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16. Abstract

For several decades, the Louisiana Department of Transportation and Development (LDOTD) has been able to rely on an ample supply of labor with appropriate equipment to provide soil design data. Budget cutbacks have forced reduction in personnel and equipment to the point that the Department forces are no longer able to keep up with the demand for their work.

Conventional boring to obtain soil samples for laboratory testing and final design data is an expensive, time consuming process. Some laboratory tests, particularly involved in strength and compressibility, are intrinsically long duration tests. Delays in starting critical projects are often the result of the time duration in testing.

In this research, the Louisiana Electric Cone Penetrometer System (LECOPS) and the accompanying data acquisition and reduction codes (TRUCK, CONEDATA & CONEXP) were developed, field tested and implemented to enable the LDOTD to maintain and even advance its soil design expertise. The results of this project will further provide a research vehicle and a desperately needed soils information data base.

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OF
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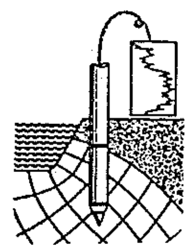
(LECOPS)
FOR DESIGN OF TRANSPORTATION FACILITIES



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State Project No. 736-13-37

Research Project No. 88-2-GT

1994

ACKNOWLEDGEMENT

The interest, funding and technical help of LDOTD, LTRC and FHWA are gratefully acknowledged. Special appreciation is extended to Messrs. Paul M. Griffin, Jr. (Geophysical Management Research Administrator) and John W. Oglesby (Research Engineer Supervisor) of the Louisiana Transportation Research Center (LTRC).

The data acquisition and computational code development phase of this project could not have been completed without the dedicated and meticulous efforts of Mr. Adrian S. Chan and Mrs. Zhou Pei, from conception to final product. The work constitutes a major portion of Mr. Chan's doctoral dissertation. Most of Mrs. Pei's Research Associate duties with the author were dedicated to the complex integration of the computer routines (exceeding 11,000 lines) into a "user friendly" code.

Mr. William T. Tierney (Research Associate), LTRC, contributed boundless physical energy and moral support to the successful field implementation phase of the project.

ABSTRACT

For several decades, the Louisiana Department of Transportation and Development (LDOTD) has been able to rely on an ample supply of labor with appropriate equipment to provide soil design data. Budget cutbacks have forced reduction in personnel and equipment to the point that the Department forces are no longer able to keep up with the demand for their work.

Conventional boring to obtain soil samples for laboratory testing and finally design data is an expensive, time consuming process. Some laboratory tests, particularly involved with soil strength and compressibility, are intrinsically long duration tests. Delays in starting critical projects are often the result of the time duration in testing.

In this research the Louisiana Electric Cone Penetrometer System (LECOPS), and the accompanying data acquisition and reduction codes (TRUCK, CONEDATA & CONEXP) were developed, field tested and implemented to enable the LDOTD to maintain and even advance its soils design expertise. The results of this project will further provide a research vehicle and a desperately needed soils information data base.

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Microcomputer versions of TRUCK, CONEDATA & CONEXP programs on three 3.5" DS, HD micro floppy disks are available from the Louisiana Transportation Research Center, 4101 Gourrier Avenue, Baton Rouge, LA 70808.

IMPLEMENTATION OF LOUISIANA ELECTRIC CONE PENETROMETER SYSTEM (LECOPS) FOR DESIGN OF TRANSPORTATION FACILITIES

EXECUTIVE SUMMARY

A. BACKGROUND

The Louisiana Department of Transportation and Development (LDOTD) has for years relied on a combination of exploratory drilling and laboratory analyses for gathering soil design data upon which to base engineering decisions. To do so, LDOTD has maintained a large fleet of sophisticated drilling equipment and staffed a number of teams of drilling personnel and laboratory staff. Under tight budgetary constraints, the drilling crews' and laboratory personnel's numbers have fallen through attrition and have not been allowed to restaff. Exploratory work has fallen behind, which forces the LDOTD to rely increasingly on consulting engineering firms for soils data. This problem of excessive work for available staff will continue into the foreseeable future.

There is a need for an in situ device and an accompanying procedure that will offset these field and laboratory losses and still remain economically feasible. The electronic cone penetrometer is such a device. The Louisiana Electric Cone Penetrometer System (LECOPS) will provide this state-of-the-art methodology to acquire and reduce data for soil engineering investigations for design of transportation facilities. The Quasi-static Cone Penetration Test (QCPT or CPT) has been used for years in Europe and some other states in lieu of conventional exploration methods. It has also been used by LDOTD on several occasions, most of which were research oriented. Summary of details and history of previous work in Louisiana can be found elsewhere (see Executive Summary, "Field Calibration of Electric Cone Penetrometers in Soft Soil," FHWA/LA/LSU-GE-85/2, 1985).

scaled down version of the electronic CPT probe has also been developed. Due to its smaller size, this CPT probe is commonly referred as the Miniature Cone Penetrometer (MQCPT or M-CPT). There is currently an active LDOTD research project on M-CPT ("Calibration and Implementation of Miniature Electric Cone Penetrometers for Road and Highway Design and Construction Control," State Project No. 736-13-36). The computer codes developed for LECOPS have commonality with M-CPT.

In practice, theoretical solutions cannot be used for the "direct" analysis of the cone penetration mechanism, so interpretation of CPT results will only be semi-empirical in nature. This implies that correlations are needed for the interpretation of cone data. Thus, side by side conventional soil testing information will be needed to further improve the reliability of the empirical correlations. Reviews of past CPT research confirmed that most of the available data and information are reported in the form of goal-specific non computer-based record keeping systems. This kind of ad hoc system will serve well only when data are needed for local correlations, and cannot be effectively used in a global sense.

It is the mission of this study to develop state-of-the-art equipment, hardware and software, for an environmentally contained cone penetrometer system mounted on a self-sufficient vehicle. The goal is to improve the CPT testing procedures as well as keeping both the hard earned conventional soil testing and in situ field testing data available for future reference. A well organized computer-based data and information maintenance system allows for acquisition, reduction, storage and retrieval of both laboratory and field data. Data can be searched and used in flexible ways with different access paths fully explained in a Reference and Operation Manual, to be printed or plotted (see TRUCK and CONEDATA computer codes in Appendix).

To achieve the above mentioned objectives an abstract data modeling in data base implementation was utilized. Most data models used in database management systems are business oriented in nature, thus application of these models to engineering data is less efficient. A semantic model is introduced in this study that takes into consideration the general aspects of engineering data. The goal of semantic modeling is to provide abstractions that naturally adapt to the way the users describe the enterprise. An expert data base system is implemented using this semantic data model geared towards engineering oriented data. The resulting system can be viewed as a knowledge or intelligent data base system that contains the knowledge of the conceptual level and physical level of the data base system (see CONEXP computer code in Appendix).

The Reference and Operation Manual given in the Appendix for TRUCK, CONEDATA and CONEXP computer codes are self explanatory and have been prepared as stand-alone documents. The source codes exceed 11,000 lines of computer programming. Microcomputer executable versions of these programs on three 3.5" DS, HD micro floppy disks are available from Louisiana Transportation Research Center, P.O. Box 94245, Baton Rouge, LA 70804-9245.

C. EQUIPMENT

A dedicated heavy vehicle is generally required to perform efficient CPT soundings. The four major components of such a vehicle are the specialized chassis and the hydraulic system, the penetrometer probes, the depth encoder, and the data acquisition hardware and software. The Louisiana Electric Cone Penetrometer System (LECOPS) which was developed in this project is shown in Figure 1.

LECOPS is a 20-ton truck powered by a caterpillar 210 HP diesel engine on a model G-744 6x6 chassis, modified by Zeligson Company of Tulsa, Oklahoma. The van body (subframe and cabin) and the hydraulic pump (maximum pressure of 300 bar at 1000 rpm) which is driven by the power take-off (PTO) of the truck were fabricated to the specifications set by the author at A.P. van den Berg, b.v.of the Netherlands, and attached to the chassis in the U.S.

The hydraulic system serves two functions: leveling the vehicle and penetrating the probes. The horizontal leveling of the vehicle is provided by three hydraulic jacks that

Figure 1a. General Exterior View of Louisiana Electric Cone Penetrometer System (LECOPS)

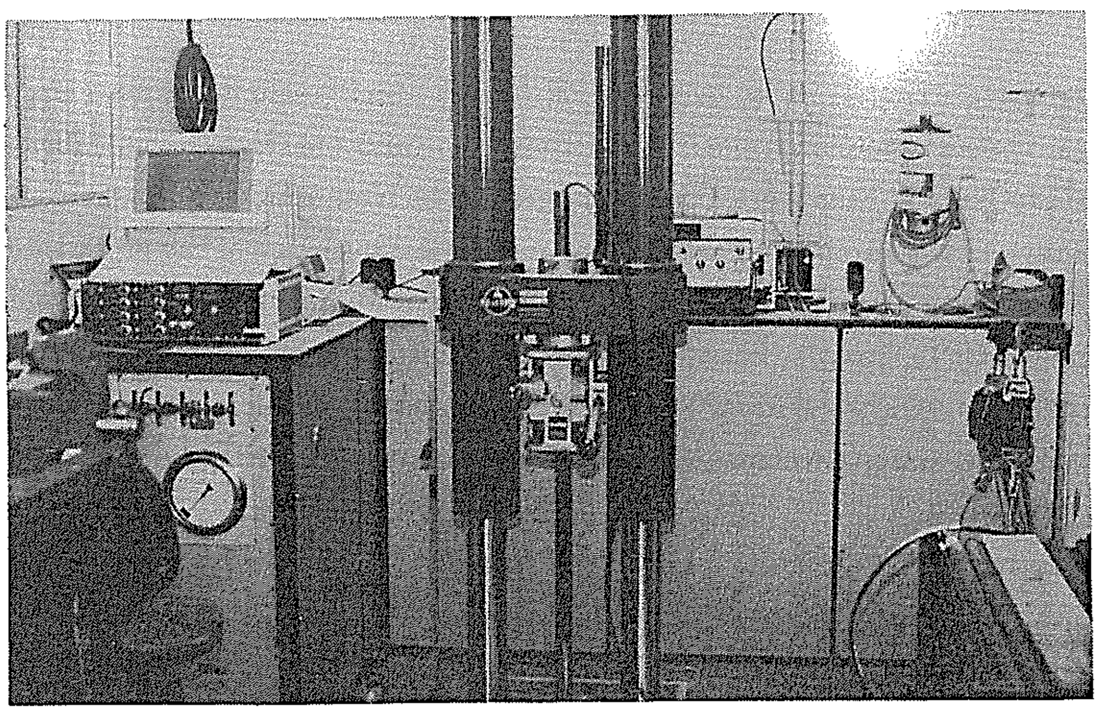

Figure 1b. General Interior View of Louisiana Electric Cone Penetrometer System (LECOPS)

are mounted on the subframe. The hydraulic jacks are equipped with heading-plates (pads) with dimensions of 500mm x 500 mm. The pads are mounted at the hydraulic jacks by means of a ball knob. The horizontal levelling is achieved by intermittently jacking the pads until verticality of penetrometer rods is realized. The penetration thrust system is Hyson 200 KN Type III. The system consists of two hydraulic cylinders connected to each other by an upper arm and a lower beam. The cylinders have a continuous stroke of 1250 mm. The hydraulic oil is supplied through the piston rod to the cylinders at an engine speed of 1200 rpm. A unique chuck-in system can push or pull the rods during the sounding operation.

In order to obtain an accurate depth measurement of the sounding profile during CPT operation, a displacement transducer (depth encoder) manufactured by Fugro-McClelland, b.v. of the Netherlands is installed. The displacement transducer consists of a bi-directional optical incremental shaft encoder which is driven by a pulley connected to the slide on the sounding rods. For every meter of displacement, 1000 output pulses are generated (for the standard penetration rate of 2 cm/sec, only 50 pulses are required). These pulses are 90 degrees phase shifted and have a square waveform on TTL levels which are polled by the computer through the digital I/O channel. A data conversion on all incoming signals will be performed every time the TTL level is high.

Penetrometers that are used by LECOPS (see Figure 2) include the standard friction cone, single & dual piezo cones, conductivity cone and the seismic cone fabricated by Fugro-McClelland Engineers, b.v. (i.e. Fugro) of the Netherlands. All penetrometers are equipped with an inclinometer to ensure vertical insertion of the probe into the ground during sounding operations. A self sufficient Miniature Cone Penetrometer system (M-CPT), has also been developed to be used with smaller vehicles (i.e. pick-up truck). Currently the M-CPT system is mounted on a vehicle similar to LECOPS. The computer codes developed for LECOPS are compatible with the M-CPT.

The electronic data acquisition hardware consists of a signal conditioning unit (PCU-M) manufactured by Fugro-McClelland b.v. of the Netherlands to the author's

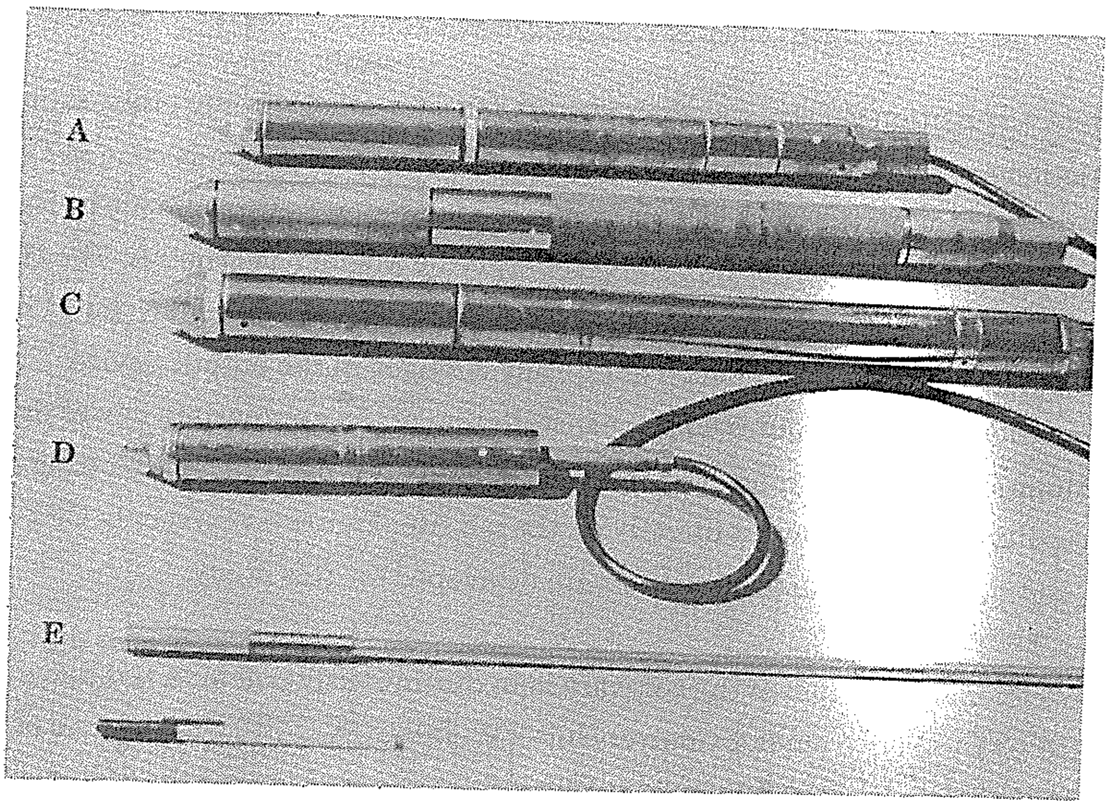

Figure 2. Cone Penetrometers Used
a. Dual Piezo Cone
b. Conductivity Cone
c. Seismic Cone
d. Friction Cone
e. Miniature Cone

specifications, a Compac Portable III micro computer with a 640x400 high resolution screen (for real time graphics processing), a forty megabyte internal hard disk drive for storage, and a Data Translation DT-2801 A analog to digital conversion and digital I/O board. Signals coming from the cone penetrometer are amplified and scaled by the PCU-M unit before they are transmitted to the DT-2801 A for conversion. Figure 3 depicts the flow path of the data acquisition system on capturing, processing, presenting and storing the CPT sounding data for interpretation. A plotter or a printer can be connected to the system to produce off-line high quality output.

The data acquisition software system for LECOPS for all electronic probe soundings (i.e. friction cone, piezo or dual piezo cone, conductivity cone, seismic cone M-CPT) is programmed around the Turbo Pascal version 4.0 language environment by Borland International and the HALO '88 graphics library by Media Cybernetics. The HALO '88 graphics library allows the graphic portion of the program to be developed in the device-independent environment. That is, any changes in the output device configurations usually require only the installation of the appropriate device driver and minimal re-programming. The software is capable of printing and plotting off-line high quality hard copy output directly on the job site. Figure 4 represents CPT and PCPT soil profiles obtained using software developed for this study.

The operational principal of the software is to continuously poll for a rod-down signal supplied by the Penetrometer Control Unit - Modular (PCU-M) through one of the digital I/O channels of the DT-2801 A. When this condition is met, the TTL depth pulse will be polled from another digital I/O channel. When the TTL logic is true, the program will trigger an analog to digital conversion on all the corresponding channels of the penetrometer. After each set of analog to digital conversions, the measured voltages are scaled to their physical representations and plotted in real time onto the gas plasma display of the computer. This allows the operator to obtain the reading at the actual unit of measurement of choice. The program operation for the friction cone, seismic cone and conductivity cone is straightforward. However, operation intervention is required in Piezo & Dual Piezo Cone Penetration Testing (PCPT & DPCPT) when dissipation of pore pressure is performed after penetration is stopped.

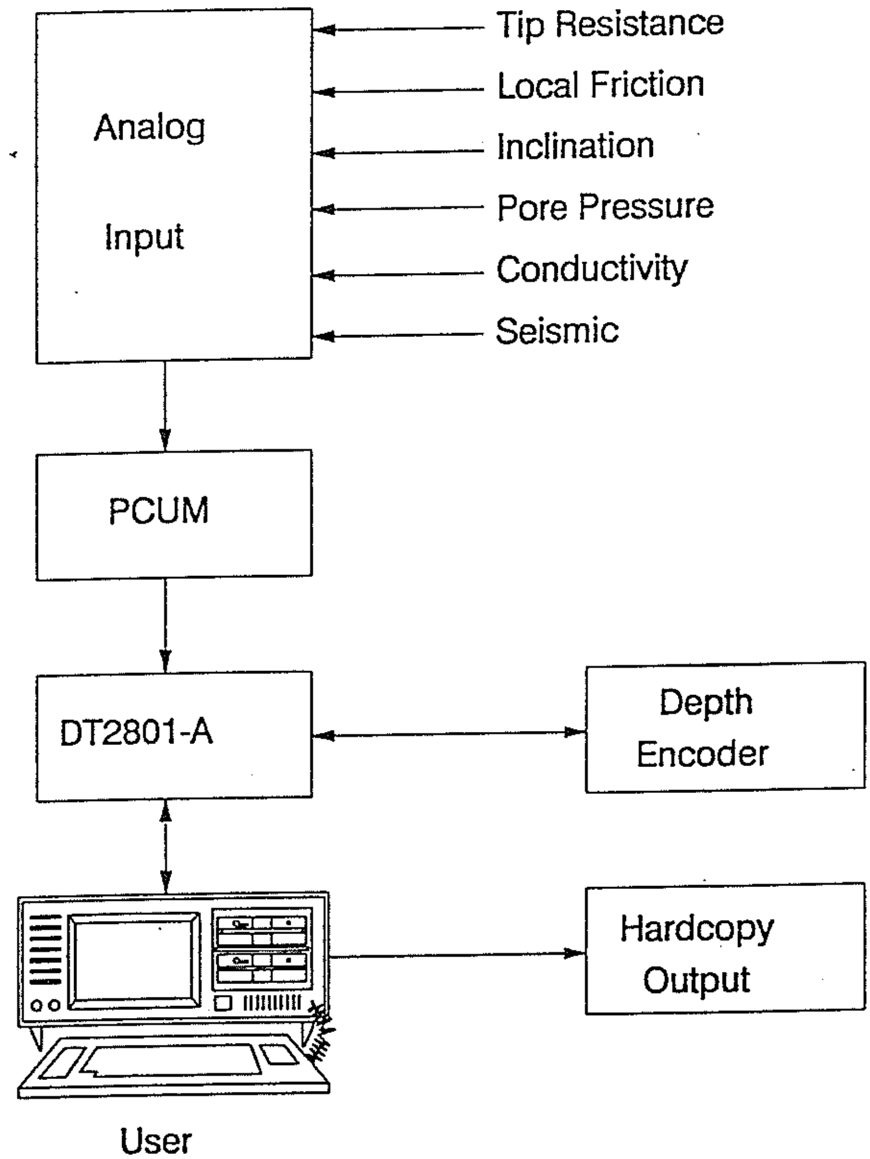

Figure 3. Data Acquisition Flow Diagram for Penetrometer Testing

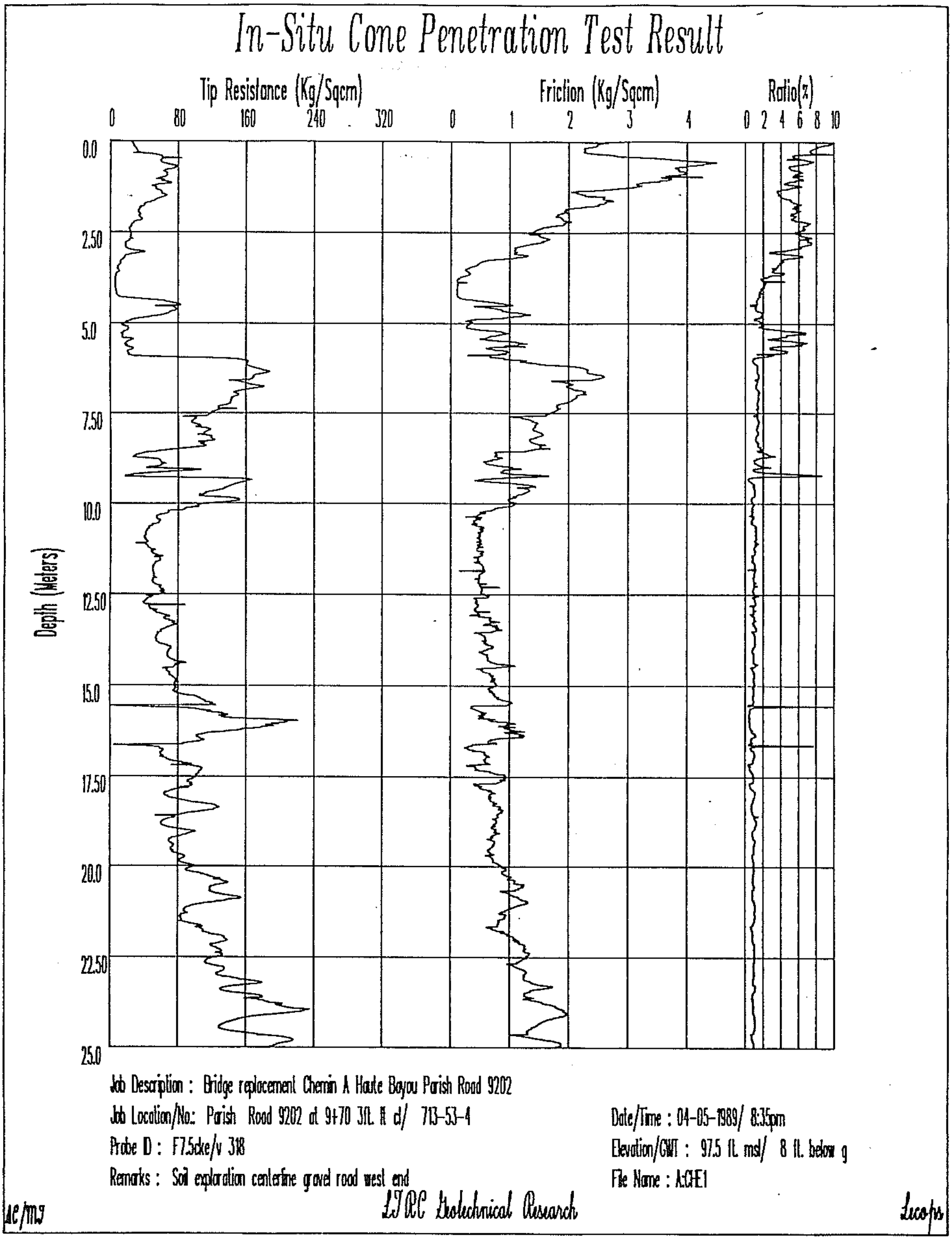

Figure 4a. Sample Output for Friction Cone Test, QCPT

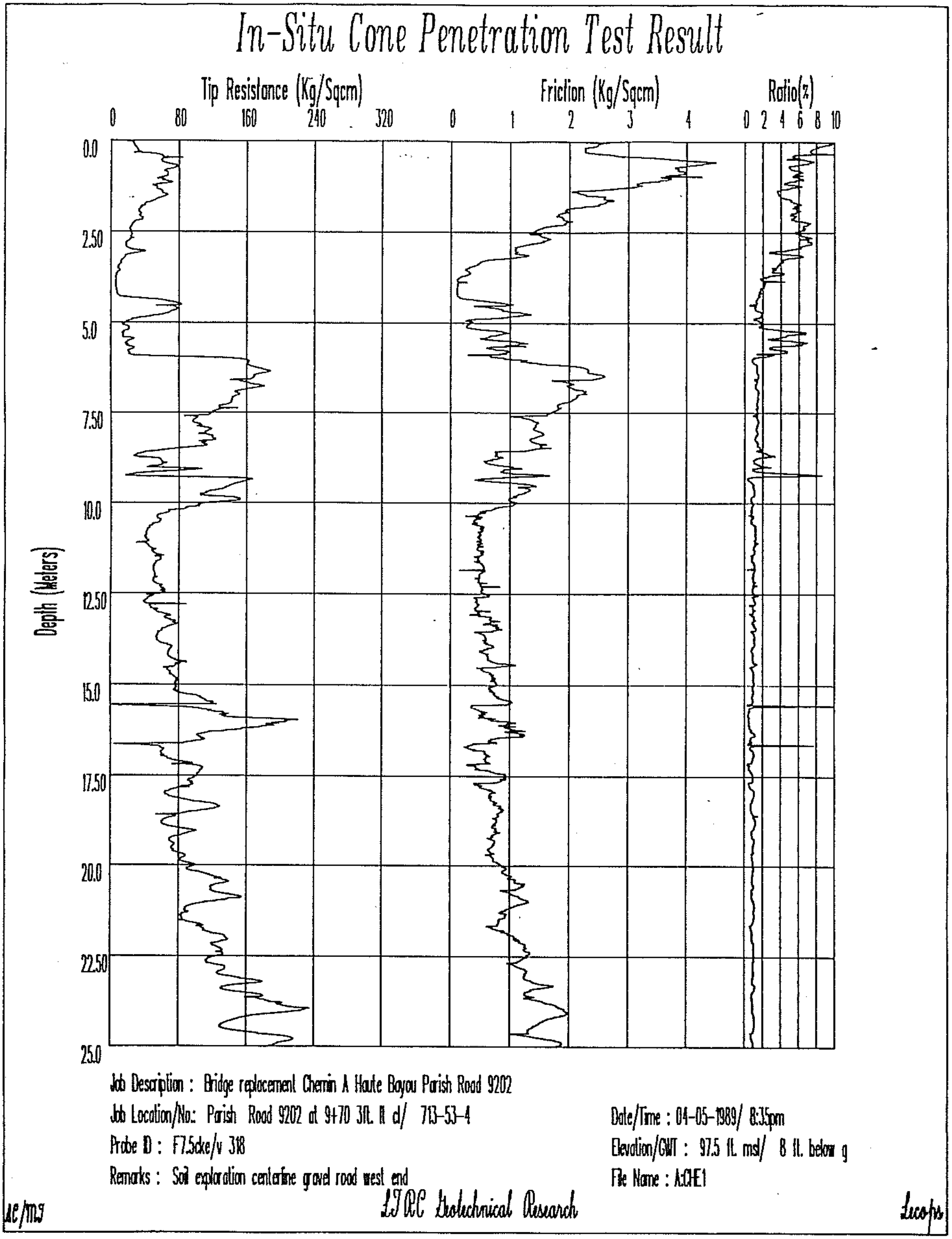

Figure 4a. Sample Output for Friction Cone Test, QCPT

Two soil samplers (MOSTAP) are also available on LECOPS. These are 35mm and 65mm diameter samplers with a length of about 1 meter to allow recovery of "undisturbed" samples at predetermined depths for comparative study of laboratory tests. Insertion of these samplers operate with the same principle as the cone penetrometers. That is, the sampler, connected to a sounding rod, is hydraulically penetrated by the push head into the formation at the desired depth. In MOSTAP sampling the only electronic measurement made is by the depth encoder.

During the course of this study LDOTD "Water Well Rules, Regulations and Standards (1985)" were put into effect. Thus the CPT holes were deemed not exempt from the environmental requirement that "geotechnical boreholes be sealed to protect groundwater from preferential pathway contamination." A sister study was conducted on "Sealing of Cone Penetrometer Testing Holes for Groundwater Protection (Collette, A. Donald & Tumay, M.T., Report No. GE-92/09, 1992)." Three aspects of "sealing" were investigated in this study: a. reentering CPT holes for sealing; b. the characteristics of specified bentonite slurry as a sealant; c. the sealing behavior of the displacement-type CPT holes under confining stress. Observations and data from in situ and laboratory case histories were studied. The in situ investigation included reentry into CPT soundings at three sites in southern Louisiana. Each attempt involved thrusting one-half inch outer diameter stainless steel tubing (inserted as a miniature cone penetrometer, M-CPT) into the location of the 10 cm^2 or 15 cm^2 CPT soundings or 80 cm^2 MOSTAP sampling tube sounding. Sealing entailed retrieving the tubing while pumping bentonite slurry at depths below 25 feet, and then pumping cement-bentonite slurry at depths shallower than 25 feet. The laboratory investigation of the effectiveness of bentonite slurry was conducted in compacted soil samples of two low hydraulic conductivity soils, a silt and a clay. In the initial model study phase, evaluation of the bentonite slurry included coring, sealing and measurement of the hydraulic conductivity of the cored/sealed sample. The hydraulic conductivity of the cored/sealed sample was compared to that of the original compacted sample. The effects of the confining stress and local strains/fractures due to soil displacement during full-size CPT sounding were simulated in the 20.7 inch diameter LSU-LTRC/Calibration Chamber System (LSU-LTRC/CALCHAS) developed for another LDOTD research project (deLima, D.C. & Tumay, M.T., Report GE-92/08, 1992). The results indicate that reentry and grout introduction into CPT soundings is a satisfactory alternate method by which CPT ground disturbances can be sealed in accordance with the Water Well Rules, Regulations and Standards of the State of Louisiana.

D. COMPUTER PROGRAM INTEGRATION

A computer-based data management system for LECOPS was developed. The system involves three parts: a. TRUCK program is the basic data acquisition routine for CPT soundings; b. CONEDATA program serves as the data repository and handling tool for the CPT and conventional testing information database; c. CONEXP program "expertly" manages the Cone Penetrometer Database System (CPDS).

Figure 5 illustrates the flow chart for the computer program integration for LECOPS. Detailed information about the definitions of terms and operating instructions of the individual programs are given in the Appendix.

E. COMPUTER PENETROMETER DATABASE SYSTEM (CPDS)

Database Management Systems (DBMS) are widely accepted as tools for reducing the problem of managing a large collection of shared data for application programmers and end users. The users interact with the database of the DBMS by submitting requests for data selection (queries) or manipulation (updates). A data model is normally used to represent the actual database during implementation. Classic data models such as the relational model, the network model or the hierarchical model do not provide sufficient tools for representing engineering data, especially CPT data. In geotechnical testing, no two borings are identical, thus, the only linkage on two sets of data from different test types for use in database implementation will be on samples collected from a close proximity three dimensional space. CPT data and geotechnical laboratory testing data from neighboring borings

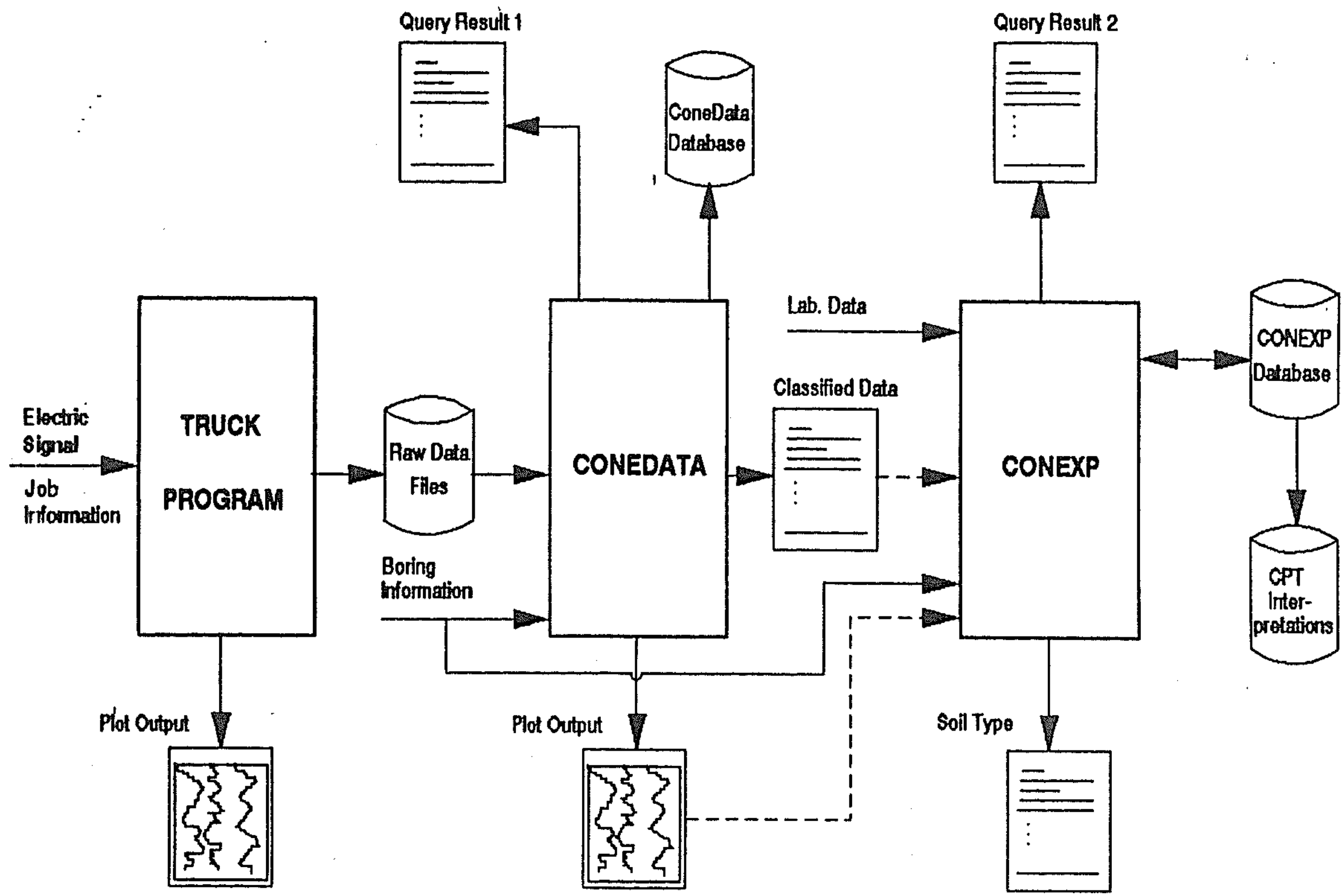

Figure 5. Overview of Computer Program Integration for LECOPS

can be incorporated into a database using the Geotechnical Engineering Database Model (GEDM) (Chan, A.S. , Report in press, 1994).

CPDS is an expert database management system that combines the explicit CPT data based on GEDM and the implicit CPT information into a database management system. Explicit CPT information is data from direct comparison of laboratory and field results on the same sounding location. Implicit CPT data are generalized implied data that are presented in chart format from culmination of past experiences. The system primarily stresses the storage and retrieval of explicit data that is generated from the CPT sounding program. That is, the most vital information from a CPT database should still be the direct data obtained from side by side borings. These data will be used for updating information contained in the implicit database. Secondarily, implicit data is used for the decision making process under the option of the user when explicit data are not available or when the user deems necessary to check on previous experience. Implicit data can also be updated and retained in the system to ensure refinement of localized correlation for soil characterization.

The computer code CONEXP, which is the expert data base management segment of the LECOPS' GEDM , is detailed in the Appendix.

F. SYNOPSIS AND DELIVERABLES

In a previous study by the author, it was recommended that "it would be advisable for state transportation departments to develop their own penetrometer systems befitting the special characteristics of the soil deposits of their region, using the correlations developed to modify the general theories of penetration."

In this study, state-of-the-art equipment, hardware and software for an environmentally contained cone penetrometer system mounted on a self-sufficient vehicle, namely Louisiana Electric Cone Penetrometer System (LECOPS) have been developed, implemented, field-tested, and initial LDOTD crews have been trained.

The deliverables included:

1. An operational CPT vehicle which is currently fully utilized by the Materials Section of LDOTD.

2. Software to operate LECOPS's data gathering and dissemination system.

3. A "user friendly" database management system for installing, keeping, and providing CPT and other geotechnical data for analysis.

The Louisiana Electric Cone Penetrometer System (LECOPS) has successfully been implemented in the field by the LDOTD for the last two years in connection with projects generally dealing with site investigation and pile capacity design and prediction. The acceptance of LECOPS by the field and office crews were very positive. It is anticipated that the current limited utilization of LECOPS in embankment control, geo-environmental engineering aspects of transportation facilities, creation of state wide data bases for soil profiling/characterization, and performance evaluation of bridge and retaining wall foundations will be expanded in the very near future. Although the system requires substantial initial capital investment, the operational costs are lower than conventional soil boring methods. Considering the reliability of operation, speed of data acquisition and reduction, and reliability of results, LECOPS has proven to be more economical in the long run.

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APPENDIX A
TRUCK PROGRAM

OVERVIEW OF LOUISIANA ELECTRIC CONE PENETROMETER SYSTEM (LECOPS)

DEFINITIONS (1 pp)

FLOW CHART

1. Testing
2. Plotting
3. Input Function
4. Display Function
5. Plot Function

PROGRAM NAMES	Test	Plot
1. Friction Cone	LSU LTRC	LSUPRINT LTRCPLOT
2. Dual Piezo Cone	LSUPIE LTRCPIE	PCPTPLOT LTRCPLT PCPLT20 LTRC2DIS DIS2PLTT DIS1PLTT
3. Conductivity Cone	LSUCOND	CONDPLOT
4. Seismic Cone	LSUSEI	SEIPLOT

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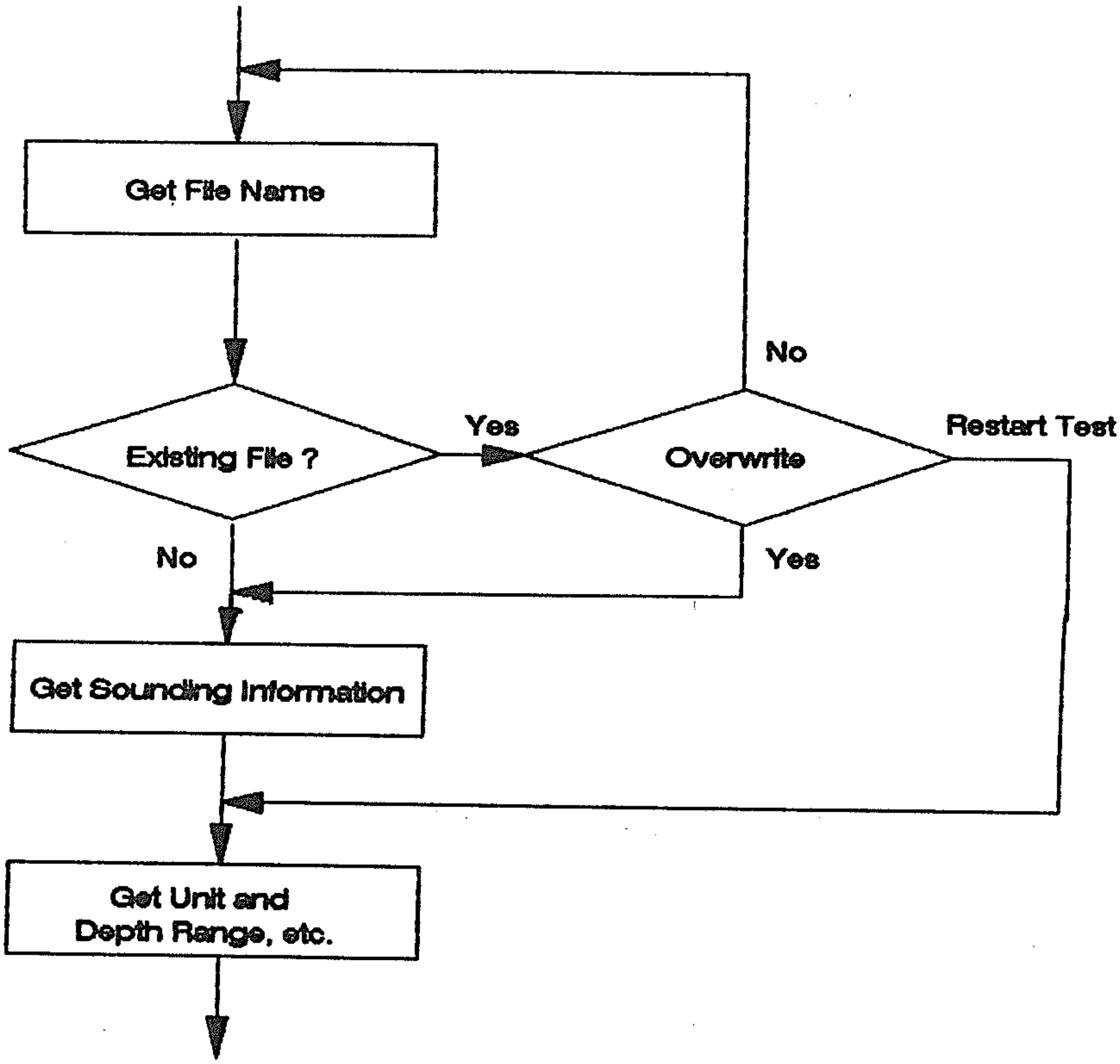

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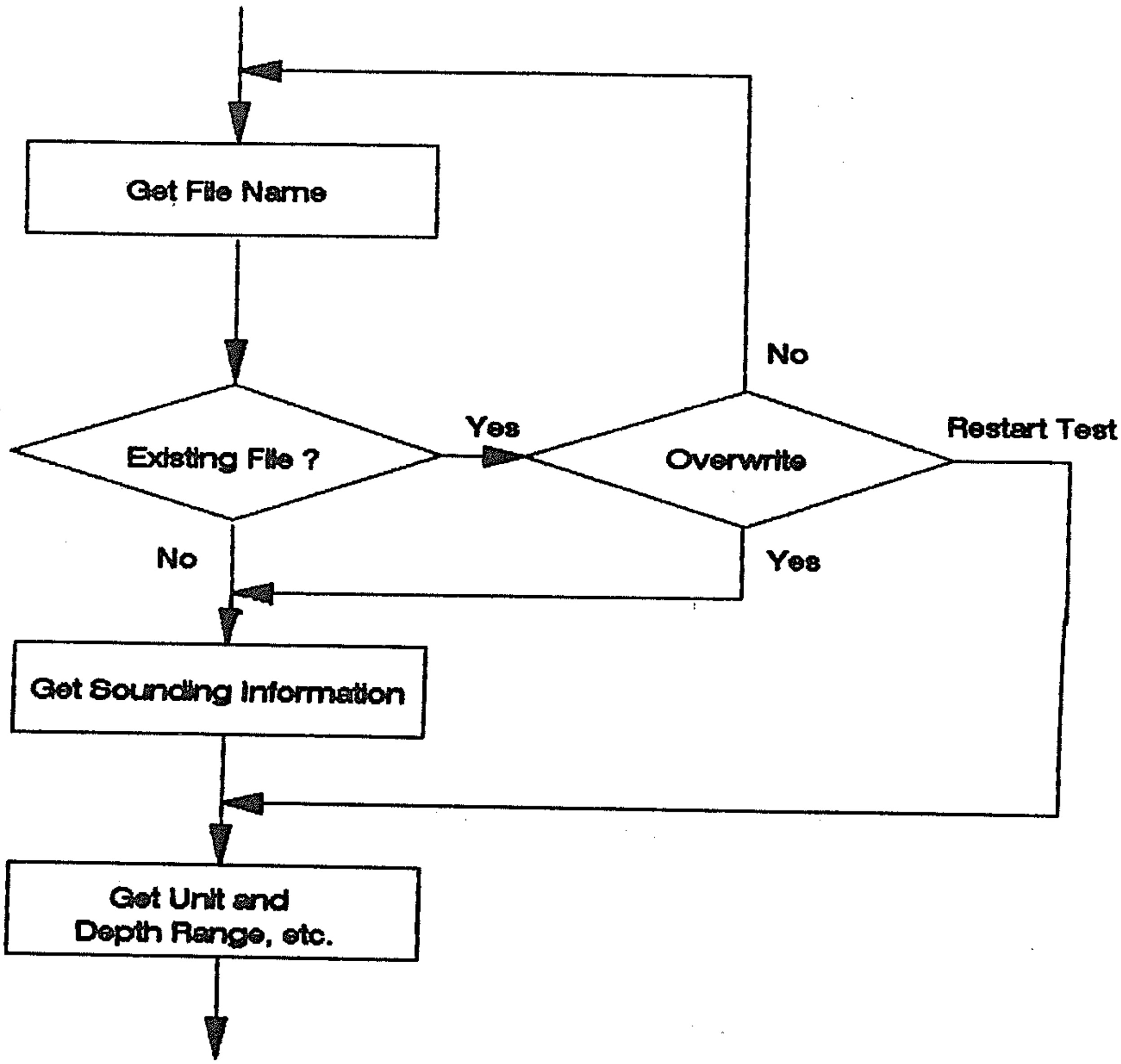

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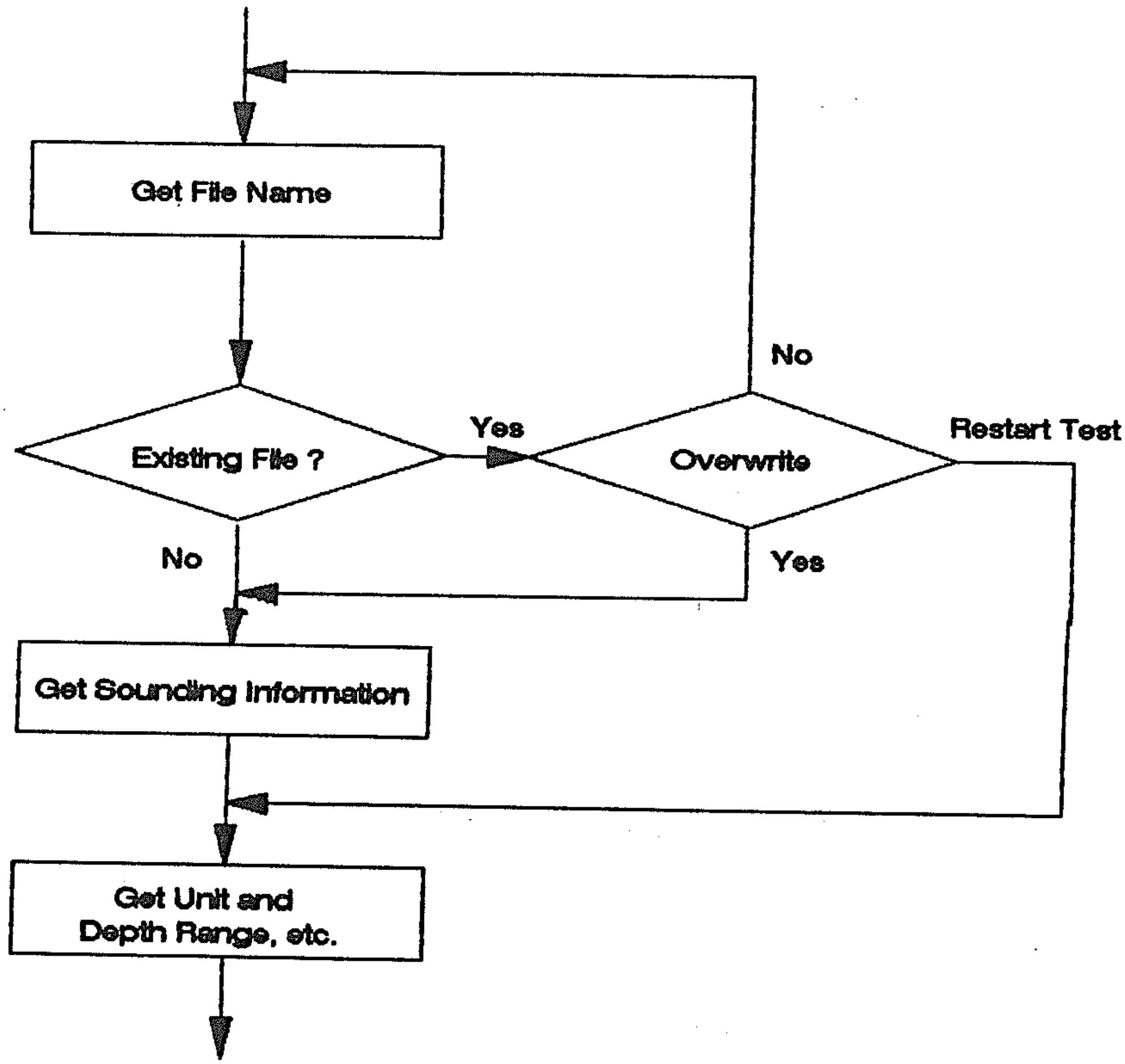

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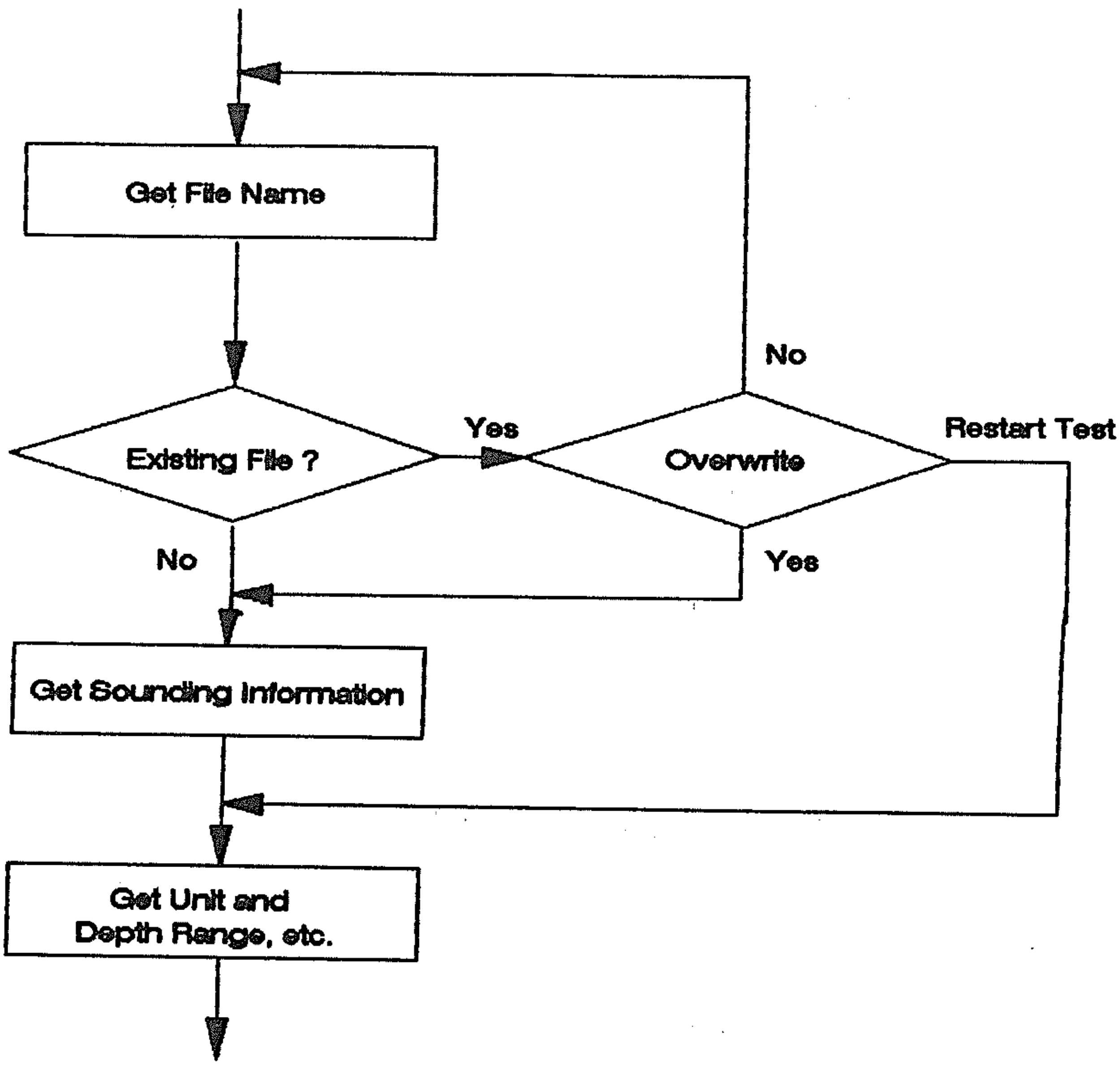
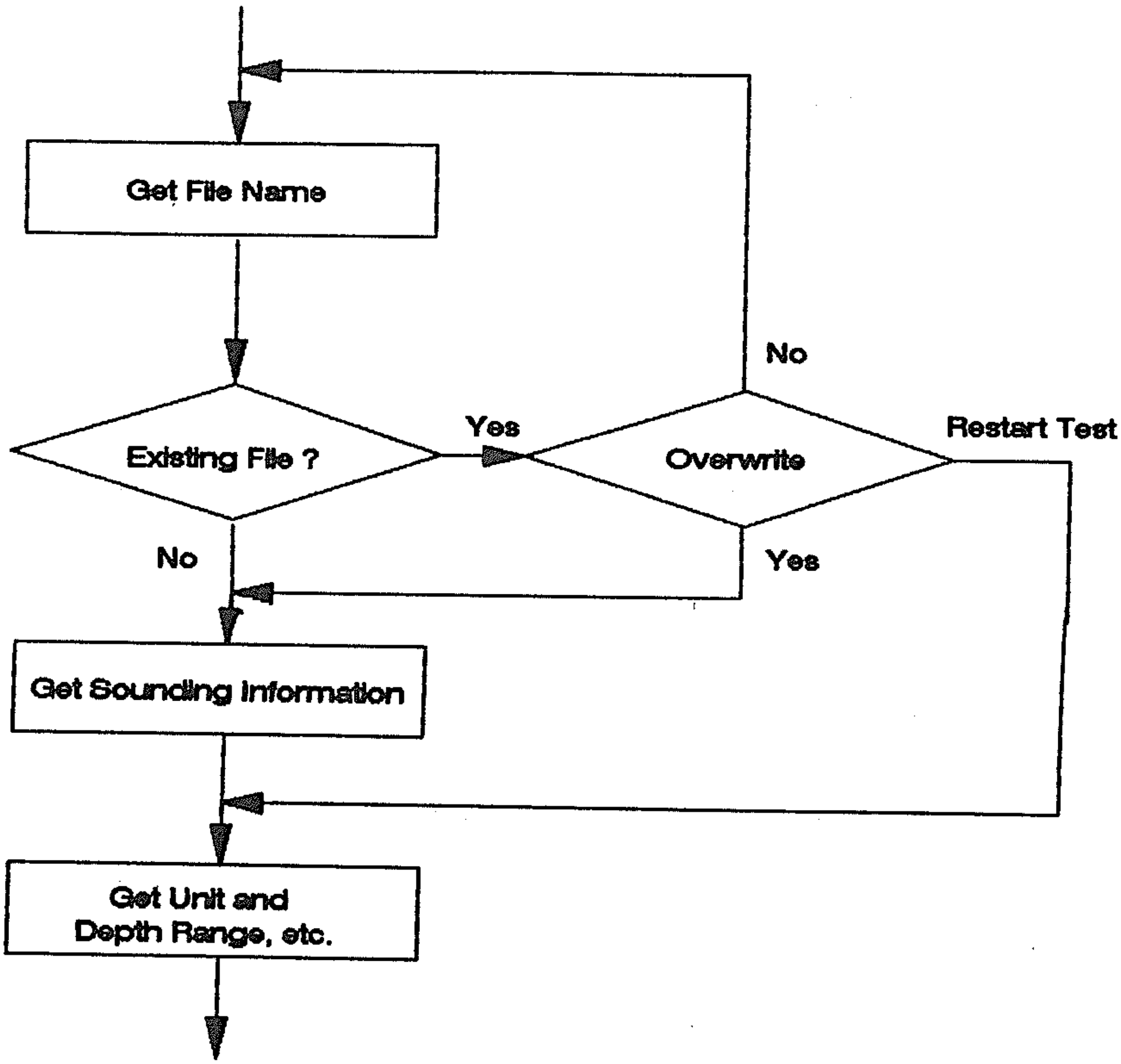


Input Function



APPENDIX B
CONEDATA PROGRAM

CONEDATA OPERATION MANUAL (14 pp)

FLOW CHART

1. Main
2. Initialization
3. Print Data
4. View Data
5. Input Data
6. Lat.-Long. Search
7. Project Number Search
8. Create Database
9. Database Name
10. Plot Data
11. Classify

SOURCE PROGRAM

1. **Function.ari**
2. **Funs.ari**
3. **Menu1.ari**

EXECUTABLE PROGRAM

three CONEDATA files:
- **CONEDATA.BAT**
- **CONEDATA EXE**
- **CONEDATA IDB**

two plotting files:
- **LSUPRINT.EXE/LTRCPLOT.EXE**
- **PCPTPLOT.EXE/LTRCPPLT.EXE**

one database file:
- **filename.DBS**

one rawdata file:
- **filename.extension**

one classify file:
- **CLASSIFY.EXE**

three reference files:
- **UPCASE.REF**
- **DATANAME.REF**
- **DATABASE.REF**

six HALO Font files:
- **HALO105.FNT**
- **HALO106.FNT**
- **HALO107.FNT**
- **HALO108.FNT**
- **HALO111.FNT**
- **HALO115.FNT**
- **HALO206.FNT**

two HALO printer and plotter derive files:
- **HALOEPSN.PRN**
- **HALO7475.EXE**

two other HALO files:
- **HALORTP4.EXE**
- **HALOTP4.P**

CONEDATA OPERATION MANUAL

CONEDATA is developed to process raw data accumulated from in-situ cone penetration testing (CPT) in the Louisiana Transportation Research Center (LTRC) research effort. CONEDATA features include:

- Database for storing sounding information from CPT
- Querying sounding information on existing CPT data
- Soil classification based on raw CPT data
- Generate plots for CPT data presentation.

1.0 GETTING STARTED

This section describes the procedures to get CONEDATA up and running on the computer. Among the topics covered are:

- The type of computer equipment that is required to use CONEDATA
- Installation of CONEDATA from the accompanying distribution disk
- Starting a CONEDATA session
- Terminating a CONEDATA session

1.1 Minimum Hardware And Software Requirement

CONEDATA will run on any IBM or IBM-compatible computer with a 80286, 80386 or 80486 central processing unit (CPU) using the MS-DOS 4.01 operating system. It is recommended that either a 80386 or 80486-based machine be used whenever this option is available as this will substantially reduce processing time. The computer must have a minimum of 640 kilobytes (KB) of random access memory (RAM). A hard disk drive with at least 2 megabytes of free space is also required. CONEDATA also requires that a dot matrix printer be connected to the first

```
System   Database   View Data
```

Figure 1 Main Menu

1.3.1 Inside CONEDATA

Three major functions are displayed on the main menu to allow the users to get access into the system (See Figure 1). The user can either move the left or right arrow key to move around the main menu to select one of these functions or by directly keying in the "accelerator key", which in this case is the highlighted character of each function in the main menu. As soon as one of the functions is selected, the sub-menu under each heading will appear. Figure 2 shows the sub-functions under the "System" function. The sub-functions include "Print" and "Quit". The "Print" function is used to produce a hardcopy of the latest result of the queries obtained during a CONEDATA session.

```
| System | Database   View Data
 Quit
 Print
```

Figure 2 "System" Sub Menu

1.4 Exiting From CONEDATA

You must exit from CONEDATA by selecting first the "System" option on the main menu. As soon as the sub-menu appears, use the "accelerator key" or the <cursor down> key to position the cursor to the Quit option and press <Enter>. The DOS prompt will appear on the screen, which indicates that the user has completed a CONEDATA session.

example of forms used within CONEDATA. Any keystrokes that are needed to efficiently running CONEDATA will be described in the appropriate sections that follow.

```
        Longitude:  Deg.          Min.          Sec.
         Latitude:  Deg.          Min.          Sec.
        File Name:
   Project Number:
         Comments:
```

Figure 4. Input Form -- Data Input Function

4.0 SAMPLE CONEDATA SESSION

An user session is described below to demonstrate individual function in the CONEDATA program. The distribution diskette contains a sample database that contains similar data described in this section. To start CONEDATA, the user will type CONEDATA at the operating system prompt. The following main menu screen will appear.

```
System  Database  View Data
```

Suppose we want to see how the CPT sounding data looks like in a datafile, we will press the <Cursor Right> key until the cursor is positioned at the "View Data" function and then press <Enter> or we can press the "Accelerator Key" (which is the character "V" at the main menu prompt) to enter into the "View Data" function, the following view data submenu screen will appear.

```
System  Database |View Data|
                  Raw Data
                  Classified Data
                  Plot
```

4.1 Query Database

Example 1:

Suppose we want to know how many borings are within a circular area where the center position is at 92° 0' 0" longitude and 31° 0' 0" latitude and a radius of 200,000 feet. We can use the "Database" function to search the database. Press the <Cursor Right> key to select the "Database" function in the main menu to display the "Lat_Long Search" sub-function similar to the following submenu screen. Now move the <Cursor Down> key to position the cursor at the "Lat_Long Search" sub-function and press <Enter>.

```
            Longitude:  Deg.  0      Min.  0      Sec.  0
             Latitude:  Deg.  0      Min.  0      Sec.  0

                 Correct ? (y/n/Esc)
```

Current Function: Latitude and Longitude Search

Output:

Output (Esc to quit this screen)

File Name	Longitude	Latitude	Comment
PHI2	91°52'37.45"	31°57'21.27"	50' S.W.BRIDGE
PHI3	91°52'37.48"	31°57'21.23"	55'S.W.BRIDGE
PHI1	91°52'35.54"	31°57'21.34"	45'E. OF N.E. COR.
CHE2	91°40'23.37"	32°21'7.22"	PARISH ROAD
CHE1	91°40'24.73"	32°21'6.45"	PARISH ROAD
SUGRCKT1	92°25'26.92"	31°19'0.78"	FOR R. BONILO
SUGRCKT3	92°25'28.23"	31°18'59.44"	FOR R. BONIOL
CHACAHU1	91°7'23.41"	30°16'52.06"	SITE 1 WEST LANE
CHACAHU3	91°7'16.33"	30°16'51.51"	SITE 3 WEST LANE
BEARTP2.CCC	90°42'46.89"	30°39'45.52"	TEST PILE 2
BEARTP3	90°42'44.07"	30°39'44.23"	TEST PILE 3
BEARTP1.CCC	90°42'42.11"	30°39'42.61"	TEST PILE 1
BONO1TP	92°25'27.34"	31°18'59.12"	BENT 47
BONO2	92°25'26.67"	31°18'59.82"	BENT 48C
BONO3	92°25'25.96"	31°19'0.52"	BENT 49C
BONO4	92°25'25.27"	31°19'1.24"	BENT 50C
BONO5TP	92°25'24.54"	31°19'1.97"	BENT 51
BONO6	92°25'23.82"	31°19'2.71"	BENT52
V1001D10	91°11'32.77"	30°17'7.89"	BENT # 1001
V1003D10	91°11'33.01"	30°17'7.82"	BENT # 1003
V1006D10	91°11'33.3"	30°17'7.68"	BENT # 1006
V1009D10	91°11'33.52"	30°17'7.56"	BENT # 1009
V1013D10	91°11'33.8"	30°17'7.42"	BENT # 1013
V1015D10	91°11'34.05"	30°17'7.27"	BENT # 1015
V1017D10	91°11'34.12"	30°17'7.12"	BENT # 1017

00001:001

Example 3:

Suppose we need information on a specific project number to see the number of soundings that are under this project number, we will select the "Project Number Search" sub-function under the "Database" function and enter a project number as the search criteria, the following screen will appear:

```
            Project Number:  455-05-44

                     Correct ? (y/n/Esc)
```

Function: Project Number Search

Example 5:

Suppose that the "ltrc" database is not the desired local database. Answer "y" to the above confirmatory prompt to input a new database name. The following screen will appear to prompt for the new database name to be loaded into main memory. Suppose we want to load "mydbase" into the main memory, simply input "mydbase" at the "New Database Name" prompt and enter "y" to confirm the input.

```
Current DataBase: LTRC

Databases Under Current directory: C:\CONEDATA

LSU101     LSU102     LSU103     MYDBASE

New Database Name:  mydbase

Correct ? (y/n/Esc)
```

Current Function: Change Data Base Name

Example 6:

Suppose we want to input a new CPT sounding "CPT20" into the current database, we will bring up the "Input Data" sub-function from the "Database" function in the main menu. An empty form similar to the following will appear on the screen.

```
     Longitude:  Deg.        Min.        Sec.
      Latitude:  Deg.        Min.        Sec.
     File Name:
Project Number:
      Comments:
```

Enter the information for CPT20 into the above screen and confirm the input when prompted by the program.

```
     Longitude:  Deg.  91    Min.  52    Sec.  0
      Latitude:  Deg.  31    Min.  57    Sec.  0
     File Name:  CPT20
Project Number:  713-53-10
      Comments:  50'S.W.BRIDGE

            Correct ? (y/n) y

            More Input ? (y/n/Esc)
```

Example 5:

Suppose that the "ltrc" database is not the desired local database. Answer "y" to the above confirmatory prompt to input a new database name. The following screen will appear to prompt for the new database name to be loaded into main memory. Suppose we want to load "mydbase" into the main memory, simply input "mydbase" at the "New Database Name" prompt and enter "y" to confirm the input.

```
Current DataBase: LTRC

Databases Under Current directory: C:\CONEDATA

LSU101     LSU102     LSU103     MYDBASE

New Database Name:  mydbase

Correct ? (y/n/Esc)
```

```
Current Function: Change Data Base Name
```

Example 6:

Suppose we want to input a new CPT sounding "CPT20" into the current database, we will bring up the "Input Data" sub-function from the "Database" function in the main menu. An empty form similar to the following will appear on the screen.

```
      Longitude:  Deg.          Min.          Sec.
       Latitude:  Deg.          Min.          Sec.
      File Name:
 Project Number:
       Comments:
```

Enter the information for CPT20 into the above screen and confirm the input when prompted by the program.

```
      Longitude:  Deg.  91     Min.  52     Sec.  0
       Latitude:  Deg.  31     Min.  57     Sec.  0
      File Name:  CPT20
 Project Number:  713-53-10
       Comments:  50'S.W.BRIDGE

                Correct ? (y/n) y

                More Input ? (y/n/Esc)
```

```
                SOIL CLASSIFICATION
                       USING
            ELECTRIC CONE PENETROMETER

                         By

            Adrian Chan and Mehmet Tumay

  Enter input file name : data.dat
  Enter output file name: data.out
```

```
Do you want to display result (Y/N)?
```

```
Do you want to get Hard copy (Y/N) ?
```

Example 9:

Suppose a graphical output of the CPT sounding is required, the "Plot" sub-function in the "View Data" sub-menu can be used to perform the job. The user is required to select the the cone type and the output device from the following screen:

```
     1. Friction Cone      2. Dualpiezo Cone    1

     1. Show on Screen     2. Plot on Plotter   1

              Correct ? (y/n/Esc)
```

After confirming the above choices, we will then input the filename, depth range, depth unit, etc. in the following prompts:

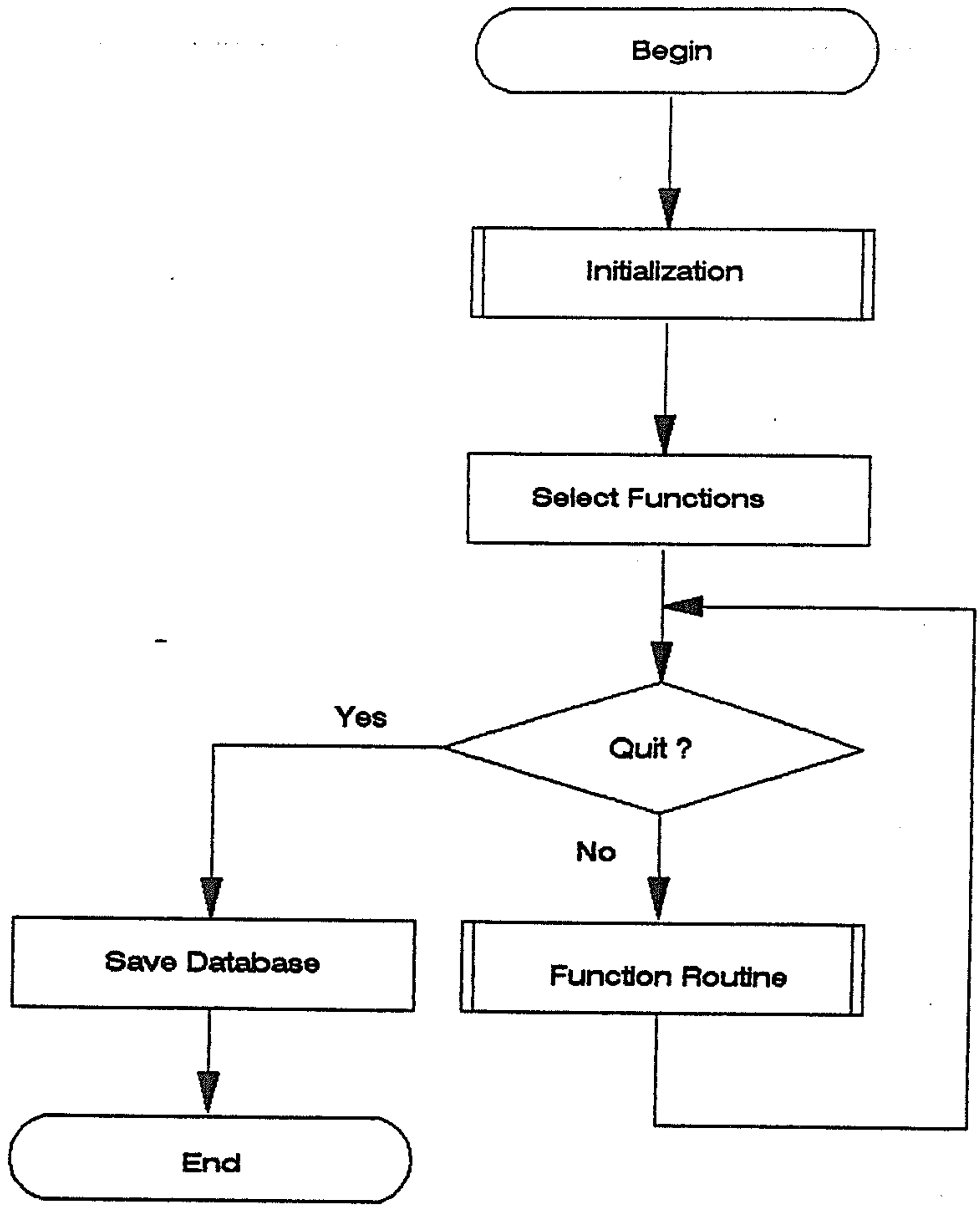
Please input file name for display/plot [data.dat]

Depth Unit Used For Plotting :

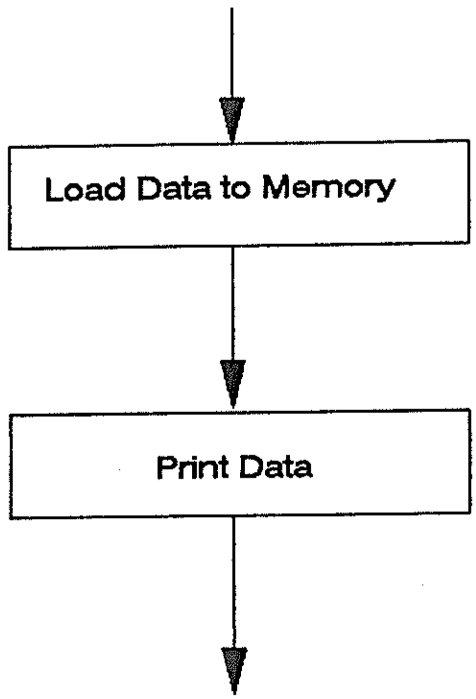
1 = Meter 2= Foot [1]

Begin depth: 0 End depth: 10

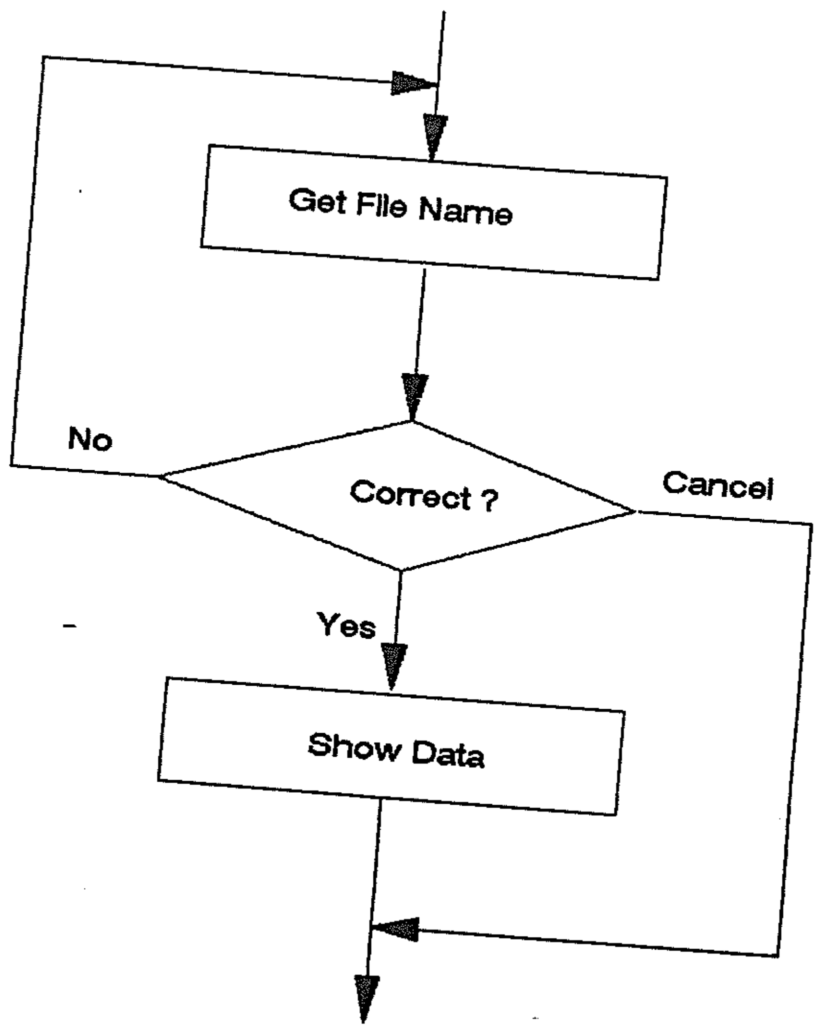
CONEDATA Program



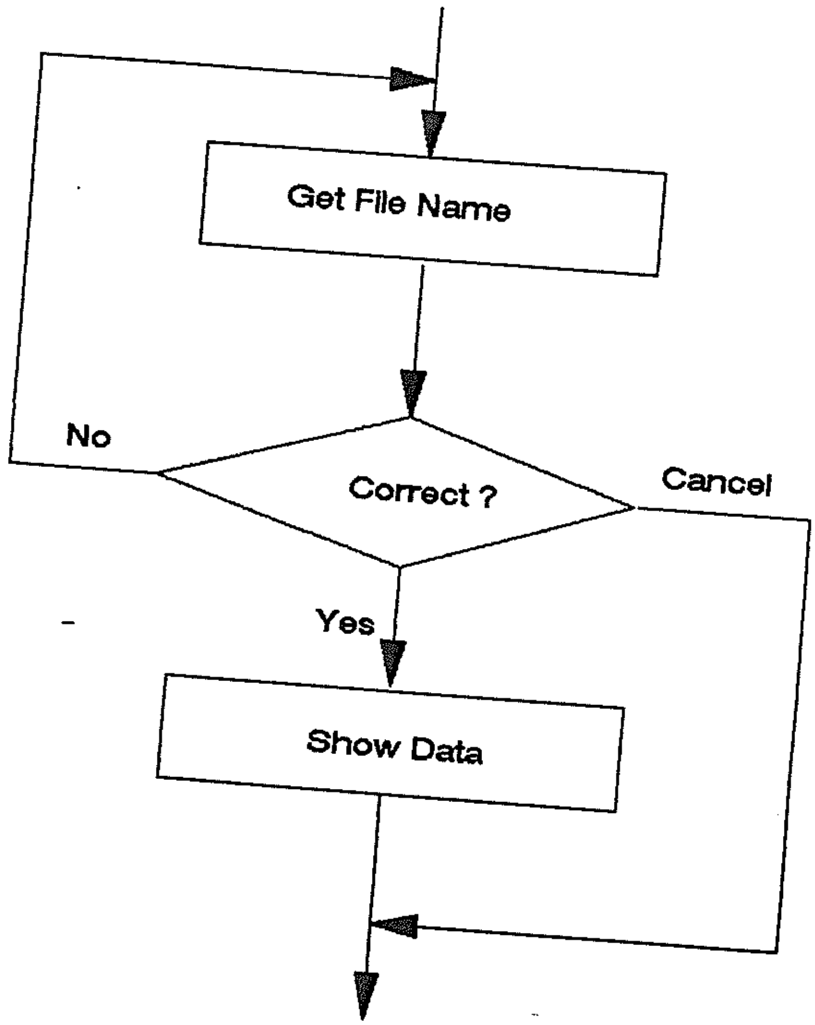
Print Routine



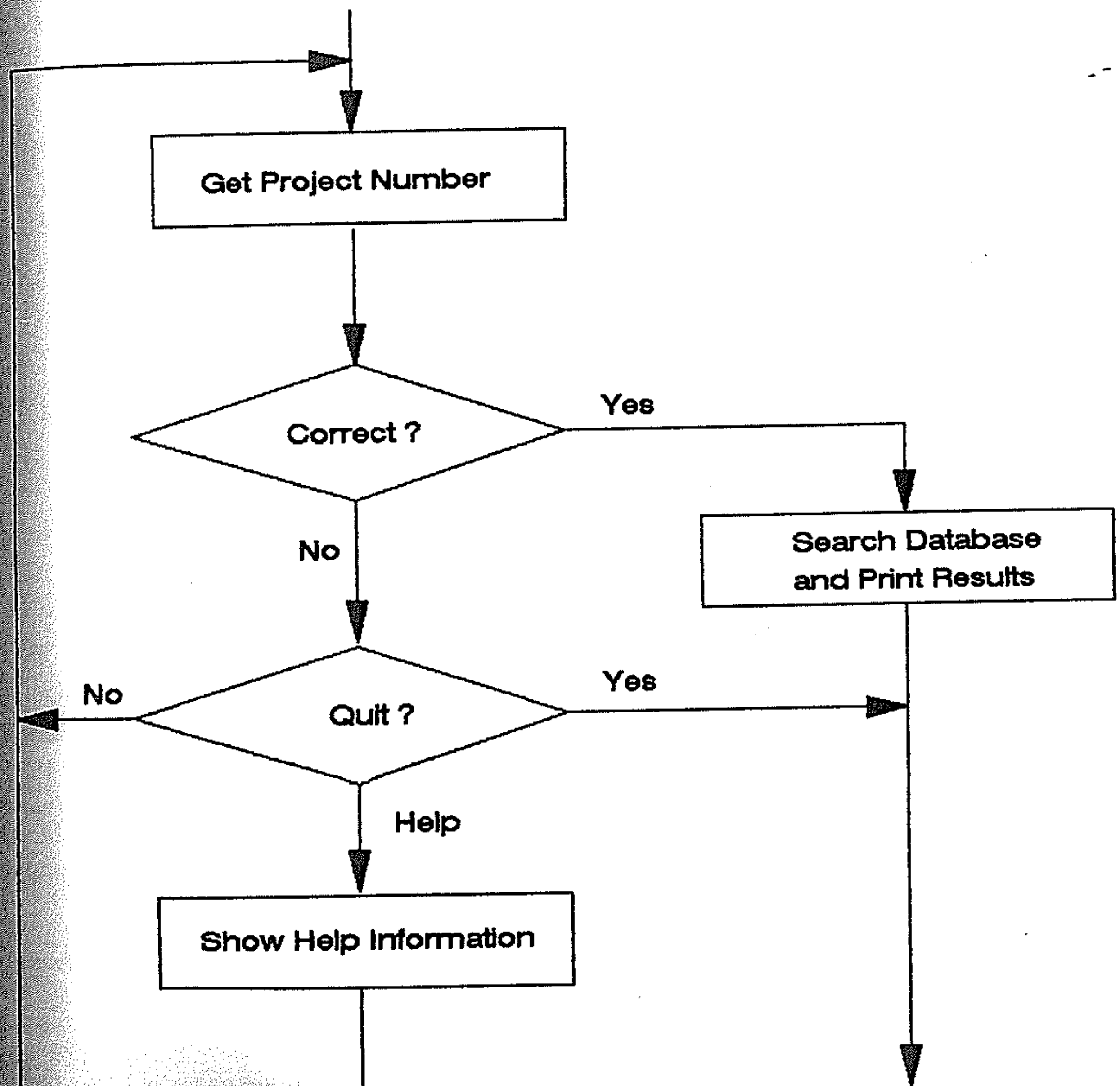
View Data Routine (ConeData)



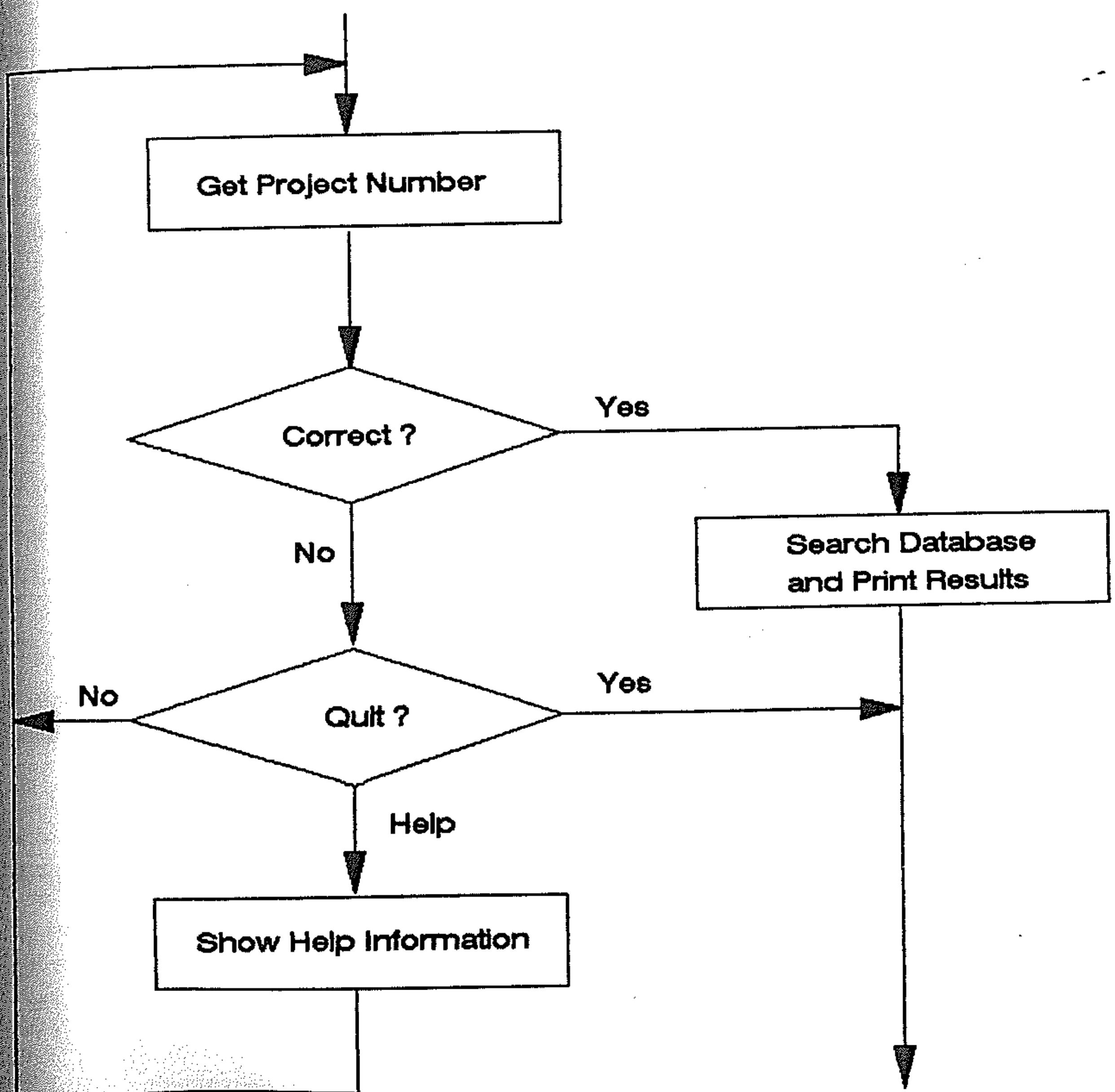
View Data Routine (ConeData)



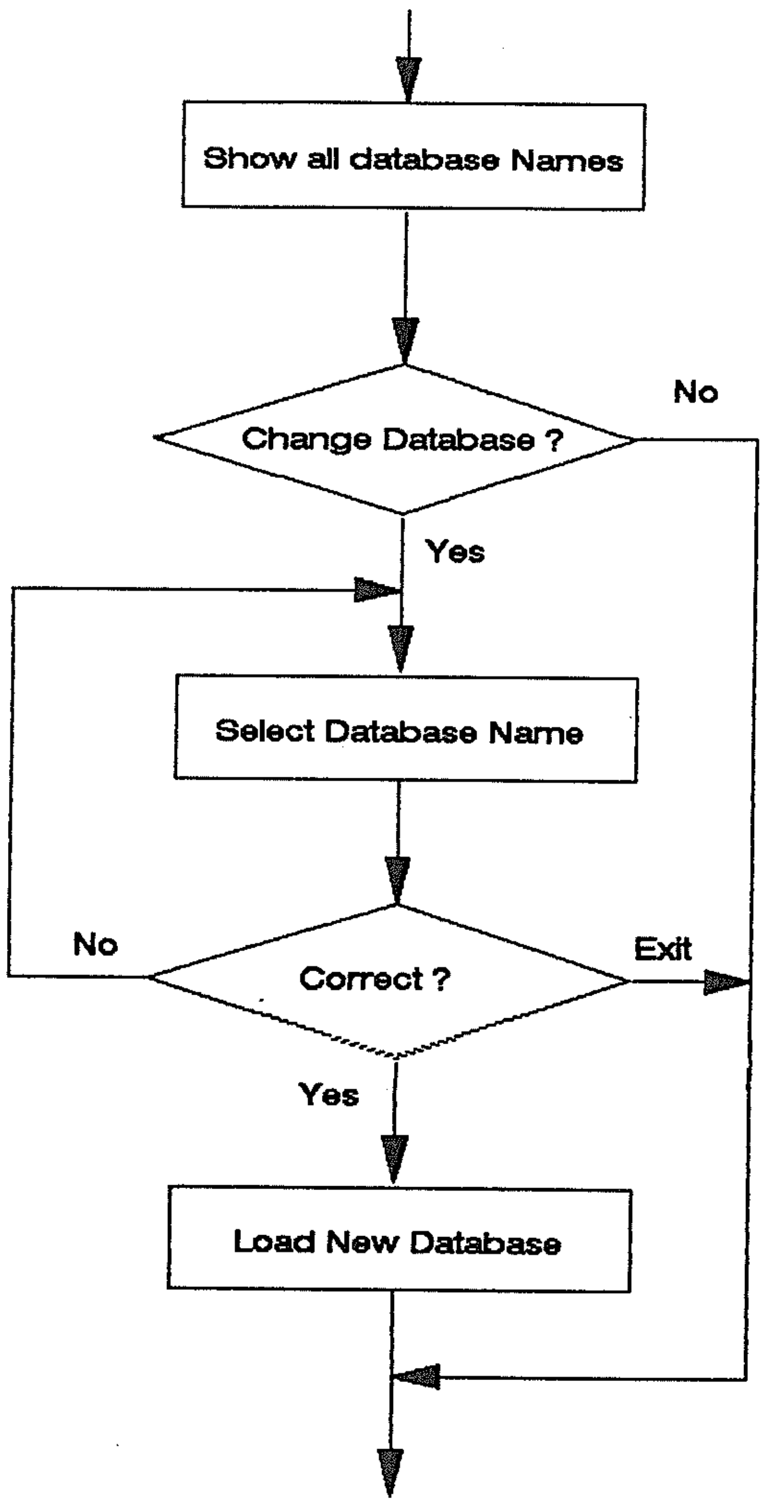
Project Search Routine (ConeData)



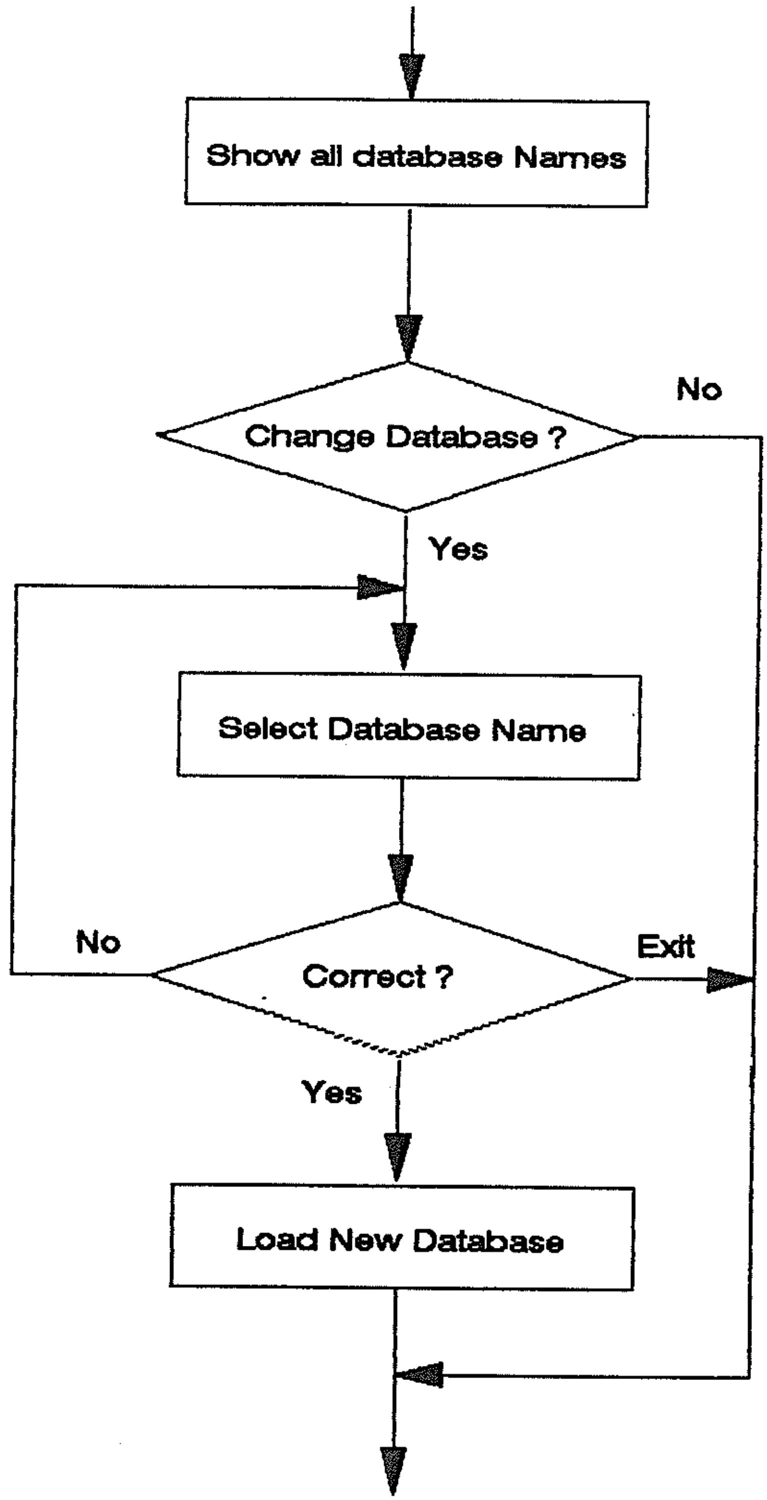
Project Search Routine (ConeData)



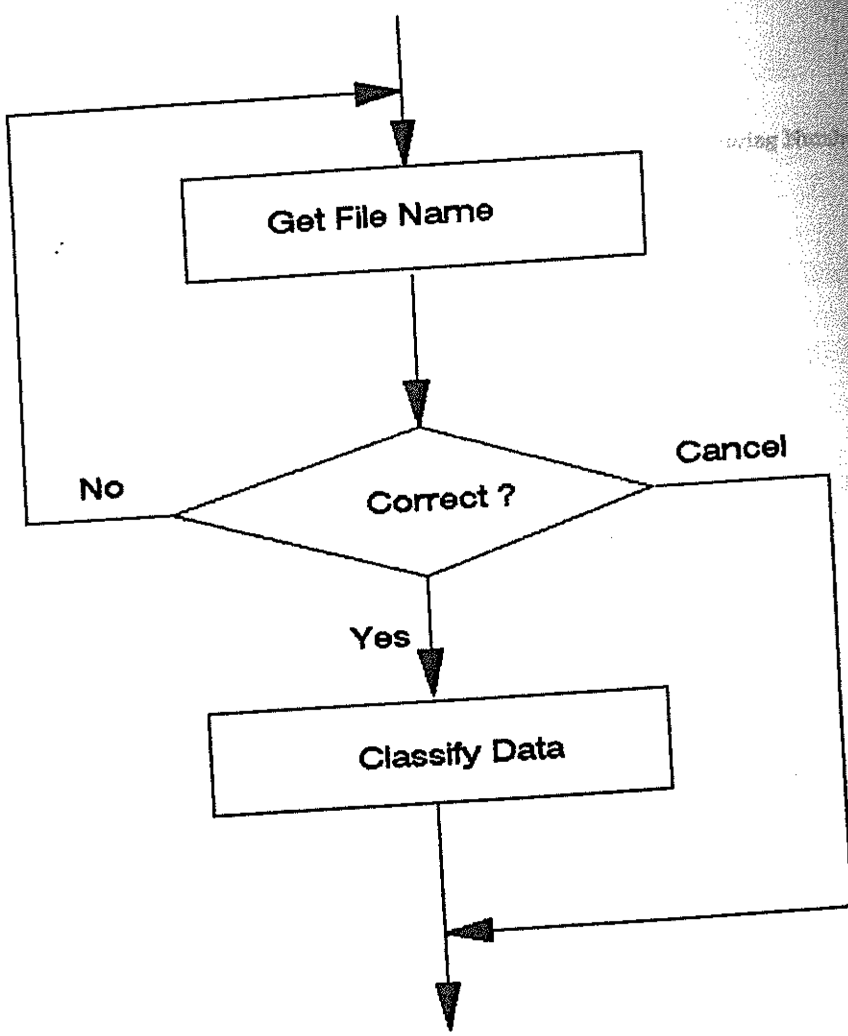
Database Name Routine (ConeData)



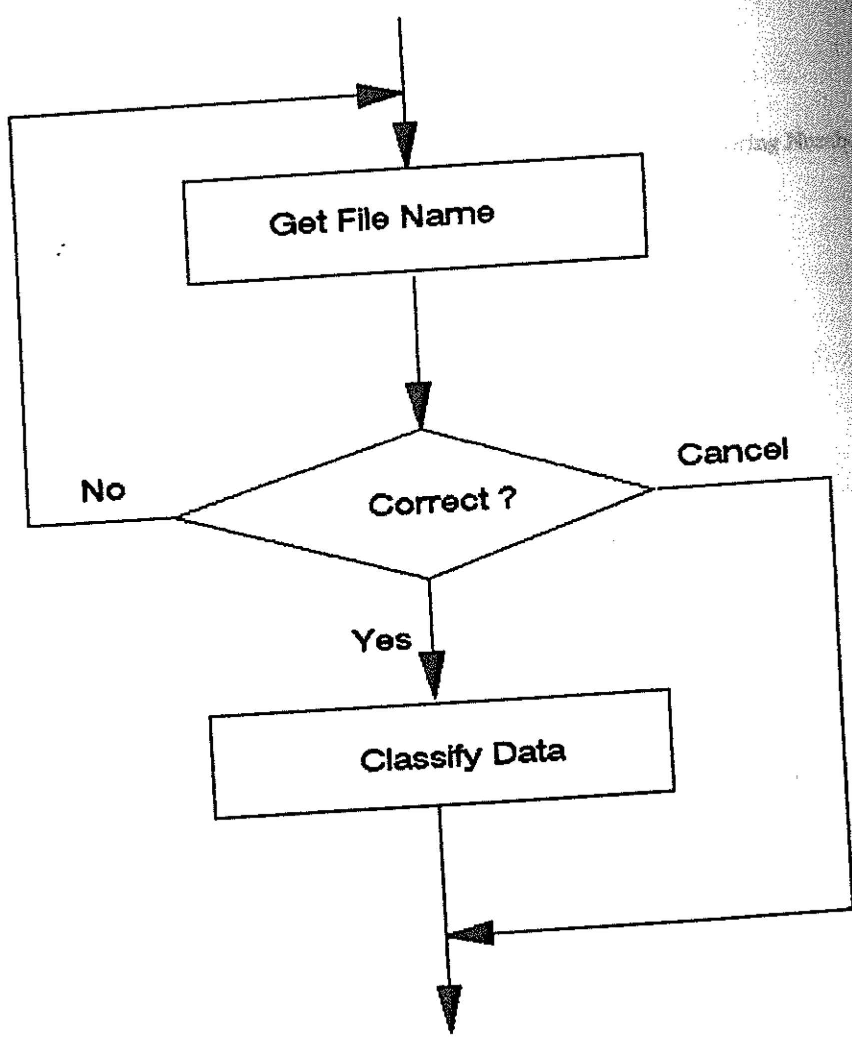
Database Name Routine (ConeData)



Classify Routine (ConeData)



Classify Routine (ConeData)



APPENDIX C
CONEXP PROGRAM

CONEXP OPERATION MANUAL (49 pp)

DEFINITIONS (2 pp)

FLOW CHART

1. Main
2. Print
3. Shell
4. Initialization
5. Soil Classification
6. Add Data to Chart
7. Chart Name
8. Adjacent Boring/Boring Information/Test Match/Existing Boring/Boring Number
9. AASHTO/General Adjacent Boring
10. Input Data
11. Database Name
12. Create Database
13. Edit Constants
14. Edit Record
15. Delete Hole
16. Output File Name

SOURCE PROGRAM

1. **First.ari**
2. **Menu.ari**
3. **Second.ari**
4. **Fun2.ari**
5. **Fun3.ari**
6. **Fun4.ari**

EXECUTABLE PROGRAM

one install file:
INSTALL.BAT

two conexp files:
CONEXP.EXE
CONEXP.IDB

three data files:
filename.DAT
filename.TAB
filename.CON

five chart files:
TUM.CHT
SEN.CHT
ROBU.CHT
ROBQT.CHT
ROBQC.CHT

thirteen reference files:
AASHTO.REF
CAPITAL.REF
CHARTNAME.REF
CONSTANT.REF
DATAFRAM..REF
FILENAME.REF
HELP1.REF
HELP2.REF
NAME.REF
SCOPE.REF
SOILNAME.REF
SOILTYPE.REF
STRUCT.REF

CONEXP OPERATION MANUAL

CONEXP is the implementation of the database model GEDM for processing data accumulated from in-situ geotechnical testing such as cone penetration testing (CPT) and/or conventional laboratory geotechnical testings during a site investigation program. CONEXP features include:

- Standard format for entering insitu (ie. CPT) and laboratory data.
- An internal database that contains information from published soil classification charts for CPT and PCPT interpretation.
- The capability to generate queries that allow verification of CPT and laboratory data.
- The capability to fine tune the internal database to allow for soil classification based on local experiences generated from actual project site.

1.0 Getting Started

This section describes the procedures to get CONEXP up and running on the computer. Among the topics covered are:

- What type of computer equipment is required to use CONEXP
- How to install CONEXP using the accompanying distribution disk
- How to start CONEXP
- How to terminate a CONEXP session

1.1 Minimum Hardware and Software Requirement

CONEXP will run on any IBM or IBM-compatible computer with a 80286, 80386 or 80486 central processing unit (CPU) using the MS-DOS 4.01 operating system. It is recommended that either a 80386 or 80486-based machine be used whenever this option is available as this will substantially reduce processing time. The computer must have a minimum of 640 kilobytes (KB) of random access memory (RAM). A hard disk drive with at least 2 megabytes of free space is also required. CONEXP requires that an 80-column dot matrix printer, preferably column printer, be connected to the first parallel port of the computer.

1.2 Installing CONEXP

To install CONEXP, first insert the diskette entitled "CONEXP Disk 1" in drive A. Next A:INSTALL, then press <Enter>. As the installation of CONEXP proceeds, follo instructions that appear on the screen. Do the following after the installation proc completed:

i. Add or modify the following lines to the CONFIG.SYS file which is nor found in the root directory of the computer:

```
BREAK=ON
BUFFERS=20
FILES=40
LASTDRIVE=E
SHELL=C:\DOS\COMMAND.COM /P /E:256
DEVICE=C:\DOS\ANSI.SYS /K
```

ii. Add or modify the following line in the AUTOEXEC.BAT file which is norm found in the root directory as follow:

```
PROMPT $P$G
PRINT /D:LPT1
```

1.3 Starting CONEXP

The installation procedure will create a sub-directory name CONEXP on the C drive. To st CONEXP from the root (C:\) directory, do the following:

i. type CD\CONEXP, then press [Enter].

ii. type CONEXP at the C:\>CONEXP prompt, then press [Enter].

The following menu (Figure 1) will appear on the screen. The following section will detail individual function of CONEXP.

```
System  Charts  Database  Edit                                   Help
```

Figure 1 Main Menu

1.3.1 Inside CONEXP

Five major functions are displayed on the main menu to allow the users to get access into the system (See Figure 1). The user can either move the left or right arrow key to move around the main menu to select one of these functions or by directly keying in the "accelerator key", which in this case is the highlighted character of each function in the main menu. As soon as one of the functions is selected, the sub-menu under each heading will appear. Figure 2 shows the sub functions under the "System" function. The "System" function, as its name suggested, is used to interface with the DOS system. The sub functions include "Print", "Shell", and "Quit". The "Print" function is used to produce a hardcopy of the result of the queries obtained during a CONEXP session. The user can select any available output files (files with an OUT extension) saved from a previous session or queries from the current session (Figure 3) for hardcopy output. The "Shell" function allows the user to temporary exit the program and perform any DOS system calls under the DOS system shell. In order to get back to the CONEXP session, the user is required to type "EXIT" and then press <enter> while inside the DOS system.

```
|System| Charts  Database  Edit                                   Help
 Print
 Shell
 Quit
```

Figure 2 "System" Sub Menu

1.4 Exiting from CONEXP

You must exit from CONEXP by selecting first the "System" option on the main menu. As soon as the sub-menu appears, use the "accelerator key" or the <cursor down> key to position the cursor to the Quit option and press <Enter>. The DOS prompt will appear on the screen, which indicates that the user has completed a CONEXP session.

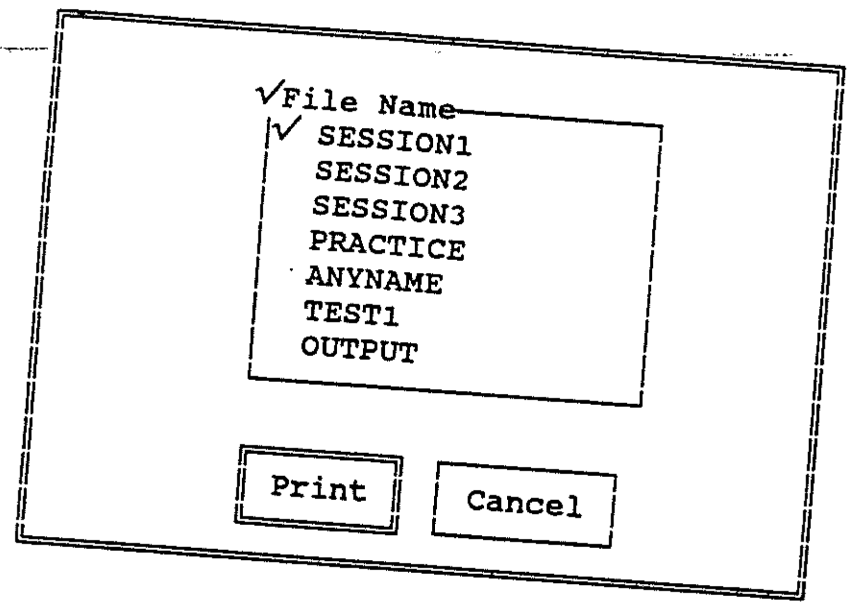


Figure 3. Selecting Files for Hardcopy Output

2.0 Getting around CONEXP

This section introduces the different types of screen displays the user will encounter when using CONEXP. It also describes the function of the keystrokes that allows the user to efficiently navigate within the CONEXP's environment, perform queries, input and/or edit data.

2.1 CONEXP Screen Displays

Most of the screen displays in CONEXP fall into three major categories, that is, menu, choice-box and form. Menu consists of the main menu and the submenu. The main menu for CONEXP is shown in Figure 1. Each option within the menu is associated with an "accelerator key" which is identified by the highlighted character on each option. When a function in the main menu is selected, (e.g. the Charts function) a submenu screen similar to Figure 4 will appear. A choice-box is used to allows the user to choose a selection from a prescribed number of choices. Figure 3 is an example of a choice-box used in selecting a file for hardcopy output. A form is used to solicit input from the user according to the information that is needed by the selected function. Figure 5 is an example of forms within CONEXP.

2.2 Common Key Stroke

Option selection within the main menu can be achieved by using the <Cursor Left> or <Cursor Right> key to position the cursor to the required function and press the <Enter> key, or use the "accelerator key" to select directly. Figure 4 is a submenu that belongs to the "Charts" sub-function of the Main Menu. Submenu selection can be achieved by using the <Cursor Up> or <Cursor Down> key to position the cursor to the required sub-function and press the <Enter> key, or use the "accelerator key" which is similar to the main menu for direct selection of sub-function. Figure 3 is an example of a choice-box used in selecting a file for hardcopy output. The <Cursor Up> or <Cursor Down> key allows the user to move to the choice, the <Space Bar> is used to select or de-select the choice, the <Tab> or <Back Tab> key is used to move from one window to another within the screen. Within a form, all input to a field is accomplished when the <Enter> key is pressed, i.e., the <Enter> key will bring the cursor to the next field position. Figure 5 is an example on forms within CONEXP. Any keystrokes that are needed to efficiently running CONEXP will be described in the appropriate sections that follow.

```
System  |Charts|  Database  Edit                          Help

         Soil Classification
         Add Data to Chart
         Chart Name
```

Figure 4. Sub-menu Under Charts Function

```
                Depth(FEET):      10

               AVE FS(TSF):       2
               AVE QC(TSF):       40
            AVE TIP U(TSF):       0
         AVE SLEEVE U(TSF):       0


         Inputs OK ? (y/n/Esc)
```

Figure 5. Input Form -- Soil Classification Chart

3.0 Main Menu System

The Main Menu consists of the System, Charts, Database, Edit and Help function for CONEXP. The following sections present the submenus under each function in the main menu.

3.1 System

The "System" function of the Main Menu is described in Section 1.3.1.

3.2 Charts

The "Charts" function consists of i) Soil Classification, ii) Add Data and iii) Chart Name sub-functions. Figure 4 shows the sub-functions that belong to the "Charts" function. The "Soil Classification" function is for user to check on existing published CPT data as correlated to general soil types. When the published data does not match local correlation, the "Add Data" function can be called up to input the particular data point into the data base. "Chart Name" is used to load a different published chart that is provided by CONEXP into the computer memory.

3.3 Edit

The "Edit" function allows the user to i) edit the values on all the constants that is used in the database, ii) rename the file that is used to store the data, iii) edit individual record in the database and iv) complete removal of a borehole information.

3.4 Database

The "Database" function allows for data manupulation, that is, for inputting and querying the database currently loaded in memory. This function lets the user to i) input laboratory data and CPT sounding data into a local database, ii) request adjacent boring information, that is, to display information from the local database that are of close proximity, iii) display information from an individual borehole or sounding, iv) request matching field or laboratory tests, that is, to display soil information based on a specific test information v) inquire boring information in existing local database, vi) quick check on boring number from existing local database, vii) obtain AASHTO classification on boreholes that contained Atterbery Limits and grain size analysis data , viii) create a new local database and ix) load other existing local database into the computer memory.

4.1 Query Database

Example 1: Use the "Charts" function to interpret CPT data obtained from the field for soil classification based on a published source (e.g. Tumay, 1987 chart). Press the "accelerator key" (i.e. the character "C") or the <Cursor Right> key to get to the following "Charts" submenu while in the Main Menu.

```
 System  |Charts|  Database  Edit                         Help
         +--------------+
         | Soil Check   |
         | Add Data     |
         | Chart Name   |
         +--------------+
```

Select the "Chart Name" sub-function by pressing the character "N" to make sure that the correct soil classification chart is residing in the internal database, namely, to check that the "TUM" chart appears on the "Chart Name" form. In this case, the "ROBQT" chart appeared as the current internal database. In order to change the "ROBQT" chart to the "TUM" classification chart, enter "y" to the "Do you want to change" prompt.

```
Current Chart File: robqt

Cone Type: friction cone

Do you want to change ? (y/n)
```

Move the <Cursor Down> key to position the cursor on the "tum(friction cone)" row in the following window. Press the <Space Bar> to select the "TUM" friction cone chart as the current internal database. Next move the cursor to the "OK" window box by pressing the <Tab> key once. Note that the "OK" window will have a double box surrounding it. This indicated that the cursor is at the "OK" window. Select "OK" by pressing the <Enter> key. This will invoked the "TUM" chart into the computer memory. If by any chance that the "ROBQT" chart is preferred, go to the "Cancel" window and hit the <Enter> key to cancel any selection.

4.1 Query Database

Example 1: Use the "Charts" function to interpret CPT data obtained from the field for soil classification based on a published source (e.g. Tumay, 1987 chart). Press the "accelerator key" (i.e. the character "C") or the <Cursor Right> key to get to the following "Charts" submenu while in the Main Menu.

```
 System  |Charts|  Database  Edit                    Help
          Soil Check
          Add Data
          Chart Name
```

Select the "Chart Name" sub-function by pressing the character "N" to make sure that the correct soil classification chart is residing in the internal database, namely, to check that the "TUM" chart appears on the "Chart Name" form. In this case, the "ROBQT" chart appeared as the current internal database. In order to change the "ROBQT" chart to the "TUM" classification chart, enter "y" to the "Do you want to change" prompt.

```
Current Chart File: robqt

Cone Type: friction cone

Do you want to change ? (y/n)
```

Move the <Cursor Down> key to position the cursor on the "tum(friction cone)" row in the following window. Press the <Space Bar> to select the "TUM" friction cone chart as the current internal database. Next move the cursor to the "OK" window box by pressing the <Tab> key once. Note that the "OK" window will have a double box surrounding it. This indicated that the cursor is at the "OK" window. Select "OK" by pressing the <Enter> key. This will invoked the "TUM" chart into the computer memory. If by any chance that the "ROBQT" chart is preferred, go to the "Cancel" window and hit the <Enter> key to cancel any selection.

Similarly, the field and laboratory local database can be queried through the "Database" function. One should note that for performing side by side comparison of CPT sounding data and laboratory testing result from adjacant borehole, we can adjust the closeness of a cluster of boreholes from which the search is performed.

Example 2: Define the proximity for searching adjacent borehole. First, select the "Edit" function from the main menu. The following "Edit" submenu screen will appear.

```
 System  Charts  Database |Edit|                    Help
                          | Constants  |
                          | File Name  |
                          | Edit Record|
                          |------------|
                          | Delete Hole|
```

Select the "Constants" sub-function to edit the value of the "near_hole" parameter. When the following screen appears, move the cursor to the "near_hole(15000)" row and press the <Space Bar> to select this constant. This will allow the user to alter the proximity of adjacent borehole as a search criteria. More than one constant can be edited moving the <Cursor Down> or <Cursor Up> key to the desired constant and then depressed the <Space Bar>. Next, use the <Tab> key to move the cursor to the "OK" window box and press <Enter>.

```
 √Constants
 |√ unit_system(default)
 |√ near_hole(15000.0,FEET)
 |  gamma(120.0,PCF)
 |  gamma_water(64.76,PCF)
 |  nk(10)
 |  constant_end_area_ratio(0.65)
 |  central_longitude(91,0,0)
 |  central_latitude(32,0,0)
 |  limitation(ave_fs,0.0,100.0,TSF)
 |  limitation(ave_qc,0.0,100.0,TSF)

    [ Ok ]              [ Cancel ]

Current Function: Edit Constants    System Unit: Default
```

Similarly, the field and laboratory local database can be queried through the "Database" function. One should note that for performing side by side comparison of CPT sounding data and laboratory testing result from adjacant borehole, we can adjust the closeness of a cluster of boreholes from which the search is performed.

Example 2: Define the proximity for searching adjacent borehole. First, select the "Edit" function from the main menu. The following "Edit" submenu screen will appear.

```
 System   Charts   Database  |Edit|                      Help
                             Constants
                             File Name
                             Edit Record
                             -----------
                             Delete Hole
```

Select the "Constants" sub-function to edit the value of the "near_hole" parameter. When the following screen appears, move the cursor to the "near_hole(15000)" row and press the <Space Bar> to select this constant. This will allow the user to alter the proximity of adjacent borehole as a search criteria. More than one constant can be edited moving the <Cursor Down> or <Cursor Up> key to the desired constant and then depressed the <Space Bar>. Next, use the <Tab> key to move the cursor to the "OK" window box and press <Enter>.

```
    √Constants
    √ unit_system(default)
    √ near_hole(15000.0,FEET)
      gamma(120.0,PCF)
      gamma_water(64.76,PCF)
      nk(10)
      constant_end_area_ratio(0.65)
      central_longitude(91,0,0)
      central_latitude(32,0,0)
      limitation(ave_fs,0.0,100.0,TSF)
      limitation(ave_qc,0.0,100.0,TSF)

       Ok                   Cancel

Current Function: Edit Constants    System Unit: Default
```

When the following screen appears, input the desire closeness or proximity between two adjacent borings during the database search. In this case, ten thousand feet is input to replace the fifteen thousand feet as the search criteria between any two boreholes during this and subsequent sessions unless a new value is desired again.

```
        near hole(FEET): 15000.0

        New Value: 10000

        Correct ? (y/n/Esc)

Current Function: Edit Constants                 System Unit: Default
```

We are now set to query the CPT and laboratory data from the database. Select the "Database" function from the Main Menu screen.

Example 3: Suppose we want to find matches of all dual piezocone tests and friction cone tests that are performed close by a friction cone test location with a sounding number of CPT131. Note that the user is required to know the longitude and latitude of CPT131 to perform the query. Further, we are only interested in displaying the average frictional resistance, the average tip resistance, the friction ratio, the average tip pore pressure and the average sleeve pore pressure of the piezocone test between 10 and 20 feet below ground surface where the frictional resistance is greater than 0.2 kg/cm^2. Use the following "Database" function screen for the selection of sub-functions "aDjacent Boring".

```
 System  Charts |Database| Edit                              Help
                 Input Data
                 Query
                   General Adjacent Boring
                   aDjacent Boring
                   Borehole Information
                   Test Match
                   Existing Boring
                   bOring Number
                   AASHTO
                 Create DataBase
                 Database Name
```

When the following screen appears, input the desire closeness or proximity between two adjacent borings during the database search. In this case, ten thousand feet is input to replace the fifteen thousand feet as the search criteria between any two boreholes during this and subsequent sessions unless a new value is desired again.

```
        near hole(FEET): 15000.0

        New Value: 10000

        Correct ? (y/n/Esc)

Current Function: Edit Constants                System Unit: Default
```

We are now set to query the CPT and laboratory data from the database. Select the "Database" function from the Main Menu screen.

Example 3: Suppose we want to find matches of all dual piezocone tests and friction cone tests that are performed close by a friction cone test location with a sounding number of CPT131. Note that the user is required to know the longitude and latitude of CPT131 to perform the query. Further, we are only interested in displaying the average frictional resistance, the average tip resistance, the friction ratio, the average tip pore pressure and the average sleeve pore pressure of the piezocone test between 10 and 20 feet below ground surface where the frictional resistance is greater than 0.2 kg/cm^2. Use the following "Database" function screen for the selection of sub-functions "aDjacent Boring".

```
System   Charts  |Database|  Edit                         Help
                 Input Data
                 Query
                  General Adjacent Boring
                  aDjacent Boring
                  Borehole Information
                  Test Match
                  Existing Boring
                  bOring Number
                  AASHTO
                 Create DataBase
                 Database Name
```

```
Attributes
  √Attributes                      √Condition
   √ ave_fs                         √ ave_fs
   √ ave_qc                           ave_qc
   √ ave_tip_u                        ave_tip_u
   √ ave_sleeve_u                     ave_sleeve_u
   √ frict_ratio                      frict_ratio
     ave_qc_corr                      ave_qc_corr
     tip_u_ratio                      tip_u_ratio

              Ok                         Cancel

Current Function: Adjacent Boring          System Unit: Default
```

Use the <Space Bar> key to select the required displayed attributes, then move the cursor t the "condition" window by depressing the <Tab> key. Select the "ave_fs" since we want t restrict our search on certain average friction resistance value. Next, move the cursor to th "OK" window by depressing on the <Tab> key and press the <Enter> key to bring up th following screen for entering the condition of average friction resistance of greater than 0. kg/cm^2.

```
     ave_fs(TSF):
     Condition: >0.2

     Correct ? (y/n/Esc)

Current Function: Adjacent Boring          System Unit: Default
```

Next, we want to further specify for boring number "CPT131" and the depth interval that we are interested in. Input the degree, minute and second of the longitude and latitude of sounding location "CPT131" on the following screen and then press the <Enter> key. Note that the Project Number (which is tied to the longitude and latitude of all sounding/boring locations within the same project), Location, State, Job Site and Elevation of "CPT131" will be displayed. The cursor will be positioned at the begin depth prompt of the Query Depth Interval. Input 10 and 20 at the begin depth and end depth prompt respectively to complete the above required query.

```
         Longitude:  Deg.  89      Min.  5       Sec.  0
          Latitude:  Deg.  31      Min.  0       Sec.  0
    Project Number:  987-65-4321
          Location:  Baton Rouge
             State:  Louisiana

     Boring Number:  cpt131
          Job Site:  Central
   Elevation(FEET):  10

  Test Depth Interval(FEET):  0.0 to 76.0
 Query Depth Interval
       Begin Depth:  10      End Depth: 20

        Correct ? (y/n/Esc)
Current Function: Adjacent Boring     System Unit: Default
```

The following three screens will display the result of the selected query based on the available data in the local database.

```
Output ( Esc to quit this screen ) ----------------------------
                                             Date: 11-11-1991
                                             Time: 11:30:57.43
         Data Query: Adjacent Boring

  Search Range(FEET): 10000.0
   Depth Range(FEET): 10.0 to 20.0
           Longitude: 89°5'0"
            Latitude: 31°0'0"
       Boring Number: cpt131              Elevation(FEET): 10.0
      Project Number: 987-65-4321
            Job Site: Central
            Location: Baton Rouge
               State: Louisiana

        Selected Tests: Dual Piezo Cone
                        Friction Cone
        Conditions:
      Friction Cone:
                ave_fs>0.2 (TSF)
      Dual Piezo Cone:
                ave_fs>0.2 (TSF)
                                                   00003:001
```

```
Output ( Esc to quit this screen )
===========================================================
        Longitude: 89°5'0"
         Latitude: 31°0'0"
    Boring Number: cpt131
   Project Number: 987-65-4321                Elevation(FEET): 1
         Job Site: Central
         Location: Baton Rouge
            State: Louisiana

Friction Cone  Penetrometer
Boring No. cpt131      Depth(FEET): 19.0 to 24.0
ave_fs          ave_qc          frict_ratio
(TSF)           (TSF)           (%)
0.4             45.0            0.89

Dual Piezo Cone  Penetrometer
Boring No.cpt9  Depth(FEET):20.0 to 22.0  Elevation(FEET):1
ave_fs          ave_qc          ave_tip_u       ave_sleeve_u    frict_rat
(TSF)           (TSF)           (TSF)           (TSF)           (%)
1.0             35.0            1.5             1.5             2.86

                                                          00047:00
```

```
Output ( Esc to quit this screen )
-----------------------------------------------------------
Friction Cone  Penetrometer
Boring No. cpt131      Depth(FEET): 14.0 to 19.0
ave_fs          ave_qc          frict_ratio
(TSF)           (TSF)           (%)
0.3             8.0             3.75

Dual Piezo Cone  Penetrometer
Boring No.cpt7  Depth(FEET):15.0 to 19.0  Elevation(FEET): 1
ave_fs          ave_qc          ave_tip_u       ave_sleeve_u    frict_ra
(TSF)           (TSF)           (TSF)           (TSF)           (%)
1.8             40.0            2.0             2.0             4.5
                                                          00069:001
```

Example 4: Get the average frictional resistance and the average tip resistance between 1 15 feet below ground surface of a friction cone penetration test with sounding numb "CPT131". We can proceed with this query in the following input sequence. First, "Database" at the main menu, then select the "Borehole Information" sub-function. No this function will allow any number of "Test Name" be selected. The following screen w

...played. Position the cursor on "friction_cone" and select this test name with the <Space Bar>. Next, move the cursor to the "OK" window with the <Tab> key and press <Enter>.

```
√Test Name
 √ friction_cone
   dual_piezo_cone
   seismic_cone
   pH_test
   atterberg
   grain_size
   cbr_proctor
   triaxial
   direct_shear
   unconfine
   consolidation

 Ok              All              Cancel

Current Function: Borehole Information    System Unit: Default
```

When the following screen appear, select the "ave_fs" and "ave_qc" attributes with the <Space Bar>. Since the query does not specify any search criteria on the attributes, we can move the cursor to the "OK" window by pressing the <Tab> key twice and then press <Enter>.

```
Attributes
   √Attributes              √Condition
    √ ave_fs                   ave_fs
    √ ave_qc                   ave_qc
      frict_ratio              frict_ratio

        Ok                    Cancel

Current Hole: Borehole Information
```

Next, specify the longitude and latitude of "CPT131" and the depth interval tha
interested in. When the following screen appear, simply input the degree, minute an
of "CPT131" location and press <Enter> at the Longitude and Latitude prompts. Si
the "Adjacent Boring" sub-function, only the begin depth and end depth of 10 and
respectively are required while the rest of the sounding information are displayed on th
automatically during the preliminary database search for valid sounding location.

```
           Longitude:  Deg.  89      Min.  5        Sec.  0
            Latitude:  Deg.  31      Min.  0        Sec.  0
      Project Number:  987-65-4321
            Location:  Baton Rouge
               State:  Louisiana

       Boring Number:  cpt131
            Job Site:  Central
     Elevation(FEET):  10.0

   Test Depth Range(FEET):  0.0 to 76.0
  Query Depth Range
       Begin Depth:  10      End Depth: 15

       Correct ? (Y/n/Esc)
Current Function: Borehole Information    System Unit: Default
```

The following two screens display the result of the above query.

```
Output ( Esc to quit this screen )
                                                  Date: 11-11-1991
        Data Query: Borehole Information          Time: 11:36:52.41

  Depth Range(FEET): 10.0 to 15.0
           Longitude: 89°5'0"
            Latitude: 31°0'0"
       Boring Number: cpt131
      Project Number: 987-65-4321            Elevation(FEET): 10.0
            Job Site: Central
            Location: Baton Rouge
               State: Louisiana

                                                        00001:001
```

```
Output ( Esc to quit this screen )
          Selected Tests: Friction Cone
=====================================================================
Friction Cone   Penetrometer

       Longitude: 89°5'0"
        Latitude: 31°0'0"                 Elevation(FEET): 10.0
   Boring Number: cpt131
  Project Number: 987-65-4321
        Job Site: Central
        Location: Baton Rouge
           State: Louisiana

Depth Range (FEET): 0.0 to 11.0

ave_fs         ave_qc
(TSF)          (TSF)
0.0            0.0

Depth Range (FEET): 11.0 to 14.0

ave_fs         ave_qc
(TSF)          (TSF)
0.1            8.0

Depth Range (FEET): 14.0 to 19.0

ave_fs         ave_qc
(TSF)          (TSF)
0.3            8.0
                                                        00051:001
```

Example 5: Suppose that we want to find a match of dual piezocone penetration test location that was performed close by a friction cone penetration test with a sounding number of CPT131. Further, we are only interested in displaying the average frictional resistance, the average tip resistance, the friction ratio and the average tip pore pressure of the piezocone test between 10 and 20 feet below ground surface where the average frictional resistance is greater than 0.2 kg/cm^2. Select the "Test Match" sub-function from the "Database" menu. The following screen will appear for the selection of the "Master Test".

```
√Master Test
 √ friction_cone
   dual_piezo_cone
   seismic_cone
   pH_test
   atterberg
   grain_size
   cbr_proctor
   triaxial
   direct_shear
   unconfine
   consolidation

 [ Ok ]                    [ Cancel ]

Current Function: Test Match    System Unit: Default
```

Select the "friction_cone" as the "Master Test" using the <Space Bar> from the above c[...] box and move the cursor to the "OK" window. Next select the "dual_piezo_cone" test <S[...] Bar> as the matching test from the following choice box when it appears.

```
       √Test Name
        √ dual_piezo_cone
          seismic_cone
          pH_test
          atterberg
          grain_size
          cbr_proctor
          triaxial
          direct_shear
          unconfine
          consolidation

   [ Ok ]          [ All ]          [ Cancel ]

Current Function: Test Match        System Unit: Default
```

Use the <Space Bar> key to select the "ave_fs", "ave_qc", "frict_ratio", and "ave_tip_u" as the required displayed attributes. Next, move the cursor to the "Condition" window and select "ave_fs" as the selection criteria. Move the cursor to the "OK" window by depressing on the <Tab> key and press the <Enter> key to bring up the input screen for entering the condition of average friction resistance of greater than 0.2 kg/cm^2.

```
Attributes
  √Attributes                      √Condition
   √ ave_fs                         √ ave_fs
   √ ave_qc                           ave_qc
   √ frict_ratio                      frict_ratio
   √ ave_tip_u
     ave_sleeve_u
     ave_qc_corr
     tip_u_ratio

          Ok                          Cancel

Current Function: Test Match              System Unit: Default
```

```
    ave_fs(TSF):
    Condition: >0.2

    Correct ? (y/n/Esc)

Current Function: Test Match              System Unit: Default
```

Next, specify the longitude and latitude of "CPT131" and the depth interval that we are interested in. When the following screen appear, simply input the degree, minute and second of "CPT131" location similar to Example 4.

```
Output ( Esc to quit this screen )
     Longitude: 89°5'0"
      Latitude: 31°0'0"
  Boring Number: cpt131                  Elevation(FEET): 10.0
 Project Number: 987-65-4321
      Job Site: Central
      Location: Baton Rouge
         State: Louisiana

Friction Cone  Penetrometer
Boring No. cpt131     Depth(FEET): 0.0 to 11.0
ave_fs        ave_qc        frict_ratio
(TSF)         (TSF)         (%)
0.0           0.0           err

Dual Piezo Cone  Penetrometer
Boring No.cpt9  Depth(FEET):0.0 to 13.0  Elevation(FEET): 10.0
ave_fs        ave_qc        ave_tip_u     frict_ratio
(TSF)         (TSF)         (TSF)         (%)
0.0           0.0           0.0           err

----------------------------------------------------------------
Friction Cone  Penetrometer
Boring No. cpt131     Depth(FEET): 19.0 to 24.0
ave_fs        ave_qc        frict_ratio
(TSF)         (TSF)         (%)
0.4           45.0          0.89

Dual Piezo Cone  Penetrometer
Boring No.cpt9  Depth(FEET):20.0 to 22.0  Elevation(FEET):10.0
ave_fs        ave_qc        ave_tip_u     frict_ratio
(TSF)         (TSF)         (TSF)         (%)
1.0           35.0          1.5           2.86
                                                  00066:001
```

Example 6: Display the site information on all friction cone and dual piezocone soundings with a project number of "987-65-4321" which is resided in the local database. We need to bring up the "Existing Boring" sub-function from the "Database" menu and select the "friction_cone" and the "dual_piezo_cone" using the <Space Bar> from the following screen.

```
Output ( Esc to quit this screen )
         Longitude: 89°5'0"
          Latitude: 31°0'0"
     Boring Number: cpt131                 Elevation(FEET): 10.0
    Project Number: 987-65-4321
          Job Site: Central
          Location: Baton Rouge
             State: Louisiana

Friction Cone  Penetrometer
Boring No. cpt131     Depth(FEET): 0.0 to 11.0
ave_fs        ave_qc       frict_ratio
(TSF)         (TSF)        (%)
0.0           0.0          err

Dual Piezo Cone  Penetrometer
Boring No.cpt9  Depth(FEET):0.0 to 13.0  Elevation(FEET): 10.0
ave_fs        ave_qc       ave_tip_u     frict_ratio
(TSF)         (TSF)        (TSF)         (%)
0.0           0.0          0.0           err

-----------------------------------------------------------------
Friction Cone  Penetrometer
Boring No. cpt131     Depth(FEET): 19.0 to 24.0
ave_fs        ave_qc       frict_ratio
(TSF)         (TSF)        (%)
0.4           45.0         0.89

Dual Piezo Cone  Penetrometer
Boring No.cpt9  Depth(FEET):20.0 to 22.0  Elevation(FEET):10.0
ave_fs        ave_qc       ave_tip_u     frict_ratio
(TSF)         (TSF)        (TSF)         (%)
1.0           35.0         1.5           2.86
                                                   00066:001
```

Example 6: Display the site information on all friction cone and dual piezocone soundings with a project number of "987-65-4321" which is resided in the local database. We need to bring up the "Existing Boring" sub-function from the "Database" menu and select the "friction_cone" and the "dual_piezo_cone" using the <Space Bar> from the following screen.

```
output ( Esc to quit this screen )
                                              Date: 11-11-1991
                                              Time: 11:57:4.89

      Data Query: Existing Boring

       Longitude:
        Latitude:                           Elevation(FEET):
   Boring Number:
  Project Number: 987-65-4321
        Job Site: Central
        Location: Baton Rouge
           State: Louisiana

        Selected Tests: Dual Piezo Cone
                        Friction Cone
                                                   00001:001
```

```
output ( Esc to quit this screen )
==================================================================
Dual Piezo Cone      Penetrometer
       Longitude: 89°3'0"
        Latitude: 31°3'0"                   Elevation(FEET): 10.0
   Boring Number: cpt10
  Project Number: 987-65-4321
        Job Site: Central
        Location: Baton Rouge
           State: Louisiana

       Longitude: 89°2'0"
        Latitude: 31°0'0"                   Elevation(FEET): 10.0
   Boring Number: cpt11
  Project Number: 987-65-4321
        Job Site: Central
        Location: Baton Rouge
           State: Louisiana
                                                   00040:001
```

```
Output ( Esc to quit this screen )
                                                   Date: 11-11-1991
                                                   Time: 11:57:4.89

      Data Query: Existing Boring

       Longitude:
        Latitude:                               Elevation(FEET):
   Boring Number:
  Project Number: 987-65-4321
        Job Site: Central
        Location: Baton Rouge
           State: Louisiana

  Selected Tests: Dual Piezo Cone
                  Friction Cone
                                                        00001:001
```

```
Output ( Esc to quit this screen )
=======================================================================
Dual Piezo Cone     Penetrometer
       Longitude: 89°3'0"
        Latitude: 31°3'0"                       Elevation(FEET): 10.0
   Boring Number: cpt10
  Project Number: 987-65-4321
        Job Site: Central
        Location: Baton Rouge
           State: Louisiana

       Longitude: 89°2'0"
        Latitude: 31°0'0"                       Elevation(FEET): 10.0
   Boring Number: cpt11
  Project Number: 987-65-4321
        Job Site: Central
        Location: Baton Rouge
           State: Louisiana
                                                        00040:001
```

```
       Longitude:  Deg.          Min.          Sec.
        Latitude:  Deg.          Min.          Sec.
  Project Number:
        Location:
           State:

     Correct ? (y/n/Esc)
Current Function: Boring Number      System Unit: Default
```

Since all the boring numbers are required from this query, all the prompts can be left blank by continuously pressing the <Enter> key. At the confirmation prompt, enter "y" and proceed to the database search. A screen similar to the following will be displayed.

```
Output ( Esc to quit this screen ) ---------------------------
                                              Date: 11-13-1991
                                              Time: 2:59:18.64
         Data Query: Boring Number

          Longitude:
           Latitude:
      Boring Number:                         Elevation(FEET):
     Project Number:
           Job Site:
           Location:
              State:

     Selected Tests: Atterberg
                     Dual Piezo Cone
                     Friction Cone
--------------------------------------------------------------

Atterberg      Classification

     Boring No.        Longitude       Latitude

     aa1               92°0'0"         32°0'0"
     sb8               90°8'0"         32°6'0"
     sb7               89°5'0"         31°8'0"
     sb9               90°9'0"         32°8'0"
     cpt13             91°0'0"         32°5'0"
                                                    00001:001
```

```
       Longitude:  Deg.          Min.          Sec.
        Latitude:  Deg.          Min.          Sec.
  Project Number:
        Location:
           State:

     Correct ? (y/n/Esc)
```

```
Current Function: Boring Number       System Unit: Default
```

Since all the boring numbers are required from this query, all the prompts can be left blank by continuously pressing the <Enter> key. At the confirmation prompt, enter "y" and proceed to the database search. A screen similar to the following will be displayed.

```
Output ( Esc to quit this screen ) ──────────────────────
                                             Date: 11-13-1991
                                             Time: 2:59:18.64

        Data Query: Boring Number

         Longitude:
          Latitude:                       Elevation(FEET):
     Boring Number:
    Project Number:
          Job Site:
          Location:
             State:

        Selected Tests: Atterberg
                        Dual Piezo Cone
                        Friction Cone
-----------------------------------------------------------------

Atterberg     Classification

     Boring No.      Longitude       Latitude

     aa1             92°0'0"         32°0'0"
     sb8             90°8'0"         32°6'0"
     sb7             89°5'0"         31°8'0"
     sb9             90°9'0"         32°8'0"
     cpt13           91°0'0"         32°5'0"
                                                    ──00001:001──
```

...g is a sample output from the "AASHTO" classification on "Boring Number aa1".

```
( Esc to quit this screen ) ──────────────────────────────
                                        Date: 11-13-1991
                                        Time: 2:43:37.71

   Data Query: AASHTO

      Longitude:                       Elevation(FEET):
       Latitude:
  Boring Number:
 Project Number:
       Job Site:
       Location:
          State:
                                              ──00001:001──
```

```
( Esc to quit this screen ) ------------------------------
 Longitude: 92°0'0"                   Elevation(FEET): 10.0
  Latitude: 32°0'0"
 ...ng Number: aa1
 ...ct Number: 000-00-0000
   Job Site: Eastern
   Location: Baton Rouge
      State: Louisiana

( FEET ): 3.0 to 4.0     Result : A-1-a

( FEET ): 4.0 to 5.0     Result : A-2-5

( FEET ): 5.0 to 6.0     Result : A-2-6
                                              ──00037:025──
```

Suppose that only general information regarding adjacent borings in the database ... such as to find all sounding/boring locations within the specify proximity either with ...gitude and latitude, a given project number or a given location. Go to the "General ...oring" sub-function from the "Database" function using the <Cursor Up> or ...own> key. The following screens demonstrate the input and output for each case.

g is a sample output from the "AASHTO" classification on "Boring Number aa1".

```
( Esc to quit this screen ) ----------------------------------------
                                         Date: 11-13-1991
                                         Time: 2:43:37.71

  Data Query: AASHTO

     Longitude:
      Latitude:                          Elevation(FEET):
 Boring Number:
roject Number:
      Job Site:
      Location:
         State:
                                        ---------00001:001---
```

```
( Esc to quit this screen ) ----------------------------------------
--------------------------------------------------------------------
Longitude: 92°0'0"
 Latitude: 32°0'0"                       Elevation(FEET): 10.0
ng Number: aa1
ct Number: 000-00-0000
 Job Site: Eastern
 Location: Baton Rouge
    State: Louisiana

FEET ): 3.0 to 4.0      Result : A-1-a

FEET ): 4.0 to 5.0      Result : A-2-5

FEET ): 5.0 to 6.0      Result : A-2-6
                                        ---------00037:025---
```

Suppose that only general information regarding adjacent borings in the database such as to find all sounding/boring locations within the specify proximity either with gitude and latitude, a given project number or a given location. Go to the "General Boring" sub-function from the "Database" function using the <Cursor Up> or Down> key. The following screens demonstrate the input and output for each case.

Case 1

Input: Given Longitude and Latitude

```
          Longitude:  Deg.  89      Min.  5       Sec.
           Latitude:  Deg.  31      Min.  0       Sec.
     Project Number:  987-65-4321
           Location:  Baton Rouge
              State:  Louisiana

      Boring Number:  cpt131
           Job Site:  Central
    Elevation(FEET):  20.0

  Test Depth Range:  0.0 to 76.0

        Correct ? (y/n/Esc)
```

Output

```
Output ( Esc to quit this screen )
                                                    Date: 11-
                                                    Time: 12:
      Data Query: Find all borings within a certain r
 Search Range(FEET): 10000.0
       Longitude: 89°5'0"
        Latitude: 31°0'0"
   Boring Number: cpt131                     Elevation(FEE
  Project Number: 987-65-4321
        Job Site: Central
        Location: Baton Rouge
           State: Louisiana

==================================================
       Longitude: 92°0'0"
        Latitude: 32°0'0"
   Boring Number: aa1                        Elevation(FE
  Project Number: 000-00-0000
        Job Site: Eastern
        Location: Baton Rouge
           State: Louisiana
                                                      -00
```

```
Output ( Esc to quit this screen )
        Longitude: 90°8'0"
         Latitude: 32°6'0"
    Boring Number: sb8
   Project Number: 123-45-6789                Elevation(FEET): 10.0
         Job Site: Northeast
         Location: Baton Rouge
            State: Louisiana
                                                          00037:025
```

Case 2

Input: Given Project Number

```
        Longitude:  Deg.          Min.          Sec.
         Latitude:  Deg.          Min.          Sec.
   Project Number:  123-45-6789
         Location:  Baton Rouge
            State:  Louisiana

      Correct ? (y/n/Esc)
```

Output

```
Output ( Esc to quit this screen )
                                              Date: 11-11-1991
                                              Time: 12:30:27.75
      Data Query: Find borings for given project number
  Project Number: 123-45-6789
        Job Site: Northeast
        Location: Baton Rouge
           State: Louisiana
=====================================================================

      Longitude: 90°8'0"
       Latitude: 32°6'0"
  Boring Number: sb8
                                           Elevation(FEET): 10.0

      Longitude: 89°5'0"
       Latitude: 31°8'0"
  Boring Number: sb7
                                           Elevation(FEET): 10.0
                                                      00001:001
```

Case 3

Input: Given Location

```
        Longitude:  Deg.          Min.          Sec.
         Latitude:  Deg.          Min.          Sec.
   Project Number:
         Location:  baton rouge
            State:  Louisiana

      Correct ? (y/n/Esc)
```

Output

```
Output ( Esc to quit this screen ) ──────────────────────────
                                              Date: 11-11-1991
 Data Query: Find project numbers for given   Time: 12:32:16.78
   Location: Baton Rouge                      location
==============================================================

        111-11-1111
        000-00-0000
        123-45-6789
        987-65-4321

──────────────────────────────────────────────00001:001──
```

4.2 Data Input and Edit

Example 10: Suppose that the soil type is not appropriate for the local interpretation on certain data points, the user can add the soil classification information for these particular points into the current internal database by pre-empting the chart area for future search. First, go to the Main Menu and select the "Charts" function.

```
System |Charts| Database  Edit                              Help
        Soil Check
        Add Data
        Chart Name
```

xt, select the "Add Data" sub-function by using the "accelerator" key or the <Cursor wn> key to add the desired soil classification into the internal database according to the local rrelation and experience. The following screen will then appear.

```
              Depth(FEET):     10

              AVE FS(TSF):      2
              AVE QC(TSF):     40
           AVE TIP U(TSF):      0
        AVE SLEEVE U(TSF):      0


        Inputs OK ? (y/n/Esc)
```

hen the "y" is pressed on the confirmation prompt, CONEXP will search for the internal tabase for any available information. The following screen will appear to display soil assification from the database based on the above input if it exists. A "y" to the confirmatory ompt in the following screen will bring up the soil classification selection screen.

```
    Soil classification from chart is:
         very stiff inorganic clay

         Do you want to change the soil type ? (y/n)
urrent Function:Add Soil Type System Unit:Default Chart Name:Tum
```

The internal database divides soil into three main group and a number of subgroup. The main group is used to determine the relative density, internal friction angle, and undrained shear strenght of the soil. It is the user's responsibility to input the main soil group and the corresponding subgroup name consistently. For example, the subgroup "sand and silty sand" should be under "sand" on the main "Soil Group". Suppose that we want the soil classification of "organic clay" to appear on the "Soil Name". First position the cursor on the "CLAY" group and select with the <Space Bar>, next move the cursor to the "Soil Name" window with the <Tab> key. Select "organic clay" from the list of available soil name with the <Space Bar>. Next, move the cursor to the "OK" window with the <Tab> key and press <Enter> to proceed.

```
√Soil Group            √Soil Name
   SAND                   sand to silty sand
   SILTY                  sand to clayey sand
 √ CLAY                   gravelly sand to sand
                          dense or cemented sand
                          shell sand or limerock
                          sandy silt to clayey silt
                          silty sand to sandy silt
                          clayey sand and silt
                          clay
                          sandy clay
                          silty clay
                        √ organic clay
                          very soft inorganic clay

      OK                          Cancel
Current Function:Add Soil Type System Unit:Default Chart Name:Tum
```

```
      Soil classification from chart is:
           organic clay

           tip resistance is: 40.0 TSF

           Upper tip resistance value: 41

           Correct ? (y/n)
Current Function:Add Soil Type System Unit:Default Chart Name:Tum
```

The internal database divides soil into three main group and a number of subgroup. The main group is used to determine the relative density, internal friction angle, and undrained shear strenght of the soil. It is the user's responsibility to input the main soil group and the corresponding subgroup name consistently. For example, the subgroup "sand and silty sand" should be under "sand" on the main "Soil Group". Suppose that we want the soil classification of "organic clay" to appear on the "Soil Name". First position the cursor on the "CLAY" group and select with the <Space Bar>, next move the cursor to the "Soil Name" window with the <Tab> key. Select "organic clay" from the list of available soil name with the <Space Bar>. Next, move the cursor to the "OK" window with the <Tab> key and press <Enter> to proceed.

```
√Soil Group            √Soil Name
   SAND                    sand to silty sand
   SILTY                   sand to clayey sand
 √ CLAY                    gravelly sand to sand
                           dense or cemented sand
                           shell sand or limerock
                           sandy silt to clayey silt
                           silty sand to sandy silt
                           clayey sand and silt
                           clay
                           sandy clay
                           silty clay
                         √ organic clay
                           very soft inorganic clay

     OK                              Cancel

Current Function:Add Soil Type System Unit:Default Chart Name:Tum
```

```
     Soil classification from chart is:
          organic clay

          tip resistance is: 40.0 TSF

          Upper tip resistance value: 41

          Correct ? (y/n)

Current Function:Add Soil Type System Unit:Default Chart Name:Tum
```

DEFINITIONS

For the function: "Adjacent Boring", "Boring Information", "Test Match", "Exist Boring" and "Boring Number", they have the same flowchart. But rule of database search, format of printout, and test name selection are different.

Adjacent Boring:
Select Test Name: select one or more test names and attributes
Search and Print: search database to find any pair of adjacent boring which contain selected tests, and print out the information about those adjacent boring and attribute values

Borehole Information:
Select Test Name: select one or more test names attributes
Search and Print: search database to find any borings which contain selected tests, and print out the boring information and attribute values

Test Match:
Select Test Name: select one master test, several other tests, and attributes
Search and Print: search database to find a pair of adjacent boring which contain master test and one of other tests respectively, and print out those boring information and attributes values.

Exist Boring:
Select Test Name: select one or more test names
Search and Print: search database to find any borings which contain selected tests, and print out those boring information contain those tests.

Boring Number:
Select Test Name: select one or more test names
Search and Print: search database to find any borings which contain selected test, and print out those boring number(comparing to "Exist Boring" function, this printout information is much more less)

Also for the functions: "AASHTO" and "General Adjacent Boring", they have the same flowchart and they have different rule of database search.

AASHTO:
Check the AASHTO soil classification for the borings which meet the input requirement.

General Adjacent Information:
This function will generate three kinds of printout according to input boring information.

INPUT: Latitude, longitude

OUTPUT: All borings within area whose center is input latitude and longitude and has certain radius.

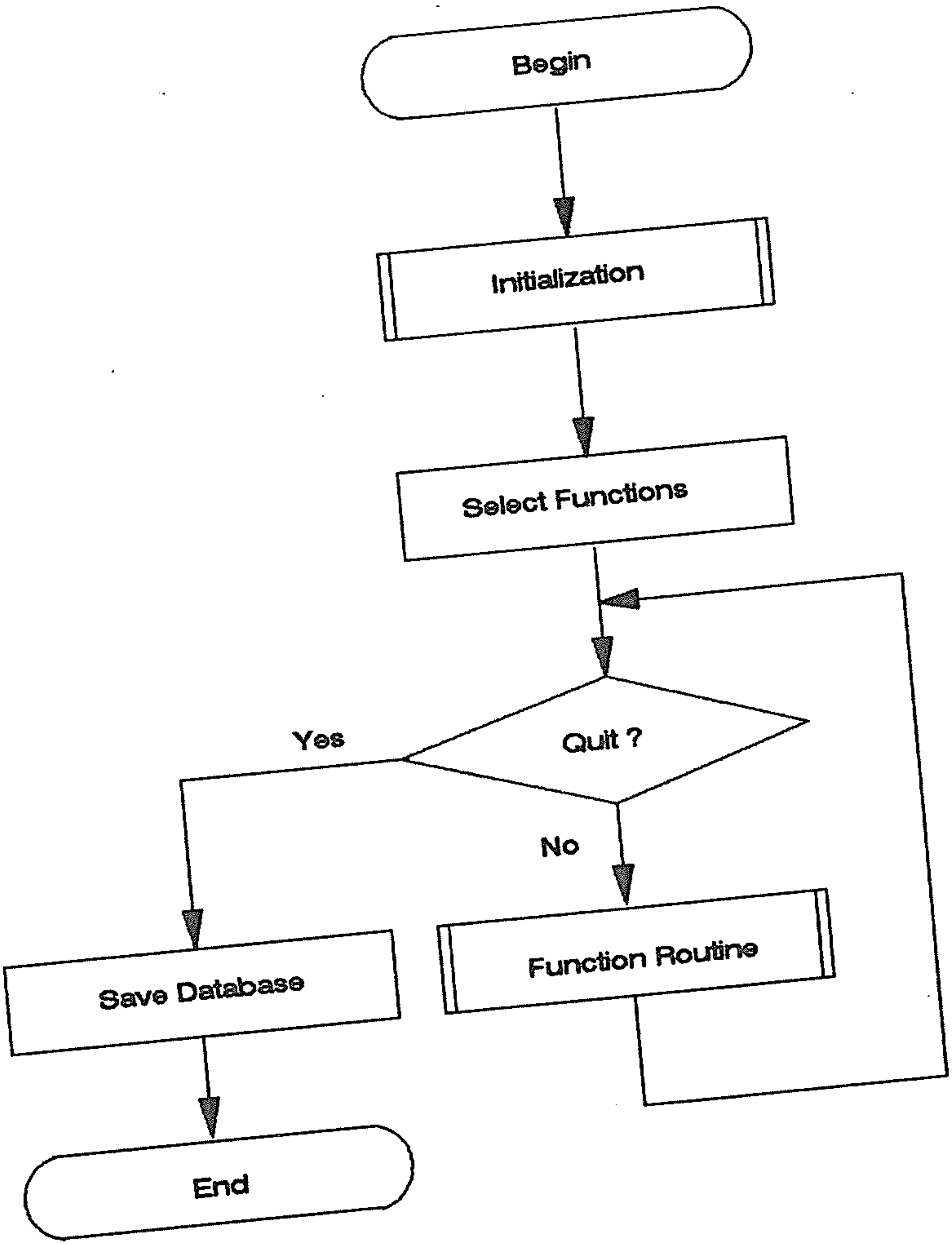
INPUT: Project Number

OUTPUT: All borings which are under input project number

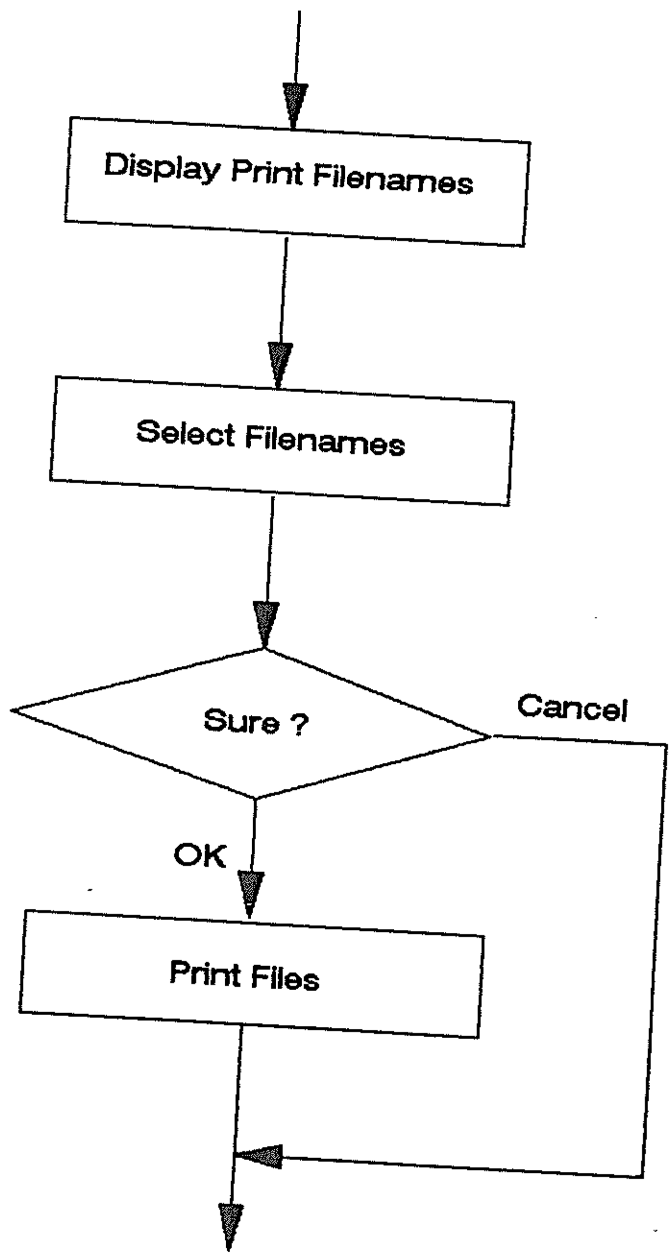
INPUT: Location

OUTPUT: All project numbers in the input location

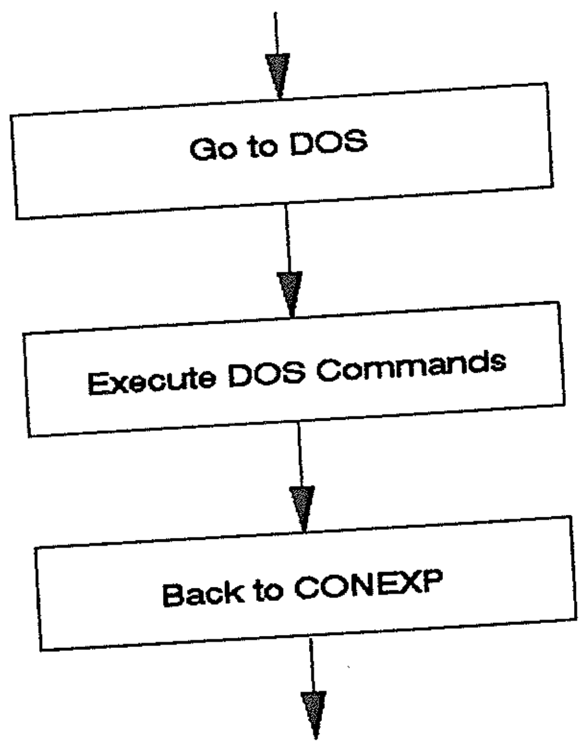
CONEXP Program

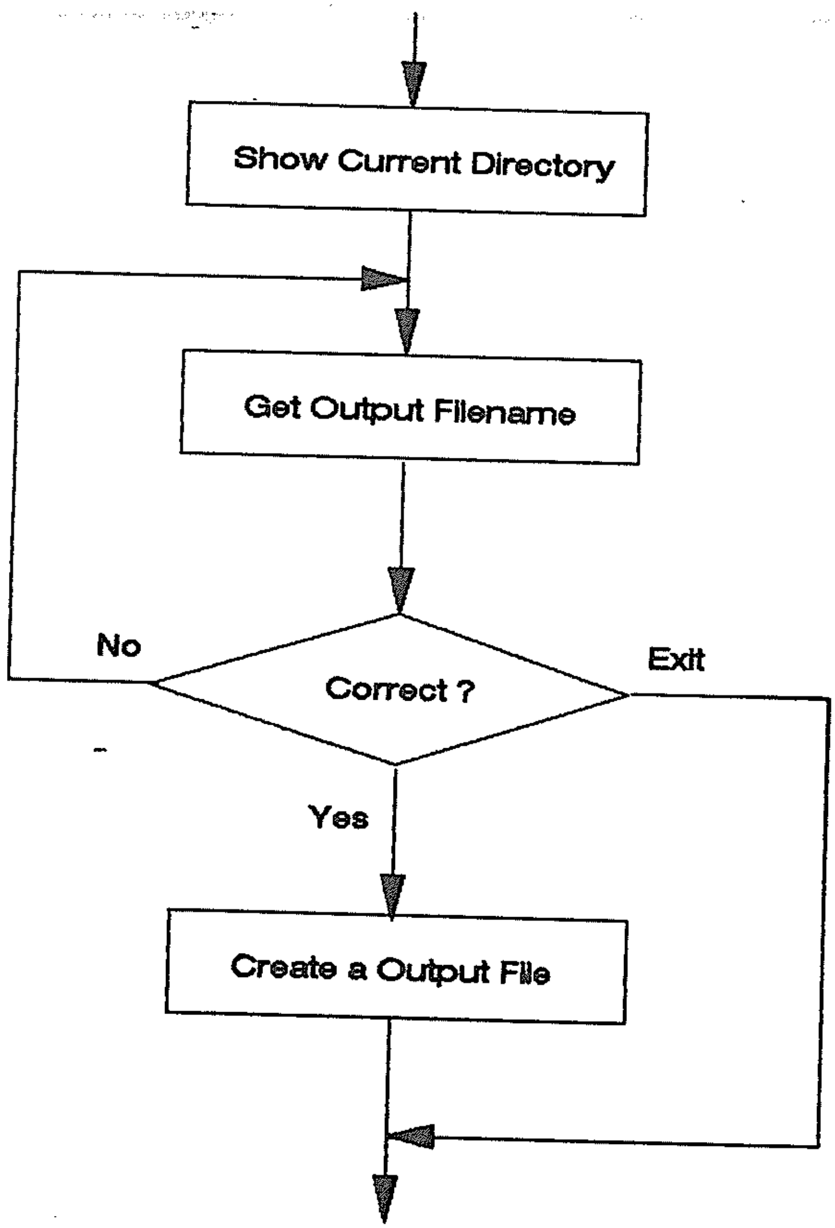


Print Routine



Shell Routine




Show Current Directory
Get Output Filename
No
Correct ?
Exit
Yes
Create a Output File

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