, the list may contain multiple pages. The <PgUp> and <PgDn> keys may be used to page through multiple-page listings of Cathodic Protection data base files. To select one of the listed databases for use, type its name at the "Database" prompt and press <Enter>. To exit the SELECTING A DATA BASE screen without changing the currently active CP data base, press <Esc>. After the data base is selected, its name and description are placed in the program's header, and you are returned to the DATABASE ADMINSTRATION MENU.

Note that if this is not the first time you have used the program, the data base that was in use the last time the program was run remains active when the program is started again and does not need to be activated with the Data Base Administration option.

If Some Files Are Missing from the Selected Database: Occasionally all or some of the disk files of a Cathodic Protection data base may be missing. This can occur, for example, if you delete the files using DOS and forget to remove the CP data base name from ICP. The MISSING FILE(S) Screen also appears when the program is started using an incomplete or missing data base. When this occurs, the MISSING FILE(S) Screen (Figure 3-5) appears. To use the incomplete data base, note the names of the

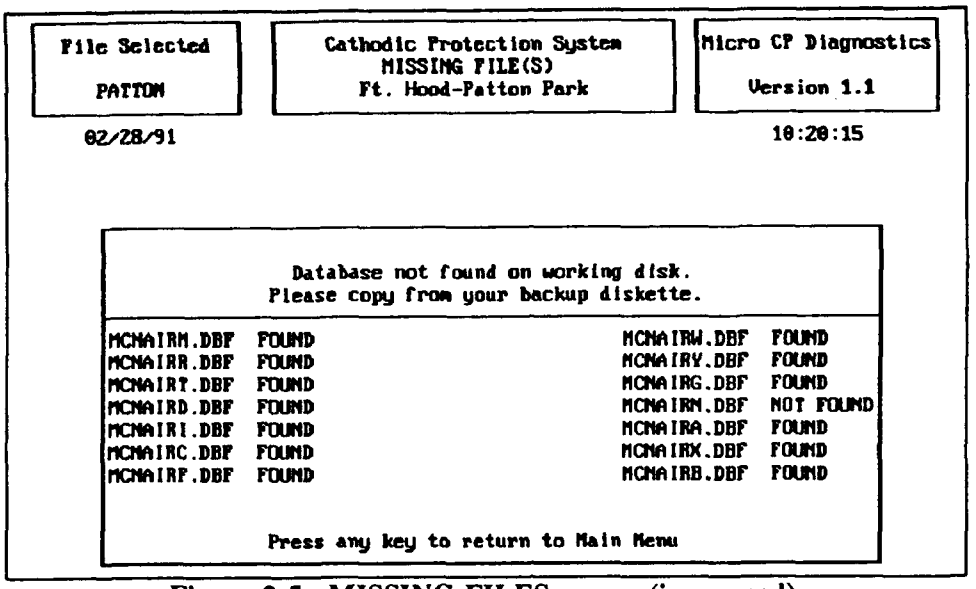

Figure 3-5. MISSING FILES screen (impressed).

missing file(s). Press any key to return to the DATABASE ADMINISTRATION MENU. Leave ICP, copy the file(s) from a backup disk, and restart ICP.

DATA BASE ADMINISTRATION MENU Option 2 – Delete a Data Base {E4}

The Delete a Database option allows you to remove data base files from your hard drive. After you select this option, enter your "delete" password when prompted. The SELECTING A DATABASE screen will appear. Select a database to delete and type its name at the prompt. Next, the DELETE A DATA BASE screen will appear (Figure 3-6). It will display the name of the data base that you have selected in the lower left hand corner of the screen and will ask you if you really wish to delete all the records associated with this data base.

If you do not wish to delete the selected data base, press <N> or <Enter> at the prompt to return to the DATABASE ADMINISTRATION MENU.

If you wish to delete all records of the data base from your hard disk and the SCP program, press the <Y> at the prompt. It is recommended that you make a backup of the files on a disk before proceeding with the delete option. DELETED DATA BASE FILES CANNOT BE RECALLED.

After the files are deleted, press any key when prompted to return to the DATABASE ADMINSTRATION MENU.

DATA BASE ADMINISTRATION MENU Option 3 – Re-Index a Data Base {E5}

This option will create new index files for the current data base. The index is used in searching files for particular records and must exist in order for the program to operate properly. Re-indexing data base files from time to time will help the system run faster. If, over a period of time, many operations have been performed such as adding or deleting records, re-indexing will help speed your work by "cleaning up" the index. This option should also be used if the index files are accidentally erased.

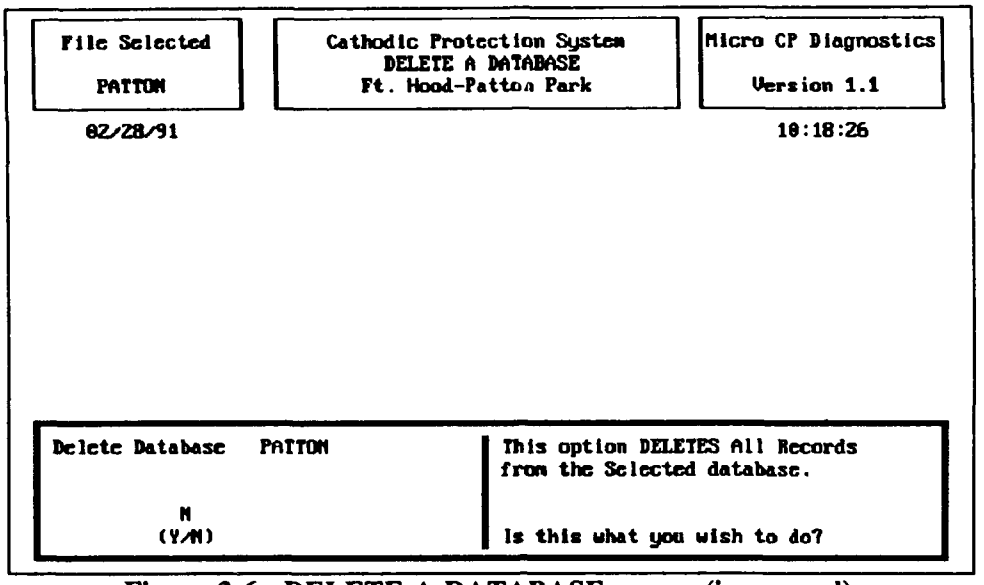

Figure 3-6. DELETE A DATABASE screen (impressed).

You will be asked if you want to rebuild the index for the currently selected data base (Figure 3-7). If this is what you want to do, press <Y> for YES. After indexing is complete, press any key to return to the DATABASE ADMINISTRATION MENU. If this is not what you want to do, press <N> for NO. The program will return to the DATA BASE ADMINISTRATION" menu.

DATABASE ADMINISTRATION MENU Option 4 — Register an Existing Database {E6}

It is possible that existing CP data bases will not be listed in the SELECTING A DATA BASE Screen's data base list. For example, this occurs if you install a new version of ICP on a computer with existing CP data bases. Before these data bases can be selected for use, they must be "registered" with the program so that it recognizes their existence. To "register" an existing data base with the system, type its name at the "Database" prompt of the SELECTING A DATA BASE Screen. The MISSING FILE(S) Screen (Figure 3-5) will list any files of the data base that may be missing. If any of the data base files are missing, note their names, exit the program, and copy them from a backup disk, then restart the ICP program, and select the data base. If no files are missing, the MISSING FILE(S) Screen is supplemented with the message that the data base is being added to the system. You are then prompted to enter a new description for the data base. After you enter the description, the new database becomes the current database in use, and you are returned to the MAIN MENU.

DATA BASE ADMINISTRATION MENU Option 0 - Return to Main Menu {E7}

This option returns you to the Main Menu of Impressed Current CP Diagnostic.

MAIN MENU Option 1 -- Data Entry & Modification {A2}

The Data Entry and Modification option of the MAIN MENU is used to create and update information about cathodic protection systems in the currently active CP data base. A CP data base must be active (selected) before this option can be used. If no CP data base is active when you select the Data Entry and Modification Option, the SELECTING A DATABASE screen will appear. Type the name of

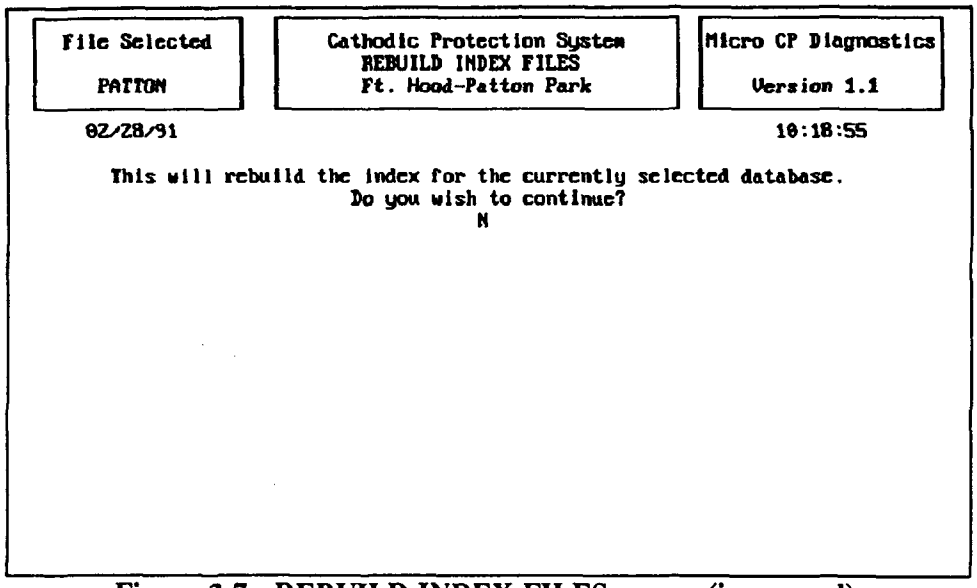

Figure 3-7. REBUILD INDEX FILES screen (impressed).

the database that you wish to work with at the prompt. If you attempt to exit the SELECTING A DATABASE screen before typing a database name, the program displays the error message:

"You can not perform option 1 without first selecting a data base!
Press any key to continue."

You will not be allowed to exit this screen without selecting a database.

After you have selected the Data Entry & Modification option and have an active database, the DD/MODIFY/DELETE MENU {A3} will appear. You will notice that the ADD/ MODIFY/ DELETE MENU Screen displays four options (Figure 3-8). Select the operation you wish to perform in the usual manner.

General Rules for Data Entry and Modification

CP system data is entered via a series of screens, each of which contains a series of prompts followed by blank spaces, or "fields," in which the data is to be entered. There are several general rules that apply throughout all of the Data Entry and Modification screens.

1. Enter data in each field by typing your response and pressing the <Enter> key. The cursor then moves to the next field.

2. If the information for a field is not available, press <Enter> to bypass that field and move the prompt to the next field. The former field will be left blank. If the information for that field becomes available at a later date, it may be entered into the program at that time.

3. The backspace and delete keys may be used to correct mistakes in data entry. The backspace key will erase the character immediately to the left of the cursor. The delete key will erase the character at the cursor.

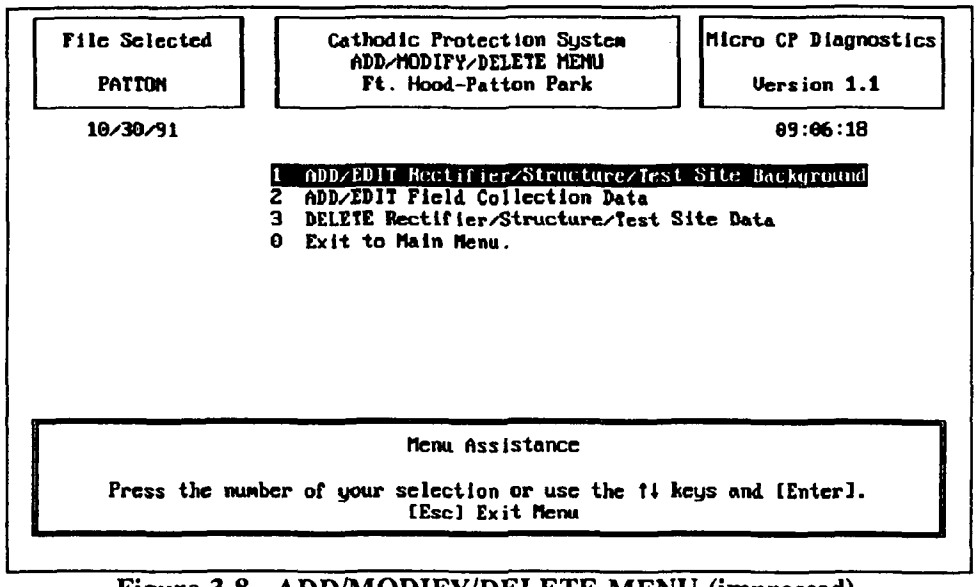

Figure 3-8. ADD/MODIFY/DELETE MENU (impressed).

4. The insert key may be used to toggle between insert mode and typeover mode.

5. The left and right arrow keys may be used to move the cursor within the field that you are currently editing.

6. The up arrow key may be used to move to the field above the one you are currently in and the down arrow key may be used to move to the field below it.

ADD/MODIFY/DELETE MENU Option 1 – ADD/MODIFY Rectifier/Structure /Test Site Background {B1}

This option allows you to create new rectifiers, junction boxes, structures, test sites, and anode beds, and enter the associated data into the system. It also allows you to edit data for existing rectifiers, junction boxes, structures, test sites, and anode beds.

After you choose this option, the ENTER ADD/EDIT PASSWORD screen (Figure 3-9) will appear. At the prompt, type your add/edit password and press <Enter>. The password will not be displayed on the screen as you type it.

After you enter your password, the SELECTING A RECTIFIER screen appears (Figure 3-10). The identification numbers of existing rectifier records are displayed on this screen. If you wish to edit an existing rectifier record (or the structure, junction box, or test site data associated with an existing rectifier record), consult this list. The <PgUp> and <PgDn> keys are used to scroll through the pages of the list. To select an existing rectifier record for editing, type the Rectifier ID (up to 10 characters) at the prompt and press <Enter>.

If you wish to create a new rectifier record, type a new Rectifier ID at the prompt. If you enter a Rectifier ID that does not already exist in the program (i.e., does not appear on the list), the screen of Figure 3-11 appears. This screen asks whether the rectifier protects underground structures (pipes or underground storage tanks) or water tanks.

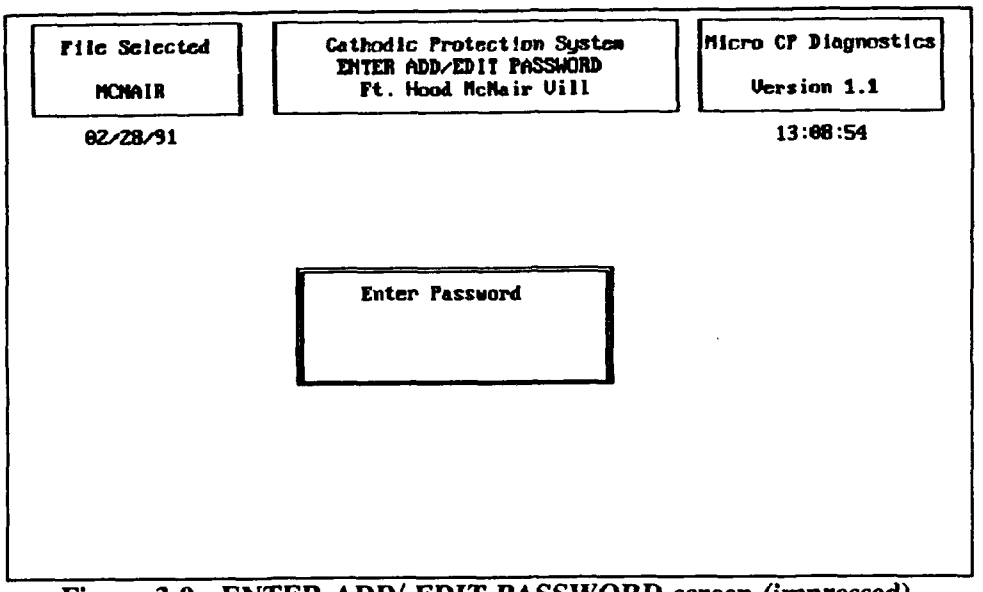

Figure 3-9. ENTER ADD/ EDIT PASSWORD screen (impressed).

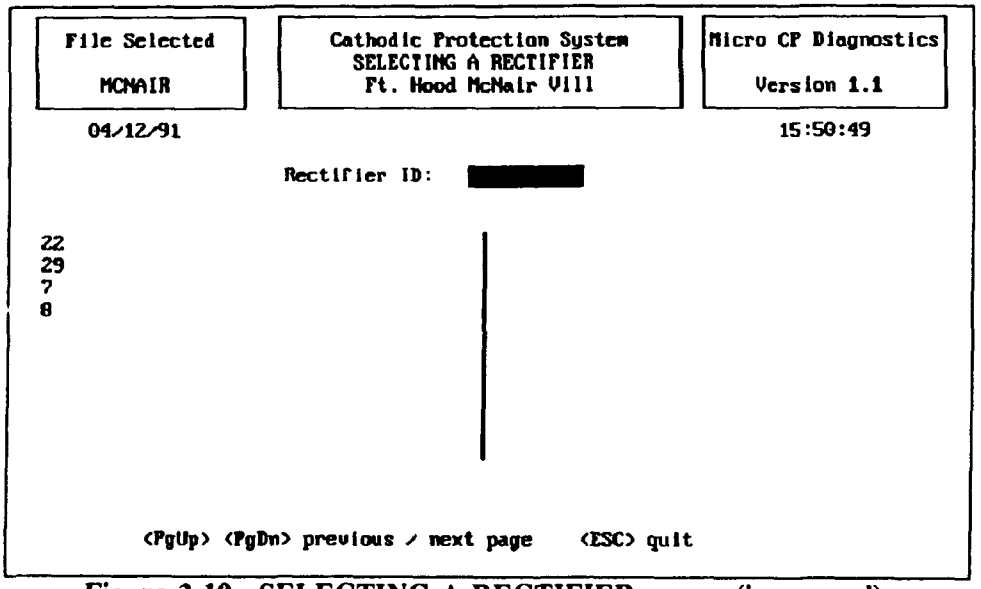

Figure 3-10. SELECTING A RECTIFIER screen (impressed).

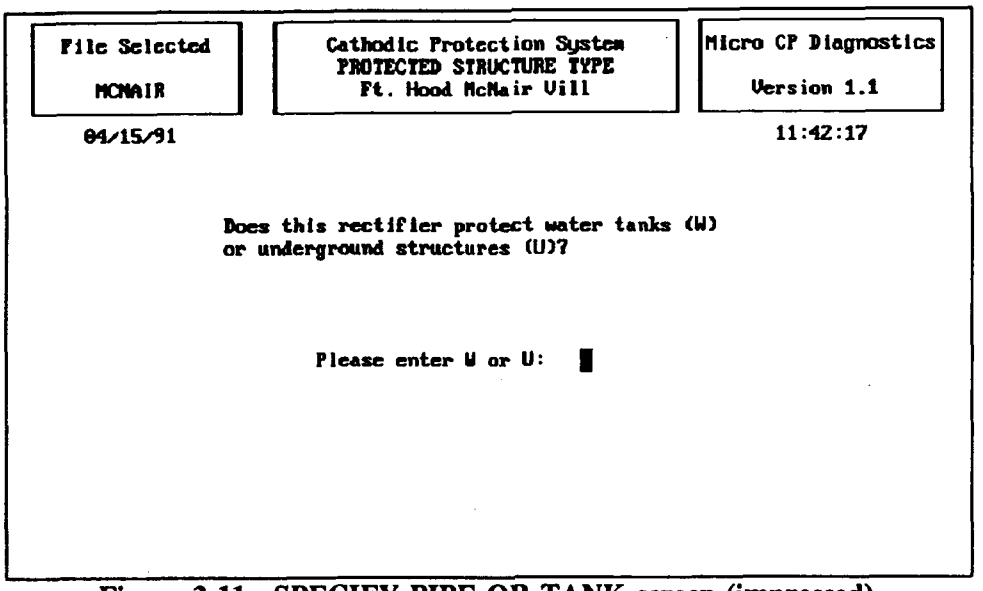

Figure 3-11. SPECIFY PIPE OR TANK screen (impressed).

After you have entered the Rectifier ID at the prompt, the ADD/EDIT RECTIFIER DATA screen (Figure 3-12) will appear. At the bottom of this screen appears a submenu, the ADD/EDIT BACKGROUND INFORMATION Submenu. {C1}

ADD/EDIT BACKGROUND INFORMATION SUBMENU Option 1 — Add/Edit Rectifier Background. {C2} This option allows you to add or edit background information about the rectifier that you have selected. After you select this option, the submenu will disappear from Rectifier Screen #1 shown in Figure 3-12. As usual, type the appropriate information at the corresponding prompts and press <Enter> to move to the next field. Rectifier Screen #2 (Figure 3-12a) allows you to enter background information for up to three rectifier circuits. To move to Rectifier Screen #2, press <Enter> on the last field of screen #1 or press <Esc> at any point on screen #1.

When numeric values are entered on the ADD/EDIT RECTIFIER DATA screen, the program will validate the value entered for each numeric field. A message will appear at the bottom left corner of the screen if a field value is invalid. Type a valid entry to correct it. The percentage value of rectifier efficiency is automatically calculated by ICP according to Equation 4 (Chapter 1).

When you have finished entering information for a particular rectifier in the ADD/EDIT RECTIFIER DATA screens (i.e., after you have pressed <Enter> on the last field of the screen), a series of screens related to the rectifier will appear on your monitor.

If the rectifier protects underground structures, these screens are the JUNCTION BOX IDENTIFICATION screen (Figure 3-13), and the GROUND BED DATA screens (Figures 3-14 and 3-15). When the JUNCTION BOX IDENTIFICATION screen appears, select a junction box from the list in the usual manner or create a new junction box record by typing a new junction box number at the prompt. After a junction box identification number has been selected, the GROUND BED DATA screen #1 shown in Figure 3-14 appears. This screens displays background information about the anode ground bed that receives current from the rectifier and protects the exterior of the structure. Enter data in the usual manner. To move to GROUND BED DATA screen #2 (Figure 3-15), press <Enter> on the last field of screen #1 or press <Esc> at any point on screen #1. Screen #2 displays initial anode current output

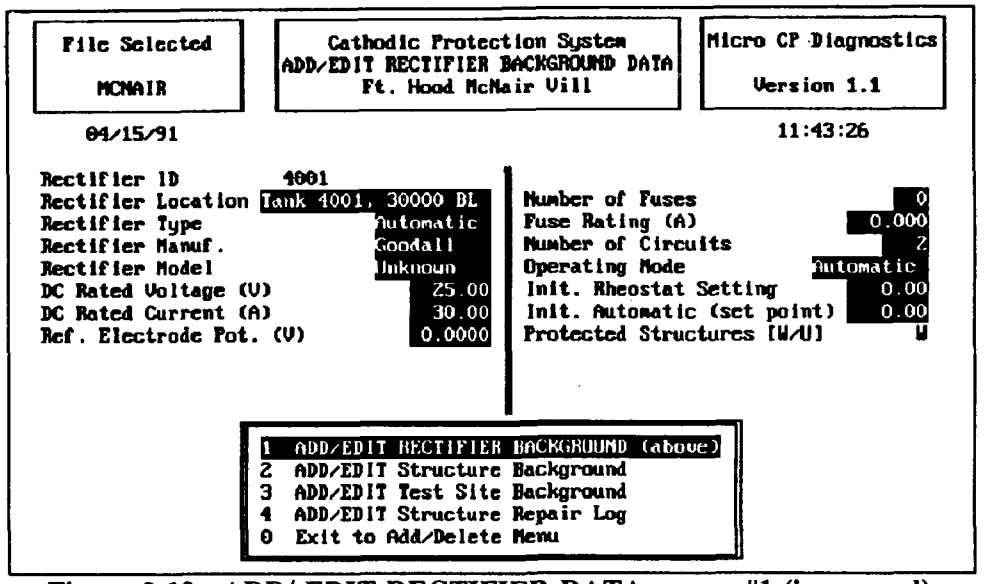

Figure 3-12. ADD/ EDIT RECTIFIER DATA screen #1 (impressed).

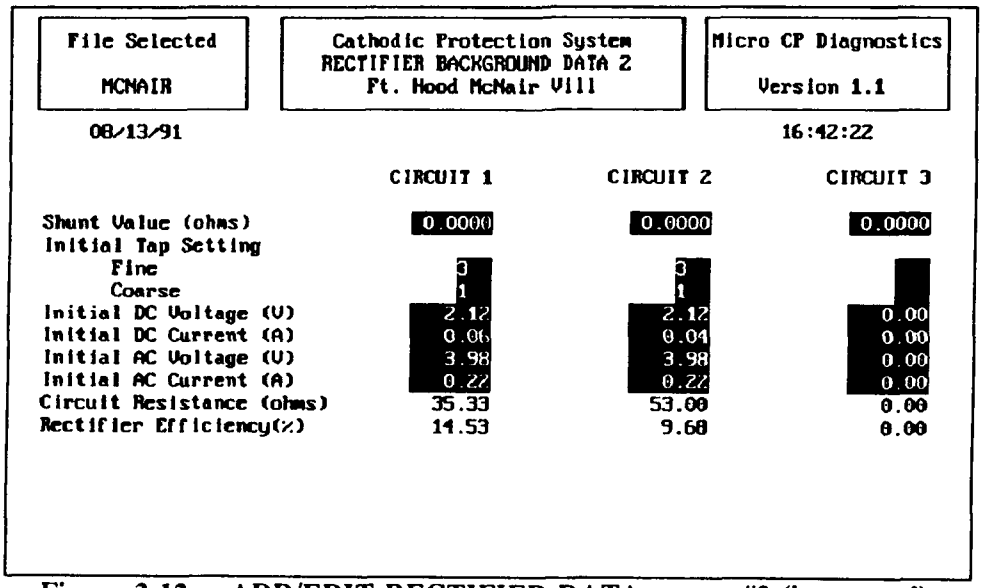

Figure 3-12a. ADD/EDIT RECTIFIER DATA screen #2 (impressed).

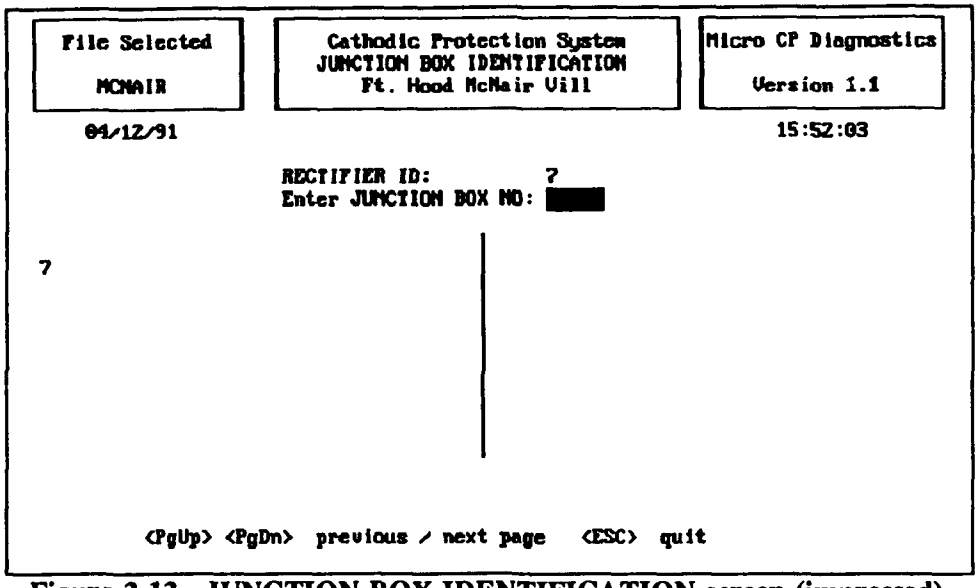

Figure 3-13. JUNCTION BOX IDENTIFICATION screen (impressed).

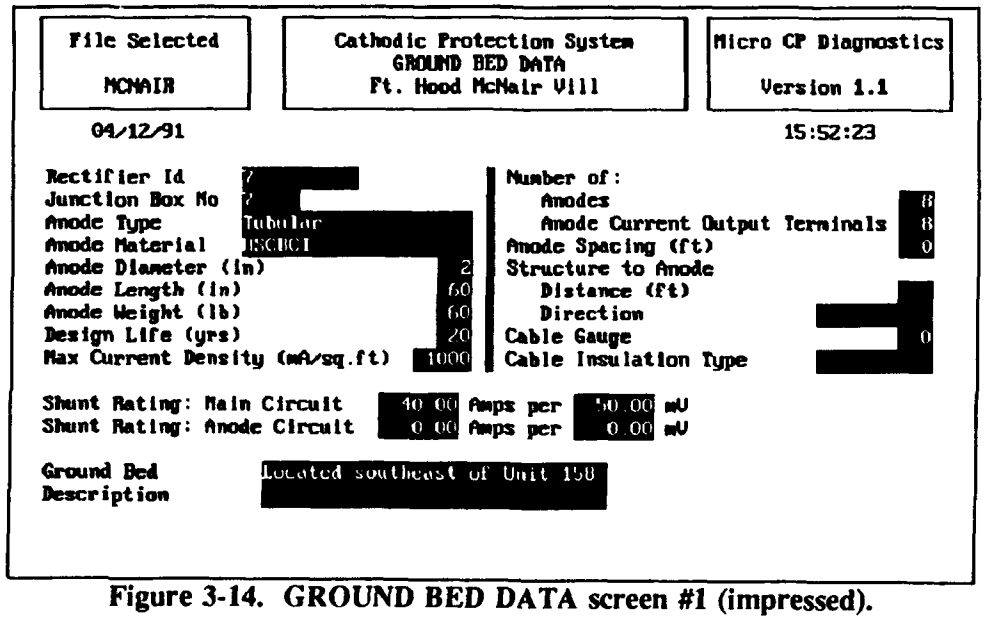

Figure 3-14. GROUND BED DATA screen #1 (impressed).

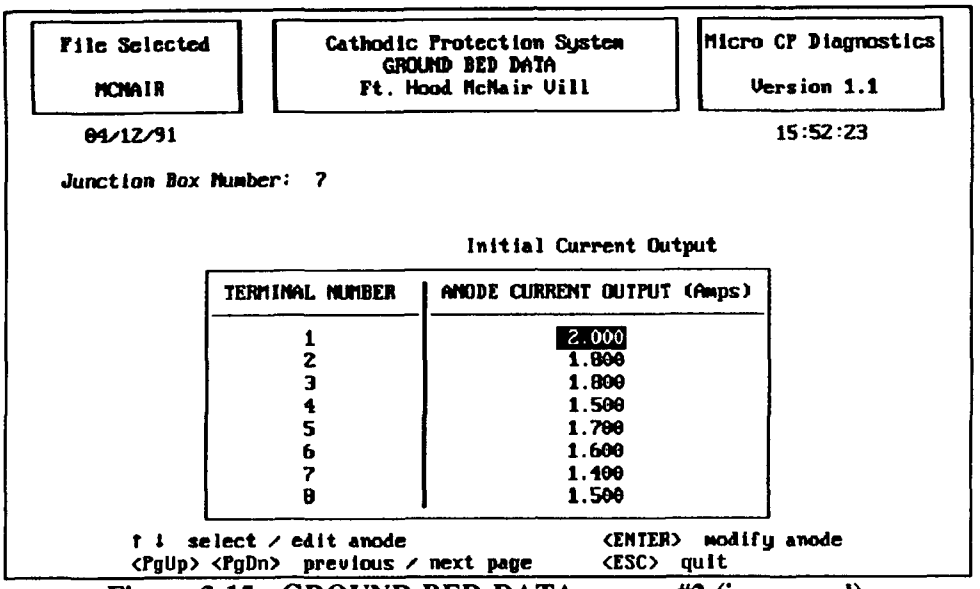

Figure 3-15. GROUND BED DATA screen #2 (impressed).

measurements. The number of terminals displayed in the table corresponds to the number that was entered in the Anode Current Output Terminals field on screen #1. Enter anode current outputs in the table and press <Esc> when you are finished to return to the JUNCTION BOX IDENTIFICATION screen.

If the rectifier protects water tanks, the screen of Figure 3-16 appears. This screen displays information about the anodes in the water tank that receive current and protect the interior of the tank.

ADD/EDIT BACKGROUND INFORMATION SUBMENU Option 2- Add/Edit Structure Background: {C3} This option allows you to enter data about structures protected by the selected rectifier. If you have told the system that the rectifier protects underground structures (as opposed to water tanks), then for each structure you will first see the STRUCTURE TYPE SPECIFICATION screen (Figure 3-17). This screen asks whether you wish to add or edit data about an underground gas pipe or an underground storage tank protected by the rectifier. If you enter a blank response, you will be returned to the SELECTING A RECTIFIER screen. Note that if you have told the system that the rectifier protects water tanks, then any structure entered at this point must be a water tank, so there is no need for the STRUCTURE TYPE SPECIFICATION screen.

Once you have specified the type of structure you wish to work with (or if you did not need to specify it), you will see a structure identification screen. If you wish to edit an existing record, consult the list of structure ID's shown on the screen. This is a complete list of the identification numbers of previously entered structures. The <PgUp> and <PgDn> keys are used to scroll through the pages of the list.

If you have chosen to work with an underground gas pipe, you will see the PIPE SECTION IDENTIFICATION screen (Figure 3-18). To select an existing pipe section record for editing, type the PIPE ID (up to 10 characters) exactly as it appears in the list at the prompt and press the <Enter> key to move the prompt to SECT ID. Enter the four-character section identification number at the prompt and press <Enter>.

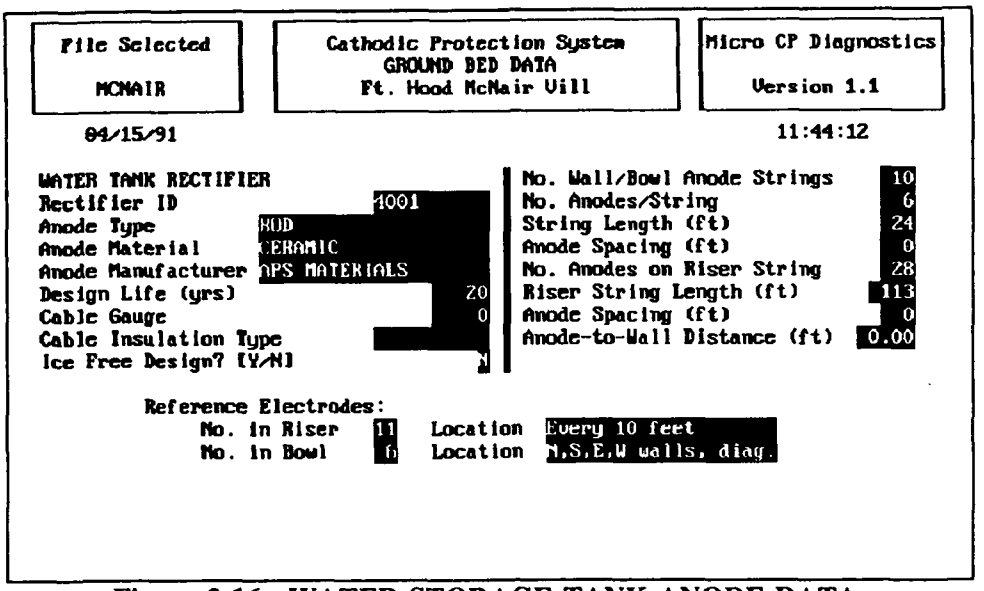

Figure 3-16. WATER STORAGE TANK ANODE DATA screen (impressed).

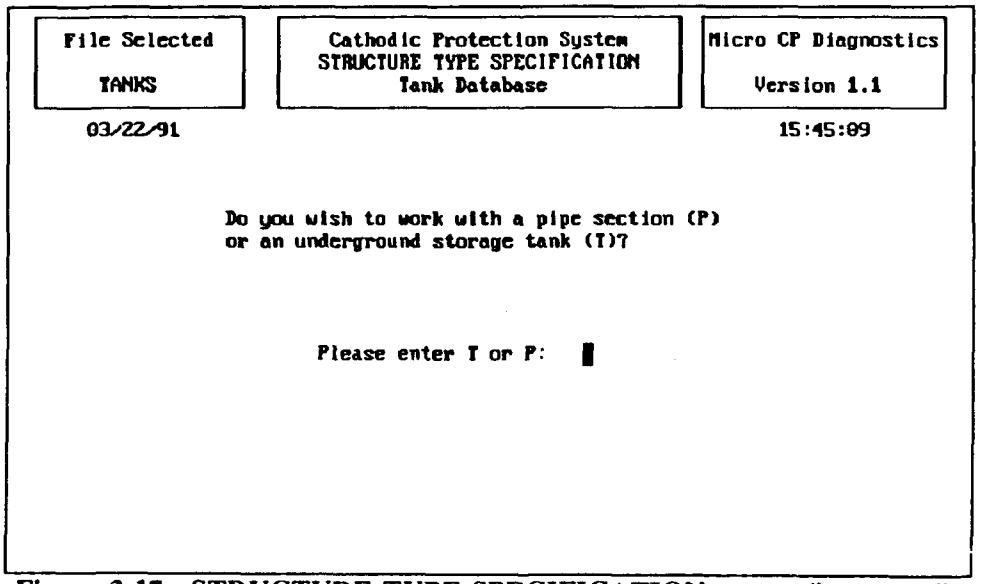

Figure 3-17. STRUCTURE TYPE SPECIFICATION screen (impressed).

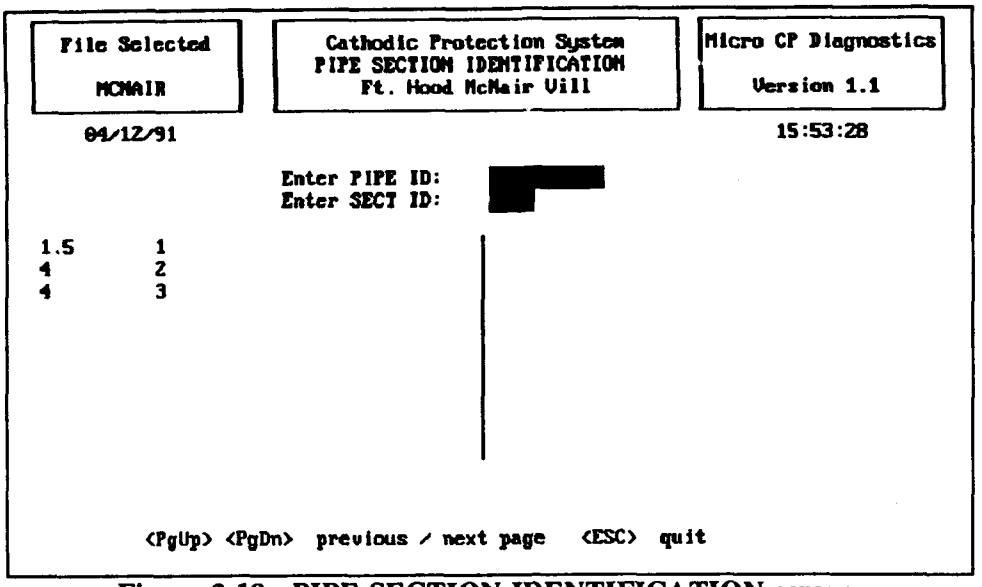

Figure 3-18. PIPE SECTION IDENTIFICATION screen (impressed).

If you have chosen to work with an underground storage tank or a water tank instead of an underground gas pipe, you will see the TANK IDENTIFICATION screen (Figure 3-19). Its operation is similar to that of the PIPE SECTION IDENTIFICATION screen. It will only display existing tanks of the type you have chosen (either underground storage tanks or water tanks).

To select an existing tank record for editing, enter the TANK ID (up to 10 characters) exactly as it appears in the list of existing structures.

If you wish to create a new record (pipe or tank), type a new structure ID at the prompt, following the procedures given in the preceding paragraph for entering structure ID's. The program automatically creates a new record when a structure ID is entered that does not already exist in the program (i.e., does not appear on the list).

After you have entered the structure ID at the prompt, a screen will appear to allow you to add and/or edit background information about the structure. If the structure is a pipe, the ADD/EDIT PIPE SECTION BACKGROUND DATA screen (Figure 3-20) will appear. If the structure is an underground storage tank, the ADD/EDIT UNDERGROUND STORAGE TANK BACKGROUND DATA screen (Figure 3-21) will appear. If the structure is a water tank, the ADD/EDIT WATER TANK BACKGROUND DATA screen (Figure 3-22) will appear.

You may now add or edit background information about the structure by typing the appropriate information at the corresponding prompts on the screen in the usual manner. If it is an underground structure, one of the prompts is the question, "Do Isolation Joints Exist?" To answer the question, press either <Y> (Yes) or <N> (No). If you press <Y> to signify that isolation joints do exist, the "ISOLATION JOINTS LOCATION" screen (Figure 3-23) will appear on your monitor.

The currently selected rectifier is automatically associated with a new structure. If the structure is protected by more than one rectifier, you may wish to make this association in the CP database. To associate additional rectifiers with the structure, answer "Y" to the question "Do you wish to modify the

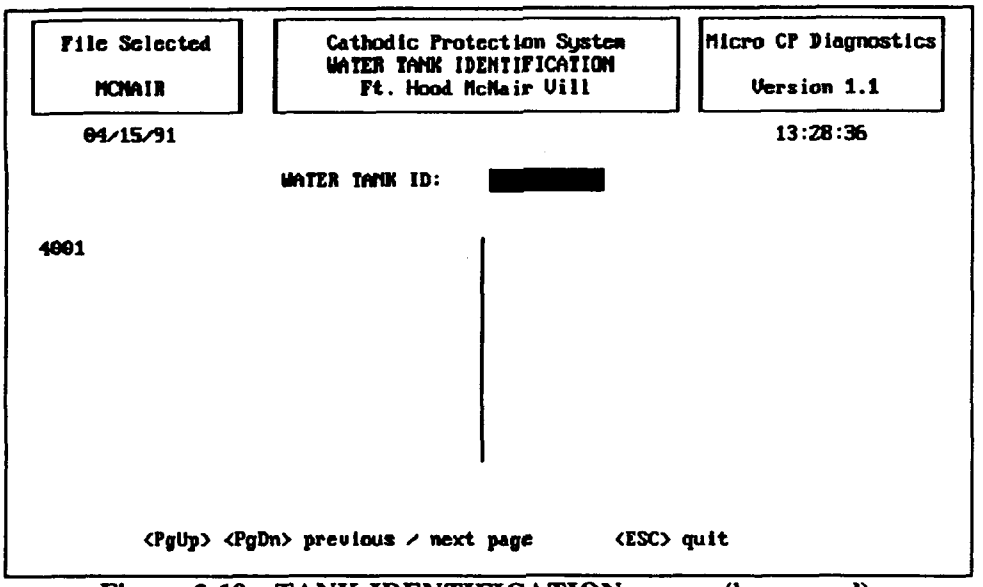

Figure 3-19. TANK IDENTIFICATION screen (impressed).

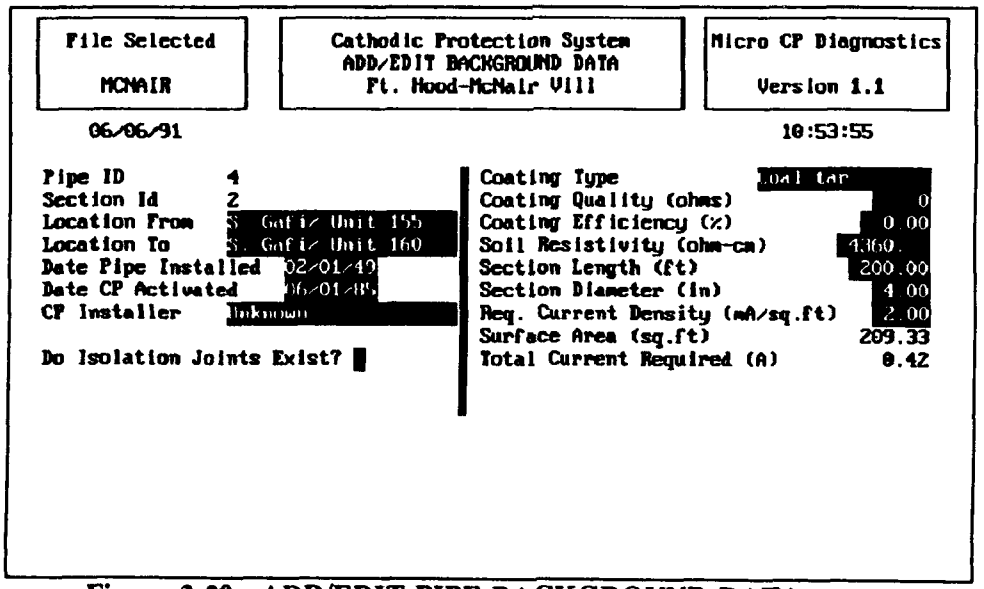

Figure 3-20. ADD/EDIT PIPE BACKGROUND DATA screen (impressed).

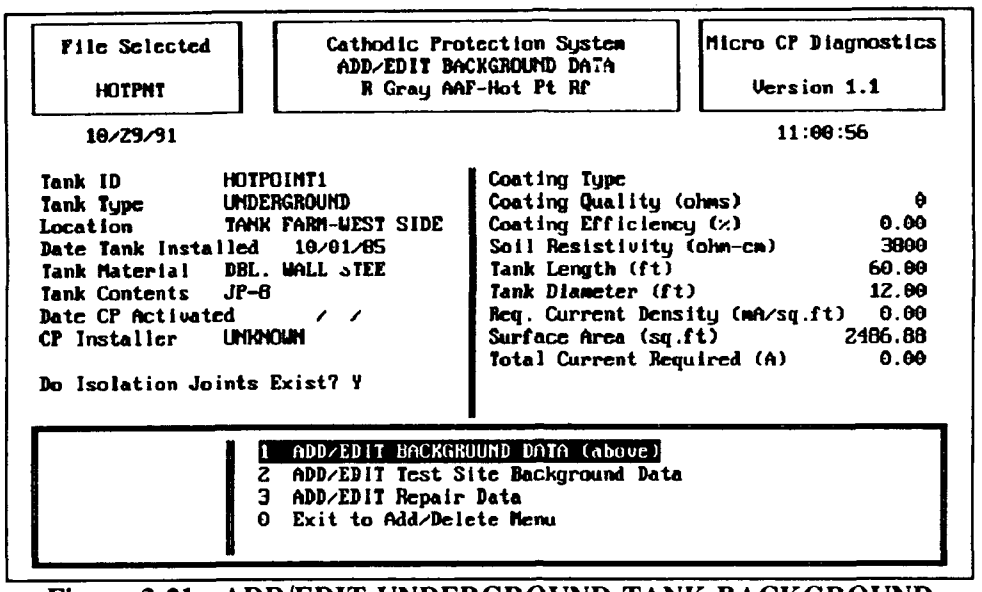

Figure 3-21. ADD/EDIT UNDERGROUND TANK BACKGROUND DATA Screen (impressed).

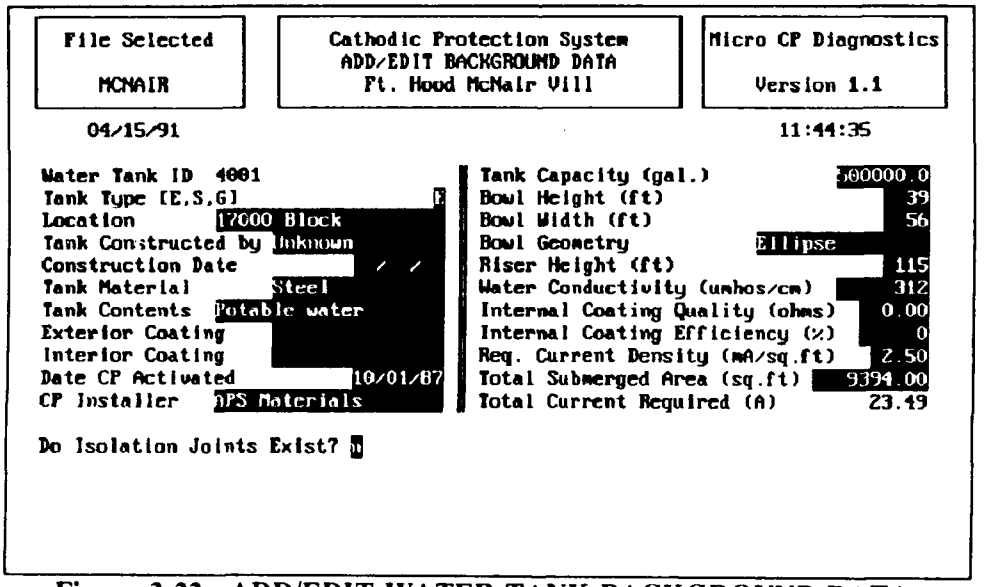

Figure 3-22. ADD/EDIT WATER TANK BACKGROUND DATA screen (impressed).

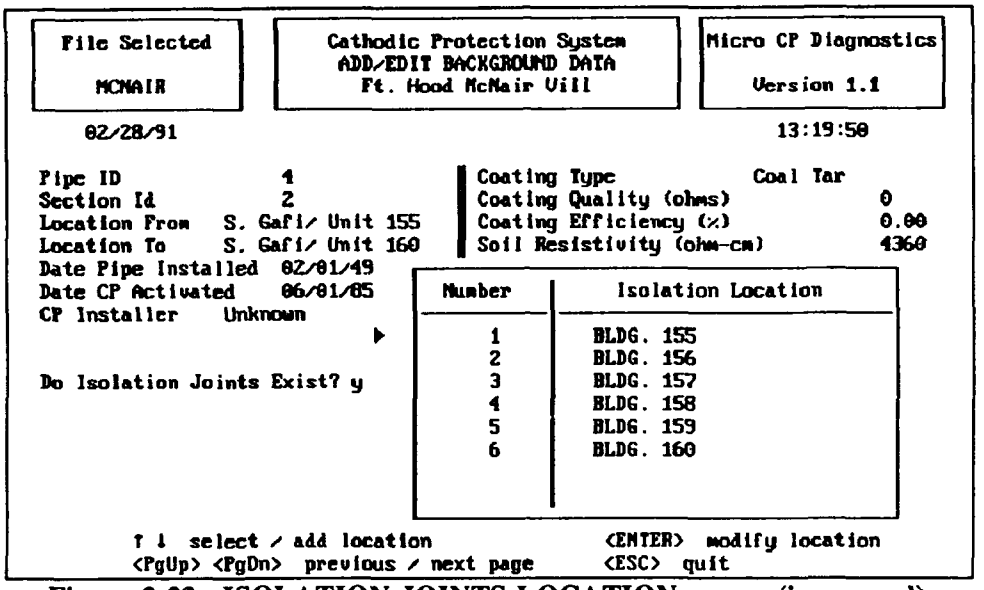

Figure 3-23. ISOLATION JOINTS LOCATION screen (impressed).

list of rectifiers that help protect this pipe section/tank?" After you answer "Y", the rectifier ID popup window will appear. Enter the IDs of the additional rectifiers that protect the structure. (Note: The rectifier prompt and popup window are not shown in the figures below.)

ADD/EDIT BACKGROUND INFORMATION SUBMENU Option 3 – Add /Edit Test Site Background. {C4} This option allows you to add or edit information about test sites that are associated with the selected rectifier. After you select this option, select a structure in the usual manner. You must select an existing structure; new structures cannot be created with this option. After a structure has been selected, the TEST SITE IDENTIFICATION screen (Figure 3-24) appears. Select a test site from the list in the usual manner or create a new test site by typing a new test site ID at the prompt.

After you have selected a test site to work with, the ADD/ EDIT TEST SITE DATA screen #1 (Figure 3-25) will appear. Enter the requested background information about the test site in the usual manner. The ADD/ EDIT TEST SITE DATA screen #2 (Figure 3-26) appears after you press <Enter> on the last field of screen #1 or after you press <Esc> at any point in screen #1.

The TEST SITE DATA screen #2 asks you to enter several pieces of information related to the measurement points of the test site. An "identifier" refers to any identifying characteristic of a test station wire (such as color), a riser, or any other measurement point at a test site which will distinguish it from the other measurement points. The "Function" field is used to describe the reason for testing the measurement point; an example entry for this field is "P/S 101," indicating that the pipe-to-soil potential of pipe 101 may be read from the wire. Only initial structure-to-soil potentials are to be entered on this screen. Do not enter other potentials or anode currents. Fields are provided for the ON and INSTANT OFF potentials and the dielectric condition for each test taken. It is important to note that the initial potentials entered here in the background data section are not evaluated when the Trouble Readings report is run. These initial measurements provide baseline information only. The reports analyze data that is entered in the "Field Collection Data" section of the program.

Press <Esc> when all entries are complete and you will return to the TEST SITE IDENTIFICATION screen. If you wish to edit data for another test site associated with this structure, type its name at the

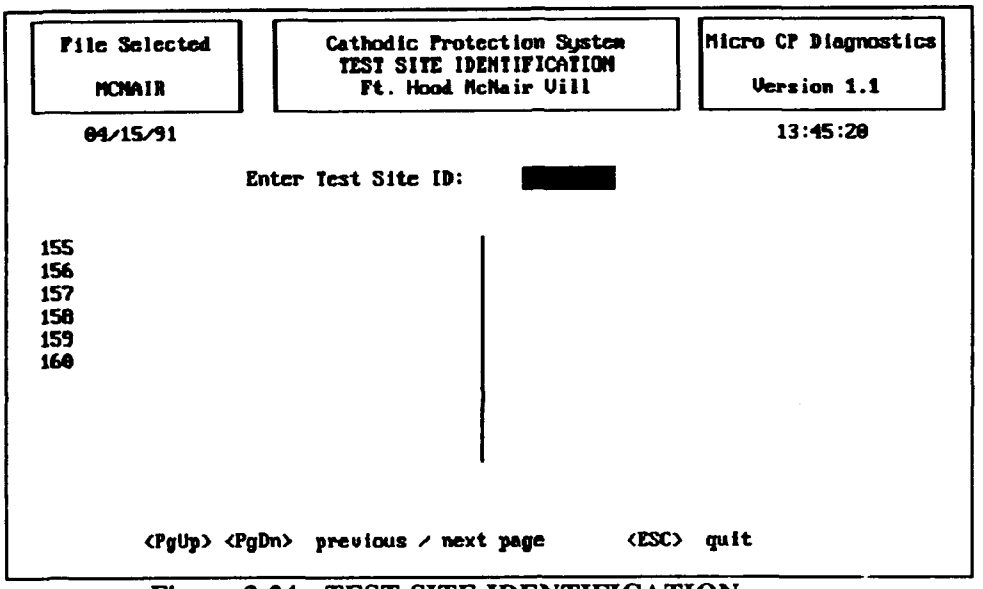

Figure 3-24. TEST SITE IDENTIFICATION screen (impressed).

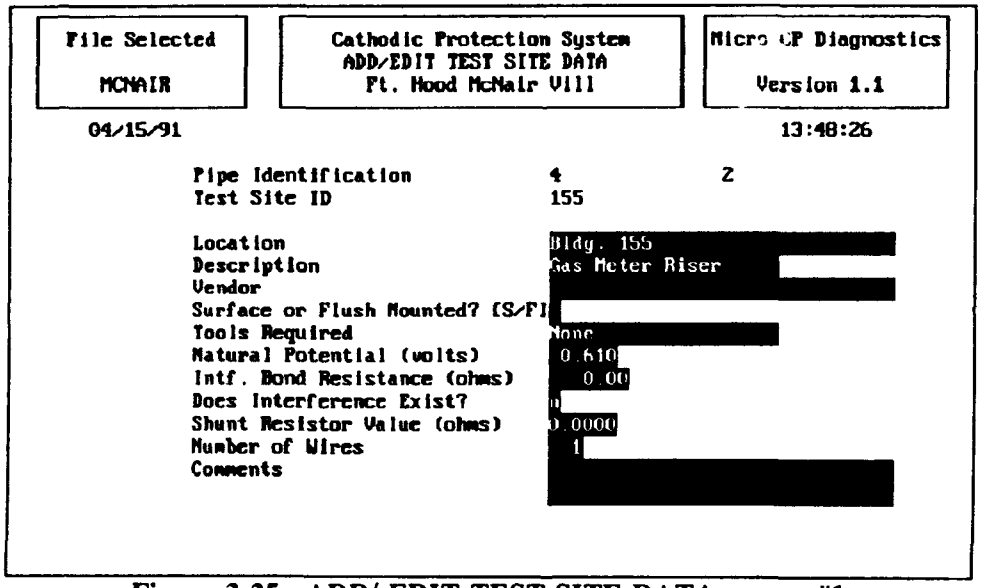

Figure 3-25. ADD/ EDIT TEST SITE DATA screen #1 (impressed).

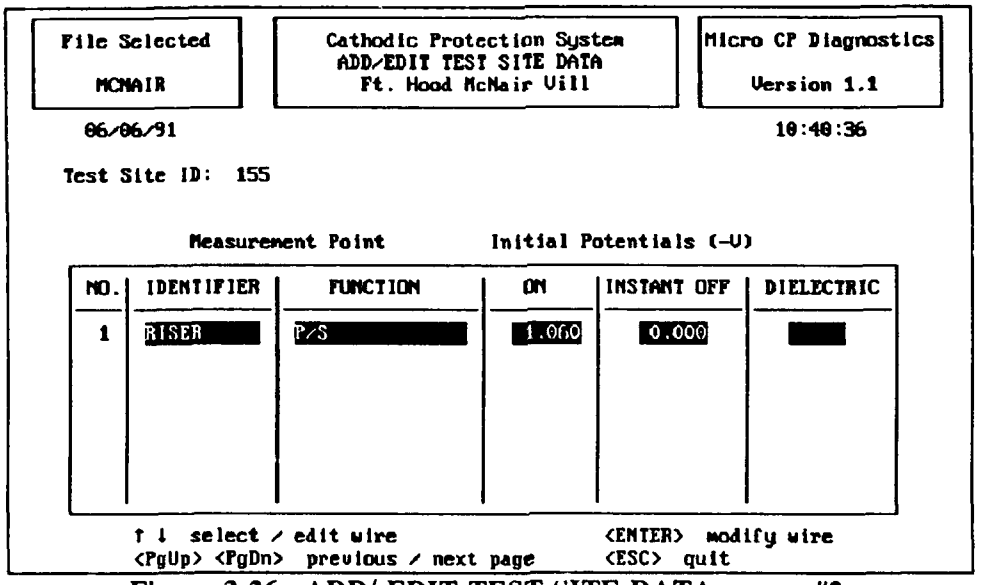

Figure 3-26. ADD/ EDIT TEST SITE DATA screen #2- initial potentials (impressed).

prompt. If you do not wish to edit data for anaother test site associated with this structure, press <Esc> to return to the ADD/ EDIT BACKGROUND INFORMATION submenu.

ADD/EDIT BACKGROUND INFORMATION SUBMENU Option 4 – Add/Edit Structure Repair Log. {C5} This option allows you to enter information regarding repairs of a cathodically protected structure. After you select this option, select a structure in the usual manner. After you select a structure, a pop-up screen appears at the bottom of the ADD/EDIT BACKGROUND DATA screen (Figure 3-27), prompting you to enter the repair information regarding the selected structure. After you enter all the repair information for this screen, the program will replace the pop-up screen with the ADD/EDIT BACKGROUND INFORMATION submenu.

ADD/EDIT BACKGROUND INFORMATION SUBMENU Option 0 – Exit to Add/Delete Menu. This option will return you to Impressed Current Cathodic Protection Diagnostic's ADD/ MODIFY/ DELETE menu.

ADD/MODIFY/DELETE MENU Option 2 – Add/Edit Field Collection Data {B2}

The ADD/EDIT Field Collection Data option allows you to enter potentials, anode currents, and rectifier readings each time they are gathered in the field. These are the measurements that will be evaluated by the analytic reports. After you select this option, the ENTER ADD/EDIT PASSWORD screen (Figure 3-9) will appear. Type your ADD/EDIT password at the prompt and press <Enter>. The password will not be displayed as you type it. After you have entered the password correctly, the FIELD COLLECTION MENU (Figure 3-28) {B3} will appear. Select the option that you wish to perform in the usual manner.

FIELD COLLECTION SUBMENU Option 1 – Add/Edit Test Site Field Data. {B4} This option allows you to enter structure-to-soil potentials that have been measured at specific test sites during field testing of the cathodic protection system. After you select this option, select a structure in the usual manner. After you have selected a structure, the TEST SITE IDENTIFICATION screen (Figure 3-24)

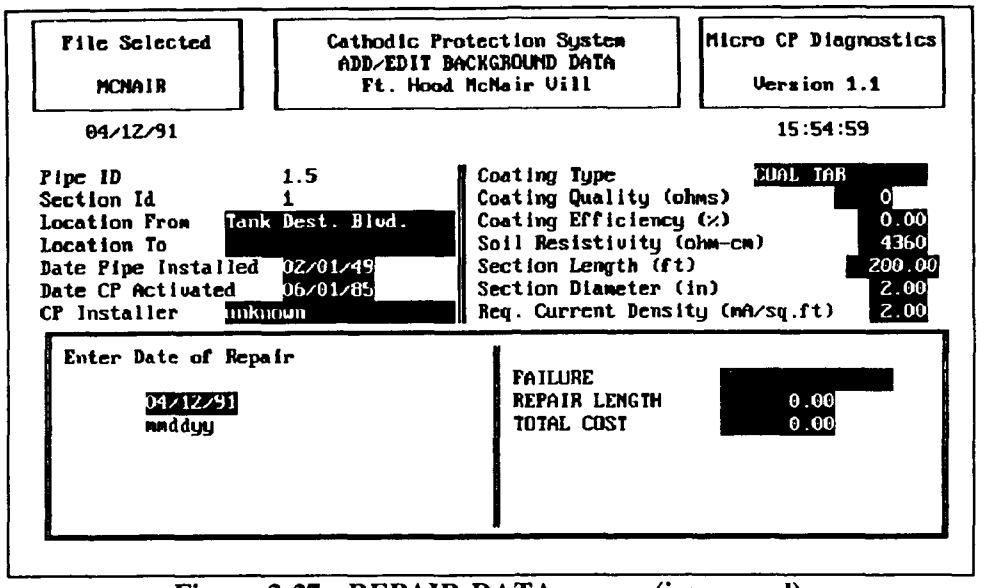

Figure 3-27. REPAIR DATA screen (impressed).

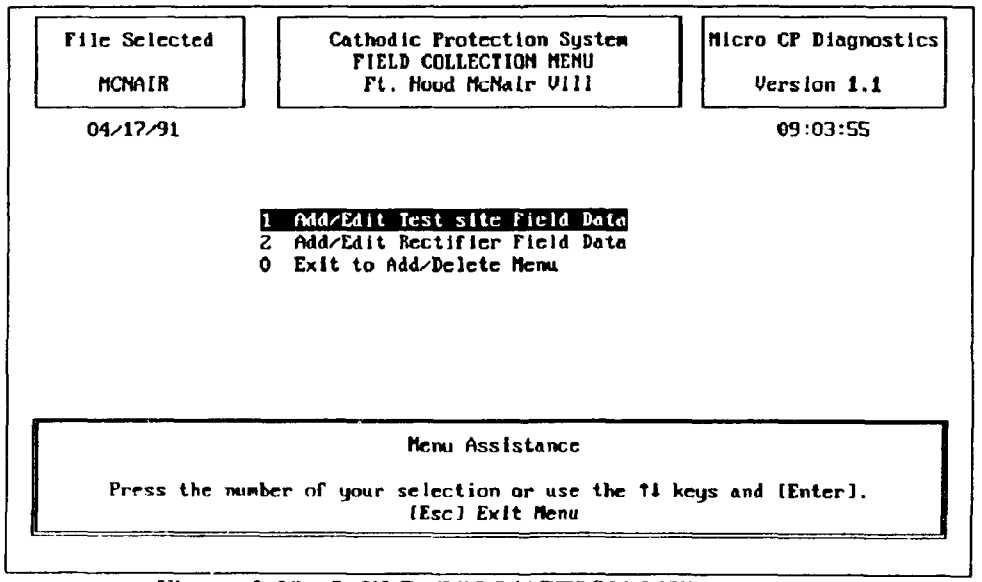

Figure 3-28. FIELD COLLECTION MENU screen (impressed).

appears and displays the test sites that are associated with the selected structure. Select a test site in the usual manner. You will be prompted to enter the date that the data was collected (Figure 3-29). Type the date, or press <Enter> to use the current date. Next, type collection comments at the prompt and press <Enter> when done. The data table will then appear (Figure 3-30). Note that only structure-to-soil potentials are entered in this table. Do not enter anode current outputs or other potential measurements. Select a measurement point by moving the pointer (on the left side of the screen) to it and pressing <Enter>. Type the data and press <Enter>. The pointer will move to the next line of the table. When you are finished entering data, press <Esc> to return to the TEST SITE IDENTIFICATION screen. If you wish to enter data for another test site associated with this structure, type its ID at the prompt. If you do not wish to enter data for another test site associated with the structure, press <Esc> to return to the FIELD COLLECTION MENU.

FIELD COLLECTION SUBMENU Option 2 – Add/Edit Rectifier Field Data. {B5} This option allows you to enter field measurements of rectifier operating parameters and anode current outputs. After you select this option, the SELECTING A RECTIFIER screen (Figure 3-10) appears. Select the rectifier for which you wish to enter data in the usual manner. The ADD/ EDIT RECTIFIER FIELD DATA screen (Figure 3-31) will appear.

Enter the data requested in the usual manner. When you are finished entering data, press <Enter> on the last field of the screen or press <Esc> at any field. The JUNCTION BOX IDENTIFICATION screen (Figure 3-13) will appear. Select the junction box that you wish to work with in the usual manner. The ANODE CURRENT OUTPUT screen will appear. Enter the data collection date and collection comments at the prompts. Press <Enter>. The rest of the screen, which contains the anode current output table, will appear (Figure 3-32). Select the terminal for which you wish to enter data by moving the pointer (on the left side of the screen) to it and pressing <Enter>. Type the data, then press <Enter>. The pointer will move to the next line of the table. When you are finished entering anode currents, press <Esc> to return to the FIELD COLLECTION MENU.

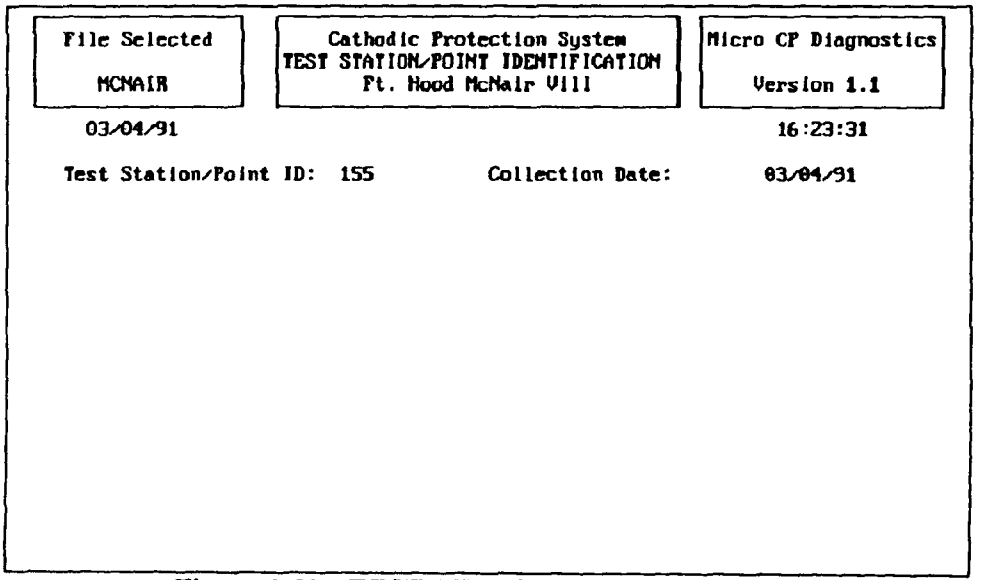

Figure 3-29. TEST SITE COLLECTION screen (impressed).

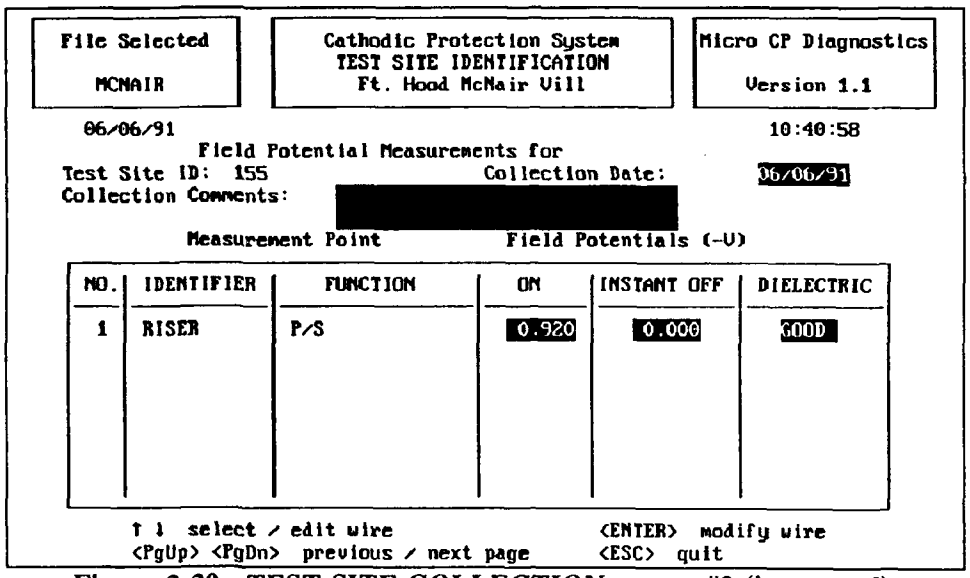

Figure 3-30. TEST SITE COLLECTION screen #2 (impressed).

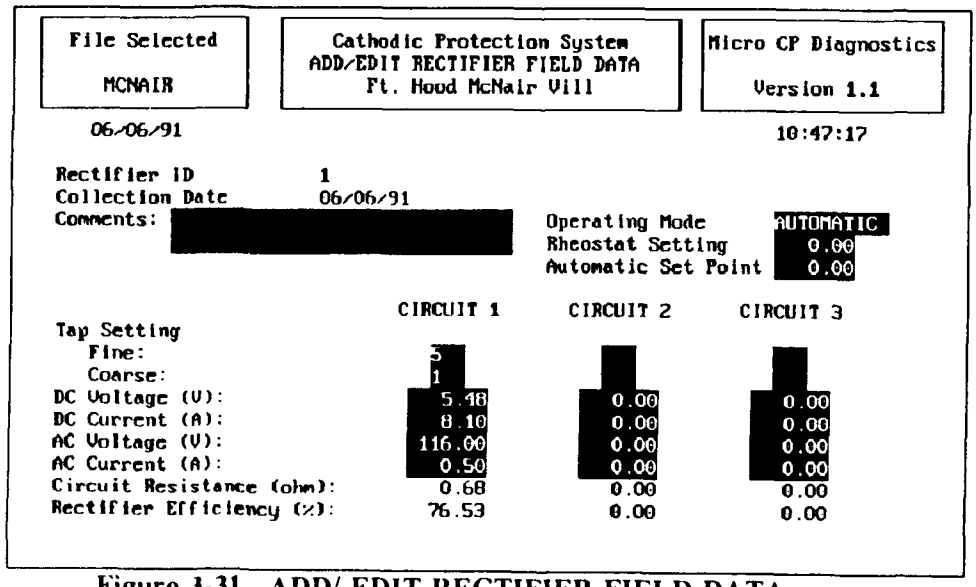

Figure 3-31. ADD/ EDIT RECTIFIER FIELD DATA screen (impressed).

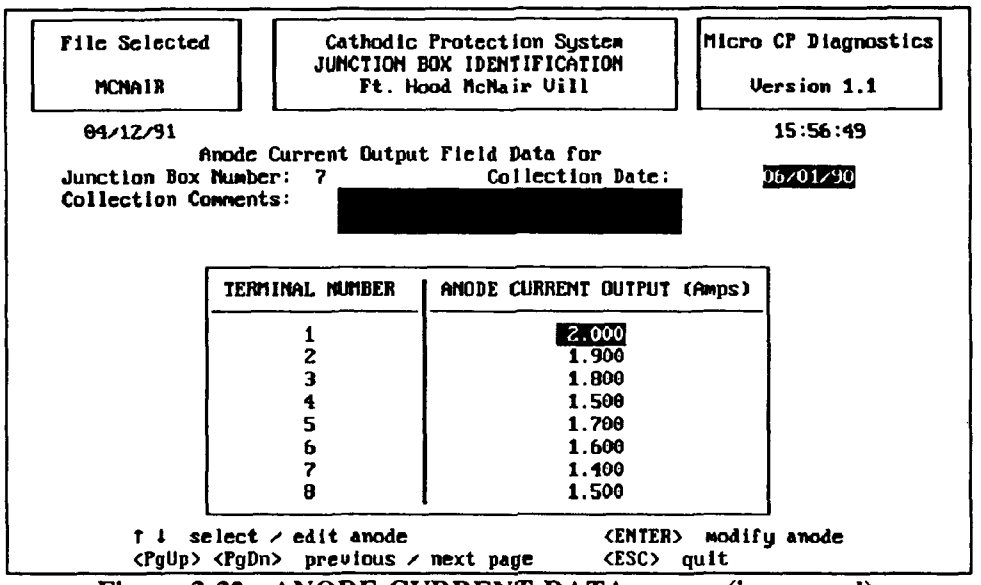

Figure 3-32. ANODE CURRENT DATA screen (impressed).

FIELD COLLECTION SUBMENU Option 0 — Exit to ADD/MODIFY/DELETE menu. This option returns you to the ADD/MODIFY/DELETE menu.

ADD/MODIFY DELETE MENU Option 3 – Delete Structure/Rectifier/Test Site Data {B6}

This option allows you to delete the rectifier, structure, and test site records from the currently selected database. After you select this option, the password screen (Figure 3-33) will appear. Enter your password at the prompt. The password will not be displayed on the screen as you type it. After you have entered your password, the program will display the DELETE MENU screen (Figure 3-34) {B7}. Select the operation that you wish to perform in the usual manner.

DELETE MENU Option 1 — Delete Rectifier Data. {B8} This option allows you to permanently delete a rectifier and all of the associated structure and test site records from the database.

WARNING: USE THIS OPTION WITH EXTREME CARE. THIS OPTION DELETES THE RECTIFIER FROM THE RECTIFIER DATA BASE AND DELETES ALL ASSOCIATED TEST SITE RECORDS. ONCE DELETED, THEY CANNOT BE RECALLED!

When you select this option, the program will display the SELECT A RECTIFIER screen (Figure 3-10). Type the ID of the rectifier that you wish to delete at the prompt and press <Enter>. The DELETE RECTIFIER DATA screen (Figure 3-35) will appear.

To delete the rectifier records corresponding to the displayed rectifier ID, answer the prompt in the submenu with <Y> (Yes). If, however, you do not wish to delete the rectifier records and all associated test site records, press <N> (No).

The lower right-hand corner of the screen displays an additional warning. As stated above, please carefully consider deletion of the rectifier information from the data base. ONCE DELETED, THIS INFORMATION CANNOT BE RECALLED.

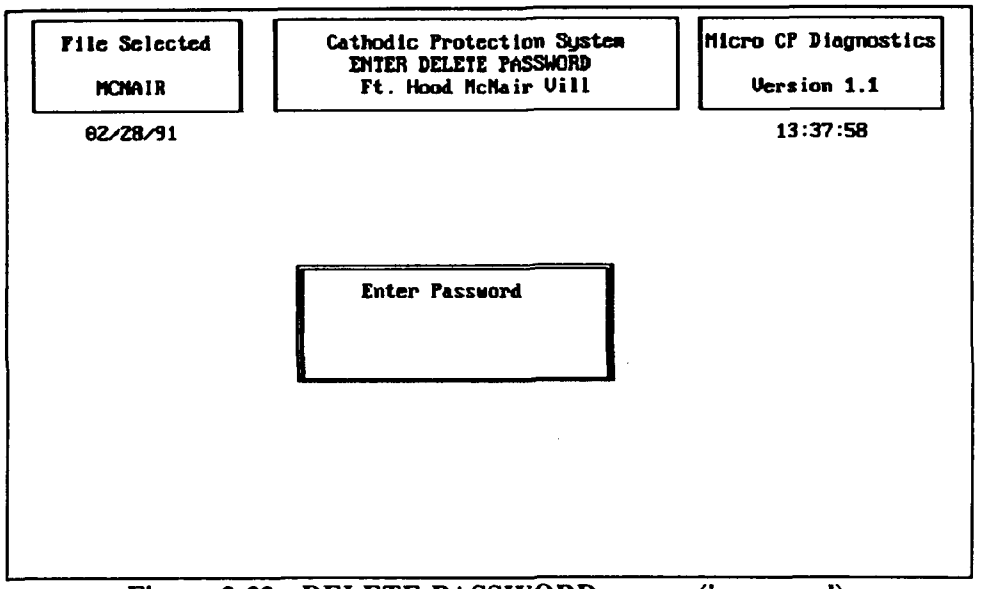

Figure 3-33. DELETE PASSWORD screen (impressed).

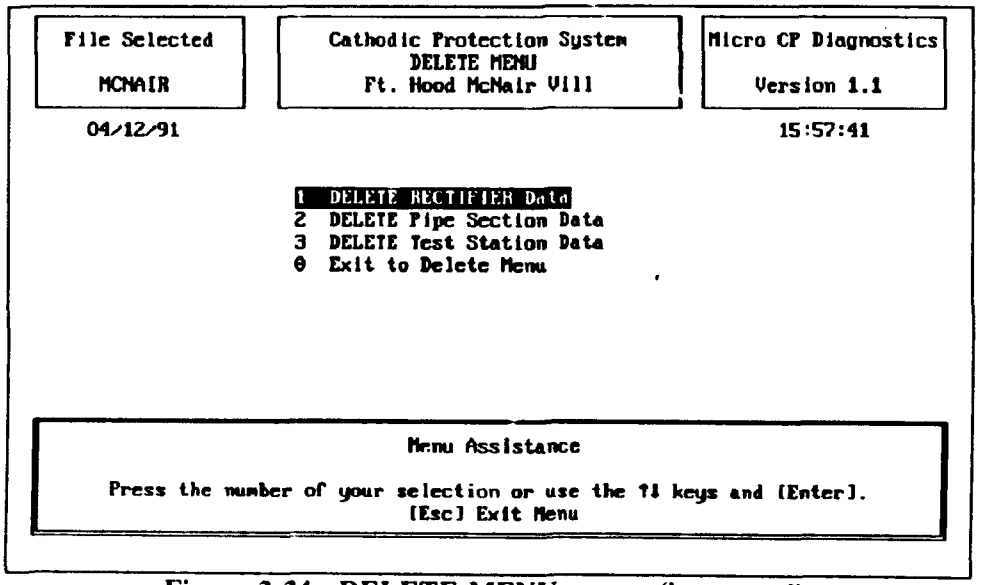

Figure 3-34. DELETE MENU screen (impressed).

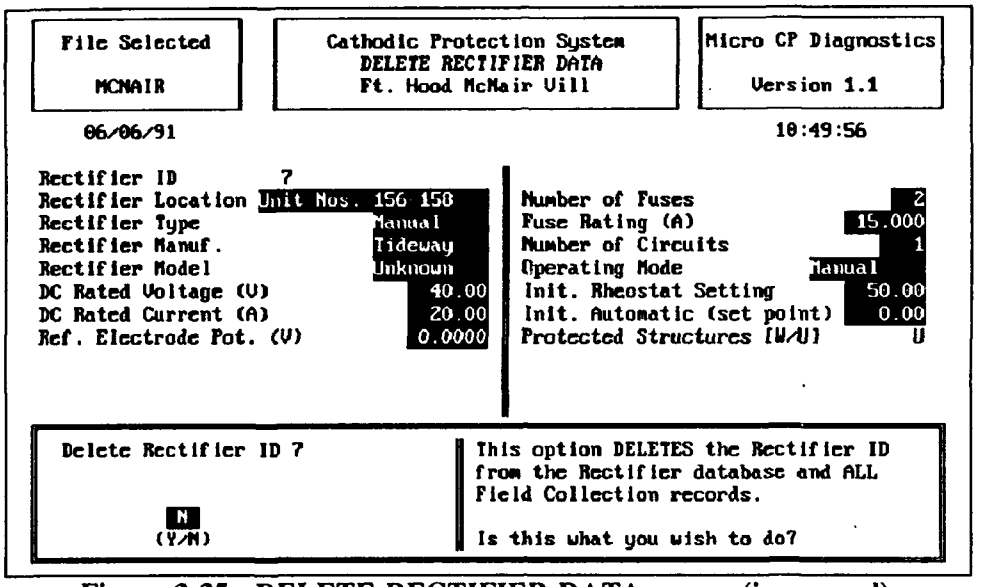

Figure 3-35. DELETE RECTIFIER DATA screen (impressed).

After you have performed this task, the program automatically returns to the DELETE MENU.

DELETE MENU Option 2 – Delete Structure Data. {B9} This option enables you to delete all records associated with a structure. Select a structure in the usual manner. The program will then generate the DELETE STRUCTURE DATA screen (Figure 3-36).

ONCE AGAIN, USE THIS OPTION WITH EXTREME CARE. THIS OPTION DELETES THE STRUCTURE INFORMATION FROM THE APPROPRIATE STRUCTURE DATA BASE AND DELETES ALL ASSOCIATED TEST SITE RECORDS. ONCE DELETED, THIS INFORMATION CANNOT BE RECALLED.

To delete the structure records corresponding to the displayed structure ID, respond to the prompt in the pop-up screen with <Y> (Yes). If you do not wish to delete the structure records, and all associated test site records, press <N> for No.

An additional warning is posted in the lower right-hand corner of the screen. Please carefully consider deletion of the structure information. ONCE DELETED, THIS INFORMATION CANNOT BE RECALLED.

After performing this task, the program returns to the DELETE MENU.

DELETE MENU Option 3 – Delete Test Site Data. {B10} By selecting the DELETE MENU's Option 3, you are able to delete all records associated with a specific Test Site.

USE THIS OPTION WITH EXTREME CARE. THIS OPTION DELETES THE TEST SITE INFORMATION FROM THE TEST SITE DATA BASE. ONCE DELETED, THIS INFORMATION CANNOT BE RECALLED.

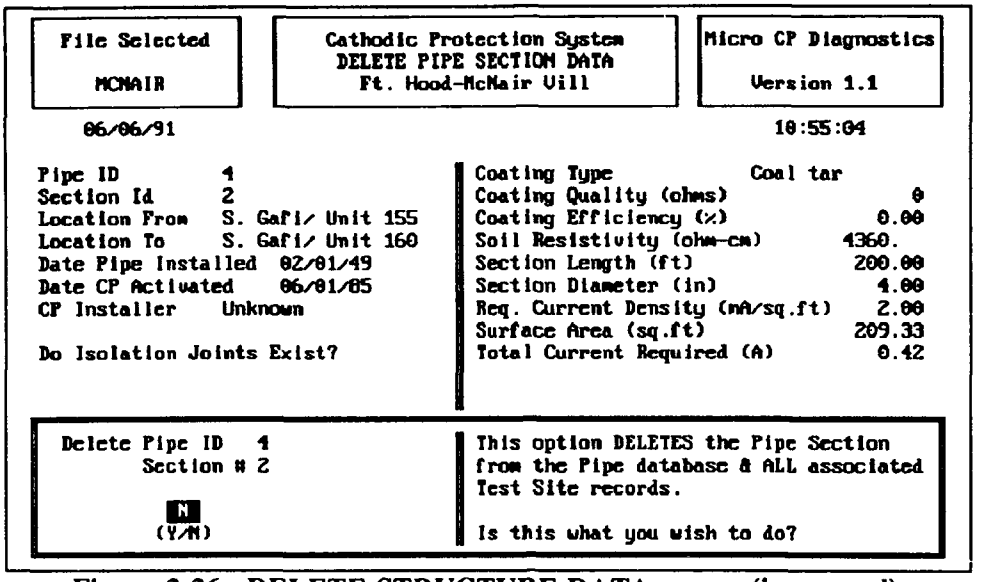

Figure 3-36. DELETE STRUCTURE DATA screen (impressed).

Select a structure in the usual manner. After you select a structure, the program will display the TEST SITE ID screen (Figure 3-24). Select the test site whose records you wish to delete by typing its ID at the prompt and press <Enter>. The ICP program will then display the DELETE TEST SITE DATA Screen (Figure 3-37).

To delete the Test Site records corresponding to the displayed Test site ID, respond to the prompt in the pop-up screen with a <Y> (Yes). If you do not wish to delete the Test site records from the data base, as well as all associated field collection records, press <N> (No).

Again, as with other deletion options, you will notice that at the lower right-hand corner of your screen an additional warning is posted. Please consider deletion of the Test site information carefully. ONCE DELETED, IT CANNOT BE RECALLED.

After you have performed this task, you will be automatically returned to the DELETE MENU.

DELETE MENU Option 0 - Exit to ADD/MODIFY/DELETE Menu. This option returns you to the ADD/MODIFY/DELETE menu.

MAIN MENU Option 2 — Data Base-Related Reports {A4}

When you select this option, the REPORT MENU {A5} will appear. To generate a report, select it from the menu and respond to the prompts. Many of the reports are displayed to the printer only, so make sure that your printer is on and loaded with paper. If you did not already configure CP Diagnostic for your printer by entering the printer control strings on the System Utility screen, be sure to do so before attempting to generate any reports. The reports that can be generated are explained below.

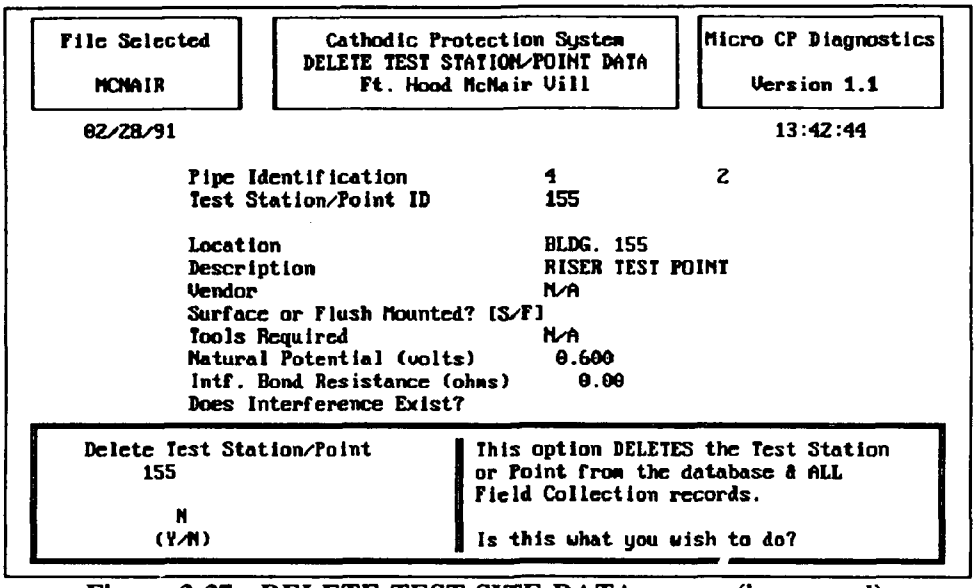

Figure 3-37. DELETE TEST SITE DATA screen (impressed).

REPORT MENU Option 1 - Field Collection Forms {D1}

This report prints a series of field data collection forms that can be used by the field inspector. A data collection form lists all test sites associated with a structure, and contains a description of each test site. The forms also list each rectifier with its associated junction boxes. The forms can be used to collect pipe-to-soil potentials at the test sites, anode current outputs at the junction boxes, and rectifier readings. Data may then be entered into Impressed Current CP Diagnostic from the data collection forms. To generate the report, select it from the menu. The inspection forms will begin printing as soon as the option is selected from the menu. After the report has printed, you will be returned to the REPORT MENU.

REPORT MENU Option 2 - Trouble Readings Report {D2}

This report identifies all test sites with readings that do not meet the selected criterion for proper cathodic protection. To generate the report, select it from the menu and enter the earliest date that you wish the readings to be analyzed at the prompt. Select the criterion that you wish to use from the CP CRITERION MENU (Figure 3-38). The criterion should be selected with extreme care. See Chapter 1 for a detailed discussion and guidance on this subject. The report will begin printing as soon as you select the criterion. The report prints every reading taken after the specified date that does not meet the selected criterion.

REPORT MENU Option 3 - Structure Listing {D3}

This report provides a listing of all structures in the data base. It gives the structure ID and location. It is useful as a concise description of the overall structure inventory. To generate the report, select it from the menu. You will be presented with a screen that asks whether you wish to send the report to the [S]creen, [P]rinter, or [Q]uit. Press the first letter of the option you wish to select. Printer [P] is the default option and may be selected by pressing <Enter>. If you choose to display the report on the screen, press the <Cntl> and <S> keys to stop or start the scrolling of the data that is being displayed. Press any key after the report has been displayed on the screen to return to the REPORT MENU. If you select [Q]uit, you will be returned to the REPORT MENU and the report will not be generated.

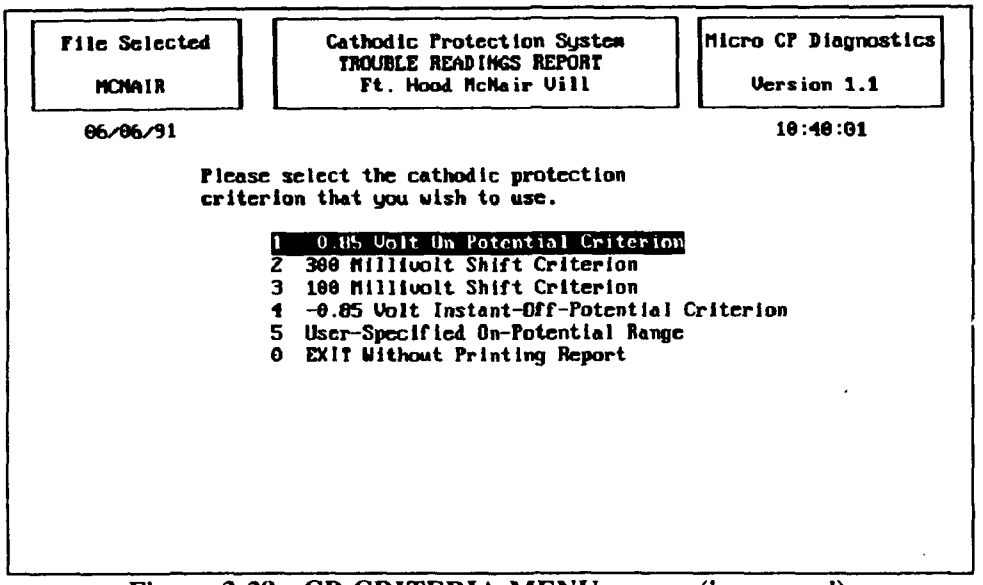

Figure 3-38. CP CRITERIA MENU screen (impressed).

REPORT MENU Option 4 - Structure Master Listing {D4}

This report displays the background information for each structure recorded in the data base, providing a more detailed description of the structures than the Structure Listing (Report 3). To generate this report, select it from the menu and respond to the [S]creen, [P]rinter, or [Q]uit prompt as described above for the Structure Listing report. If you choose to display the report on the screen, press the <Cntl> and <S> keys to stop or start the scrolling of the data that is being displayed. Press any key after the report has been displayed on the screen to return to the REPORT MENU. If you select [Q]uit, you will be returned to the REPORT MENU, and the report will not be generated.

REPORT MENU Option 5 - Field Collection Report {D5}

This report gives a complete listing of all field data (arranged by test point) collected at all test sites during a user-specified time period. The listing includes dates, potentials, and dielectric status for each test point. To generate the report, select it from the menu, and it will begin printing immediately. After the report is printed, you will be returned to the REPORT MENU screen.

REPORT MENU Option 6 - System History Report {D6}

This report lists dates and descriptions of repairs that were performed and dates and locations that field measurements were taken for all structures throughout the life of the system. The listing is in chronological order. To generate the report, select it from the menu and it will begin printing immediately. After the report is printed, you will automatically be returned to the REPORT MENU screen.

REPORT MENU Option 7 - Test Sites Not Collected Report {D7}

This report prints the identifiers of all test sites from which field data has not been collected over a specified range of time. To generate the report, select it from the menu and enter the desired range of dates at the prompt. To keep the default (current) date, simply press <Enter>. Respond to the [S]creen,

[P]rinter, or [Q]uit option as discussed above. You will be returned to the REPORT MENU after the report is printed.

REPORT MENU Option 8 - Repair History Report {D8}

This report prints the contents of the repair database including repair date, failure type, repair length, and cost of repair. The repairs are listed by year, and annual repair costs are totalled. This report can be printed for structure or for all structures in the database. To generate the report, select it from the menu. At the prompt, enter a structure ID if you wish to print the report for one structure only, or enter "ALL" if you wish to print the report for all structures in the database. Press <Enter> after you type your selection, and the report will be printed. You will be returned to the REPORT MENU after the report is printed.

REPORT MENU Option 9 - Anode Current Output Drop Report {D9}

This report identifies the rectifier, junction box, and anode current output for any anode current terminal that has experienced a drop in the anode current output over time. A significant drop in anode current output is defined to be a drop of at least 10 percent between any two readings (they need not be consecutive) or a drop of any amount over three consecutive readings (that is, two consecutive drops of any amount). To generate this report, select it from the menu and enter the earliest and latest reading dates that you wish the report to consider. The report will print immediately after you enter the dates, and you will be returned to the REPORT MENU after the report is printed.

REPORT MENU Option 10 - Rectifier Master Listing {D10}

This report prints the background information for each rectifier recorded in the data base.

REPORT MENU Option 11 - Rectifier History Report {D11}

This report prints all field collection data recorded for each rectifier. The user may specify a range of dates for the report. The report provides only field measurements collected during the requested range of dates.

REPORT MENU Option 0 - Return to Main Menu

This option returns you to the Main Menu screen of Impressed Current CP Diagnostic.

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APPENDIX A: Sample Implementation Specification for Sacrificial CP Diagnostic

OVERVIEW

This Appendix contains an example of a scope of work that may be used by an Army installation wishing to utilize a contractor for the implementation of Sacrificial CP Diagnostic. Words that are in **[bold print and brackets]** indicate site specific data to be inserted by the installation. This Appendix is only intended to be a guide for the technical content of the scope of work. Each installation may wish to add, change, or delete sections or use a different format depending upon its typical contracting procedures.

Maps are referred to throughout the specification. These maps are to be supplied by each installation as an attachment and are not included in this publication.

The remainder of Appendix B contains the complete sample implementation specification.

SPECIAL NOTE: The Army Technical Manual referred to in Paragraph 1.1.4 of the specification was in publication and had not been released at the time that this manual was written. Until it is released, references to it should be deleted from this specification. Such references will appear in {brackets}. When it is released, insert the number in place of the question marks given in each bracketed reference.

SCOPE OF WORK

IMPLEMENTATION OF SACRIFICIAL CP DIAGNOSTIC AT [INSTALLATION'S NAME]

1.0 GENERAL

1.1 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1.1.1 U.S. Army Construction Engineering Research Laboratory (USACERL)

USACERL ADP Report M-91/24	Cathodic Protection Diagnostic Computer Program for Sacrificial and Impressed Current Systems: Overview and User's Manual

1.1.2 Headquarters, Department of the Air Force

Air Force Manual AFM 85-5 9 February 1982	Maintenance and Operation of Cathodic Protection Systems

1.1.3 National Association of Corrosion Engineers

NACE Standard RP-01-69 January 1983 revision	Recommended Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE Standard RP-02-85 March 1985	Recommended Practice, Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems

{1.1.4 Headquarters, Department of the Army}

{Technical Manual TM 5-??? (This document had not yet been released when this manual was published)}	{Operation and Maintenance of Cathodic Protection Systems}

1.2 SYNOPSIS OF WORK

The Contractor shall furnish all materials and perform all services required to implement the Sacrificial Cathodic Protection (CP) Diagnostic computer program as set forth in these detailed specifications for **[installation's name]**. Approximately **[insert number]** linear feet of underground piping and **[insert number]** underground storage tanks are to be included. These structures are shown on the maps in Appendix III of this specification. CP Diagnostic maintains background information and field test data about cathodic protection systems and the structures that they protect and generates reports that assist in pinpointing system malfunctions. Work shall be accomplished in accordance with the publications cited in section 1.1, except as modified elsewhere in these specifications. The following items of work, explained more fully in Sections 2.0 through 6.0, are included:

1.2.1 Inventory and Initial Field Testing: Establish an identification system for the specified underground pipes, underground storage tanks, and test sites as directed in the CP Diagnostic User Manual. Furnish reproducible mylar maps showing the pipe network, tanks, and test sites with all of the identification numbers clearly marked. Collect and record all of the required background data for each structure and test site, initial structure-to-soil potentials, initial anode current outputs, and dielectric conditions as explained under Section 2.0, Inventory.

1.2.2 Data Entry: Enter all data into the CP Diagnostic program and provide a complete database and an error-free run.

1.2.3 Generation of Reports: Furnish computer printouts of the reports specified in Section 4.0. These reports show the information input into the data base and pinpoint possible problems in the cathodic protection system. Include these the final report, along with a discussion of the results. Provide recommendations where applicable.

1.2.4 Training: Provide training to DEH personnel on the CP Diagnostic system set-up and use.

1.2.5 Preparation of Final Report: A final report as discussed in Section 6.0 shall be prepared with a formal narrative section describing the work and method of accomplishment. All data and program-generated reports shall also be included. The final report shall be presented to the DEH at an exit briefing.

1.3 PROJECT MANAGEMENT

1.3.1 Project Supervisor: The supervisor shall serve as a single point of contact and liaison for all work required under this Contract. Upon award of the Contract, this individual and an alternate shall be immediately designated in writing by the Contractor. These designated individuals shall be approved by the Government Project Engineer. One of these individuals shall be available at the installation whenever the Contractor is performing work under this Contract.

1.3.2 Installation Assistance: A duly authorized representative from within the Directorate of Engineering and Housing will serve as the point of contact for obtaining available information and assisting in establishing contacts with the proper individuals and organizations, as necessary, in the accomplishment of the work required under this Contract.

1.3.3 Public Disclosures: The Contractor shall make no public announcements or disclosures relative to information contained or developed in this Contract, except as authorized by the Contracting Office.

1.3.4 Conferences: Conferences shall be scheduled as shown on the Implementation Schedule based on work status or whenever requested by the Contractor or Government Project Engineer for the resolution of questions or problems encountered in the performance of the work. The Contractor shall be required to attend and participate in all conferences pertinent to the work as directed by the Contracting Officer.

1.3.5 Qualifications of Personnel: Field inspections shall be performed by technically trained personnel under the direct supervision of a National Association of Corrosion Engineers (NACE)-accredited Cathodic Protection Specialist OR a NACE-accredited Corrosion Specialist with a specialty area of Cathodic Protection. All data and the final report shall be, at a minimum, reviewed and signed by a NACE-accredited Cathodic Protection Specialist OR NACE-accredited Corrosion Specialist with a specialty area of Cathodic Protection.

1.3.6 Scheduling: At the beginning of the contract period, the Contractor shall submit an implementation schedule using the format shown in Appendix II of this specification for approval by the Government Project Engineer. Detailed schedules for field work will be coordinated through the Government Project Engineer each week. In-progress reviews should be scheduled as follows:

- At the completion of establishing the structure and test site identification in the office and prior to proceeding with any field work.
- At the completion of the field survey data input.
- At the final exit briefing during the presentation to the DEH of the complete CP Diagnostic system.

Incremental Contractor checked data shall be furnished to the government as required by the Government Project Engineer for review and concurrence.

1.4 PAYMENT

1.4.1 Overhead, Supervision, Site Visits and Inspection: All overhead, supervision, travel costs, and other expenses to be incurred by the Contractor, directly or indirectly, including costs of the site visits throughout the work, shall be included in the proposal under the work items described. These costs shall not be considered separately.

1.4.2 Monthly Payment, Less Deductions: The Contractor shall be paid, upon the submission of proper invoices or vouchers, the prices stipulated in the proposed schedule rendered and accepted, less deductions, if any, as herein provided. Unless otherwise specified, payment will be on performance accepted by the U. S. Government when the amount due on such performance so warrants. Payment may be requested not more than once each month.

1.4.3 10 Percent Retention: In making such payments, the U.S. Government may, at its option, retain 10 percent of the estimated amount until final completion and acceptance of the Contract work. However, if the U.S. Government, at any time after 50 percent of the work has been completed, finds that satisfactory work is being performed, it may authorize any of the remaining payments to be made in full. When the work is substantially complete, if the Government considers the amount to be retained in excess of the amount adequate for the protection of the U.S. Government, the Government may, at its discretion, release to the Contractor all or a portion of such excess amount.

1.4.4 Final Payment on Release: Upon completion and acceptance of all work, the amount due the Contractor under this Contract is dependent upon the presentation of a properly executed voucher after

the Contractor has furnished the U.S. Government with a release, if required, of all claims against the U.S. Government arising by virtue of this Contract, other than claims in stated amounts as may be specifically expected by the Contractor from the operation of the release. If the Contractor's claim to amounts payable under this Contract has been assigned under the Assignment of Claims Act of 1940, as amended (31 U.S.C. 203, 41 U.S.C. 15), a release may also be required of the assignee.

1.5 SAFETY

The Contractor shall conduct operations in a safe manner at all times. Safety provisions shall be consistent with the Army Corps of Engineers Safety Manual. The Contractor's operation shall not cause a potential safety hazard to occupants of the area, Contractor's and U.S. Government personnel, and U.S. Government property.

1.6 CONTRACTOR & INSTALLATION WORK HOURS

The normal hours of operation at the installation will be between **[insert hours]** Monday through Friday except on the following Federal holidays:

New Years Day	President's Day
Memorial Day	4th of July
Labor Day	Veterans Day
Thanksgiving	Christmas
Martin Luther King Day	Columbus Day

Field work in Family Housing areas shall be conducted during the hours of **[insert hours]**. Other site conditions or security requirements may necessitate that the required field work be performed outside of the normal hours of operation.

1.7 ACCESS TO RESTRICTED AREAS

The list of structures and test sites which are in restricted areas, and the procedure to obtain access to these areas is as follows: **[insert list of structures/ test sites and access procedures]**

1.8 CONTRACT DURATION

The Contract completion date shall be **[insert number]** calendar days after the Notice to Proceed has been received by the Contractor.

1.9 POINTS OF CONTACT

1.9.1 Directorate of Engineering and Housing Point of Contact: **[list name(s) here]**

[INSERT OTHER ORGANIZATIONS AND POINTS OF CONTACT HERE AS APPLICABLE]

2.0 INVENTORY AND INITIAL FIELD TESTING

2.1 GENERAL

A complete description of the inventory and field test data requirements for CP Diagnostic is given in the USACERL report "Cathodic Protection Diagnostic Computer Program for Sacrificial and Impressed Current Systems: Overview and User's Manual." This publication will be referred to as the CP Diagnostic User's Manual throughout the remainder of this specification. The Contractor shall utilize installation drawings and records, perform field surveys, conduct interviews with DEH personnel, and assemble other information as necessary to gather the required data. The Contractor shall make a reasonable effort to obtain 100 percent of the required data. If any part of the required data cannot be collected, the Contractor shall submit in writing a complete list of the unavailable data, along with a reason for its unavailability. The reason must be approved by the Contracting Officer before the database will be accepted as "error-free" as discussed in Section 3.0. A complete listing and explanation of unavailable data shall also be given in the final report. The Contractor shall copy blank forms from the CP Diagnostic User's Manual or other reference as necessary to perform work and submit with the final report as specified by this Contract.

2.2 DEFINITION AND IDENTIFICATION OF PROTECTED STRUCTURES

The Contractor shall define and set up an identification system for the network of protected structures as described in the CP Diagnostic User Manual. This shall be done in coordination with and shall be subject to approval by the DEH point of contact given in section 1.9. For an underground piping system, this procedure involves dividing the system into a series of pipe sections, each with its own unique identification number. For a system of underground storage tanks, each tank will be assigned its own unique identification number. These structures shall be clearly identified on the reproducible maps described in 1.2.1.

2.3 COLLECTION OF STRUCTURE BACKGROUND DATA

The Contractor shall collect a complete set of background data as described in the CP Diagnostic User's Manual for each structure (i.e., pipe section or tank) identified under paragraph 2.2. This information shall be collected on the Pipe Section Background Data Sheet and/or the Underground Tank Background Data Sheet provided in the CP Diagnostic User's Manual or a reasonable facsimile thereof. One form shall be completed for each structure. It is the Contractor's responsibility to reproduce the forms in sufficient quantities to collect data for the entire system. The following information is required for each pipe section:

- Location from
- Location to
- Date installed
- Date CP activated
- CP installer
- Coating type
- Locations of isolation joints
- Coating quality (ohms)
- Coating efficiency (%)
- Soil resistivity (ohm-cm)
- Section length (ft)
- Section diameter (in)
- Required current density (mA/sq ft)

The following information is required for each underground storage tank:

- Tank type
- Location
- Date tank installed
- Tank material
- Tank contents
- Date CP activated
- CP installer
- Locations of isolation joints
- Coating type
- Coating quality (ohms)
- Coating efficiency (%)
- Soil resistivity (ohm-cm)
- Tank length (ft)
- Tank diameter (ft)
- Required current density (mA/sq ft)

2.4 DEFINITION OF CATHODIC PROTECTION SYSTEM

The cathodic protection system itself is defined as a series of "test sites" with their associated anodes or anode beds. A "test site" may either be a test station or any other test point at which potential or current measurements are taken, such as a riser or a valve. Each test site is associated with a particular structure. The Contractor shall define and set up an identification system for the test sites as described in the CP Diagnostic User's Manual. This shall be done in coordination with and shall be subject to approval by the DEH point of contact given in paragraph 1.9.

2.5 COLLECTION OF TEST SITE BACKGROUND DATA

The Contractor shall collect a complete set of background data as described in the CP Diagnostic User's Manual for each test site identified under paragraph 2.4. This information shall be collected on the Test Site Background Data Sheet provided in the CP Diagnostic User Manual or a reasonable facsimile thereof. One form shall be completed for each test site. It is the Contractor's responsibility to reproduce the forms in sufficient quantities to collect data for the entire system. The following background information is required for each test site:

- Structure ID
- Location
- Description
- Vendor
- Surface or flush mounted
- Tools required
- Natural potential (volts)
- Interference bond resistance (ohms)
- Does interference exist?
- Shunt resistor value (ohms)
- Number of wires
- Comments

2.6 COLLECTION OF TEST SITE POTENTIAL MEASUREMENTS

For each potential measurement point of each test site identified in 2.4, the Contractor shall assign an identifier (such as wire color) and shall collect the following information:

- Measurement point identifier
- Function of measurement point
- "Connected" potential (volts)
- "Disconnected" potential (volts)

If initial potentials (those that were taken when the CP system was installed) are available, they shall also be recorded on the data sheets.

Potentials shall be measured using the procedures in AFM 85-5 {and/or Army TM 5-???}. All of the collected information shall be recorded on the Test Site Background Data Sheets that were prepared under paragraph 2.5.

2.7 COLLECTION OF DIELECTRIC CONDITION DATA

The Contractor shall determine the condition (i.e., good, shorted, etc.) of each dielectric fitting and shall record this information.

2.8 COLLECTION OF ANODE BACKGROUND DATA

The Contractor shall collect a complete set of background data as described in the CP Diagnostic User's Manual for the anodes associated with each of the test sites identified under 2.4. This information shall be recorded in Part II of the Test Site Background Data Sheets prepared under paragraph 2.5. The following information is required:

- Anode type
- Anode material
- Anode diameter (in)
- Anode length (in)
- Anode weight (lbs)
- Number of anodes
- Number of anode current output terminals
- Design life (yrs)
- Anode spacing (ft)
- Structure to anode distance (ft)
- Structure to anode direction
- Cable gauge
- Cable insulation type

2.9 COLLECTION OF INITIAL ANODE CURRENT OUTPUTS

For each anode current output terminal of each test site identified in 2.4, the Contractor shall measure the anode current output in amperes. The measurements shall be recorded in Part II of the Test Site Background Data Sheets that were prepared under paragraph 2.5. If initial currents (those that were taken when the CP system was installed) are available, they shall also be recorded on the data sheets. Currents shall be measured using the procedures in AFM 85-5 {and/or Army TM 5-???}.

3.0 DATA ENTRY

3.1 GENERAL

The Contractor shall code for entry into CP Diagnostic all verified data collected from installation drawings and records, field surveys, interviews, or other sources. Coding for the computer shall be in accordance with the CP Diagnostic User's Manual. The result shall be a complete, error-free database.

3.2 DATA ENTRY

The Contractor shall enter data into the database on a Government-owned microcomputer. The Government shall provide a copy of the CP Diagnostic program for the Contractor's use. The Contractor shall ensure and verify that the data stored in the database corresponds with the field data. Care shall be taken to ensure that data input into the database follows a sequence that avoids duplication or omissions and provides as a finished product an error free, complete database ready for CP Diagnostic operations.

3.3 INITIAL DATA CHECKING

The structure and test site identification information shall be entered, checked, corrected by the Contractor, and approved by the Government's Contracting Representative before other data is input into the program. This information must correspond to the reproducible drawings covered in Paragraph 1.2.1.

3.4 DATA CHECKING

When the structure and test site information is approved and the remainder of the data has been entered, checked, and corrected by the Contractor, the Contractor shall produce one copy of the data stored in the computer for review by the Government. Any input errors discovered through the review of this "data dump" will be changed by the Contractor within a 2-week period after the review.

3.5 FINAL DATA CHECKING

If 5 percent or more of the data requires changes, a second "data dump" and review will be required. The Contractor will respond to changes of the second data dump within a 1-week period. Review and correction will continue in this same fashion until the data base is error free.

4.0 GENERATION AND INTERPRETATION OF REPORTS

4.1 STRUCTURE MASTER LISTING

The Contractor shall generate a complete Structure Master Listing report for the entire final (error-free) CP Diagnostic database for **[installation's name]**. This report displays background information for each structure in the database and shall be submitted as part of the final report.

4.2 STRUCTURE LISTING

The Contractor shall generate a complete Structure Listing report for the entire final (error-free) CP Diagnostic database for **[installation's name]**. This report gives a concise listing (ID and location) for all of the structures in the database and shall be submitted as part of the final report.

4.3 TROUBLE READINGS REPORT

The Contractor shall generate a complete Trouble Readings report for the entire final (error-free) CP Diagnostic database for **[installation's name]**. This report identifies all test sites at which the measurements do not meet the selected criteria of cathodic protection. Selection of the criteria to be used shall be made in conjunction with the DEH and a NACE-certified Corrosion Specialist. Based upon the results of the Trouble Readings report, the contractor shall identify locations in the system where problems exist and further investigation is warranted. This shall be documented in the final report. Guidance for the selection of criteria and the interpretation of data can be found in AFM 85-5, {Army TM 5-???,} NACE RP-01-69, and NACE RP-02-85.

5.0 TRAINING

5.1 CLASSROOM INSTRUCTION

The Contractor will provide a minimum of **[insert number]** hours of training in the use of the CP Diagnostic System to employees of the DEH during the Contract. This orientation and training will include, but is not to limited to, the following:

- Computer and program start-up
- Definition of structures and test sites
- Field data collection (i.e., structure-to-soil potentials, anode current outputs, and dielectric conditions)
- Data entry and editing
- Report generation
- Interpretation of reports
- Use of the reports to identify problems with the CP system
- Backing up the data base
- Exiting the program.

5.2 SCHEDULING

A training schedule will be coordinated with and submitted to the DEH for approval a minimum of 15 working days prior to the training. The Contractor will contact the DEH representative directly to reserve conference rooms and training areas and to check the availability of audio/visual equipment, computer terminals, and other equipment or facilities necessary for the training. Equipment (e.g., audio/ visual equipment, computer terminals, etc.) that is necessary for the training but is not available from the DEH shall be furnished by the Contractor.

5.3 LIST OF ATTENDEES

The Contractor shall include, in the final report, a list of DEH personnel including name, title, office symbol, and telephone number that were trained under this contract.

6.0 FINAL REPORT

6.1 REPORT FORMAT

Formal reports and tabular data shall be typed or computer-printed (at least near letter quality) on 8-1/2 x 11-in. bond paper with foldouts for maps, sketches, schematics, charts, graphs and other illustrative material, as may be necessary. Data which cannot be clearly described in narrative form shall be shown graphically.

6.2 REPORT BINDING

Formal documents shall be securely bound with a durable cover. The title of the document shall appear on the cover of all submittal documents. Final documents shall be bound in a manner which will facilitate repeated disassembly and reassembly, unless otherwise specified herein.

6.3 NETWORK DRAWINGS

Site maps showing the locations of the protected structures and the test sites shall be reproducible mylar drawings. The drawings shall provide easy identification of the pipe sections, tanks, and test sites.

6.4 REPORT SUBMITTAL

[Insert number] preliminary (draft) copies of the final report shall be submitted to the Government for approval. Following the return of comments, the Contracting Officer will schedule a meeting for their discussion if necessary. The Contractor shall furnish written notification of intended action on each comment within one week after this meeting. Intention of noncompliance with any comment shall be substantiated in detail. Authorization to proceed with final submittal will be granted in writing with or after the Contracting Officer's approval of the contractor's intended actions on the review comments. **[Insert number]** copies of the final report will be submitted.

6.5 ORGANIZATION OF REPORT

Narrative contents shall be arranged in a logical sequence and organized by sections. Reproducible transparencies, drawings, and/or maps shall be submitted separately. The report shall fully document the implementation process, the data collected, and the results achieved. The report shall include, but is not limited to, the following items:

6.5.1 A formal narrative section describing the work that was done, how it was accomplished, and when it was accomplished. The narrative shall include a brief description of each of the following portions of this report.

6.5.2 The CP Diagnostic reports specified in Section 4 shall be generated from the completed data base and submitted as part of the final report.

6.5.3 Based upon the results of the above reports, the contractor shall note areas of the system in which further investigation is warranted to pinpoint problems in the CP system. The contractor shall make recommendations as to the nature, extent, and approximate "ballpark" cost of these investigations.

6.5.4 A list of DEH personnel including name, title, office symbol, and telephone number that were trained by the Contractor under the Contract.

6.5.5 An Appendix containing copies of all of the data collection forms that were completed under Section 2, Inventory. These shall be arranged in an organized, logical sequence.

6.5.6 All maps and drawings necessary to identify the CP system and protected structures, including two copies of the mylar maps.

6.5.7 A backup copy of the complete, error-free CP Diagnostic database on 5-1/4 in. floppy disks.

6.6 EXIT BRIEFING

Upon completion of the work, an exit briefing will be given to the DEH. The final report shall be presented to the DEH at this briefing. The briefing shall cover the scope of work, accomplishments, findings, problems, conclusions, and identification of problem areas in the CP system.

CONTRACT SPECIFICATION APPENDIX I

LIST OF GOVERNMENT FURNISHED MATERIALS AND INFORMATION

The Government shall furnish the following items at the time the Notice to Proceed is issued; however, all will be returned to the Government at the end of the project:

- Area site plan maps (1 set)
- Supplemental area maps (1 set)
- Drawings of the cathodically protected structures (1 set)
- Drawings or other description of the cathodic protection system. If drawings showing the cathodic protection system do not exist, other descriptive material shall be provided as available.
- Other existing background or historical information (as available) that cannot be readily measured in the field by the Contractor and is required under Section 2.0, Inventory.
- CP Diagnostic computer program
- USACERL ADP Report "Cathodic Protection Diagnostic Computer Program for Sacrificial and Impressed Current Systems: Overview and User's Manual."

CONTRACT SPECIFICATION APPENDIX II

IMPLEMENTATION SCHEDULE

ITEM NUMBER

1. Mylar Maps . . . . . .
2. Structure and System Identification . . . . . .
3. Background and Field Data Collection . . . . . .
4. Data Entry . . . . . .
5. Report Generation and Interpretation . . . . . .
6. Training . . . . . .
7. Final Report and Briefing . . . . . .

0 20 40 60 80 100 120 140 160 180 200

Calendar Days from Contractor's Notice to Proceed

[INSTALLATION MAPS SHOULD BE ATTACHED AS APPENDIX III. ANY OTHER ATTACHMENTS SUCH AS PRICE/COST SCHEDULES SHOULD BE INCLUDED IN ADDITIONAL APPENDICES]

APPENDIX B: Background Data Collection Forms for Sacrificial CP Diagnostic

PIPE SECTION BACKGROUND DATA SHEET (SACRIFICIAL)

The numbers in brackets [ ] represent the maximum number of characters to be entered in the field.

Pipe ID [10] _____

Section ID [4] _____

Location From [20] _____

Location To [20] _____

Date Pipe Installed (MM/DD/YY) _____ / _____ / _____

Date CP Activated (MM/DD/YY) _____ / _____ / _____

CP Installer [20] _____

Coating Type [15] _____

Coating Quality (ohms) _ _ _ _ _

Coating Efficiency (%) _ _ _ . _ _

Soil Resistivity (ohm-cm) _ _ _ _ _ . _ _

Section Length (ft) _ _ _ _ . _ _

Section Diameter (in) _ _ . _ _

Required Current Density (mA/ sq. ft.) _ _ . _ _

Do Isolation Joints Exist? Y N (circle one) If Yes, fill out the following table. If you need more space, continue underneath the table or on the back.

NO.	LOCATION [20]	NO.	LOCATION [20]
1		8	
2		9	
3		10	
4		11	
5		12	
6		13	
7		14	

UNDERGROUND TANK BACKGROUND DATA SHEET (SACRIFICIAL)

The numbers in brackets [ ] represent the maximum number of characters to be entered in the field.

Tank ID [10] _____

Tank Type [15] _____

Location [20] _____

Date Tank Installed (MM/DD/YY) ____ / ____ / ____

Tank Material [20] _____

Tank Contents [20] _____

Date CP Activated (MM/DD/YY) ____ / ____ / ____

CP Installer [20] _____

Coating Type [15] _____

Coating Quality (ohms) _____

Coating Efficiency (%) ____.__

Soil Resistivity (ohm-cm) _____

Tank Length (ft) ____.__

Tank Diameter (ft) __.__

Required Current Density (mA/ sq. ft.) ____.__

Do Isolation Joints Exist? Y N (circle one) If Yes, fill out the following table:
If you need more space, continue underneath the table or on the back.

NO.	LOCATION [20]	NO.	LOCATION [20]
1		7	
2		8	
3		9	
4		10	
5		11	
6		12	

TEST SITE BACKGROUND DATA SHEET

The numbers in brackets [ ] represent the maximum number of characters to be entered in the field.

Part I: Test Site Information and Initial Potentials

Pipe ID [10] _____ Section ID [4] _____
OR Tank ID [10] _____

Test Site ID [8] _____

Location [30] _____

Description [30] _____

Vendor [30] _____

Surface or Flush Mounted? S F Tools Required [20] _____
Natural Potential (V) __ __ . __ __ __ Intf. Bond Resistance (ohms) __ __ __ __ . __ __

Does interference exist? Y N Shunt Resistor Value (ohms) __ . __ __ __ __

Number of Wires __ __ __ (should be the same as the number of entries in the Initial Potentials table below)

Comment 1 [30] _____
Comment 2 [30] _____

POTENTIALS (VOLTS)

NO.	IDENTIFIER	FUNCTION	CONNECTED *	DISCONNECTED *	DIELECTRIC
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	

* Enter initial potentials in the left half of each block. These are potentials that were measured at CP system installation. Enter today's potentials in the right half of each block.

TEST SITE BACKGROUND DATA SHEET (cont'd)

Part II: Anode Bed Data and Initial Anode Current Outputs

Test Site ID [8] _____

Anode Type [20] _____

Anode Material [20] _____

Anode Diameter (inches) _____ Anode Length (inches) _____

Anode Weight (lbs.) _____

Number of: Anodes _____ Anode Current Output Terminals _____
(should be the same as the number of entries in the Anode Current table below)

Design Life (yrs.) _____ Anode Spacing (ft.) _____

Structure to Anode: Distance (ft.) _____ Direction [20] _____
Cable Gauge _____ Cable Insulation Type [10] _____

ANODE CURRENT OUTPUTS (AMPS)

If you need more space, continue underneath the table or on the back. *Initial* anode currents are those that were measured when the CP system was installed.

TERMINAL NUMBER	INITIAL ANODE CURRENT (A)	TODAY'S ANODE CURRENT (A)	TERMINAL NUMBER	INITIAL ANODE CURRENT (A)	TODAY'S ANODE CURRENT (A)
1			8		
2			9		
3			10		
4			11		
5			12		
6			13		
7			14		

TEST SITE BACKGROUND DATA SHEET (cont'd)

Part II: Anode Bed Data and Initial Anode Current Outputs

Test Site ID [8] _____

Anode Type [20] _____

Anode Material [20] _____

Anode Diameter (inches) _____ Anode Length (inches) _____

Anode Weight (lbs.) _____

Number of: Anodes _____ Anode Current Output Terminals _____
(should be the same as the number of entries in the Anode Current table below)

Design Life (yrs.) _____ Anode Spacing (ft.) _____

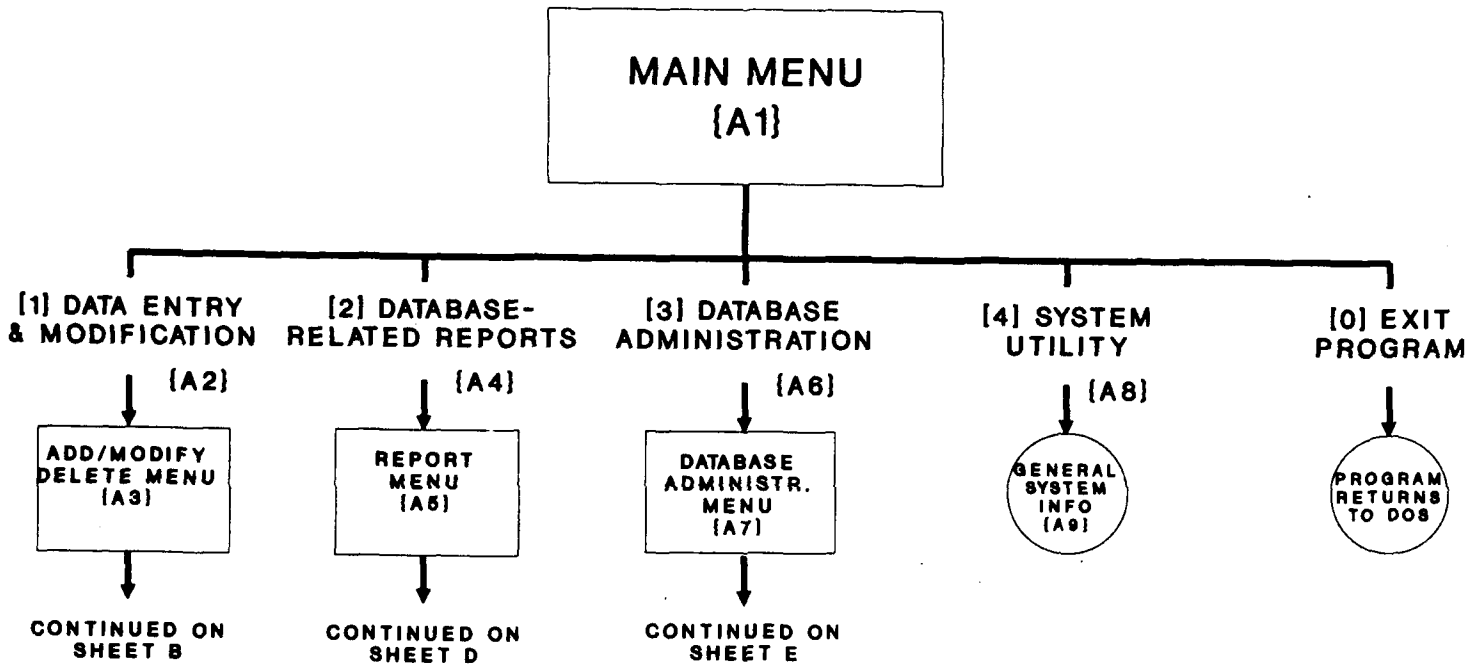
Structure to Anode: Distance (ft.) _____ Direction [20] _____
Cable Gauge _____ Cable Insulation Type [10] _____

ANODE CURRENT OUTPUTS (AMPS)

If you need more space, continue underneath the table or on the back. *Initial* anode currents are those that were measured when the CP system was installed.

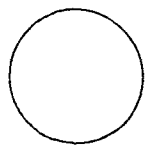
TERMINAL NUMBER	INITIAL ANODE CURRENT (A)	TODAY'S ANODE CURRENT (A)	TERMINAL NUMBER	INITIAL ANODE CURRENT (A)	TODAY'S ANODE CURRENT (A)
1			8		
2			9		
3			10		
4			11		
5			12		
6			13		
7			14		

SACRIFICIAL CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET A



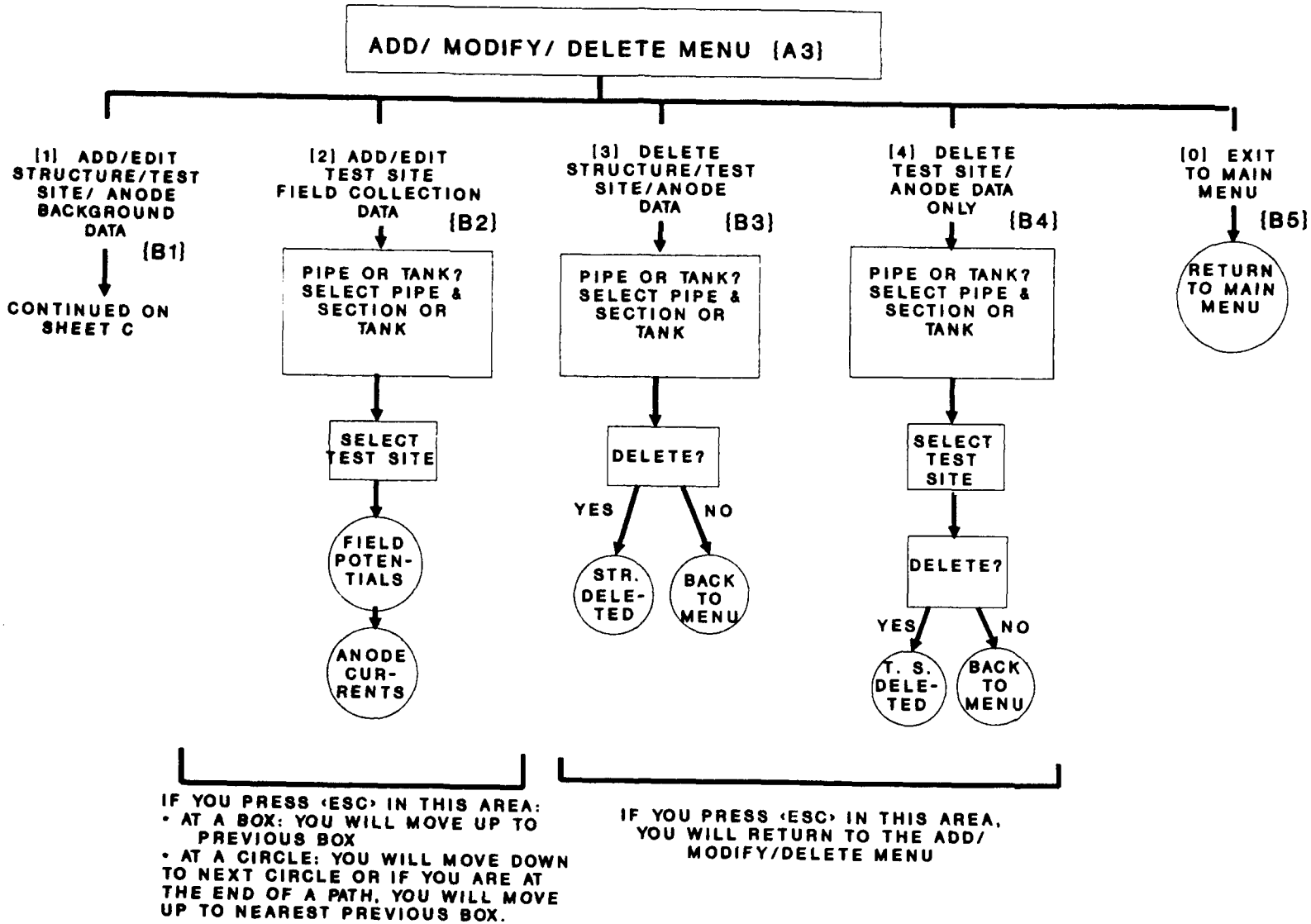
FLOW CHART CONVENTIONS

- DECISION



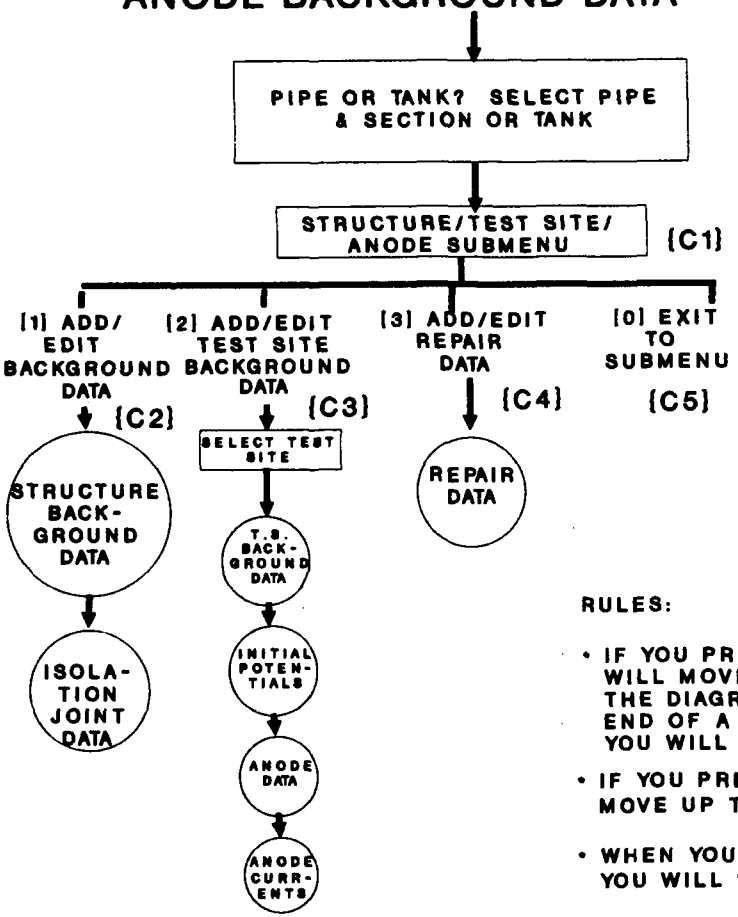
- DATA ENTRY SCREEN OR OTHER PROGRAM OPTION THAT DOES NOT INVOLVE A DECISION

SACRIFICIAL CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET B



SACRIFICIAL CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET C

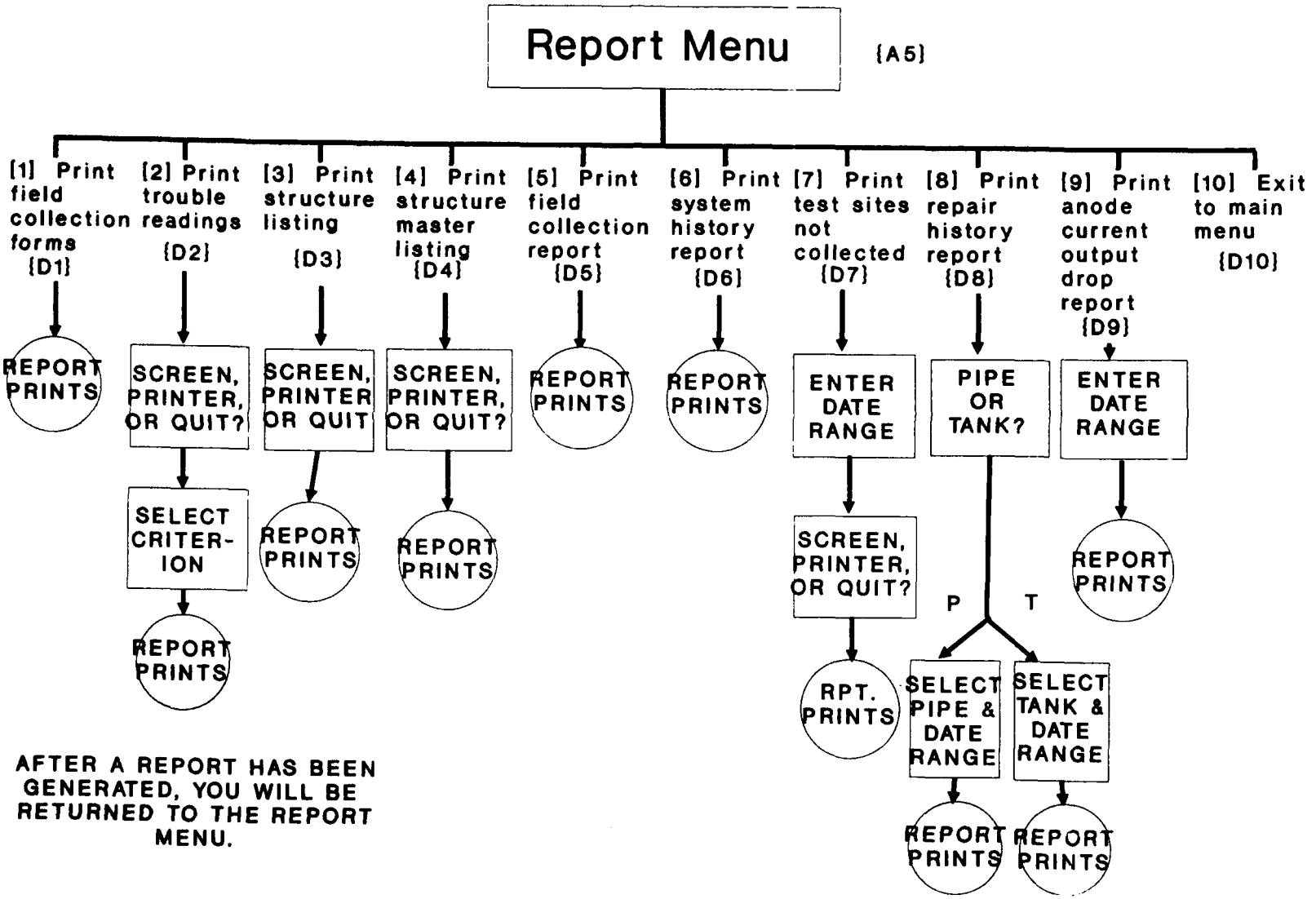
[1] ADD/EDIT STRUCTURE/ TEST SITE ANODE BACKGROUND DATA {B1}



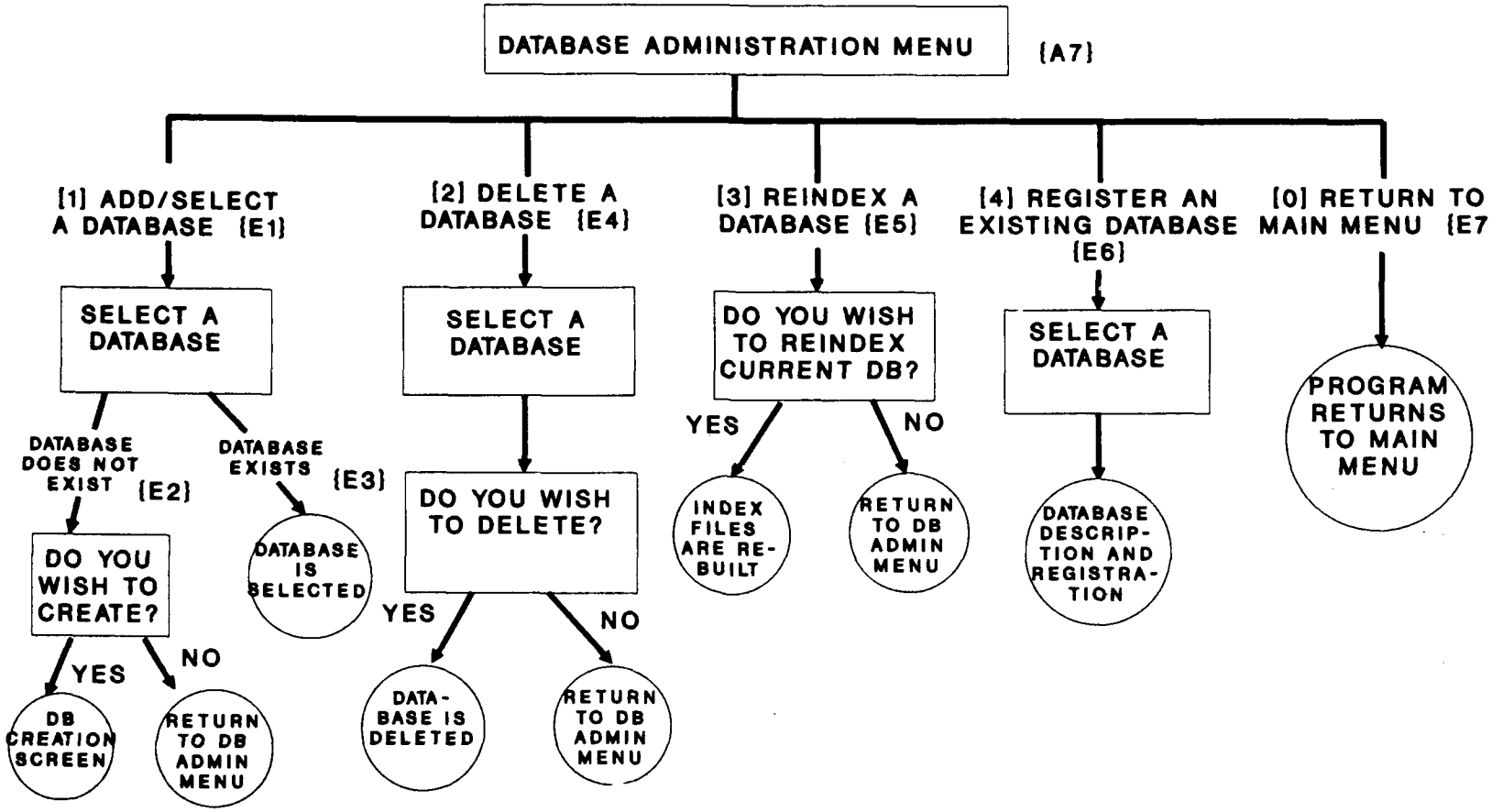
RULES:

- IF YOU PRESS ‹ESC› AT A CIRCLE, YOU WILL MOVE DOWN TO THE NEXT STEP IN THE DIAGRAM UNLESS YOU ARE AT THE END OF A PATH. AT THE END OF A PATH, YOU WILL MOVE UP TO THE NEAREST BOX.
- IF YOU PRESS ‹ESC› AT A BOX, YOU WILL \ MOVE UP TO THE NEAREST PREVIOUS BOX.
- WHEN YOU REACH THE END OF A PATH, YOU WILL MOVE UP TO THE NEAREST BOX.

SACRIFICIAL CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET D



SACRIFICIAL CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET E



RULE: IN DATABASE ADMINISTRATION, IF YOU HIT <ESC>, OR REACH THE END OF A PATH IN THE CHART, OR ANSWER "N" TO A Y/N PROMPT, YOU WILL BE RETURNED TO THE DATABASE ADMINISTRATION MENU.

APPENDIX D: Sample Implementation Specification for Impressed Current CP Diagnostic

OVERVIEW

This Appendix contains an example of a scope of work which may be used by an Army installation wishing to utilize a contractor for the implementation of Impressed Current CP Diagnostic. Words that are in **[bold print and brackets]** indicate site specific data to be inserted by the installation. This Appendix is only intended to be a guide for the technical content of the scope of work. Each installation may wish to add, change, or delete sections or use a different format depending upon its typical contracting procedures.

Maps are referred to throughout the specification. These maps are to be supplied by each installation as an attachment and are not included in this publication.

The remainder of Appendix D contains the complete sample implementation specification.

SPECIAL NOTE: The Army Technical Manual referred to in Paragraph 1.1.4 of the specification was in publication and had not been released at the time that this manual was written. Until it is released, references to it should be deleted from this specification. Such references will appear in {brackets}. When it is released, insert the number in place of the question marks given in each bracketed reference.

SCOPE OF WORK

IMPLEMENTATION OF IMPRESSED CURRENT CP DIAGNOSTIC AT [INSTALLATION'S NAME]

1.0 GENERAL

1.1 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1.1.1 U.S. Army Construction Engineering Research Laboratory (USACERL)

USACERL ADP Report M-91/24	Cathodic Protection Diagnostic Computer Program for Sacrificial and Impressed Current Systems: Overview and User's Manual

1.1.2 Headquarters, Department of the Air Force

Air Force Manual AFM 85-5 9 February 1982	Maintenance and Operation of Cathodic Protection Systems

1.1.3 National Association of Corrosion Engineers

NACE Standard RP-01-69 January 1983 revision	Recommended Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE Standard RP-02-85 March 1985	Recommended Practice, Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems

{1.1.4 Headquarters, Department of the Army}

{Technical Manual TM 5-??? (This document had not yet been released when this manual was published)}	{Operation and Maintenance of Cathodic Protection Systems}

1.2 SYNOPSIS OF WORK

The Contractor shall furnish all materials and perform all services required to implement the Impressed Current Cathodic Protection (CP) Diagnostic computer program as set forth in these detailed specifications for **[installation's name]**. Approximately **[insert number]** linear feet of underground piping, **[insert number]** underground storage tanks, and **[insert number]** water storage tanks are to be included. These structures are shown on the maps in Appendix III of this specification. CP Diagnostic maintains background information and field test data about cathodic protection systems and the structures that they protect and generates reports that assist in pinpointing system malfunctions. Work shall be accomplished in accordance with the publications cited in section 1.1, except as modified elsewhere in these specifications. The following items of work, explained more fully in Sections 2.0 through 6.0, are included:

1.2.1 Inventory and Initial Field Testing: Establish an identification system for the specified rectifiers, junction boxes, underground pipes, underground storage tanks, water storage tanks, and test sites as directed in the CP Diagnostic User Manual. Furnish reproducible mylar maps showing the rectifiers, junction boxes, pipe network, tanks, and test sites with all of the identification numbers clearly marked. Collect and record all of the required background data for each rectifier, junction box, anode bed, structure, and test site, initial structure-to-soil potentials, initial anode current outputs, and dielectric conditions as explained under Section 2.0, Inventory.

1.2.2 Data Entry: Enter all data into the CP Diagnostic program and provide a complete database and an error-free run.

1.2.3 Generation of Reports: Furnish computer printouts of the reports specified in Section 4.0. These reports show the information input into the data base and pinpoint possible problems in the cathodic protection system. Include these the final report, along with a discussion of the results. Provide recommendations where applicable.

1.2.4 Training: Provide training to DEH personnel on the CP Diagnostic system set-up and use.

1.2.5 Preparation of Final Report: A final report as discussed in Section 6.0 shall be prepared with a formal narrative section describing the work and method of accomplishment. All data and program-generated reports shall also be included. The final report shall be presented to the DEH at an exit briefing.

1.3 PROJECT MANAGEMENT

1.3.1 Project Supervisor: The supervisor shall serve as a single point of contact and liaison for all work required under this Contract. Upon award of the Contract, this individual and an alternate shall be immediately designated in writing by the Contractor. These designated individuals shall be approved by the Government Project Engineer. One of these individuals shall be available at the installation whenever the Contractor is performing work under this Contract.

1.3.2 Installation Assistance: A duly authorized representative from within the Directorate of Engineering and Housing will serve as the point of contact for obtaining available information and assisting in establishing contacts with the proper individuals and organizations, as necessary, in the accomplishment of the work required under this Contract.

1.3.3 Public Disclosures: The Contractor shall make no public announcements or disclosures relative to information contained or developed in this Contract, except as authorized by the Contracting Office.

1.3.4 Conferences: Conferences shall be scheduled as shown on the Implementation Schedule based on work status or whenever requested by the Contractor or Government Project Engineer for the resolution of questions or problems encountered in the performance of the work. The Contractor shall be required to attend and participate in all conferences pertinent to the work as directed by the Contracting Officer.

1.3.5 Qualifications of Personnel: Field inspections shall be performed by technically trained personnel under the direct supervision of a National Association of Corrosion Engineers (NACE)-accredited Cathodic Protection Specialist OR a NACE-accredited Corrosion Specialist with a specialty area of Cathodic Protection. All data and the final report shall be, at a minimum, reviewed and signed by a NACE-accredited Cathodic Protection Specialist OR NACE-accredited Corrosion Specialist with a specialty area of Cathodic Protection.

1.3.6 Scheduling: At the beginning of the contract period, the Contractor shall submit an implementation schedule using the format shown in Appendix II of this specification for approval by the Government Project Engineer. Detailed schedules for field work will be coordinated through the Government Project Engineer each week. In-progress reviews should be scheduled as follows:

- At the completion of establishing the rectifier, junction box, structure and test site identification in the office and prior to proceeding with any field work.
- At the completion of the field survey data input.
- At the final exit briefing during the presentation to the DEH of the complete CP Diagnostic system.

Incremental Contractor checked data shall be furnished to the government as required by the Government Project Engineer for review and concurrence.

1.4 PAYMENT

1.4.1 Overhead, Supervision, Site Visits and Inspection: All overhead, supervision, travel costs, and other expenses to be incurred by the Contractor, directly or indirectly, including costs of the site visits throughout the work, shall be included in the proposal under the work items described. These costs shall not be considered separately.

1.4.2 Monthly Payment, Less Deductions: The Contractor shall be paid, upon the submission of proper invoices or vouchers, the prices stipulated in the proposed schedule rendered and accepted, less deductions, if any, as herein provided. Unless otherwise specified, payment will be on performance accepted by the U.S. Government when the amount due on such performance so warrants. Payment may be requested not more than once each month.

1.4.3 10 Percent Retention: In making such payments, the U.S. Government may, at its option, retain 10 percent of the estimated amount until final completion and acceptance of the Contract work. However, if the U.S. Government, at any time after 50 percent of the work has been completed, finds that satisfactory work is being performed, it may authorize any of the remaining payments to be made in full. When the work is substantially complete, if the Government considers the amount to be retained in excess

excess of the amount adequate for the protection of the U.S. Government, the Government may, at its discretion, release to the Contractor all or a portion of such excess amount.

1.4.4 Final Payment on Release: Upon completion and acceptance of all work, the amount due the Contractor under this Contract is dependent upon the presentation of a properly executed voucher after the Contractor has furnished the U.S. Government with a release, if required, of all claims against the U.S. Government arising by virtue of this Contract, other than claims in stated amounts as may be specifically expected by the Contractor from the operation of the release. If the Contractor's claim to amounts payable under this Contract has been assigned under the Assignment of Claims Act of 1940, as amended (31 U.S.C. 203, 41 U.S.C. 15), a release may also be required of the assignee.

1.5 SAFETY

The Contractor shall conduct operations in a safe manner at all times. Safety provisions shall be consistent with the Army Corps of Engineers Safety Manual. The Contractor's operation shall not cause a potential safety hazard to occupants of the area, Contractor's and U.S. Government personnel, and U.S. Government property.

1.6 CONTRACTOR & INSTALLATION WORK HOURS

The normal hours of operation at the installation will be between **[insert hours]** Monday through Friday except on the following Federal holidays:

New Years Day	President's Day
Memorial Day	4th of July
Labor Day	Veterans Day
Thanksgiving	Christmas
Martin Luther King Day	Columbus Day.

Field work in Family Housing areas shall be conducted during the hours of **[insert hours]**. Other site conditions or security requirements may necessitate that the required field work be performed outside of the normal hours of operation.

1.7 ACCESS TO RESTRICTED AREAS

The list of structures and test sites which are in restricted areas, and the procedure to obtain access to these areas is as follows: **[insert list of structures/ test sites and access procedures]**

1.8 CONTRACT DURATION

The Contract completion date shall be **[insert number]** calendar days after the Notice to Proceed has been received by the Contractor.

1.9 POINTS OF CONTACT

1.9.1 Directorate of Engineering and Housing Point of Contact: **[list name(s) here]**

[INSERT OTHER ORGANIZATIONS AND POINTS OF CONTACT HERE AS APPLICABLE]

2.0 INVENTORY AND INITIAL FIELD TESTING

2.1 GENERAL

A complete description of the inventory and field test data requirements for CP Diagnostic is given in the USACERL report "Cathodic Protection Diagnostic Computer Program for Sacrificial and Impressed Current Systems: Overview and User's Manual." This publication will be referred to as the CP Diagnostic User's Manual throughout the remainder of this specification. The Contractor shall use installation drawings and records, perform field surveys, conduct interviews with DEH personnel, and assemble other information as necessary to gather the required data. The Contractor shall make a reasonable effort to obtain 100 percent of the required data. If any part of the required data cannot be collected, the Contractor shall submit in writing a complete list of the unavailable data, along with a reason for its unavailability. The reason must be approved by the Contracting Officer before the database will be accepted as "error-free" as discussed in Section 3.0. A complete listing and explanation of unavailable data shall also be given in the final report. The Contractor shall copy blank forms from the CP Diagnostic User's Manual or other reference as necessary to perform work and submit with the final report as specified by this Contract.

2.2 IDENTIFICATION OF RECTIFIERS

The Contractor shall define and set up an identification system for all of the rectifiers for which CP Diagnostic is to be implemented as described in the CP Diagnostic User's Manual. This shall be done in coordination with and shall be subject to approval by the DEH point of contact given in section 1.9. Each rectifier shall be assigned its own unique identification number. The rectifiers shall be clearly identified on the reproducible maps described in 1.2.1.

2.3 COLLECTION OF RECTIFIER BACKGROUND DATA

The Contractor shall collect a complete set of background data as described in the CP Diagnostic User's Manual for each rectifier identified under paragraph 2.2. This information shall be collected on the Rectifier Background Data Sheet provided in the CP Diagnostic User's Manual or a reasonable facsimile thereof. One form shall be completed for each rectifier. The following information is required for each rectifier:

- Location
- Rectifier type
- Rectifier manufacturer
- Rectifier model
- DC rated voltage
- DC rated current
- Reference electrode potential
- Number of fuses
- Fuse rating
- Number of circuits
- Operating mode
- Initial rheostat setting
- Initial automatic (set point).

For each circuit of the rectifier, the following information is required:

- Shunt value
- Tap setting: fine
- Tap setting: coarse
- Circuit resistance
- DC voltage
- DC current
- AC voltage
- AC current.

If initial rectifier readings (i.e., those taken when the CP system was installed) are available, they shall also be recorded on the data sheets.

2.4 IDENTIFICATION OF JUNCTION BOXES AND ANODE GROUND BEDS

The Contractor shall define and set up an identification system for all junction boxes associated with all of the rectifiers identified in paragraph 2.2 which protect underground structures. This shall be done as described in the CP Diagnostic User's Manual. This shall be done in coordination with and shall be subject to approval by the DEH point of contact given in section 1.9. Each junction box (with its associated ground bed) shall be assigned an identification number. The junction boxes shall be clearly identified on the reproducible maps described in 1.2.1.

2.5 COLLECTION OF JUNCTION BOX AND ANODE GROUND BED BACKGROUND DATA

The Contractor shall collect a complete set of background data for each junction box identified in paragraph 2.4 with its associated anode ground bed as described in the CP Diagnostic User's Manual. This information shall be collected on the Ground Bed Background Data Sheet provided in the CP Diagnostic User's Manual or a reasonable facsimile thereof. One form shall be completed for each junction box/ ground bed. The following information is required for each junction box/ anode ground bed:

- Anode type
- Anode material
- Anode diameter
- Anode length
- Anode weight
- Design life
- Maximum current density
- Number of anodes
- Number of anode current output terminals
- Anode spacing
- Structure-to-anode distance
- Structure-to-anode direction
- Cable gauge
- Cable insulation type
- Shunt ratings
- Ground bed description.

2.6 COLLECTION OF ANODE CURRENT OUTPUTS

For each anode current output terminal of each junction box identified in 2.4, the Contractor shall measure the anode current output in amperes. The measurements shall be recorded on the Ground Bed Background Data Sheets that were prepared under paragraph 2.5. If initial currents (those that were taken when the CP system was installed) are available, they shall also be recorded on the data sheets. Currents shall be measured using the procedures in AFM 85-5 {and/or Army TM 5-???}.

2.7 COLLECTION OF WATER STORAGE TANK ANODE BACKGROUND DATA

For each of the rectifiers identified in Paragraph 2.2 that protects a water storage tank, the Contractor shall collect a complete set of background information concerning the anodes in the water tank as described in the CP Diagnostic User's Manual. This information shall be collected on the Water Tank Anode Background Data Sheet provided in the CP Diagnostic User's Manual or a reasonable facsimile thereof. One form shall be completed for each rectifier that protects a water storage tank. The following information is required for each rectifier with its associated anodes:

- Anode type
- Anode material
- Number of anodes per wall/bowl string
- Wall/bowl anode spacing

- Anode manufacturer
- Design life
- Cable gauge
- Cable insulation type
- Is it an ice-free design?
- Number of wall/bowl anode strings
- Number of anodes on riser string
- Riser string length
- Riser anode spacing
- Anode-to-wall distance
- Number and location of reference electrodes
- Wall/bowl anode string length.

2.8 DEFINITION AND IDENTIFICATION OF PROTECTED STRUCTURES

The Contractor shall define and set up an identification system for the network of protected structures as described in the CP Diagnostic User Manual. This shall be done in coordination with and shall be subject to approval by the DEH point of contact given in section 1.9. For an underground piping system, this procedure involves dividing the system up into a series of pipe sections, each with its own unique identification number. For a system of underground storage tanks and/or water storage tanks, each tank will be assigned its own unique identification number. Each structure shall be given a unique ID and shall be clearly identified on the reproducible maps described in 1.2.1.

2.9 COLLECTION OF STRUCTURE BACKGROUND DATA

The Contractor shall collect a complete set of background data as described in the CP Diagnostic User's Manual for each structure (i.e., pipe section or tank) identified under paragraph 2.2. This information shall be collected on the Pipe Section Background Data Sheet the Underground Tank Background Data Sheet, and/or the Water Tank Background Data Sheet provided in the CP Diagnostic User's Manual or a reasonable facsimile thereof. One form shall be completed for each structure. It is the Contractor's responsibility to reproduce the forms in sufficient quantities to collect data for the entire system. The following information is required for each pipe section:

- Location from
- Location to
- Date installed
- Date CP activated
- CP installer
- Coating type
- Locations of isolation joints
- Coating quality (ohms)
- Coating efficiency (%)
- Soil resistivity (ohm-cm)
- Section length (ft)
- Section diameter (in)
- Required current density (ma/sq ft).

The following information is required for each underground storage tank:

- Tank type
- Location
- Date tank installed
- Tank material
- Tank contents
- Date CP activated
- CP installer
- Locations of isolation joints
- Coating type
- Coating quality (ohms)
- Coating efficiency (%)
- Soil resistivity (ohm-cm)
- Tank length (ft)
- Tank diameter (ft)
- Required current density (ma/sq ft).

The following information is required for each water storage tank:

- Tank type
- Location
- Constructed by
- Construction date
- Tank material
- Tank contents
- Exterior coating
- Interior coating
- Date CP activated
- Tank capacity
- Bowl height
- Bowl width
- Bowl geometry
- Riser height
- Water conductivity
- Internal coating quality
- Internal coating efficiency
- Required current density
- Total submerged area
- Location of isolation joints.

2.10 IDENTIFICATION AND DEFINITION OF TEST SITES

Each protected structure may have associated with it a series of "test sites." A "test site" may either be a test station or any other test point at which potential measurements are taken, such as a riser or a valve. The Contractor shall define and set up an identification system for test sites and shall assign an ID to each test site associated with each structure that was identified in paragraph 2.8. This shall be done as described in the CP Diagnostic User's Manual. This shall be done in coordination with and shall be subject to approval by the DEH point of contact given in paragraph 1.9.

2.11 COLLECTION OF TEST SITE BACKGROUND DATA

The Contractor shall collect a complete set of background data as described in the CP Diagnostic User's Manual for each test site identified under paragraph 2.10. This information shall be collected on the Test Site Background Data Sheet provided in the CP Diagnostic User's Manual or a reasonable facsimile thereof. One form shall be completed for each test site. It is the Contractor's responsibility to reproduce the forms in sufficient quantities to collect data for the entire system. The following background information is required for each test site:

- Structure ID
- Location
- Description
- Vendor
- Surface or flush mounted
- Tools required
- Natural potential (volts)
- Interference bond resistance (ohms)
- Does interference exist?
- Shunt resistor value (ohms)
- Number of wires
- Comments.

2.12 COLLECTION OF TEST SITE POTENTIAL MEASUREMENTS

For each potential measurement point of each test site identified in 2.10, the Contractor shall assign an identifier (such as wire color) and shall collect the following information:

- Measurement point identifier
- Function of measurement point
- On potential (volts)
- "Instant-off" and/or off potential as required for evaluation of the system against the cathodic protection criteria selected under section 4.3

If initial potentials (those that were taken when the CP system was installed) are available, they shall also be recorded on the data sheets.

Potentials shall be measured using the procedures in AFM 85-5 {and/or Army TM 5-???}. All of the collected information shall be recorded on the Test Site Background Data Sheets that were prepared under paragraph 2.11.

2.13 COLLECTION OF INITIAL DIELECTRIC CONDITION DATA

The Contractor shall determine the condition (i.e., good, shorted, etc.) of each dielectric fitting and shall record this information.

3.0 DATA ENTRY

3.1 GENERAL

The Contractor shall code for entry into CP Diagnostic all verified data collected from installation drawings and records, field surveys, interviews, or other sources. Coding for the computer shall be in accordance with the CP Diagnostic User's Manual. The result shall be a complete, error-free database.

3.2 DATA ENTRY

The Contractor shall enter data into the database on a Government-owned microcomputer. The Government shall provide a copy of the CP Diagnostic program for the Contractor's use. The Contractor shall ensure and verify that the data stored in the database corresponds with the field data. Care shall be taken to ensure that data input into the database follows a sequence that avoids duplication or omissions and provides as a finished product an error free, complete database ready for CP Diagnostic operations.

3.3 INITIAL DATA CHECKING

The rectifier, junction box/ ground bed, structure, and test site identification information shall be entered, checked, corrected by the Contractor, and approved by the Government's Contracting Representative prior to other data being input into the program. This information must correspond to the reproducible drawings covered in Paragraph 1.2.1.

3.4 DATA CHECKING

When the rectifier, junction box, anode/ ground bed, structure, and test site information is approved and the remainder of the data has been entered, checked, and corrected by the Contractor, the Contractor shall produce one copy of the data stored in the computer for review by the Government. Any input errors discovered through the review of this "data dump" will be changed by the Contractor within a 2-week period after the review.

3.5 FINAL DATA CHECKING

If 5 percent or more of the data requires changes, a second "data dump" and review will be required. The Contractor will respond to changes of the second data dump within a 1-week period. Review and correction will continue in this same fashion until the data base is error free.

4.0 GENERATION AND INTERPRETATION OF REPORTS

4.1 STRUCTURE MASTER LISTING

The Contractor shall generate a complete Structure Master Listing report for the entire final (error-free) CP Diagnostic database for **[installation's name]**. This report displays background information for each structure in the database and shall be submitted as part of the final report.

4.2 STRUCTURE LISTING

The Contractor shall generate a complete Structure Listing report for the entire final (error-free) CP Diagnostic database for **[installation's name]**. This report gives a concise listing (ID and location) for all of the structures in the database and shall be submitted as part of the final report.

4.3 TROUBLE READINGS REPORT

The Contractor shall generate a complete Trouble Readings report for the entire final (error-free) CP Diagnostic database for **[installation's name]**. This report identifies all test sites at which the measurements do not meet the selected criteria of cathodic protection. Selection of the criteria to be used shall be made in conjunction with the DEH and a NACE-certified Corrosion Specialist. Based upon the results of the Trouble Readings report, the contractor shall identify locations in the system where problems exist and further investigation is warranted. This shall be documented in the final report. Guidance for the selection of criteria and the interpretation of data can be found in AFM 85-5, {Army TM 5-???,} NACE RP-01-69, and NACE RP-02-85.

4.4 RECTIFIER MASTER LISTING REPORT

The Contractor shall generate a complete Rectifier Master Listing report for the entire final (error-free) CP Diagnostic database for **[installation's name]**. This report prints the background information for each rectifier recorded in the database and shall be submitted with the final report.

5.0 TRAINING

5.1 CLASSROOM INSTRUCTION

The Contractor will provide a minimum of **[insert number]** hours of training in the use of the CP Diagnostic System to employees of the DEH during the Contract. This orientation and training will include, but is not to limited to, the following:

- Computer and program startup
- Definition of rectifiers, junction boxes, structures and test sites
- Field data collection (i.e., structure-to-soil potentials, anode current outputs, rectifier readings, and dielectric conditions)
- Data entry and editing
- Report generation
- Interpretation of reports
- Use of the reports to identify problems with the CP system
- Backing up the data base
- Exiting the program

5.2 SCHEDULING

A training schedule will be coordinated with and submitted to the DEH for approval a minimum of 15 working days prior to the training. The Contractor will contact the DEH representative directly to reserve conference rooms and training areas and to check the availability of audio/visual equipment, computer terminals, and other equipment or facilities necessary for the training. Equipment (e.g., audio/ visual equipment, computer terminals, etc.) that is necessary for the training but is not available from the DEH shall be furnished by the Contractor.

5.3 LIST OF ATTENDEES

The Contractor shall include, in the final report, a list of DEH personnel including name, title, office symbol, and telephone number that were trained under this contract.

6.0 FINAL REPORT

6.1 REPORT FORMAT

Formal reports and tabular data shall be typed or computer-printed (at least near letter quality) on 8-1/2 x 11-in. bond paper with foldouts for maps, sketches, schematics, charts, graphs and other illustrative material, as may be necessary. Data which cannot be clearly described in narrative form shall be shown graphically.

6.2 REPORT BINDING

Formal documents shall be securely bound with a durable cover. The title of the document shall appear on the cover of all submittal documents. Final documents shall be bound in a manner which will facilitate repeated disassembly and reassembly, unless otherwise specified herein.

6.3 NETWORK DRAWINGS

Site maps showing the locations of the protected structures, rectifiers, junction boxes, and the test sites shall be reproducible mylar drawings. The drawings shall provide easy identification of the pipe sections, tanks, and test sites.

6.4 REPORT SUBMITTAL

[Insert number] preliminary (draft) copies of the final report shall be submitted to the Government for approval. Following the return of comments, the Contracting Officer will schedule a meeting for their discussion if necessary. The Contractor shall furnish written notification of intended action on each comment within 1 week after this meeting. Intention of noncompliance with any comment shall be substantiated in detail. Authorization to proceed with final submittal will be granted in writing with or after the Contracting Officer's approval of the contractor's intended actions on the review comments. **[Insert number]** copies of the final report will be submitted.

6.5 ORGANIZATION OF REPORT

Narrative contents shall be arranged in a logical sequence and organized by sections. Reproducible transparencies, drawings, and/or maps shall be submitted separately. The report shall fully document the implementation process, the data collected, and the results achieved. The report shall include, but is not limited to, the following items:

6.5.1 A formal narrative section describing the work that was done, how it was accomplished, and when it was accomplished. The narrative shall include a brief description of each of the following portions of this report.

6.5.2 The CP Diagnostic reports specified in Section 4 shall be generated from the completed data base and submitted as part of the final report.

6.5.3 Based upon the results of the above reports, the contractor shall note areas of the system in which further investigation is warranted to pinpoint problems in the CP system. The contractor shall make recommendations as to the nature, extent, and approximate "ballpark" cost of these investigations.

6.5.4 A list of DEH personnel including name, title, office symbol, and telephone number that were trained by the Contractor under the Contract.

6.5.5 An Appendix containing copies of all of the data collection forms that were completed under Section 2, Inventory. These shall be arranged in an organized, logical sequence.

6.5.6 All maps and drawings necessary to identify the CP system and protected structures, including two copies of the mylar maps.

6.5.7 A backup copy of the complete, error-free CP Diagnostic database on 5-1/4 in. floppy disks.

6.6 EXIT BRIEFING

Upon completion of the work, an exit briefing will be given to the DEH. The final report shall be presented to the DEH at this briefing. The briefing shall cover the scope of work, accomplishments, findings, problems, conclusions, and identification of problem areas in the CP system.

CONTRACT SPECIFICATION APPENDIX I

LIST OF GOVERNMENT FURNISHED MATERIALS AND INFORMATION

The Government shall furnish the following items at the time the Notice to Proceed is issued, however, all will be returned to the Government at the end of the project:

- Area site plan maps (1 set)
- Supplemental area maps (1 set)
- Drawings of the cathodically protected structures (1 set)
- Drawings or other description of the cathodic protection system. If drawings showing the cathodic protection system do not exist, other descriptive material shall be provided as available.
- Other existing background or historical information (as available) that cannot be readily measured in the field by the Contractor and is required under Section 2.0, Inventory.
- CP Diagnostic computer program
- USACERL ADP Report "Cathodic Protection Diagnostic Computer Program for Sacrificial and Impressed Current Systems: Overview and User's Manual"

CONTRACT SPECIFICATION APPENDIX II

IMPLEMENTATION SCHEDULE

ITEM NUMBER

1. Mylar Maps . . . . . .
2. Structure and System Identification . . . . . .
3. Background and Field Data Collection . . . . . .
4. Data Entry . . . . . .
5. Report Generation and Interpretation . . . . . .
6. Training . . . . . .
7. Final Report and Briefing . . . . . .

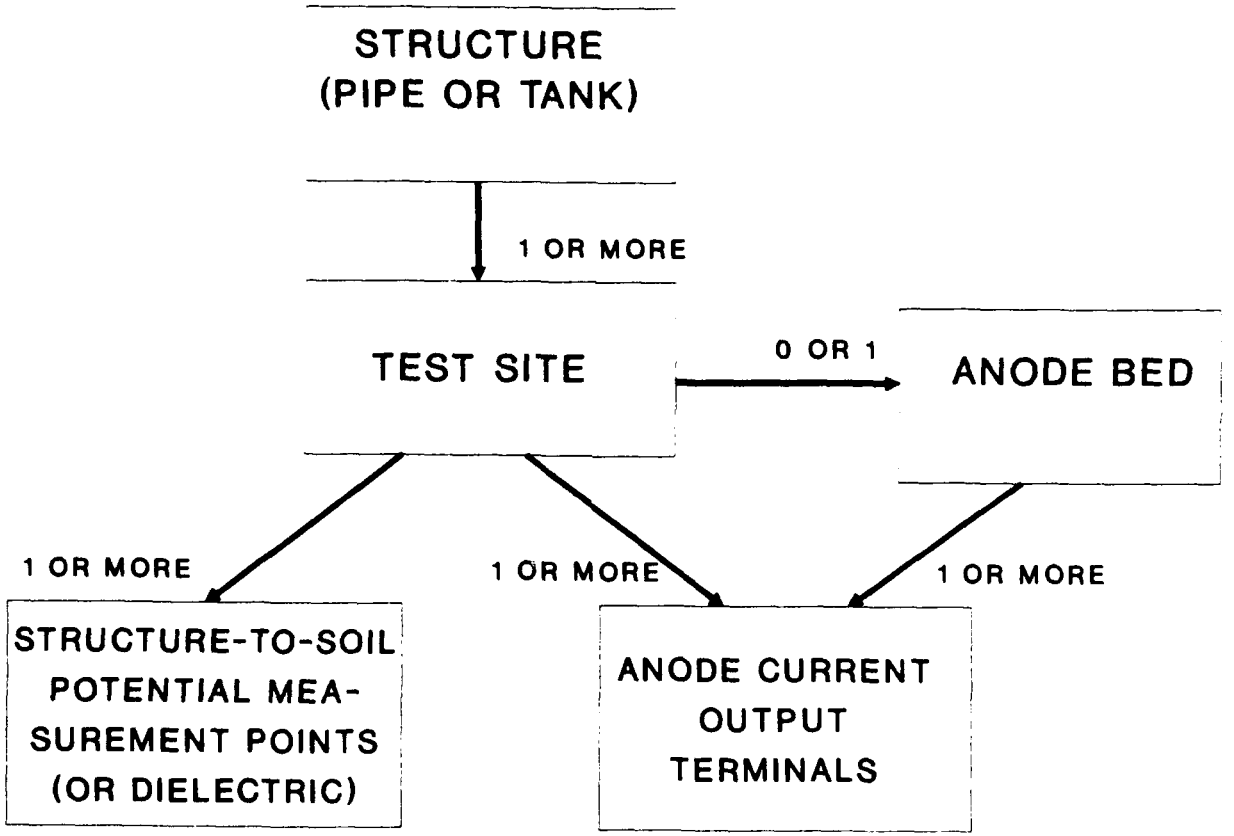
0 20 40 60 80 100 120 140 160 180 200

Calendar Days from Contractor's Notice to Proceed

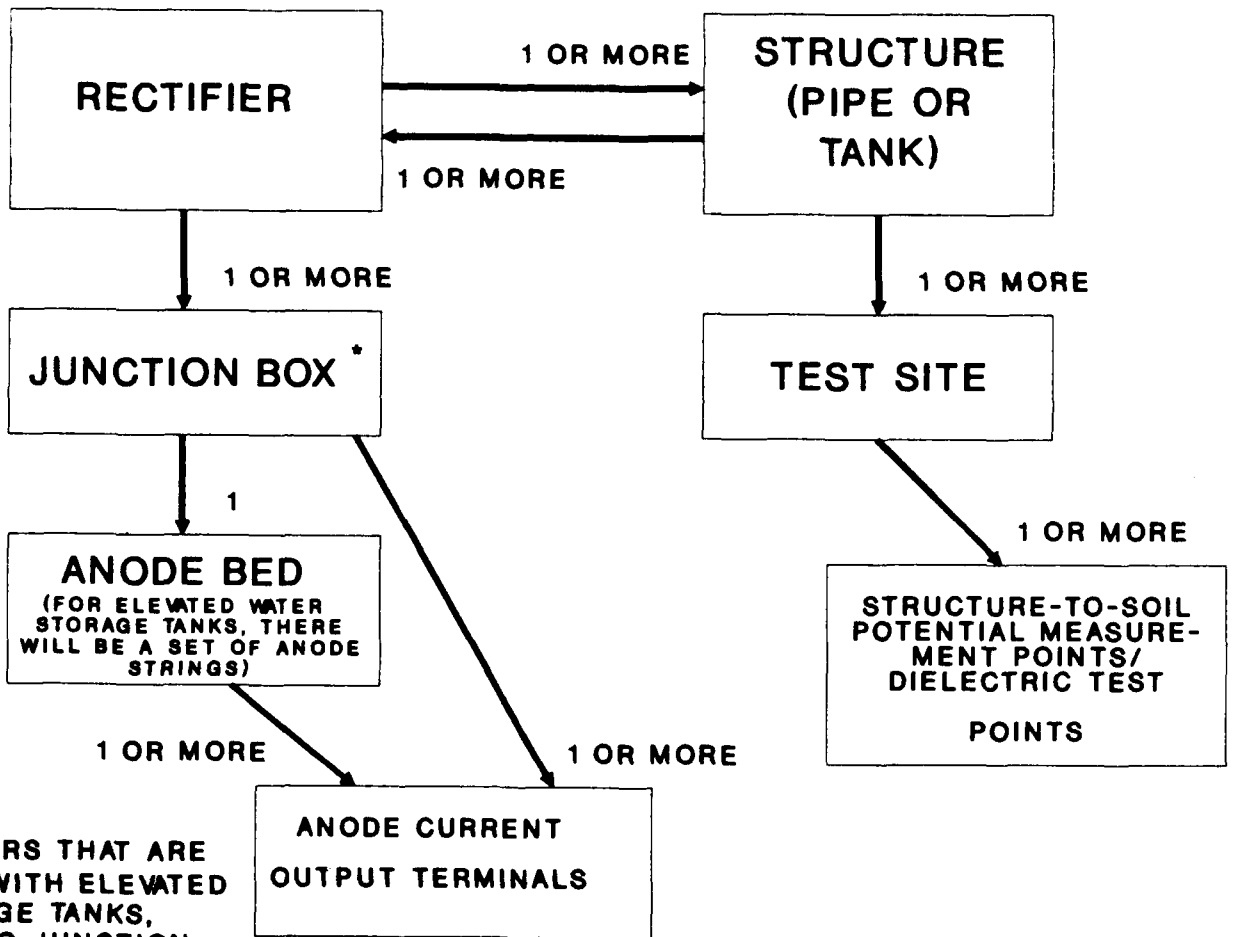
[INSTALLATION MAPS SHOULD BE ATTACHED AS APPENDIX III. ANY OTHER ATTACHMENTS SUCH AS PRICE/COST SCHEDULES SHOULD BE INCLUDED IN ADDITIONAL APPENDICES]

APPENDIX E: Relationships Between System Components

RELATIONSHIPS BETWEEN SYSTEM COMPONENTS--SACRIFICIAL



RELATIONSHIPS BETWEEN SYSTEM COMPONENTS- IMPRESSED CURRENT



* FOR RECTIFIERS THAT ARE ASSOCIATED WITH ELEVATED WATER STORAGE TANKS, THERE ARE NO JUNCTION BOX RECORDS.

APPENDIX F: Background Data Collection Forms for Impressed Current CP Diagnostic

RECTIFIER BACKGROUND DATA SHEET (IMPRESSED CURRENT)

Rectifier ID [10] _____

Rectifier Location [20] _____

Rectifier Type [10] _____ Rectifier Manufacturer [10] _____
Rectifier Model [10] _____

DC Rated Voltage (V) _____.___ DC Rated Current (A) _____.___

Reference Electrode Potential (V) ___.____

Number of Fuses _____ Fuse Rating (A) ____.____

Number of Circuits _____

Operating Mode _____

Initial Rheostat Setting _____.___

Initial Automatic (set point) _____.___

Enter the settings for each circuit in the following table. Enter initial settings in the left half of each block. These are the settings that were measured at CP system installation. Enter today's settings in the right half of each block.

Parameter	Circuit 1	Circuit 2	Circuit 3
Shunt Value (ohms)	|	|	|
Tap Setting: Fine	|	|	|
Tap Setting: Coarse	|	|	|
Circuit Resistance (ohms)	|	|	|
DC Voltage (V)	|	|	|
DC Current (A)	|	|	|
AC Voltage (V)	|	|	|
AC Current (A)	|	|	|

GROUND BED BACKGROUND DATA SHEET (IMPRESSED CURRENT)

The numbers in brackets [ ] represent the maximum number of characters to be entered in the field.

Rectifier ID [10] _____ Junction Box ID [5] _____

Anode Type [20] _____

Anode Material [20] _____

Anode Diameter (in) ___ Anode Length (in) ___ Anode Weight (lb) ___

Design Life (yr) ___ Max. Current Density (mA/sq.ft.) _____

Number of: Anodes ___ Anode Current Output Terminals ___

Anode Spacing (ft) ___

Structure to Anode: Distance (ft) ___ Direction [20] _____
Cable Gauge ___ Cable Insulation Type [10] _____

Shunt Rating: Main Circuit _____.___ Amps per _____.___ mV

Anode Circuit _____.___ Amps per _____.___ mV

Ground Bed Description [60] _____

_____

ANODE CURRENT OUTPUTS (AMPS)

Initial anode currents refer to currents that were measured when the CP system was installed.

TERMINAL NUMBER	INITIAL ANODE CURRENT (A)	TODAY'S ANODE CURRENT (A)	TERMINAL NUMBER	INITIAL ANODE CURRENT (A)	TODAY'S ANODE CURRENT (A)
1			8		
2			9		
3			10		
4			11		
5			12		
6			13		
7			14		

WATER TANK ANODE BACKGROUND DATA SHEET (IMPRESSED CURRENT)

The numbers in brackets [ ] represent the maximum number of characters to be entered in the field.

Rectifier ID [10] _____

Anode Type [20] _____

Anode Material [20] _____

Anode Manufacturer [20] _____

Design Life (yrs) _____

Cable Gauge _____ Cable Insulation Type [10] _____

Is this an ice-free design? Yes No (circle one)

Wall/ Bowl Anode Strings:

No. of Wall/ Bowl Anode Strings _____ No. Anodes per String _____

String Length (ft) _____ Anode Spacing (ft) _____

Riser Anode String:

No. of Anodes on Riser String _____ Riser String Length (ft) _____

Anode Spacing (ft) _____

Anode-to-Wall Distance (ft) _____

Reference Electrodes:

No. in Riser: _____ Location [20] _____

No. in Bowl: _____ Location [20] _____

PIPE SECTION BACKGROUND DATA SHEET (IMPRESSED CURRENT)

The numbers in brackets [ ] represent the maximum number of characters to be entered in the field.

Pipe ID [10] _____

Section ID [4] _____

Location From [20] _____

Location To [20] _____

Date Pipe Installed (MM/DD/YY) _____/_____/_____

Date CP Activated (MM/DD/YY) _____/_____/_____

CP Installer [20] _____

Coating Type [15] _____

Coating Quality (ohms) _ _ _ _ _ _ _

Coating Efficiency (%) _ _ _ _ _ _ . _ _

Soil Resistivity (ohm-cm) _ _ _ _ _ _ _

Section Length (ft) _ _ _ _ _ _ _ . _ _

Section Diameter (in) _ _ _ . _ _

Required Current Density (mA/sq ft) _ _ _ . _ _

Do Isolation Joints Exist? Yes No (circle one) If Yes, fill out the following table:

NUMBER [4]	LOCATION [20]	NUMBER [4]	LOCATION [20]

Which rectifier(s) protect this structure? _____

UNDERGROUND TANK BACKGROUND DATA SHEET (IMPRESSED CURRENT)

The numbers in brackets [ ] represent the maximum number of characters to be entered in the field.

Tank ID [10] _____

Tank Type [15] _____

Location [20] _____

Date Tank Installed (MM/DD/YY) _____ / _____ / _____

Tank Material [20] _____

Tank Contents [20] _____

Date CP Activated (MM/DD/YY) _____ / _____ / _____

CP Installer [20] _____

Coating Type [15] _____

Coating Quality (ohms) _ _ _ _ _ _ _

Coating Efficiency (%) _ _ _ _ _ _ . _ _

Soil Resistivity (ohm-cm) _ _ _ _ _ _ _

Tank Length (ft) _ _ _ _ _ _ _ . _ _

Tank Diameter (in) _ _ _ . _ _

Required Current Density (mA/sq ft) _ _ _ _ . _ _

Do Isolation Joints Exist? Yes No (circle one) If Yes, fill out the following table:

NUMBER [4]	LOCATION [20]	NUMBER [4]	LOCATION [20]

Which rectifier(s) protect this structure? _____

WATER TANK BACKGROUND DATA

Rectifier ID [10] _____

Tank ID [10] _____ Type of Tank (circle one) E S G

Location [20] _____

Tank Constructed By [15] _____

Construction Date (MM/DD/YY) _____ / _____ / _____

Tank Material [15] _____

Tank Contents [20] _____

Exterior Coating [15] _____

Interior Coating [15] _____

Date CP Activated (MM/DD/YY) _____ / _____ / _____

CP Installer [20] _____

Tank Capacity (gallons) _ _ _ _ _ _ _ _ . _ _

Bowl Height (ft.) _ _ _ _ _ Bowl Width (ft.) _ _ _ _ _

Bowl Geometry [15] _____ Riser Height (ft.) _ _ _ _ _
Water Conductivity (µmhos/cm) _ _ _ _ _ _ _ _ _ _

Internal Coating Quality (ohms) _ _ _ _ . _ _ _ Int. Coating Efficiency (%) _ _ _ _ _ _ _
Required Current Density (mA/sq ft) _ _ . _ _ _

Total Submerged Area (sq ft) _ _ _ _ _ _ _ _ . _ _ _

Do Isolation Joints Exist? Yes No If yes, fill out table below:

Number [4]	Location [20]	Number [4]	Location [20]

TEST SITE BACKGROUND DATA SHEET

The numbers in brackets [ ] represent the maximum number of characters to be entered in the field.

Pipe ID [10] _____ Section ID [4] _____
OR Tank ID [10] _____

Test Site ID [8] _____

Location [30] _____

Description [20] _____

Vendor [30] _____

Surface or Flush Mounted? S F Tools Required [20] _____
Natural Potential (V) __ __ . __ __ __ Intf. Bond Resistance (ohms) __ __ __ __ . __ __

Does interference exist? Y N Shunt Resistor Value (ohms) __ . __ __ __ __

Number of Wires __ __ __ (should be the same as the number of entries in the Initial Potentials table below)

Comment 1 [30] _____
Comment 2 [30] _____

POTENTIALS (VOLTS)

NO.	IDENTIFIER	FUNCTION	CONNECTED *	DISCONNECTED *	DIELECTRIC
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	
			|	|	

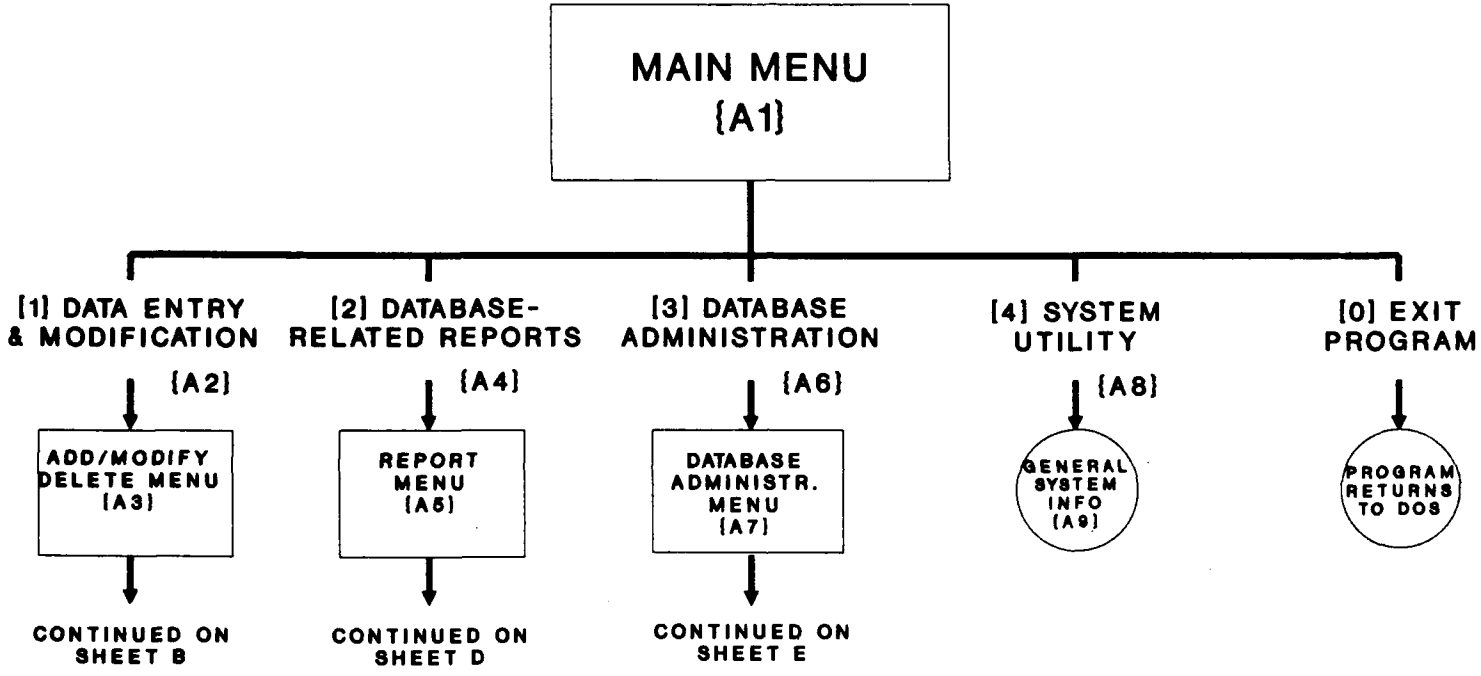
* Enter initial potentials in the left half of each block. These are potentials that were measured at CP system installation. Enter today's potentials in the right half of each block.

APPENDIX G: Diagram of Program Flow for Impressed Current CP Diagnostic

The following five pages labelled A through E depict the flow through the Impressed Current CP Diagnostic program. The following conventions and symbols are used:

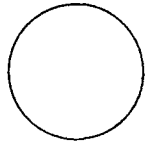
- A rectangle denotes a point of decision. This includes menus, selection screens (such as selecting a pipe section or selecting a database), and other places where a decision is required before you can proceed.
- A circle denotes any other data entry screen or option that does not involve a decision.
- A letter and number in brackets { } denotes a cross-reference to the main text of the manual. All menus and menu options are cross-referenced with the main text.

IMPRESSED CURRENT CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET A



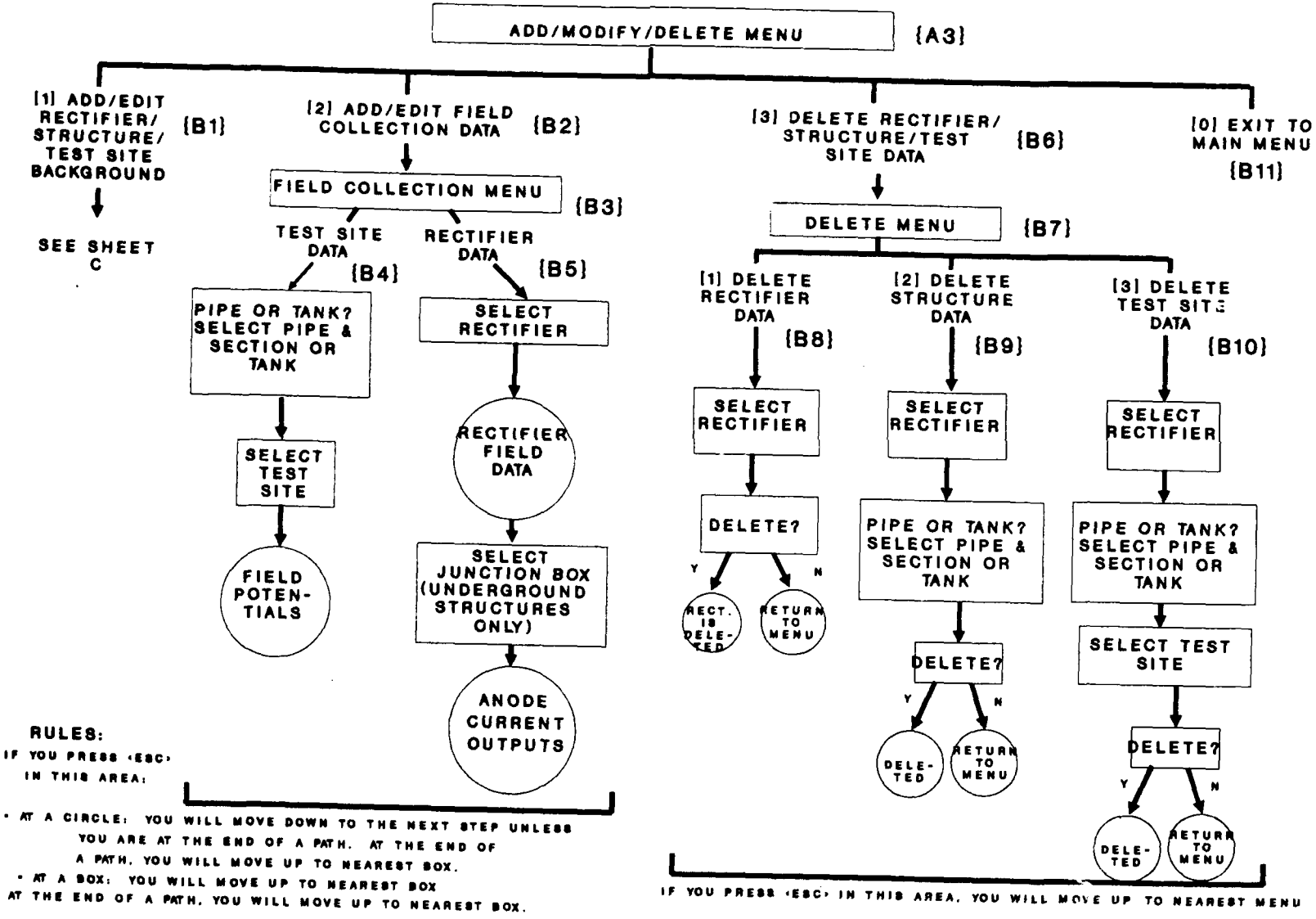
FLOW CHART CONVENTIONS

- DECISION

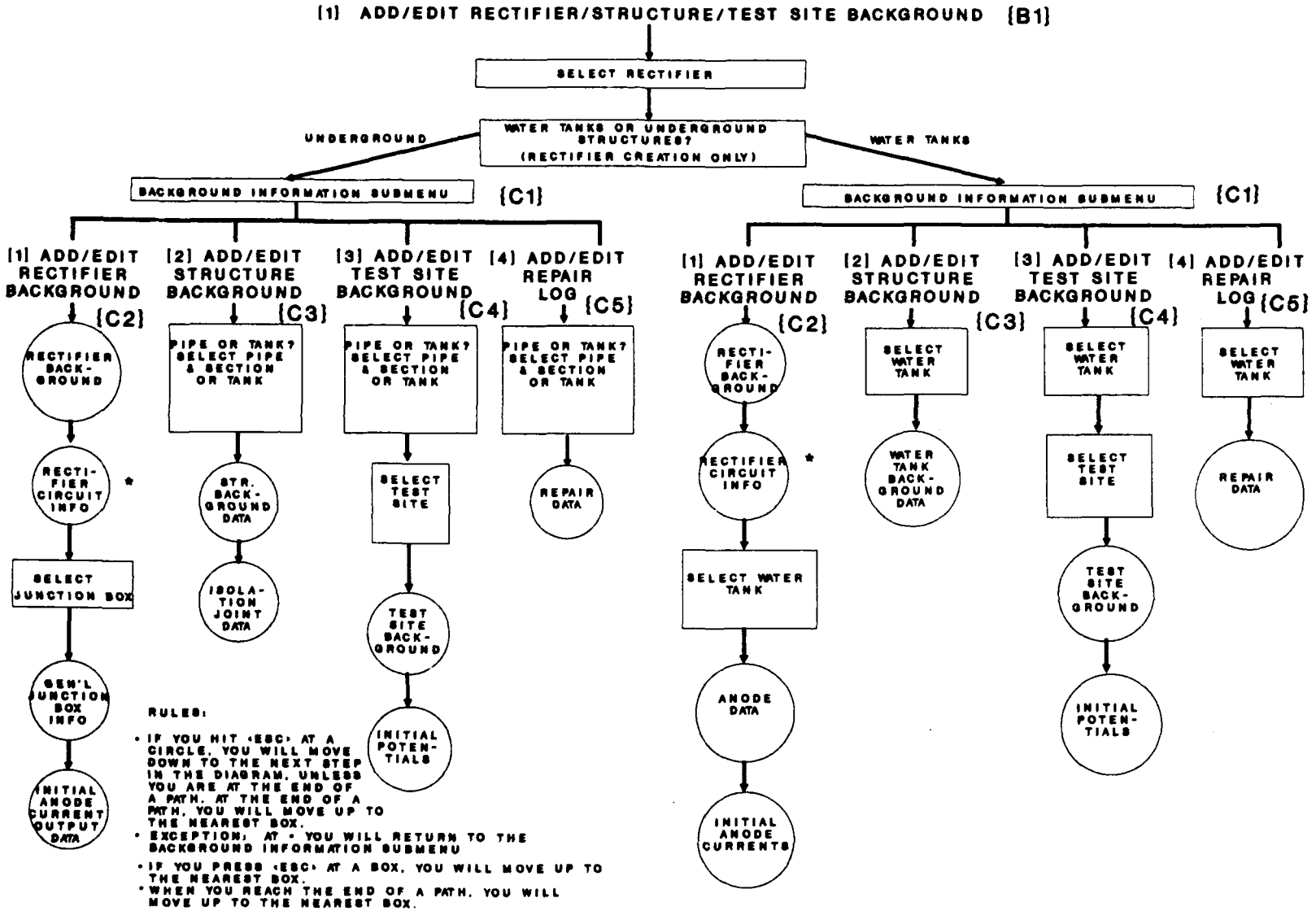


- DATA ENTRY SCREEN OR OTHER PROGRAM OPTION THAT DOES NOT INVOLVE A DECISION

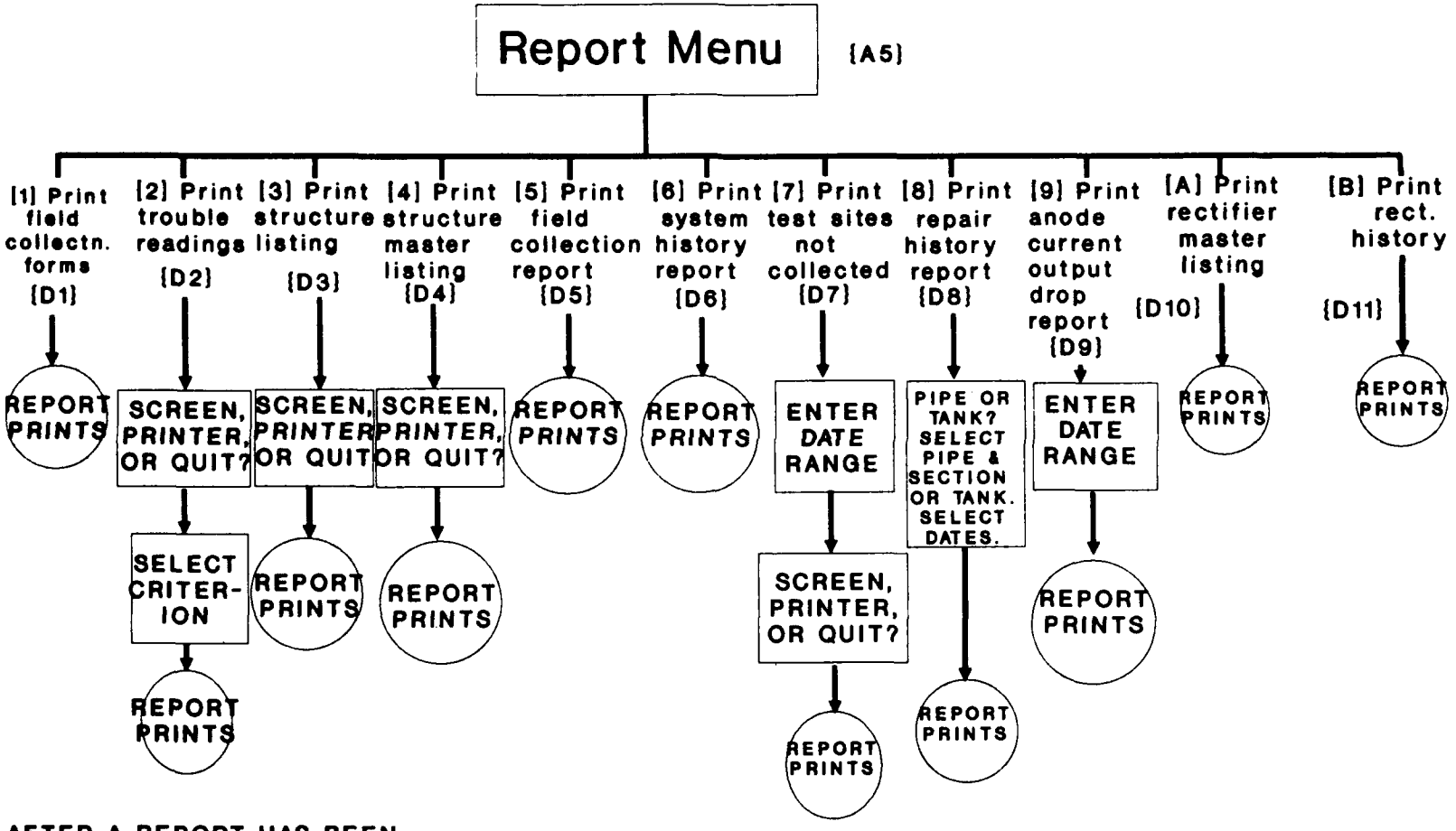
IMPRESSED CURRENT CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET B



IMPRESSED CURRENT CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET C

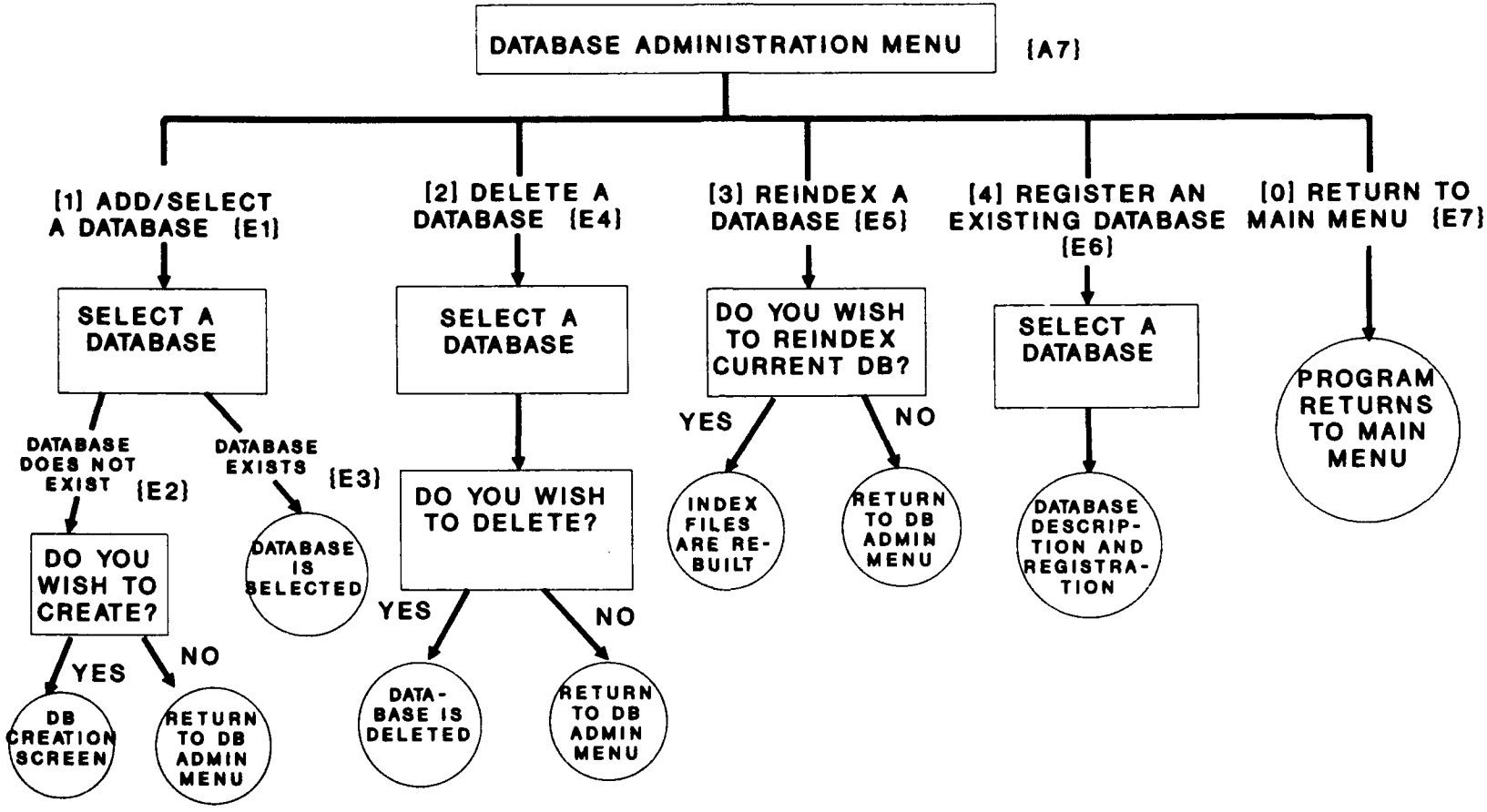


IMPRESSED CURRENT CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET D



AFTER A REPORT HAS BEEN GENERATED, YOU WILL BE RETURNED TO THE REPORT MENU.

IMPRESSED CURRENT CP DIAGNOSTIC DIAGRAM OF PROGRAM FLOW: SHEET E



RULE: IN DATABASE ADMINISTRATION, IF YOU HIT <ESC>, OR REACH THE END OF A PATH IN THE CHART, OR ANSWER "N" TO A Y/N PROMPT, YOU WILL BE RETURNED TO THE DATABASE ADMINISTRATION MENU.

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