

**USER'S GUIDE
FOR THE URANIUM ORE RESERVE
CALCULATION SYSTEM
(URAD)**



A TECHNICAL DOCUMENT ISSUED BY THE
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1988

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USER'S GUIDE FOR THE URANIUM ORE RESERVE CALCULATION SYSTEM (URAD)

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FOREWORD

The URAD (Uranium Reserves and Data) system consists of four computer programs designed to facilitate the evaluation of uranium ore reserves analysis and the handling of basic uranium assay data.

URAD is designed specifically as a training tool for anyone unfamiliar with the methodology, data requirements, and/or general computer applications in the field of uranium ore reserves analysis. However, it can effectively be used in a 'production' environment involving considerable amounts of data.

The basic structure and methodology of the system are outgrowths of the methods developed by the Ore Reserves Branch, Grand Junction Office, U.S. Atomic Energy Commission during the 1960's and 1970's by a number of workers who include E.Berkoff, P.C.DeVergie, W.D.Grundy, R.J.Meehan, J.Patterson and J.H.Scott.

In order to make this system available to Member States, a contract with Mr. P.C.DeVergie was made in order to convert the system from a mainframe to a microcomputer. The Grand Junction system as it stood circa 1978 was chosen because of its high reliability and years of successful operation.

The resulting programs are written in Microsoft FORTRAN (Version 3.1) and may be run on any IBM-compatible microcomputer under DOS 2.1 (or later). The system was developed for the International Atomic Energy Agency under contract 1010.5410.231.B1 during the period February through June, 1987.

Responsible IAEA staff member was Mr. D. McCarn.

Mr. Paul C. deVergie died just before the issuance of this publication. In addition to being the person who was contracted by the Agency to develop this program for microcomputer usage, Mr. Paul deVergie was an active participant and contributor to a number of Agency meetings on uranium resources while still working with the US Department of Energy (previously US Atomic Energy Commission). In 1987 he also served as an Agency technical co-operation expert to the People's Republic of China. There is no doubt that his contribution to this publication will be greatly appreciated by workers in this field.

EDITORIAL NOTE

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INTRODUCTION

1.0 INTRODUCTION

1.1 BACKGROUND

The URAD (Uranium Reserves and Data) system consists of four computer programs designed to facilitate the evaluation of uranium ore reserves analysis and the handling of basic uranium assay data. The programs are written in Microsoft FORTRAN (Version 3.1) and may be run on any IBM-compatible micro-computer under DOS 2.1 (or later). The system was developed for the International Atomic Energy Agency under contract 1010.5410.231.B1 during the period February through June, 1987. The documentation was edited by D. McCarn of the IAEA in March, 1988. The basic structure and methodology of the system are outgrowths of methods developed by the Ore Reserves Branch, Grand Junction Office, U.S. Atomic Energy Commission (GJO/AEC) during the 1960's and early 1970's.

URAD is designed specifically as a training tool for anyone unfamiliar with the methodology, data requirements, and/or general computer applications in the field of uranium ore reserves analysis. However, it can effectively be used in a 'production' environment involving considerable amounts of data.

Only a basic working knowledge of DOS 2.1 is needed to maintain the system and run the programs.

1.2 HISTORY AND ACKNOWLEDGMENTS

The computational algorithms, and output forms in URAD were in, large part converted directly from programs and utility subroutines developed GJO/AEC. The history of this development is reviewed briefly to provide readers with some continuity for reference between the URAD system and the original publications cited in this guide.

During the period 1960-1968 GJO/AEC developed the following computer programs:

GAMLOG (J.H. Scott, 1962) The interpretation of gamma-ray log data using a digital computer. U.S. Atomic Energy Commission, GJO, RME-143.

DOLLAR (J. Scott, 1963) The Dollar Program For Calculating Uranium Ore Reserves. U.S.A.E.C., GJO, RME-142.

GRADE (J. Scott, 1963) The Grade Program For Calculating Uranium Ore Reserves. U.S.A.E.C., GJO, RME-145.

ORSAC (R.J. Meehan and W.D.Grundy, 1964) Estimation of Uranium Ore Reserves by Statistical Methods and a Digital Computer. U.S.A.E.C., GJO, RME-183.

SCOR (P. deVergie, 1962) Calculation of underground or open pit reserves using grade cutoffs arbitrarily assigned or determined by

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economics. Paper presented to the Colorado Mining Association in 1968.

(A review of the GJO computer applications was presented in 1964 by J. Patterson, P. deVergie, and R.J. Meehan at the 1964 International Symposium on Computer Applications in the Minerals Industry, Colorado School of Mines, Golden, Colorado)

Each of the above programs was initiated somewhat independently at a time when gamma-log data were being taken from gamma-ray logs using "hand" methods, and each had its own particular method for inputting and processing the data.

The period 1962-1969 saw a rapid increase in utilization of automatic digitizing of gamma-log data. The GJO system for automatic digitizing was described in:

Young, H.B. and deVergie, P.C., 1963, Preparation of Gamma-ray Log Data for IBM Card Punching, U.S.A.E.C., GJO, RME-144.

A set of routines (PEDAT, deVergie, 1963) was developed to serve as a standard data input program to read in and edit various types of data and was incorporated into SCOR, ORSAC, and GRADE (but not into DOLLAR).

When the CDC 3100 computer was installed at GJO in 1969, program MDDAT (deVergie, 1969) was developed as a 'front-end' module which processed all data and created secondary data files (binary) prior to processing by ore reserves programs. MDDAT included the GAMLOG interpretation routines. Programs ORSAC and SCOR were converted with some modifications.

DOLLAR and GRADE were combined into GRADEV (R.J.Meehan), to which was added the additional capability of handling vanadium assays. The PEDAT routines were modified and then added to each ore reserve program in order to process and edit the secondary files created by MDDAT.

Modifications and enhancements continued on these programs up through 1979, when the CDC 6600 was installed at GJO. In designing URAD, it was judged that the GJO system, as it stood circa 1978, would be most useful point at which to begin. A considerable amount of the material presented herein was originally never fully documented due to the ongoing changes and additions which were constantly taking place.

1.2.1 Modifications in URAD

For URAD, the MDDAT program was modified and revised into program "URDAT" (URanium DATA system); The original diverse formats for basic sample data were revised and standardized, and a new format ("Q") was added. The computational algorithms in GRADEV (renamed "RESUV" (REServes for Uranium and Vanadium) and ORSAC were left intact.

SCOR was considerably modified; and the PEDAT routines were revised and enhanced. The major changes in the all the programs occurred in the processing of the data and input of program parameters. The file handling and data input procedures were completely revised to form the UCON system, which is altogether new. Input of parameters into the ore reserve programs was stand-

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ardized to the extent feasible, and all such input was made interactive except for the UCON file handling and data edit instructions.

Output features were redesigned specifically for microcomputer printer capability.

1.2.2 Additional Sources of Information

The following publications were excellent sources for information relating to ore reserves and basic interpretation of gamma-log data:

Practical Borehole Logging Procedures for Mineral Exploration with Emphasis on Uranium, I.A.E.A., Vienna, Techn. Report Series No. 259.

Methods for the Estimation of Uranium Ore Reserves (an Instruction Manual), I.A.E.A, Vienna, Technical Report Series No.255.

1.3 GENERAL SCOPE OF THE URAD SYSTEM

1.4 ORGANIZATION OF THE USER GUIDE

This guide includes the following major sections:

The **OVERVIEW OF THE URAD SYSTEM** (Section 2.0) shows the major elements of the URAD system.

The **REVIEW OF SAMPLE DATA** (Section 3.0) describes the general type of sample data found in URAD and includes discussions on radiometric logging data and disequilibrium correction of radiometric data.

A complete description of the file structure and sample type formats of the UDAT basic sample data files is provided under: **UDAT SYSTEM -- PRIMARY (BASIC) FILES, GENERAL FILE STRUCTURE** (Section 4.0);

UDAT SYSTEM -- PRIMARY FILES, DESCRIPTIVE DATA FOR SAMPLE SETS (Section 5.0); and,

UDAT SYSTEM -- PRIMARY FILES, INDIVIDUAL DATA FORMATS (Section 6.0).

A complete description of the UCON system for file access and sample editing is given in **THE UCON SYSTEM** (Section 7.0).

PROGRAM URDAT (Section 8.0) explains the initial processing of the primary UDAT files to obtain standard output listings and gamma-log interpretations of radiometric data, and to create **intermediate UDAT files** which are used by the ore reserves programs - RESUV, ORSAC, and SCOR.

A general description of the parameters which must be input interactively to the ore reserve programs, is given in the **DEFINITION OF ORE RESERVES PARAMETERS** (Section 9.0).

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INTERACTIVE ENTRY OF PROGRAM CONTROLS AND PARAMETERS (Section 10.0) reviews the method used by URAD for entering program parameters interactively (i.e. during program execution) on the console.

Preliminary steps required before running an ore reserve program are reviewed under **GENERAL PROCEDURES FOR RUNNING THE ORE RESERVES PROGRAMS** (Section 11.0). Also described is the interactive entry of those parameters which are standard to all programs.

The ore reserve calculation programs **RESUV** (Section 12.0), **ORSAC** (Section 13.0) and **SCOR** (Section 14.0) are described in detail. These sections include: the concepts and operational features of each program; detailed instructions for running the programs; and sample output from test cases.

APPENDIX A (Section 15.0) describes the concepts used in the GAMLOG method of interpreting borehole radiometric data and is excerpted from RME-145 (Section 1.2).

APPENDIX B (Section 16.0) is a listing of file 'STARDAT', a test primary sample data file containing a set of actual gamlog data which are identified for a fictitious property.

APPENDIX C (Section 17.0) contains a test run and output list by the URDAT program from test data contained in the supplied diskettes.

Section 18.0 contains an index of terms which, it is hoped, will be useful to the user of the URAD system.

1.5 TEXT NOTATIONS, SYMBOLS, AND ABBREVIATIONS

1.5.1 General Notations and Symbols

- Single quotes (' ') are used only when referring to data (in a UCON file) which specifically require enclosing single quotes as part of the actual data entry.
- Double quotes (" ") may be used for new or "colloquial" terms, types of data elements, and descriptions of codes and actual data entries. However, double quotes are never part of any actual data either in files or as interactive entries.
- Underlining ("_") is used to indicate a blank (character) when giving examples of alphanumeric fields.
- **Bold Face** is used for highlighting terms or phrases, or for warning comments.
- Percent is denoted by "%".
- A small "*" in equations denotes multiplication.
- A slash "/" in equations denotes division.
- A plus "+" in equations denotes addition.

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- A minus "-" in equations denotes subtraction.
- Two asterisks "**" in equations denote exponentiation (power).
- "{ < (--) > }" in equations denotes hierarchy of operations.
- "Alphabetic" characters refer to the letters "A" through "Z".
- "Alphanumeric" characters refer to the entire ASCII character set, including numbers, characters, and special characters (but not "alternate" characters).
- A program "RUN" is the complete processing of all the blocks and files defined in a UCON file. A RUN begins with the entry of the program name and ends when all blocks in the UCON file have been processed and program operations completed.
- A "block pass" is the complete processing of one block of data as defined by a UCON file.
- A "default" value or file name is one which will be used in a program RUN if some optional value or name is not supplied.
- All data currently used in the program are in the "English" weight / measure system; one ton = 2000 pounds.

1.5.2 Notation in Field Descriptions for UDAT Formats

A "field" is the location on a record in which a particular data element is placed. In fixed-field formats such as required by the UDAT files, a field is specified by the column numbers of the record. In partially-free-format records such as in the UCON (partially) and RNGTBL files, it may be referred to by its position with respect to a specific code and/or to other fields.

The following field notation is used in this text:

- "C" denotes "column" and the number following "C" is the exact column number of a field in a given record; when a field consists of more than one column, the first and last columns are enclosed in parenthesis; example "C(5-8)" means "columns 5 through 8", "C22" means "column 22".
- "D" denotes the number of places to the left of the last column of a numeric field at which an assumed decimal is positioned; example "D = 2" means that a decimal is assumed 2 places to the left of the last column of the field ("one place to the left" means "immediately to the left").
- "E" denotes the type of data entry, either "A", "N", or "B", where,
- "N" denotes "numeric, i.e. the numbers "0" through "9". Unless a "D" (above) is specifically mentioned, no decimal is assumed.
- "A" denotes alphanumeric data unless otherwise specified.

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Note: The special notations described above should not be confused with actual codes used as data.

1.5.3 Abbreviations in Text and Illustrations

The following are abbreviations used throughout the text:

```
Blk = block
BLTH = bottom lithologic unit
BOTEL = bottom elevation
CE-fields = entries in columns 13 through 72 of
            continuation records
Coord. = abbreviation for coordinates
CPS (cps) = counts per seconds
Cu. = cubic (**3)
DT = dead time
Elev. = elevation
Fmt. = format
Ft. = feet
grd. = grade
LOGe = logarithm to the base e
max. = maximum
min. = minimum
mng. = mining
ms = microseconds
MV = maximum value
PITBT = depth to pit bottom
sec = seconds
sq. = square (**2)
thk. or
thick. = thickness
TLTH = top lithologic unit
TOPEL = top elevation
tot. = total
yd(s) = yard(s)
```

1.6 URAD BENCHMARKS

Please note that benchmarks for all programs are contained in the supplied diskettes and include input and output results. Please compare the results of the benchmark input data with each of these files to assure correct operation.

2.0 OVERVIEW OF THE URAD SYSTEM

2.1 OVERALL STRUCTURE

The overall structure of URAD is charted on Figure 2.1.

2.1.1 Processing Primary Data Files

The system for storing the basic uranium sample assay data (Section 3.0) used in URAD is termed "UDAT" (Sections 4.0, 5.0, & 6.0) and requires the data to be established in **UDAT files** in one of several "standard" formats. Basic data may be entered (Figure 2.1, step 1) into the UDAT files from the keyboard, or by "automatic-digitizing" procedures, and are stored permanently in **Primary** (basic) UDAT files. UDAT files may be on hard or floppy disk. If data already exist on some medium (ex: floppy disk) which is compatible with the microcomputer hardware system but are not in the formats required by the UDAT system, they may be entered into a UDAT file by writing a "conversion" program which will arrange them in one of the UDAT formats.

UCON Files (Section 7.0) are small temporary files (Figure 2.1, step 2) created to provide instructions for selecting, editing, and submitting to URDAT any of the data from one or more primary UDAT files. They are also created (step 5) to provide similar instructions relating to the intermediate UDAT files used as input to the ore reserves programs. When so used, they serve to define the blocks (Section 7.1.2) for which reserves will be calculated. A UCON file must be available each time any one of the four main programs is run and will apply to one specific RUN only. However, the same UCON file could be used with each of the reserves programs if the applicable sample data were to be identical.

Program **URDAT** (Section 8.0) processes (Figure 2.1, step 3) the primary UDAT files to:

1. Create output listing and data summaries (see print-output file, below).
2. Carry out any required interpretation of radiometric data, using the GAMLOG (Section 15.0) method.
3. Create standardized Intermediate UDAT files which are used for data input to the RESUV (Section 12.0), ORSAC (Section 13.0), or SCOR (Section 14.0) ore reserve programs. These intermediate files may be saved or deleted at the option of the user. During a single URDAT RUN, any number of primary UDAT files may be processed but only one intermediate UDAT file may be created.

2.1.2 Ore Reserve Calculation Programs

The ore reserves calculation programs -- RESUV, ORSAC, and SCOR -- are each run independently (Figure 2.1, step 6). Each utilizes an appropriate UCON

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file to obtain sample data from the intermediate UDAT files, and any number of such files may be processed in one block pass (and during one RUN).

The reserves programs carry out the ore reserve calculations and create output listings of the results (see print-output file, below).

Program SCOR optionally creates "USUM" files which contain summaries of the ore interval analysis on a given set of data under a given set of physical and economic criteria.

2.1.3 Print-Output Files

Print-output ("p-o") files (Section 8.2) are those files (excluding the intermediate UDAT files) on which output of results from the various programs will be placed. P-o file names are assigned interactively at the start of program execution. If the printer is designated as the p-o file, then the results are printed directly on the printer during program execution. If some other file is designated, then results must be printed separately, (after program execution is completed) using the utility program FORPRINT (Figure 2.1, steps 4 & 7; Section 8.2.3).

Since a variety of print control commands not standard to FORTRAN are sent to the printer in URAD, program RESTPRN (Section 8.2.3.1) is provided to restore the printer to standard if a RUN is abnormally aborted while printing is taking place. Section 8.2 provides detailed information on print output options.

2.2 URAD FILES

2.2.1 Working File Name Protocol

UDAT, UCON, and print-output p-o files may be considered as "working files". Any names may be assigned to URAD working files, providing they follow DOS convention; however, a file name may not be referenced by more than 15 characters. This allows the inclusion of a device name d: but not directory or subdirectory names. Examples of URAD working file names are "FILENAME", "A:FILENAME", "FILENAME.DAT", "A:FILENAME.BIN".

The naming, saving, backup, transfer and/or deleting of any URAD files is left entirely up to the user, except that URAD does provide default names for the UCON file and print output file to be used in a run.

URAD does not automatically provide filename extensions .xxx to file names assigned by the user. If extensions are used, it is suggested that the extension ".DAT" be given to primary UDAT files, and ".B" or ".BIN" to intermediate UDAT files.

2.2.2 File Location

When UDAT or UCON files are entered interactively during program execution, they must always be available either in the current working directory of the default drive, if no device name is provided, or in the root directory of

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the specified disk, if a reference device name is included. Similarly, p-o files will be created or accessed either in from the working directory of the default drive or the root directory of a specified disk.

File "RNGTBL" is a special file; when needed (Section 5.2.1.2), it must always be in the current working directory of the default drive.

2.2.2.1 Hard Disk Available

With a hard disk, it is most convenient to keep the .EXE modules, the working files, and RNGTBL all in one directory -- always using it as the working directory when running the programs. Any available additional disk drives may be used as optional working file storage.

Optionally, the .EXE files may be in one directory example: "URX" and the working files and RNGTBL in another example: "URW". Then, URW may be used as the working directory and the .EXE modules may be accessed by first issuing the DOS command "PATH \URX" (or setting the path in an autoexec batch file).

To run any of the programs, simply issue the DOS program execute command i.e. type the program name & press RETURN .

2.2.2.2 Hard Disk Not Available

With a single or dual floppy drive (but no hard disk) system, the ".EXE" modules may be kept on one set of disks, and other disks used to hold the working files -- in the disk root directory.

To run a program (after booting the system), simply enter the disk containing the desired program .EXE module into the default drive and issue the DOS program execute command . When the console monitor message to specify file "OUTPUT" appears, remove the program disk and enter the disk(s) containing the required UCON file and primary or secondary UDAT file(s), or, for program FORPRINT, the p-o file to be printed. If URDAT is being run, the disk in the default drive must contain file RNGTBL (if needed).

2.2.3 Files included with Guide

The following files are included with this Guide.

2.2.3.1 Program Execute Modules

Execute modules compiled for use with a mathematics co-processor are: URDAT.EXE, RESUV.EXE, ORSAC.EXE, SCOR.EXE, FORPRINT.EXE, and RESTPRN.EXE.

For use in a microcomputer system lacking a math co-processor, the above are optionally available as: URDAT2.EXE, RESUV2.EXE, ORSAC2.EXE, SCOR2.EXE, FORPRIN2.EXE, and RESTPRN2.EXE.

2.2.3.2 FORTRAN Source Programs

FORTRAN source code is available for URDAT, RESUV, ORSAC, SCOR, FORPRINT, and RESTPRN.

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2.2.3.3 Test UDAT Primary Data Files

GAMDAT examples of the various primary data formats
GAMDATV for testing bimodal (uranium and vanadium) format
STARDAT 230 sample sets from a hypothetical uranium deposit
STARDATL for testing lithologic data

2.2.3.4 Test UCON files

UCON1 use for test URDAT RUN on file GAMDAT
UCONL use for test URDAT RUN on file STARDATL
UCONS use for test URDAT RUN on file STARDAT
UCONV use for test URDAT RUN on file GAMDATV

2.2.3.5 Test UDAT Intermediate Data Files

STARDATL.B created by running URDAT using UCONL
STARDAT.B created by running URDAT using UCONS
GAMDATV.B created by running URDAT using UCONV

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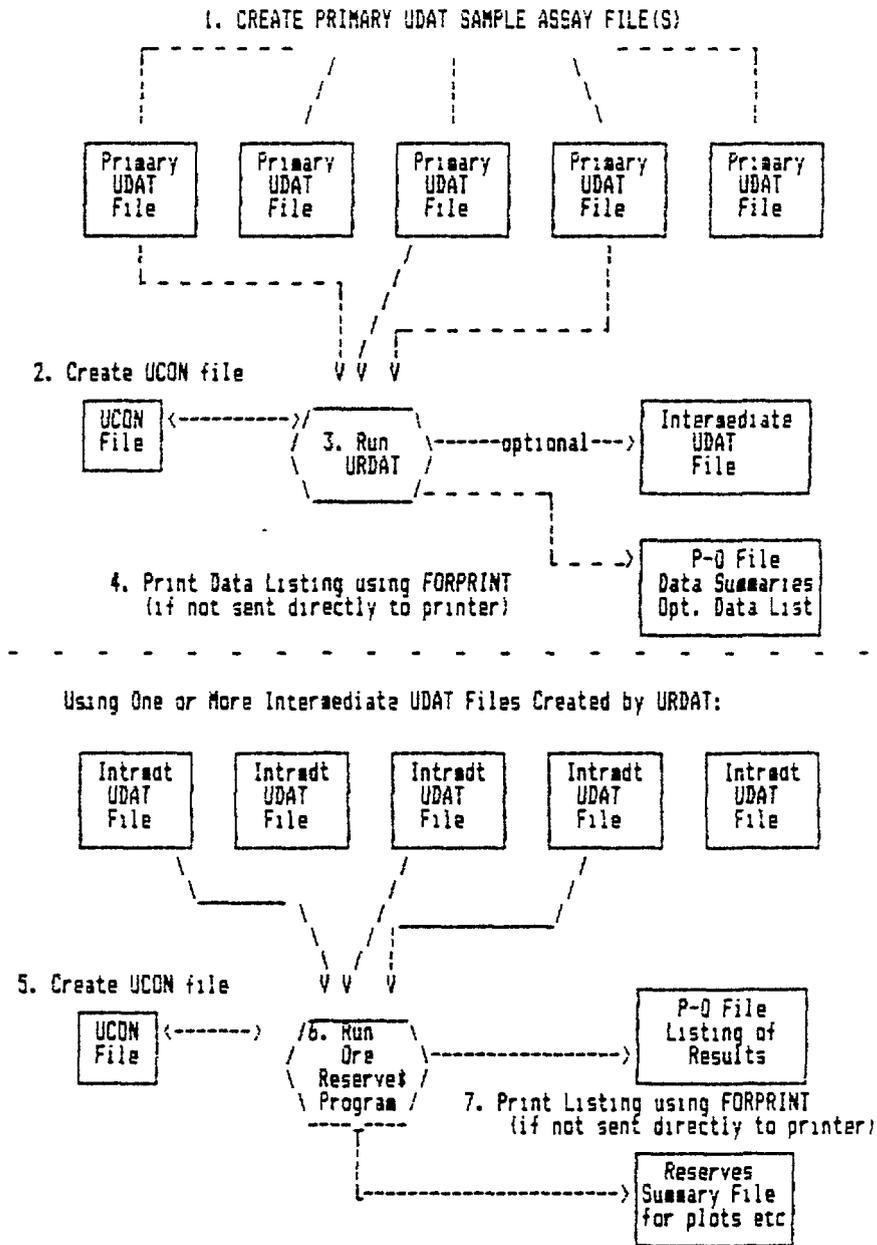


FIGURE 2.1 OVERALL STRUCTURE OF THE URAD SYSTEM

3.0 REVIEW OF URANIUM SAMPLE DATA

3.1 GENERAL

When the utilization of computers as an aid to ore reserves analysis is first introduced to any individual or organizational entity, prime interest is usually focused on the ore reserves computations themselves. The main concerns are technical justification, reliability of results, the advantage of one particular method over another, computational speeds, the form of output, and so forth. However, once the computer is adopted as a working tool, the users invariably find that the handling of data begins to occupy a seemingly disproportionate amount of their time and effort. As the computer utilization increases and the amount of data grows larger, more and more work is expected of the computer, and attendant data manipulation becomes increasingly difficult and complex.

Data entry and storage are a common facet of all computer applications. In the working environment, data associated with minerals, especially uranium, presents some unique problems:

1. There is great diversity in type, collection method, and form of data.
2. There are a considerable number of ways the data may be used.
3. The data do not generally lend themselves to easily available standard data base management systems.

For an individual or group desiring the flexibility of handling any type of data which may become available, there is a major benefit in establishing a standard data system which will contain all the information needed but, at the same time, is not unwieldy and may be easily accessed.

The following discussion of the URAD data system is therefore intended not only as a guide to running the programs themselves, but also as a forewarner of future needs and problems which may be encountered by the user in the development of any mineral sample data base.

The system itself is, to some extent, a "holdover" from the punch-card/magnetic tape environment (and associated data reduction methods) which prevailed in the 1960's and 1970's. Sample data are initially entered from the console keyboard and stored in 80-column records, and strict rules on data format apply. However, word-processing systems currently available for use with microcomputers greatly facilitate the entry, edit, and listing of the data. If applicable data already exist in "machine-readable" form (Section 3.3.1), they may be converted to the required formats.

The automatic digitizing of data from gamma-ray log strip charts also provides a relatively quick method of entering data into the files. Specific techniques for such procedures are not discussed in this guide, as they depend to a large extent on the equipment employed. However, the parameters and coding systems required by URAD for such digitized information are detailed in Sections 5.0 & 6.0.

REVIEW OF URANIUM SAMPLE DATA

The next step up from the current URAD system would be one which allowed interactive entry of basic sample data and stored these data in a more compressed form. However, it would be easy to convert both the UDAT primary and secondary files to any other data base system

3.2 URANIUM SAMPLE DATA USED IN URAD

3.2.1 Definitions Used in Guide Relating to Sample Data

The general term **sample** as used herein refers to a linear extent of some material and its corresponding representative mineral content. In this Section, and Sections 4, 5, & 6, the term **sample assays** refer directly to the percentage or "grade" of a "mineral" (actually a specific element or compound) in the total material, as determined through laboratory analysis. The minerals applicable to URAD are uranium (U, with grade generally expressed to the nearest 1000'th of 1 percent U308) and vanadium (V, with grade expressed to the nearest 100'th of 1 percent V205).

Chemical uranium assays refer to assays for which an estimate of the actual grade has been made either directly or indirectly; this would include chemical, fluorometric, or neutron-activation, analyses. **Radiometric** (or "radiometric-equivalent") assays are those based solely on observed radiation (usually gamma-radiation) with the assumption that the represented uranium and its daughter products are in radiometric equilibrium (see Section 3.4). (In the sections describing the ore reserve programs, the term "assays" is used generically for all sample data.)

Sample **readings** refer to numeric values from which sample grades may ultimately be determined.

Each sample consists of a **sample interval** which is defined by **thickness** in feet, and mineral **grade** -- either an actual grade (example: percent U308) or a "reading". In the latter case, the factors required to make the estimate are included in the **sample description** (below).

3.2.2 Sample Sets

Samples suitable for effective use in ore reserves analysis are usually grouped in approximately linear "sets", each set consisting of one or more samples. A **sample set** includes a **description**, i.e. one or more symbolic identifiers (hole number or sample number, property number) and sufficient information to accurately assign any sample in the set to a position in some three-dimensional coordinate reference system. A single "point of origin" suffices to establish this if the set is vertical. If the set is not vertical, then additional information must be provided as to its direction from the origin point.

Examples of sample sets are: a series of core samples from a bore hole; a series of samples from one total channel sample; measurements of radiometric "counts-per-second" from a bore hole.

A sample set may be further characterized by geologic environment.

REVIEW OF URANIUM SAMPLE DATA

A **data set** is simply a group of sample sets which have some generic commonality from the user's point of view. A **data file** is a specifically named DOS computer file containing sample set data in structured form.

3.2.3 Uranium Sample Data

The basic sample data used in uranium ore reserves calculations consist mainly of:

1. Radiometric data from logs of surface or underground boreholes.
2. Interpretation of the actual uranium values represented by the above. These may be in the form of: 1) values at equal spacing along the borehole; or, 2) interpretations of thickness and average grade of total anomalies.
3. Chemical or radiometric assays of core or cuttings from boreholes.
4. Chemical or radiometric assays of representative samples of materials (example: "channel" samples) from mine workings.
5. Radiometric or "direct" measurements from "face-scanning" in mine workings.

3.3 BOREHOLE RADIOMETRIC LOGGING DATA

The term "borehole radiometric logging" refers to the act of measuring the amount of radioactivity received by a sensor moving along a borehole; and a "radiometric log" (or "gamma log") is the resulting record of the radioactivity measurements. Such measurements are termed "borehole radiometric logging data", or simply "gamma-log" data.

For this section, and other sections dealing with gamma-log data, it will be useful for the reader to refer to Section 17.

During the past 35 years, there has been considerable evolution in the methods of both handling and "interpreting" such data, i.e. estimating the uranium grades represented by them. These methods have progressed from paper-and-pencil recording and simple factoring of individual values read from hand-driven instruments to direct recording of computer-calculated uranium estimates directly onto magnetic tape in sophisticated mobile logging units.

Since gamma-log data are not always immediately available in the most up-to-date or advanced form to those responsible for reserve calculations, a brief review is warranted of the various forms in which they may be received.

The term "readings" refers to measurements of the radioactivity at given positions in the borehole recorded either directly during the logging procedure or subsequently measured from the continuous curve representing the radiometric amplitude on a printed "strip" log (Section 3.3.4). Readings are almost always taken at regular, consecutive intervals, usually 0.5 or 1.0 feet along the length of the borehole. Readings may be in counts-per-second (cps) or in inches-of-deflection (when measured from a "strip" log).

REVIEW OF URANIUM SAMPLE DATA

URAD uses the "GAMLOG" method (Scott, 1963) described in Section 15 to interpret such data.

The term "interpreted" refers to gamma-log data for which an estimate of uranium content has been made. "Uninterpreted" refers to gamma-log data requiring further processing to obtain an estimation of the uranium content represented by the data.

"Descriptive" data which must be provided along with uninterpreted radiometric logging data from any borehole are: 1) the K-factor; 2) the applicable attenuation factors; 3) the dead-time correction factor; 4) the interval at which the readings were taken; 5) the depth from the top ("collar") of the borehole at which the first reading was taken; 6) the depth to any natural water and/or drilling fluid standing in the hole at the time the log was made, as well as information on hole casing, if applicable. These factors are important since they must also be entered as data with each sample set of gamma-log data (Section 5.3) in the UDAT files.

In the following summary of the most commonly available types of gamma-log data, brief reference is made to the format(s) used in entering them in the URAD data files. These formats are described in detail in Section 6.

3.3.1 Direct "Readout" to Machine-Readable Media

As of this date, "state-of-the-art" radiometric logging units in commercial use record (or "read out") radiometric readings, in "counts-per-second" ("cps") directly onto a "machine-readable" ("computer-readable") medium -- usually magnetic tape. Some even have the capability of interpreting and converting the readings to estimated uranium values during the actual logging process. During the early 1980's, logging sensors were developed to measure the actual uranium content in boreholes, but these methods have not yet been put into widespread commercial use for uranium exploration the United States.

In order to utilize data on magnetic tape without intervening manual transcription, the microcomputer must either have an interface with an appropriate magnetic tape drive or reader, or the data must be "down-loaded", on a different computer, to a medium (floppy disk, hard disk, or other) which is compatible with the given microcomputer system.

A utility program may be easily written to convert such data (or any other uranium sample set data which is not in the UDAT form) to the required UDAT formats. During the period when the precursor to the URAD system was in full operation, this type of situation was the rule rather than the exception. It is far easier to convert such data to one of the UDAT formats than to write an input program such as URDAT for each new format type that is encountered.

A discussion of the methods involved in the above processes is outside the scope of this guide.

3.3.2 Direct Readout to Printed Media

Cps readings recorded during the logging process are sometimes printed directly on to paper tape or are printed from magnetic tape. Such data may be

REVIEW OF URANIUM SAMPLE DATA

entered into the UDAT files using the "F1U" borehole log format (Section 6.3).

3.3.3 Interpreted Values

Listings of estimated uranium values based on interpretations made by some other computer are sometimes available from the logging company or some other source. These may be entered into the UDAT files using the "FnQ" borehole format (Section 6.3) or the "contiguous" format (Section 6.1).

3.3.4 Readings from Printed Radiometric Strip Logs

The term "printed radiometric strip log" or "strip log" is used in this guide to describe the continuous curve automatically drawn, usually by pen and ink (stylus) on scaled chart paper, to represent the amplitude of radio activity measured in the borehole during logging procedures. The general definition of the strip log includes the chart paper and associated background material as well as the curve itself. If direct readout of cps, on some readable medium, is not available, then the printed radiometric strip log provides the only source of data by which to estimate the radioactivity and corresponding uranium content represented in the borehole.

Two types of uninterpreted readings may be taken at points along the continuous radiometric amplitude curve on a strip log.

1. "Inch-Deflection Readings" are measured from the base line of the log to the radiometric amplitude curve either by hand or by automatic "digitizing" methods. These are entered into the UDAT files using the "A-E,1" or "F11" borehole log formats. If they are automatically digitized onto microcomputer disk then a simple "utility" computer program can be written to convert the data into the "A-E,1" or "F11" formats.

2. Transparent overlays may be designed to allow the reading of points along the amplitude curve in terms of cps, either uncorrected or corrected for dead time. Such readings are entered using the "F1U" or "F1C" formats.

In either case, if hand/overlay methods are utilized, the readings can be directly transcribed into the data files using the console typewriter.

3.3.5 Total Anomalies

If a computer is lacking to interpret individual readings taken on a 0.5 or 1.0-foot basis, the total thickness and average grade represented by total anomalies may be estimated from printed logs or from tabulations of cps readings using the method described in Technical Report Series No. 259, "Practical Borehole Logging Procedures for Mineral Exploration with Emphasis on Uranium", IAEA, 1986 (Section 1.2.2). Further reading on the subject published by the IAEA is Technical Report Series No. 212, "Borehole Logging for Uranium Exploration", IAEA, 1982.

Section 17) Uranium values estimated in this manner are most easily entered into the UDAT files by using the "non-contiguous" format (Section 6.2).

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3.3.6 Inch-Deflection vs Counts-per-Second Readings

In the current URAD format system, inch-deflection readings are assumed to be recorded to the nearest one-hundredth of an inch. When the radiometric count rate exceeds around 50,000 cps, there is a minor, but noticeable difference in the interpreted U308 values derived from actual cps and those derived from the cps calculated by: $\text{cps} = \text{inches-deflection} \times \text{cps/inch}$, where, cps/inch is based on the appropriate logging range scale. This may be observed in file "GAMDATX" contained in the supplied diskettes, by comparing the high grade values of sample set "TEST 4" with those in "TEST 6" (see also comments in Section 5.4).

The effect is simply caused by the difference in the number of possible significant digits in the cps readings as opposed to those available in the combination of inch-deflection and range-scale values; the latter has less.

In practice, it was found futile to attempt to digitize readings to the nearest 1000th of an inch from strip-logs, since the stylus trace of the radiometric amplitude curve has a width generally greater than 100th of an inch. However, if it were desired to record to the nearest 1000th of an inch, then a new format, say, "i" (instead of "I") could be added to allow for the extra digit in the continuation record CE-fields.

3.4 RADIOMETRIC DISEQUILIBRIUM

3.4.1 General Concepts

The uranium occurring in a deposit may be out of equilibrium with respect to its daughter products. The deposit may be so recent that equilibrium has not yet been reached, or it may have been reached in the past and since then the deposit may have been subjected to processes which have caused the uranium and/or the chief gamma-giving products (chiefly radium 226) to be preferentially removed, at least locally.

For such deposits, it is necessary to adjust radiometric values to obtain the best approximation of representative uranium grade. "Equivalent-radiometric" assays and interpretations of borehole log radiometric data are most commonly subject to such adjustment. An equivalent-radiometric assay is defined as an assay which is made to determine uranium content but is based on measurements of the gross count gamma radiation from the daughter products; the resulting estimate of the uranium content must assume that the uranium and its daughter products are in equilibrium.

Normally, during the course of evaluating a deposit, as many samples (representative of the deposit) are taken as considered necessary and are analyzed for both chemical and radiometric-equivalent grade. Comparisons are made of the resulting values to determine the ratio of the chemical to the radiometric grades. Simple arithmetic averages of uranium:radiometric ratios do not always suffice for adjustment purposes. The ratios are often not straight line functions, and different portions of the same deposit may be characterized by different disequilibrium relationships. Oxidized portions often favor the radiometric values, and, conversely, the quantity of uranium

REVIEW OF URANIUM SAMPLE DATA

in unoxidized or enriched portions is often not completely reflected by the radiometric values.

Accordingly, it is useful to: classify such sample assay data according to their local geologic environments; to fit values from selected classes to several functions using statistical methods such as regression analyses; and, of course, review the "goodness-of-fit" of the derived coefficients. In order to obtain valid results, a complete spectrum of grade values must be represented in each class. Functions which have proved useful are:

$$Y = A + BX + CX^{**2} + DX^{**3} + EX^{**4} \quad (1) ,$$

$$\text{LOGe } Y = A + B \times \text{LOGe} X \quad (2) , \quad \text{and}$$

where,

X = observed radiometric value,

Y = predicted chemical value,

A, B, C, D, E are coefficients.

3.4.2 Application of Disequilibrium Correction Coefficients

If disequilibrium coefficients have been determined, they may be applied to radiometric data in the UDAT files as explained in Section 7.6.6. All sample data are coded as to whether or not they may be subject to corrections (Figure 5.1). Corrections may be applied when running program URDAT to create intermediate UDAT files, or they may be applied during the processing of the intermediate files by one of the ore reserves programs. The latter method is recommended since once the corrections have been made by URDAT, no further changes should be applied when processing the intermediate files.

4.0 UDAT SYSTEM -- PRIMARY (BASIC) FILES, GENERAL STRUCTURE

In URAD, all sample data are stored as linear sample sets, as defined above, regardless of their type and origin, and are contained in standard DOS files herein termed "UDAT" (Uranium, DATA) files.

Sample data are first entered and stored in **UDAT primary ("basic") files** (Section 4.1) which are in the "sequential, formatted" mode and consist of records having a maximum length of 80 characters each. The data may be entered according to one of several formats.

Program URDAT (Section 8.0) processes the primary files and creates **UDAT intermediate** files which are completely standardized and are in the "sequential, binary" mode. The intermediate files are used as input to the ore reserves programs.

There is no limit to the number of UDAT files or the number of sample sets within either a primary or intermediate file except those imposed by the constraints of the microcomputer system itself. UDAT files may reside on hard disk or floppy disk and may be given any DOS-compatible file names.

File size is limited to the available capacity of the disk involved.

This Section, and Sections 5 & 6, describe the attributes of the UDAT primary data files. The intermediate files are described in Section 8.5.

Note: Program URDAT is designed so that additional format types may be added to the URAD system if needed.

4.1 PRIMARY UDAT FILES

All sample data in a primary file is entered according to "fixed-field" formats in accordance to prescribed rules, but unformatted text is also allowed. No records may be greater than 80 columns (characters). Sample sets within a given file may consist of any of the UDAT sample types, i.e. "contiguous", "contiguous bimetal", "non-contiguous", "A-E", or "F"; and different types may be included within the same file.

4.1.1 Test Primary UDAT Files

Four test primary UDAT sample assay files are included with this guide. They may be easily scanned by using available word-processing programs.

4.1.1.1 Test File GAMDAT

Test file "GAMDAT" contains examples of all the formats. A listing of file "GAMDAT" is shown on Figure 4.1a-b. If program URDAT (Section 8.0) is run using test file "UCON1" as the UCON file, the variables listed in the designated print-output from the RUN (Appendix C) may be compared to

UDAT SYSTEM: GENERAL FILE STRUCTURE

those in Figure 4.1a (part 1) and 4.1b (part 2) (see also Sections 3.3.6 and 5.4).

4.1.1.2 Test File STARDAT

Figure 4.2 is a partial listing of test file "STARDAT" which consists of 230 actual sample sets in the "F1U" format. The results of running URDAT on these sets is shown on Appendix C. This file is used to illustrate many of the features of the URAD programs.

4.1.1.3 Test File GAMDATV

Figure 4.3 is a partial listing of test file "GAMDATV" which contains sample sets in the "V" format (both uranium and vanadium assays). File GAMDATV is used in describing program RESUV.

4.1.1.4 Test File STARDATL

File "STARDATL" consists of selected sample sets, from the STARDAT primary UDAT file, to which have been added hypothetical lithologic records (Section 6.4). It may be used to test the lithologic edit features of the UCON system (Section 7.6.4).

4.2 FORMATTED DATA

4.2.1 Sample Set Record Types

A UDAT file consists simply of data from one or more sample sets, with each set comprised of a **header** record and, optionally, **continuation** records. Every sample point to be recognized in the files must be represented by a header record, but continuation records are not required if the interval represented by the sample point is considered devoid of significant mineral content ("barren"). **Lithologic and directional** data records may, optionally, follow the continuation records (or the header record, if there are no continuation records). The organization of the sample sets listed in Figure 4.1 is described by the comment records ("C" in column 1).

There are limits to the number of continuation records within a sample set; these are defined in the discussion of the individual UDAT formats (Section 6.0).

4.2.1.1 Header Records

The very first record of any sample set consists of an **identification or "header" record** containing the descriptive information and, if required, gamma-log interpretation parameters. The point of origin is referenced by two coordinates and an elevation (see Figure 6.1). Each header record must contain a primary **"sample-type" code** in column 13; subsidiary sample-type codes may be required in columns 14 and 15. The sample-type codes define

UDAT SYSTEM: GENERAL FILE STRUCTURE

both the type and format of the data within the given sample set. (Some header records may also contain sample data.)

If the sample set is considered "barren", i.e. there are no continuation records, the interval of "barrenness" is assumed to be between the reference elevation and the "total depth sampled" (Section 5.2.7).

4.2.1.2 Continuation Records

One or more **continuation records** containing sample intervals and corresponding grades may follow. Each sample interval is represented by a thickness and mineral grade value.

For borehole log data, the sample interval thicknesses are all the same, and the value of the interval is entered on the header record. For intervals of barren material between anomalies, only the thicknesses are included; the grade of such intervals is assumed to be negligible.

4.2.1.3 Lithologic Records

One or two records containing "**lithologic**" (**geologic**) **information** (Section 6.4) may follow either the last continuation record of a sample set or the header record (see *NOTE). Lithologic records all have the same format, regardless of the format of the header and continuation records.

Note: if a given group of samples sets have been characterized with lithologic information, a barren sample set in that group must also contain applicable lithologic data, or else it will be ignored completely in a RUN when lithologic edit control is used.

4.2.1.4 Directional Data Records

One or more records containing information on the direction and attitude of the linear sample set may follow the last lithologic record, the last continuation record or the header record. If the information is not present, the sample set is assumed to be vertical. Directional data records all have the same format, regardless of the sample set type.

This first version of the guide does not include a description on the format and use of directional data.

4.2.2 Format Types

Three basic format types are used:

4.2.2.1 Contiguous Format

The "contiguous" format is best suited when entering chemical or radiometric assays (from mine workings or borehole materials) from a list of contiguous

UDAT SYSTEM: GENERAL FILE STRUCTURE

samples recorded without regard to mineral content. The contiguous format may contain uranium assays only (**unimetal**) or uranium and vanadium assays (**bimetal**).

4.2.2.2 Non-contiguous Format

The "non-contiguous" format is best suited for transcribing sample data from maps or tabulations where low-grade samples have already been censored; it is also useful for entering interpretations of "total" anomalies from strip logs. It does not provide for vanadium assays.

4.2.2.3 Borehole Log Formats

The "borehole log" formats are used for entering data derived from continuous measurements in boreholes. The "FnQ" format is used to enter interpreted values; the "A-E" and "F1U", "F1C" and "F1I" formats are used for data which must be additionally interpreted.

4.3 FORMAT-FREE TEXT

In addition to the specific sample set data, general text information concerning the file or any sample set may be freely interspersed within a primary UDAT file, as shown in Figure 4.1. The character "C" in the first column of any record in a primary UDAT file automatically denotes the remainder of the record as being text information.

The "C" **must** be entered in column 1 of any record which is not in a standard sample set format. If it is not, serious problems will result during processing of the data.

No text information is carried over to the intermediate UDAT files.

UDAT SYSTEM: GENERAL FILE STRUCTURE

```

C   A SET OF VARIOUS TYPES OF ASSAY DATA FOR TESTING THE URDAT SYSTEM.
C
C   CONTIGUOUS FORMAT, 'UNIMETAL'.
C   Header Record
0  AAATEST 12      5000  5000 700051500100  500  10 05 20 02 30 06 40 02URDAT
C   Continuation Records (2)
1  AAATEST 1 50 10 50 15 40 02 40 05 40 09 20 30 30 04 20 08 20 20 50 10URDAT
2  AAATEST 1 50 35 40 30 20 06 20 04 20 10 20 40 20 03 20 02 20 04 20 01URDAT
C
C   BARREN SAMPLE SET
C   Header Record
0  AAATESTA12      5000  5000 700051500100                                URDAT
C
C   CONTIGUOUS FORMAT, 'BIMETAL'.
C   Header Record
0  VVVTEST 2V1      8000  50001100051500100 4000      10 105 05 20 102 02VDATA
C   Continuation Records (3)
1  VVVTEST 2 50 200 04 20 555 10 20 050 15 20 200 02100  05 01 05 100 20VDATA
2  VVVTEST 2 50 400 04 40 555 50 20  02 02 20 200 01100  20 01 05 500 25VDATA
3  VVVTEST 2 10 010 02 20 100 50 20 010 02 20 200 55100  20 01 05  20 02VDATA
C
C   NON-CONTIGUOUS FORMAT.
C   Header Record
0  AAATEST92611    5055  6055 7000 1500100 300  130 40  05 1365 50 02URDAT
C   Continuation Records (2)
1  AAATEST82 145 100 11 155 150 25 170  50 104 175  50  82 180  50 07URDAT
2  AAATEST82 200  90  02 209 110  09 220  60  48 230  60  12 236  40 03URDAT
C
C   BOREHOLE LOG FORMAT, 'FIU', UNCORRECTED CPS.
C   Header Record
0  BBBTEST 3FIU  7930  9376 72030  10051890052300337  128  3  A3URDAT
C   Continuation Records (7)
001BBBTEST 3  1591 - 000400 000700 002200 001400 001200 003500 003700 URDAT
002BBBTEST 3  003000 001800 002200 003800 008000 017800 023800 016700 URDAT
003BBBTEST 3  015100 013000 008400 007600 004400 001600 001000 000700 URDAT
004BBBTEST 3  000600 000500 000600 000700 000800 001000 000800 000600 URDAT
005BBBTEST 3  000500 000700 002100 004100 001900 000600 000500 000300 URDAT
006BBBTEST 3  13 - 000300 001100 002400 001100 000700 000700 000800 URDAT
007BBBTEST 3  000300                                URDAT
C   Header Record
0  BBBTEST 4FIU  7780  9198 72110  10051850053290337  128  3  A3URDAT
C   Continuation Records (11)
001BBBTEST 4  1583 - 000500 000600 000800 001200 002300 003500 006000 URDAT
002BBBTEST 4  009500 008000 003000 002100 001800 002500 002200 001900 URDAT
003BBBTEST 4  003600 010400 029900 060100 056400 056200 043400 017500 URDAT
004BBBTEST 4  010400 011600 015300 026000 037100 038000 035600 026100 URDAT
005BBBTEST 4  013800 007100 005500 003500 003500 004000 007700 023600 URDAT
006BBBTEST 4  067900 129000 163900 178700 181000 173700 129700 068600 URDAT
007BBBTEST 4  023600 004700 001600 001100 000800 000700 000700 001000 URDAT
008BBBTEST 4  001000 002300 005700 012400 022500 049900 069200 068500 URDAT
009BBBTEST 4  083200 103000 100100 104500 110000 113300 116700 121600 URDAT
010BBBTEST 4  084100 067700 096600 090100 038300 017200 009700 007700 URDAT
011BBBTEST 4  003000 002500 001000 000700                                URDAT
C
C   BOREHOLE LOG FORMAT, 'AII' (NEEDS FILE RN6TBL), INCHES DEFLECTION.
C   Header Record
0  CCCTEST 5A11  7930  9376 72030  10051890052390337  96128  3  A1URDAT
001CCCTEST 5  1591 - 400 3 700 3 220 7 140 7 120 7 350 7 370 7 URDAT
002CCCTEST 5  300 7 180 7 220 7 380 7 800 7 1781 1 2381 1 1671 1 URDAT
003CCCTEST 5  1511 1 1301 1 0841 1 0761 1 0441 1 0161 1 0101 1 0071 1 URDAT
004CCCTEST 5  0061 1 0051 1 0061 1 0071 1 0081 1 0101 1 0081 1 0061 1 URDAT
005CCCTEST 5  0051 1 0071 1 0211 1 0411 1 0191 1 0061 1 0051 1 0031 1 URDAT
006CCCTEST 5  13 - 0031 1 0111 1 0241 1 0111 1 0071 1 0071 1 0081 1 URDAT
007CCCTEST 5  0031 1                                URDAT

```

FIGURE 4.1A

LISTING OF TEST FILE "GAMDAT" SHOWING VARIOUS FORMATS (PART 1)

UDAT SYSTEM: GENERAL FILE STRUCTURE

```

C
C BOREHOLE LOG FORMAT, 'A3I' (NEEDS FILE RN6TBL), INCHES DEFLECTION.
C Header Record
CCCTEST 6A3I 7890 9198 72110 10051850053290337 128 3 A3URDAT
C Continuation Records (11)
001CCCTEST 6 1583 - 0051 1 0061 1 0081 1 0121 1 0231 1 0351 1 0601 1 URDAT
002CCCTEST 6 0951 1 0801 1 0301 1 0211 1 0181 1 0251 1 0221 1 0191 1 URDAT
003CCCTEST 6 0361 1 1041 1 2991 1 6011 1 5641 1 5621 1 4341 1 1751 1 URDAT
004CCCTEST 6 1041 1 1161 1 1531 1 2601 1 3711 1 3801 1 3561 1 2611 1 URDAT
005CCCTEST 6 1381 1 0711 1 0551 1 0351 1 0351 1 0401 1 0771 1 2361 1 URDAT
006CCCTEST 6 6791 1 1291 3 3281 2 3571 2 3621 2 3471 2 2591 2 6861 1 URDAT
007CCCTEST 6 2361 1 0471 1 0161 1 0111 1 0081 1 0071 1 0071 1 0101 1 URDAT
008CCCTEST 6 0101 1 0231 1 0571 1 1241 1 2251 1 4991 1 6921 1 6851 1 URDAT
009CCCTEST 6 8321 1 1031 3 1001 3 2091 2 1101 3 2271 2 2331 2 2431 2 URDAT
010CCCTEST 6 8411 1 6771 1 9661 1 9011 1 3831 1 1721 1 0971 1 0771 1 URDAT
011CCCTEST 6 0301 1 0251 1 0101 1 0071 1 URDAT
C
C BOREHOLE LOG FORMAT, 'F1I', INCHES DEFLECTION.
C Header Record
BBBTTEST 7F1I 7930 9376 72030 10051890052300337 94128 31000X3URDAT
C Continuation Records (7)
001BBBTTEST 7 1591 - 4002 7 7002 7 2203 3 1403 3 1203 3 3503 3 3703 3 URDAT
002BBBTTEST 7 3003 3 1803 3 2203 3 3803 3 8003 3 1783 9 2383 9 1673 9 URDAT
003BBBTTEST 7 1513 9 1303 9 0843 9 0763 9 0443 9 0163 9 0103 9 0073 9 URDAT
004BBBTTEST 7 0063 9 0053 9 0063 9 0073 9 0083 9 0103 9 0083 9 0063 9 URDAT
005BBBTTEST 7 0053 9 0073 9 0213 9 0413 9 0193 9 0063 9 0053 9 0033 9 URDAT
006BBBTTEST 7 13 - 0033 9 0113 9 0243 9 0113 9 0073 9 0073 9 0083 9 URDAT
007BBBTTEST 7 0033 9 URDAT
C Lithologic Records (2)
101BBBTTEST 7L JM12 50JM13 100JM14 150JM151000JM161150JM171200JM181250 URDAT
102BBBTTEST 7L JM191500JM201600JM211650JM221700
C
C BARREN SAMPLE SET (WITH LITHOLOGIC DATA).
C Header Record
BBBTTEST 9F1I 7780 9198 72110 10051850053290337 94128 3 14URDAT
C Lithologic Records (2)
101BBBTTEST 9L JM12 50JM13 100JM14 150JM151000JM161150JM171200JM181250 URDAT
102BBBTTEST 9L JM191300JM201350JM211400JM221450
C
C BOREHOLE LOG FORMAT, 'F1Q', EST. URANIUM VALUES. UNCORRECTED FOR DISEQLB.
C Header Record
BBBTTEST10F1Q 7780 9198 72110 10051850053290337 94128 3 14URDAT
C Continuation Records (7)
001BBBTTEST10 1581 - 004 000 032 008 000 041 035 URDAT
002BBBTTEST10 029 008 016 022 035 174 296 106 URDAT
003BBBTTEST10 137 130 049 081 035 002 008 007 URDAT
004BBBTTEST10 005 003 005 006 006 011 007 005 URDAT
005BBBTTEST10 003 000 013 059 009 000 005 003 URDAT
006BBBTTEST10 13 - 001 009 027 008 005 006 008 URDAT
007BBBTTEST10 002 URDAT
C Lithologic Record (1)
101BBBTTEST10L JM12 50JM13 100JM14 150JM151000JM162000 URDAT
C
C BOREHOLE LOG FORMAT, 'F2Q', EST. URANIUM VALUES; CORRECTED FOR DISEQLB.
C Header Record
BBBTTEST11F2Q 7780 9198 72110 10051850053290337 94128 3 14URDAT
C Continuation Records (2)
001BBBTTEST11 1583 - 0612 0 022 120 311 500 880 1000 URDAT
002BBBTTEST11 878 555 110 060 001 000 022 URDAT

```

FIGURE 4.1B

LISTING OF TEST FILE "GAMDAT" SHOWING VARIOUS FORMATS (PART 2)

AAA	142F1U	1200	200	2140	0	507	5	195097	0106	6	STARMSA
AAA	143F1U	1200	400	2144	0	459	5	52795667	0112	.9	STARMSA
1AAA	143	4045-	000047	000054	000115	000187	000346	000400	000404		STARMSA
2AAA	143	000430	000673	000890	001040	001271	001366	000688	000395		STARMSA
3AAA	143	000123	000108	000179	000405	000483	000432	000312	000221		STARMSA
4AAA	143	000141	000109	000098	000116	000140	000116	000058	000017		STARMSA
5AAA	143	000014	000015								STARMSA
AAA	144F1U	1200	600	2145	0	638	5	565667	0112	.9	STARMSA
1AAA	144	3835-	000049	000108	000407	001044	001089	000507	000318		STARMSA
2AAA	144	000277	000251	000232	000193	000167	000254	000296	000344		STARMSA
3AAA	144	000327	000189	000126	000094	000118	000095	000041	000036		STARMSA
4AAA	144	000027	1505 -	000052	000062	000067	000068	000076	000100		STARMSA
5AAA	144	000188	000295	000439	000832	000855	000711	000494	000374		STARMSA
6AAA	144	000260	000168	000118	000092	000094	000066	000031	000023		STARMSA
7AAA	144	000023									STARMSA
AAA	145F1U	1200	800	2144	0	426	5	675667	0112	.9	STARMSA
1AAA	145	3790-	000045	000039	000044	000101	000189	000180	000090		STARMSA
2AAA	145	000063	000072	000101	000120	000078	000066	000057	000044		STARMSA
3AAA	145	000040	000059	000063	000055	000069	000076	000153	000226		STARMSA
4AAA	145	000252	000257	000141	000108	000079	000058	000051	000055		STARMSA
5AAA	145	000119	000152	000107	000083	000064	000140	000383	000428		STARMSA
6AAA	145	000285	000215	000096	000072	000099	000075	000036	000023		STARMSA
7AAA	145	000021									STARMSA
AAA	146F1U	1200	1000	2144	0	507	5	195097	0106	6	STARMSA
AAA	147F1U	1200	1200	2145	0	440	5	665667	0112	.9	STARMSA
1AAA	147	3765-	000015	000022	000036	000051	000050	000050	000071		STARMSA
2AAA	147	000128	000188	000253	000289	000221	000052	000035	000030		STARMSA
3AAA	147	000024	000017								STARMSA
AAA	148F1U	1200	1400	2146	0	507	5	195097	0106	6	STARMSA
AAA	149F1U	1200	1600	2144	0	440	5	585667	0112	.9	STARMSA
AAA	150F1U	1200	1800	2145	0	400	5	685667	0112	.9	STARMSA
1AAA	150	3470-	000041	000046	000059	000082	000158	000351	000625		STARMSA
2AAA	150	000763	000725	000871	001304	002356	002541	002381	001633		STARMSA
3AAA	150	001102	000522	000169	000100	000068	000039	000012	000009		STARMSA
AAA	151F1U	1200	2000	2150	0	507	5	195097	0106	6	STARMSA
AAA	152F1U	1200	2200	2151	0	507	5	195097	0106	6	STARMSA
AAA	153F1U	1400	200	2136	0	452	5	346517	0106	6	STARMSA
1AAA	153	3620-	000048	000066	000089	000122	000112	000091	000069		STARMSA
2AAA	153	000054	000061	000059	000067	000092	000151	000179	000161		STARMSA
3AAA	153	000149	000146	000145	000149	000132	000142	000266	000440		STARMSA
4AAA	153	000467	000278	000138	000042	000023	000019	115 -	000077		STARMSA
5AAA	153	000112	000159	000143	000086	000060	000046	65 -	000051		STARMSA
6AAA	153	000064	000117	000265	000179	000122	000076	000042	000025		STARMSA
7AAA	153	275 -	000049	000047	000091	000220	000330	000301	000158		STARMSA
9AAA	153	000106	000082	000067	000056						STARMSA
AAA	154F1U	1400	400	2138	0	455	5	26467	0106	6	STARMSA
1AAA	154	3625-	000049	000054	000076	000087	000084	000049	000046		STARMSA
2AAA	154	000046	000047	000040	000046	000062	000059	000074	000104		STARMSA
3AAA	154	000141	000209	000276	000339	000377	000403	000390	000365		STARMSA
4AAA	154	000346	000244	000189	000166	000166	000141	000085	000051		STARMSA
5AAA	154	000034	65 -	000059	000066	000093	000156	000250	000266		STARMSA
6AAA	154	000168	000056	000058	000066	000076	000079	000082	000111		STARMSA
7AAA	154	000231	000242	000208	000186	000179	000142	000131	000139		STARMSA
8AAA	154	000137	000125	000111	000104	000110	000120	000113	000109		STARMSA
9AAA	154	000092	000090	000127	000231	000287	000278	000238	000199		STARMSA
10AAA	154	000228	000330	000288	000244	000180	000080	000059	245 -		STARMSA
11AAA	154	000051	000058	000067	000106	000258	000565	000694	000446		STARMSA
12AAA	154	000239	000136	000102	000096	000080	000064	000043			STARMSA

FIGURE 4.2

PARTIAL LISTING OF TEST FILE "STARDAT"

```

0VVVTEST 1V1 5100 5050 70055 700040 VDATA
0VVVTEST 2V1 5000 5000 70005 720060 0400 10 105 05 20 102 02VDATA
1VVVTEST 2 50 200 04 20 555 10 20 050 15 20 200 02100 05 01 05 100 20VDATA
2VVVTEST 2 50 400 04 40 555 50 20 02 02 20 200 01100 20 01 05 500 25VDATA
3VVVTEST 2 10 010 02 20 100 50 20 010 02 20 200 55100 20 01 05 20 02VDATA
0VVVTEST 3V1 5200 5000 70110 750070 0390 10 45 05 20 82 03VDATA
1VVVTEST 3 40 300 07 40 80 13 40 080 12 60 110 09 50 06 04 15 123 30VDATA
2VVVTEST 3 20 460 14 10 255 54 40 01 12 30 260 01120 30 11 08 240 35VDATA
3VVVTEST 3 20 013 05 30 160 44 90 014 11 20 300 16 45 43 06 15 120 03VDATA
4VVVTEST 3 10 223 15130 260 04 30 035 15 80 100 19 82 140 17 35 244 01VDATA
0VVVTEST 4V1 5300 5000 70045 715054 VDATA
0VVVTEST 5V1 5400 5000 70104 730040 0370 20 200 09 21 129 12VDATA
1VVVTEST 5 70 98 19 23 155 14 30 050 02 10 200 02 80 05 21 05 100120VDATA
2VVVTEST 5150 300 08 40 555 02 40 05 02 20 100 07 60 44 09 65 500 25VDATA
3VVVTEST 5 25 010 02 30 70 55 55 110 08 40 05 15 45 20 01 VDATA
0VVVTEST 6V1 5500 5000 70055 740065 0360 20 67 02 80 102 14VDATA
1VVVTEST 6 60 300 04 20 165 15 70 050 11 20 200 04100 05 05 25 100 24VDATA
2VVVTEST 6 15 400 06140 05 02 30 42 14 20 200 09 30 26 03 65 20 02VDATA
0VVVTEST 7V1 5100 5100 70080 770063 0300 10 46 03 30 87 09VDATA
1VVVTEST 7100 80 06 35 255 10 40 150 22 30 87 06 30 35 01 55 100 01VDATA
2VVVTEST 7 40 60 04 70 225 52 20 12 02 26 30 01 40 120 11 65 130 15VDATA
3VVVTEST 7 10 010 02120 100 10 45 160 08 20 67 15 20 30 14 15 30 01VDATA
4VVVTEST 7 25 110 02 40 189 12 65 74 28 10 43 05 40 25 09 20 53 02VDATA
0VVVTEST 8V1 5200 5100 70072 715061 0320 30 46 01 20 92 06VDATA
0VVVTEST 9V1 5300 5100 70005 720048 0330 100 15 01 40 51 04VDATA
1VVVTEST 9 50 210 05 30 132 14 10 450 48 30 160 03 90 05 01 15 400 21VDATA
2VVVTEST 9 20 60 07 20 35 20 40 122 12 30 30 01 30 20 01105 080 15VDATA
3VVVTEST 9 10 30 02 20 50 30 25 120 22 10 200 55 30 20 04 40 65 06VDATA
4VVVTEST 9 20 44 06 10 150 70 10 120 16 40 74 05 10 190 16 25 05 06VDATA
5VVVTEST 9 5 230102 15 321 32 10 47 02 20 68 07 20 25 03 20 56 03VDATA
0VVVTEST10V1 5400 5100 70025 740049 0355 70 39 02 20 102 07VDATA
1VVVTEST10 20 57 12 20 35 15 20 075 15 30 200 26 60 81 19 10 100 17VDATA
2VVVTEST10150 20 02 50 25 07 20 31 02 20 140 03 60 20 01 55 50 03VDATA
0VVVTEST11V1 5000 5200 70030 760040 0320 30 55 05 30 121 05VDATA
1VVVTEST11 40 84 14 20 435 60 10 250115 60 200 18100 05 01 05 100 20VDATA
2VVVTEST11 50 60 04 30 077 50 50 12 01 20 60 21100 20 01 45 134 25VDATA
3VVVTEST11 40 010 02 20 100 30 20 044 08 20 75 26 20 130 31 04 20 02VDATA
0VVVTEST12V1 5100 5200 70115 720058 VDATA
0VVVTEST13V1 5200 5200 70107 737046 0325 20 45 05 30 111 07VDATA
1VVVTEST13 50 200 04 20 155 10 20 170 15 20 200 22 40 305 31 35 100 16VDATA
2VVVTEST13 30 400 44 40 54 06 20 32 02 20 40 01 20 20 01105 50 06VDATA
3VVVTEST13 20 110 08 20 200 34 30 110 06 20 64 05100 20 01 04 20 02VDATA
0VVVTEST14V1 5300 5200 70136 725050 0357 50 65 04 20 102 14VDATA
1VVVTEST14 50 205 24 20 345 30 5 460115 20 200 21 30 35 01105 20 02VDATA
2VVVTEST14 20 90 08 40 175 30 20 202 22 20 100 05100 20 01 25 500 25VDATA
3VVVTEST14 50 180 12120 50 02 VDATA
0VVVTEST15V1 5400 5200 70131 745046 0320 50 44 03 50 102 12VDATA
1VVVTEST15 35 200 24 20 355 40 20 150 15 20 60 04100 15 01 35 100 20VDATA
2VVVTEST15 50 400 32 25 421 36 30 162 13 50 48 03 20 42 06100 30 02VDATA
3VVVTEST15 50 110 09 20 364 50 20 310 21 20 174 12 80 33 02105 20 02VDATA
0VVVTEST16V1 5600 5200 70105 756047 0365 40 65 05 20 102 15VDATA
1VVVTEST16 65 310 26 20 135 10 20 050 07100 40 02 20 45 08 20 200 20VDATA
2VVVTEST16 40 232 14 20 188 20120 12 02 20 200 11 20 40 06 05 500125VDATA
3VVVTEST16100 210 02 80 30 03 50 010 02 VDATA
0VVVTEST17V1 5500 5200 70084 750051 VDATA

```

FIGURE 4 3
LISTING OF TEST FILE "GAMDATV"

5.0 UDAT SYSTEM -- PRIMARY FILES. DESCRIPTION OF DATA IN SAMPLE SETS

Refer to Section 6.0 and Figure 6.1 for the formats and specific field locations of all sample set data discussed in this Section.

5.1 DESCRIPTIVE DATA COMMON TO RECORDS IN EVERY SAMPLE SET

The following descriptive data elements are common (in type and format) to all sample sets and are entered in every record; they are listed in the order of their relative importance, not in the order in which they appear on the records.

5.1.1 Hole Number / Sample Set Identification

A sample identification number (/code/symbol) used to describe a sample set is hereafter termed the "hole number" because most of the samples available during the time that the URAD program were originally developed were from borehole data. The hole number is that data element which must uniquely identify any sample set. Duplicate hole numbers should not be assigned to different sample sets within a data file, and if possible, should be avoided throughout the entire UDAT file system.

The hole number is located in C(7-12) (columns 7 through 12) of every sample set data record, including the header, continuation, geologic, or directional records. It may consist of any combination of alphanumeric characters. However, these characters (including blanks) must be entered in exactly the same columns in each record within a sample set. For example, if the hole number is entered as "A D 12" in a header record, it cannot be entered as "AD12 ", "A D 12", "A-D12 ", etc. in another record of the same sample set. It must be entered exactly as "A D 12"; otherwise the URDAT program will abort, since the hole number is the only key for identifying records belonging to the same sample set.

A hole number should not be left as all blanks; at least 1 character should be assigned.

The hole number is probably the single most important sample set identifier and is used throughout the URAD system for identification and edit purposes. When data are received with sample identifications that are greater than 6 characters, such identification must be reduced to 6 characters.

Considerable forethought is required in setting up a sample identification system for assay data which will be processed by computer method. The entire renumbering and cataloguing of the sample identification of, say, 2000 samples may not seem warranted but in the long run it is well worthwhile. The use of sample identification codes consisting of greater than 6 characters has been tried and found to be extremely cumbersome, especially when creating maps using a plotter. The number of possible combinations of six alphabetic letters and/or numbers are sufficient even for a fairly large number of sample sets.

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5.1.2 Area Number

The area number is a secondary identifier which is used to classify sample sets into logical groupings such as land survey boundaries, ore blocks, anticipated mining phases or any other unit for which separate analyses may be foreseen. The assignment of area numbers to sample sets is optional, but recommended if the data in a given file consist of over, say, 100 sample sets.

The area number is entered in C(4-6) of each record and consists of any combination of 3 alphanumeric characters, including blanks. The same rules of identity apply to the area numbers as do to the hole numbers, i.e. a given area number must always be entered in exactly the same form. However, the same area number may be assigned to as many sample sets as desired.

The area numbers are used both as identifiers for "cataloguing" purposes and as edit control parameters (Section 7.6.9).

5.1.3 Property Code

The "property code" is an additional 7-character code provided for sample identification. It may consist of any combination of alphanumeric characters and is entered in C(73-79) of each record. It is primarily used for identification of the area, property, mine, or other such broad grouping by which the sample sets may be conveniently categorized but is not used in any program operations such as editing. The same property code may be assigned to as many sample sets as desired.

5.1.4 Record Count or Index

Columns 1 through 3 are reserved for indexing (or "counting") the number of records within one given sample set. The record index numbers are primarily for convenience in visual inspection of the records and they ignored in the URAD programs. However, they are necessary if it is ever desired to sort the sample data.

Theoretically, in a computer sort procedure, the primary key would be the property code, the secondary key -- the area number, the 3rd key -- the hole number, and the last key -- the record index.

In each header record, the record index field is left blank, or a "0" (zero) may be entered. The first continuation record contains a "1" in C3, the second continuation record contains a "2" in C3, and so forth. It is recommended that the index for lithologic data records within a sample set begin with "101" and those for directional records with "201".

5.1.5 Example Drill Hole Location Plot

Figure 5.5 is an example drill hole location map made from data in test file "STARDAT". It shows the position and hole number of each sample set for the hypothetical property "STARMSA" based on the sample set header records in file "STARDAT". Also shown is the outline of the areas indicated by the area numbers "AAA", "BBB", and "CCC" that are on the header records.

5.2 DESCRIPTIVE DATA COMMON TO ALL HEADER RECORDS

The following data elements are common (in type and format) to all sample sets (with minor exceptions as noted), and are entered in every header record. These are discussed in the order of their appearance in the record.

5.2.1 Sample-Type Codes

C(13-15) of each header record contain "sample-type" codes which identify the type and format of the given sample set. Figure 5.1 provides a complete summary of all sample-type codes used in the UDAT system. C(14-15) may sometimes be blank, but C(13) must always contain a code.

Note that the codes determine whether or not estimated uranium values will be subject to correction for radiometric disequilibrium.

Codes "A" through "F" in C13 indicate borehole log data, while numeric codes indicate other types of sample data. "V" is used for the sample data which contain vanadium as well as uranium assays. "L" denotes lithologic data.

C14 is an accessory code which is applied in several ways. With the bimetal ("V") format, it flags whether or not the uranium values are subject to disequilibrium correction; With the non-contiguous format, it is always "1".

C15, with borehole log data, denotes the type of readings in the data:

- "I" for inches of deflection from baseline in rectilinear logs.
- "Z" for inches of deflection from baseline in curvilinear logs.
- "U" for uncorrected (for dead time) counts per second.
- "C" for corrected (for dead time) counts per second.
- "Q" for interpreted borehole log data.

Note: A description of the "Z" format and interpretation of curvilinear logs is not included in this first version of the URAD user's guide.

C15 is also used in the non-contiguous format to specify whether samples are referenced by depth or elevation.

Columns 13, 14, and 15 are designated as sample-type codes 1, 2, and 3 respectively.

The term "A-E,1" (or simply "A-E") is an abbreviation for: "A, B, C, D, or E" in C13, "1-9" in C14, and "1" in column 15. The "A-E" and "F11" codes refer to borehole log readings in inches of deflection and are further described in the following two sections.

5.2.1.1 Scales and Ranges

When a radiometric strip log is generated, the "sensitivity" of the recording instrumentation must be limited to the extent that the stylus does not exceed the limits of the strip-chart paper. Conversely, the sensitivity must be sufficient that any "anomalous" radioactivity is well defined. Therefore, strip logs are generated, various recording scales are used to specify the

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number of counts-per-second (cps) that are represented by a given length of deflection from the baseline of the strip chart.

Note: If the logging probe is of the geiger type, the unit of radioactivity may be milliroentgens per hour (mr/hr) instead of cps. When the term "cps" is used herein, it is understood that it may be substituted by "mr/hr".

Each scale is usually defined by a range, which is simply a number code used as a "short-cut" method of noting, on the strip chart, the scale that is in effect for any segment of the radiometric amplitude curve.

The ranges and associated scales employed by various logging units vary considerably. The scale denoted by a range may be in terms of cps-per-inch or cps of total, or "full-scale", deflection (commonly 10 inches) on the chart paper. Examples of gamma-ray logging factors, scales and ranges for selected logging units are shown on Figures 5.2a, b, c, & d.

Note: There is always the possibility that the true "full-scale" deflection for a given logging unit may not be the same as the total inches of deflection indicated by the chart paper used on the recorder. It is wise to thoroughly check out the specifications of the logging unit.

Radiometric data "digitized" (Section 3.3.4) from strip logs in terms of inches-of-deflection must also include information on the associated scales. This is done by entering a numeric "range code" along with each inches-of-deflection reading in the CE-fields (Section 6.3.2) of the continuation records. The range code refers to a "range/scale" table which provides the values for cps- (or mr/hr-) per-inch, or at full scale, represented by the range codes for the given log type.

When readings are in inches-deflection, the sample-type code in C13 determines the range/scale system (Section 5.2.1.2) which applies to the range codes associated with the readings in the given sample set. If the code refers to a "full-scale" system, the reference full-scale-deflection (in inches), must also be entered as a data element (Section 5.3.6).

During computer processing, the sample-type codes in C(13-14) and the range codes in the C-E fields are used, in combination, to find the the appropriate cps- mr/hr- -per-inch scale value --which is then multiplied by the inches-of-deflection to give total counts-per-second represented by the reading. The scale is found by searching a table of values previously established for the given range/scale system.

5.2.1.2 Range/Scale Code Systems

URAD contains two range/scale numeric coding systems. A given sample set must be in one system or the other, but both types may be included in any file. For either system, the code "1" must be entered in column 15 (sample-type code 3) of the applicable header record to denote that the readings are in inches-of-deflection.

The "1" code and associated range numbering systems apply only to borehole log data entered as inch-deflection readings from strip logs!

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1. The "A-E,1" System utilizes the cps-per-inch range/scale method and a set of ranges and associated scales is established for a particular logging unit (or probe) type. The given type is defined by sample-type codes 1 and 2 in columns 13 and 14, respectively, of the header record; in this case the two codes actually represent one 2-character code and will be so referenced in the remainder of this section. The 2-character code may consist of any combination of "A", "B", "C", "D", or "E" in column 13 and the numbers 1 through 9 in column 14. Some examples are: "A1", "B9", "E3", and so forth.

A DOS file designated as "RNGTBL" must be established to contain the scale values represented by the numeric range codes for each and every "A - E" 2-character code which is entered in header records in any of the sample assay data files. Each record in file "RNGTBL" contains the appropriate 2-character sample-type code, followed by a list of scales, each of which denotes cps/inch for a specific range code associated with the given log type.

A test RNGTBL file is included with this guide; it contains the range/scale data tabulated in figure 5.2 for sample-types "A11", "A31", etc. The scale for A11 and A31 are necessary for processing the "A-E, 1"-format sample set data included in test file "GAMDAT". The other types are used to demonstrate the flexibility in entering the scale values.

Figure 5.3 is a structured illustration of the data contained in the RNGTBL file.

The range code to which each scale applies is implicitly determined by the position of a particular scale value on the list. Using Figures 5.3 as an example, the first record contains "A1" in columns 1 and 2. This is followed by a list of scale values (each separated by a comma). The first value -- 20 cps/inch -- represents range code 1, the second value, -- 40 cps/inch -- represents range code 2 and so forth. The range codes and associated scales for each sample-type code are shown in Figure 5.2a.

The requirements for a record in file "RNGTBL" are that: the sample-type-code must be in column 1 and 2; each scale value must be immediately followed by a comma; no "imbedded" blanks may be present; and, the maximum allowable number of digits is 7 (including the decimal point), but a decimal is not required if not applicable. No other record types are permitted in "RNGTBL".

The advantage of the "A-E,1" system is that it provides a means for establishing a specific set of range/scale values for a given log type. The disadvantage is that an entry must be made in file RNGTBL for each new log type (i.e. one with a different range/scale system) for which data are entered in the "A-E" format. If a sample set in the "A-E" format is processed by program URDAT and either 1) no RNGTBL is available in the default drive, or (2) RNGTBL contains no list identified by the given 2-character code in the sample set header record, the program will automatically terminate.

When the "A-E,1" system is used, the no data entry is required for "Full-scale deflection" in the header record.

2. The "F11" System uses a "standardized" numeric range code table with the scale values (Figure 5.4) contained within the URDAT program. It is activated by sample type codes "F" (C13), "1" (C14), and "1" (C15) in the sample set header record.

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Scale values are in counts-per-second per total inches of the deflection (full-scale) on the strip log chart and relate to the "full-scale" inches entry (Section 5.6.3) on the header record. The inches deflection and range numbers are entered in the CE-fields exactly as for the "A-E" format, but cps values are calculated by dividing the scale value (represented by the applicable range code) by the value of the "full scale deflection", and then multiplying the results by the inches deflection of the given reading.

As an example, if an inch-deflection reading under the "F11" format has an associated range code of "33" (Figure 5.4) and the "full-scale inches" on the header record is 10.0, then the cps-per-inch will be determined as 1000.0 (10000/10); if the "full-scale inches is 5.0, the cps-per-inch will be 2000.0 (10000/5).

The advantage of the "F11" system is that it covers most of the strip log recording scales currently in use, and new, 2-character sample codes and associated range/scale values need not be established for each new log type. However, if a set of scales not included in Figure 5.4 is encountered, then the "A-E" format may be used. The main disadvantage of the "F11" system is that the logging-unit type is not explicitly defined by the sample-type code. For this reason, space is provided on the header (Section 5.3.7) for a log-type "identifier"; the coding system for this must be established by the user.

NOTE: when preparing to enter inch-deflection readings for a sample set into the data files, whether "manually" or by automatic digitizing methods, the range/scale notation used for the given borehole log must be carefully reviewed and understood. Confusing "full-scale" with "cps-per-inch" ranges and scales will lead to large-scale errors in converting the readings to counts per second. The choice of which URDAT range/scale coding system to use should be made well in advance of the actual data entry.

5.2.2 Coordinates

Two numeric coordinates of up to 7 digits each should be entered, to the nearest foot (MV = 9999999 ft), in each header record. These entries are not mandatory and their absence will not cause URAD programs to abort. However, they are needed for certain types of edits in the URAD system and, eventually, for plotting purposes as well as for certain geostatistical programs.

As with the hole numbers, considerable forethought should be given to planning the coordinate systems to be used for data which will be computer-processed. Coordinates should be related to an origin which not only references data within a given file, but all data which may be eventually evaluated "in toto" at some future date. The reestablishment of a new coordinate system for data originally referenced by several "local" coordinate systems is well worth the effort.

Coordinates must lie within the first quadrant of the Cartesian coordinate system; they cannot be negative.

5.2.2.1 North Coordinate

The north coordinate is the northerly component (y-axis) of distance from the reference origin and is entered in C(16-22).

5.2.2.2 East Coordinate

The east coordinate, C(23-29) is the easterly component (x-axis) of distance from the reference origin.

5.2.3 Collar (or Reference) Elevation

The collar elevation is the vertical (z-axis) point of reference for a sample set. It is a positive or negative numeric value, entered in C(30-35) to the nearest tenth of a foot, and may consist of up to 6 digits (MV = 99999.9 ft), with a decimal point always assumed between C34 and C35. It represents the origin point of the sample set. For borehole data, this elevation represents the "collar" (or surface) elevation of the borehole. If there is an interval of assumed barren material between the collar elevation and the top of the first sample of the set, then the thickness of the barren interval is denoted by the entry -- "depth to first sample" (Section 5.2.6).

An entry for collar elevation is not mandatory but is highly recommended since certain edit procedures are based on the elevations, and it may be required for certain geostatistical and plotting programs. Sea level is the best reference datum for collar elevation. If any other datum is used, it should be applied to all sample sets which may be evaluated "in toto" at some future date.

Negative values for collar elevation are allowed.

5.2.4 Depth to Pit Bottom

This entry is used to provide information on existing open pit mine workings and is useful both for plotting and for editing sample data with respect to the current position of an open pit (see also Sections 9.1.12 and 14.1). It represents the depth (from the collar) to the intersection of the given sample set with the bottom of pit workings, and may be used to estimate how much of the material represented by the sample set has been removed.

Pit-bottom depths are normally entered into a data set at some point after pit excavation has actually taken place and a certain amount of mining has taken place. Comparisons may then be made between the amount of ore actually mined and reserve calculations based on original samples currently positioned within the pit and above the pit bottom. Reserves may also be calculated for unmined portions of the pit.

The pit-bottom depth is entered to the nearest 10th of a foot in C(36-39) and may consist of up to 4 digits (MV = 999.9 ft); the decimal is assumed between C(38) and C(39). It should not be entered unless a pit actually exists. If a sample set begins at the bottom of a pit, then the pit-bottom depth should be entered as zero. If the pit-bottom depth entry is blank, it is assumed that no open pit exists at the given sample set location.

5.2.5 Depth to Oxidized/Non-oxidized Contact

This entry is used to mark the approximate position of a change (if known) from an oxidized to non-oxidized environment within the total interval represented by a sample set. It is sometimes approximated by the top of the water table (which can often be identified by electric logs). In certain uranium deposits it is distinguished by color change, caused, for example, by the transition of hydrous iron oxides to iron sulphides.

A value entered for the "oxidized/non-oxidized" contact will allow the application of separate equations for disequilibrium correction (Section 3.4) to radiometric grades determined for any samples in the given sample set.

The depth from the top of the sample set (represented by the collar elevation) to the approximate oxidized/non-oxidized contact is entered to the nearest foot in C(40-42) and may consist of up to 3 digits (MV = 999 ft). If there are no data available on such a contact, then the field is left blank. If the entire interval of the zone represented by the sample set is presumed to be in an unoxidized environment, a zero is entered. If the entire interval represented by the sample set is presumed to be in an oxidized environment, then the bottom of the sampled interval is entered.

5.2.6 Depth to First Sample

The distance between the point referenced by the collar and the top of the first sample interval of a sample set (or to the first radiometric reading that represents a sample interval) is entered to the nearest tenth of a foot. It may consist of up to 5 digits, with a decimal point assumed 1 place to the left of the rightmost digit (MV = 9999.9 ft). For the contiguous formats, the value is entered in C(43-47), with the decimal point assumed between C46 and C47. For the borehole log formats, it is entered in the first continuation record (Section 6.3.2.4). For the non-contiguous format, it is not used because the first sample interval defines the value (Section 6.2).

5.2.7 Total Depth Sampled

The distance from the point represented by the collar to the bottom (or end) of the sampled interval is entered in C(43-47) to the nearest tenth of a foot, with the decimal point assumed between C46 and C47. Up to 5 digits are allowed (MV = 9999.9 ft). For borehole log data, this distance represents the bottom depth logged (not necessarily the bottom of the hole). For other data it represents the distance to the bottom of the last interval of the sample set.

Note: The contiguous sample formats do not provide any entry for total depth sampled, and it is calculated in the URDAT program. If an interval of barren material is known to exist below the last sampled interval, it should be entered as a "pseudo-sample".

5.3 ADDITIONAL ENTRIES COMMON TO BOREHOLE LOG HEADER RECORDS

All borehole log data ("A-E" and "F") must include, in the header records, the following additional data which is used for interpretation. Although the "FnQ" format does not require some of these data for successful processing, they should be entered for reference purposes.

5.3.1 Readout Interval

This is the interval at which readings are recorded during the logging process or at which representative readings are measured from strip logs. It is generally 0.5 or 1.0 feet and is entered in C(48-49) to the nearest tenth of a foot, as a 2-digit number with the decimal assumed between C48 and C49.

5.3.2 Depth to Hole Water

This is the distance from the collar to the level of any water and/or drilling fluid which may be standing in the hole when it was logged. If the field is left blank, it is assumed that all recorded intervals were logged in water. The "depth to hole water" is entered in C(50-52) to the nearest foot; up to three digits are allowed (MV = 999 ft). This value is used in conjunction with the "attenuation" factors (Section 4.3.4).

5.3.3 K-Factor

The k-factor is the basic constant of proportionality which is used to convert the radiometric data to representative estimated uranium values (See Section 17). It is usually derived by logging a simulated drill hole (or "test" hole) which contains a measured interval of known uranium grade. The normal "standard" is usually a dry (no fluid) four and one half inch diameter hole, with the uranium assumed to be at radiometric equilibrium as possible. (However, the "standard" could instead be a hole completely filled with liquid).

The k-factor is applied directly to radiometric cps measured in holes having the same characteristics as the test hole. For borehole environments differing from the standard, "attenuation" factors are used; see Section 5.3.4.

The logging speed and time constant at which the k-factor has been computed must also be known so that any changes in logging speed during logging procedures may be entered into the data (Sections 6.3.2.4 and 17).

Up to 3 significant digits of the k-factor are entered in C(53-55), followed by an exponent, in C56, which is assumed to be negative. To determine the proper entry and exponent, simply count the number of places that the decimal must be moved so that it will be immediately to the right of the last significant digit allowed.

Example: if the k-factor is 0.0000312, the decimal must be moved 7 places to the right -- 0000312.; the k-factor entry is 312 and the exponent is entered as 7. If the k-factor is 0.0001462, the decimal must be moved to the right 6

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places -- 000146.2; the k-factor entry is 146 (3 significant digits) and the exponent entered is 6.

For situations where more than three significant digits of the k-factor are desired, see Section 6.3.2.4.

5.3.4 Attenuation Factors

When logging boreholes in the field, conditions which may often vary from those existing in the "test hole" (Section 5.3.3) are: existence (or lack) of fluid in the hole; different hole diameter; and, the presence of hole casing. These differences are taken into account by applying, to the k-factor, multiplicative (see below) attenuation factors based on theoretical considerations or additional calibrations in "test holes" having conditions which vary from the "standard" test hole. Since it is not feasible to construct a series of test holes to cover every possible deviation from the "standard", correction curves are generally developed. Example hole attenuation data are shown in Figure 5.2. Two attenuation factors are provided in UDAT formats; one is for correcting the k-factor for readings in air-filled portions (dry environment) of a drill hole and the other for fluid- (water"-) filled portions or "wet" environments; each factor is used independently of the other. The depth to hole water (Section 5.3.2) is entered so that the distinction can be made between the two environments. Applicable casing, hole-diameter, and other attenuation factors must be included in the air and the water correction factors before they are entered in the header records.

For example, if the air and water correction factor are 1.00 and 1.10, respectively, at a given hole diameter and the casing factor is 1.2 for 1/8-inch casing, then for a 1/8-inch cased hole, the air and water correction factors must be entered as 1.20 and 1.32, respectively.

Correction for additional factors which directly affect the k-factor are discussed in Section 6.3.2.4.

5.3.4.1 Air Correction Factor

The "air correction factor" applies to changes in the "dry" environment and is entered in C(57-59), to the nearest hundredth of a unit, with the decimal point assumed between C57 and C58; up to three digits are allowed (MV = 9.99).

An air correction factor is not needed when the entire interval represented by a sample set was logged in fluid.

If the k-factor was determined for a "dry" environment and the conditions of the logged hole match those in the test hole, then the air correction factor should be entered as "1.00" (decimal point omitted). If no air correction factor is entered in the header record, it is assumed to be 1.00.

An air correction factor other than 1.00 is needed when:

1. The k-factor was originally determined for a "dry" environment, but the casing conditions and/or hole-diameter of the logged hole are different from the test hole.

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2. The k-factor was originally determined for a "wet" environment.

5.3.4.2 Water Correction Factor

The water correction factor applies to changes in the "wet" environment and is entered in C(60-62), to the nearest hundredth of a unit, with the decimal point assumed between C60 and C61; up to three digits are allowed (MV = 9.99).

A water correction factor is not needed when the entire interval represented by a sample set was logged in air.

If the k-factor was determined for a "wet" environment and the conditions of the logged hole match those in the test hole, then the water correction factor should be entered as "1.00" (decimal point omitted). If no water correction factor is entered in the header record, it is assumed to be 1.00.

A water correction factor other than 1.00 is needed when:

1. The k-factor was originally determined for a "wet" environment, but the casing conditions, fluid conditions and/or hole-diameter of the logged hole are different from the test hole.
2. The k-factor was originally determined for a "dry" environment.

5.3.5 Dead Time Factor

The dead time reflects attenuation in the "counting" capability of the electronic equipment used to log the hole according to the equation:

$$CPSt = CPSo / (1 - (CPSo \times (DT/1000000))) \text{ where,}$$

CPSt = "true" counts per second,

CPSo = observed counts per second,

DT = equipment dead time in microseconds (ms).

The dead time is entered in microseconds in C(63-66). It is the only data element in the header record which may contain an explicit decimal point. The decimal point may be in any position of the field; if the decimal is not entered, it is assumed to be to the right of C66. The dead time value therefore may range from 0.001 to 9999 ms; there may be up to four significant digits if the decimal is not entered, and three significant digits if it is entered.

5.3.6 Full-Scale Deflection

In URDAT, the range codes used for the "F11" format (Section 5.2.1.2) are based on the full-scale deflection of the stylus (on a strip log) at the

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given range, where the "full scale" is the number of cps represented at the total scaled width of the chart paper used for the log (or as otherwise specified for the given logging unit; see note, Section 5.2.1.1). For example, if a scale of "1000" is specified for a full scale at 10 inches, each inch of deflection represents 100 cps; if the same scale is indicated for a 5-inch full scale, then it represents 200 cps per inch. This is in contrast to the method used for the "A-E" format where the range code applies to a scale which is already established as cps per inch.

Therefore, whenever the "F11" is used, the number of inches represented as applying to "full scale" must be entered in C(67-70) of the header record, with the decimal assumed between C68 and C69.

5.3.7 Logging Unit (Log Type) Code

It has been generally found prudent to maintain a record of the characteristics of the logging units used in obtaining borehole data. C(71-72) of the header record (for the "borehole log" format) is reserved for any 2-character code which the user may establish to identify the particular unit which was used to obtain the data represented in the given sample set.

5.4 SAMPLE DATA

The UDAT system provides formats for entering any of the sample data described in Section 3. The formats for the various types of sample data differ according to the type of data involved and are discussed separately and in detail in the following section.

File "GAMDAT" is a test primary UDAT file containing examples of the various sample assay data formats. In this file, sample sets "TEST 1", "TESTA1", "TEST 2", "TESTB2", "TEST 9", and "TEST11" are hypothetical data sets. ("TEST 8" was removed since it simply duplicated another set.)

Sets "TEST 3" and "TEST 4" are digital cps readings from an actual log. To show the relationships of the various borehole log formats, "TEST 5" and "TEST 7" were prepared to simulate (as closely as possible) "TEST 3" cps readings as though they had been digitized from a strip-chart as inch-deflection readings. "TEST 5" is based on the RNGTBL range-code system, and "TEST 7" on the internal "F11" range-code system. Similarly, "TEST 6" simulates "TEST 4" (RNGTBL system).

In preparing "TEST10", the U308 interpreted values from "TEST 3" were used.

All lithologic data are hypothetical.

When file GAMDAT is processed by URDAT, without any editing (using UCON file "UCON1, for example), the results are as shown in APPENDIX C. The discrepancies in the high grade portions of "TEST 4" and "TEST 6" are discussed in Section 3.3.6.

Files "STARDAT", "GAMDATV", and "STARDATL" are other test files (Section 4.1) which illustrate various types of sample data.

UDAT SYSTEM: FILES DESCRIPTION

TYPE OF FORMATS AND DATA	SAMPLE-TYPE CODES		
	Type1 (C13)	Type2 (C14)	Type3 (C15)
<u>Contiguous Format</u>			
Unimetal (uranium only)			
Radioelectric-equivalent assays - - - - -	1	B**	B
* Chemical (or equivalent) assays - - - - -	2	B	B
Interpretations of borehole anomalies (uncorrected for disequilibrium) - - - -	3	B	B
* Interpretations of borehole anomalies (corrected for disequilibrium) - - - - -	4	B	B
* Any designation desired by user; must be already corrected for disequilibrium -	5	B	B
Bimetal (uranium and vanadium)			
Uranium is radioelectric-equivalent - - - - -	V	1	B
* Uranium is chemical (or equivalent) - - - - -	V	2	B
<u>Non-contiguous Format</u>			

Radioelectric-equivalent assays - - - - -	6	1	1 or 2
* Chemical (or equivalent) assays - - - - -	7	1	1 or 2
Interpretations of borehole anomalies (uncorrected for disequilibrium) - - - -	8	1	1 or 2
* Interpretations of borehole anomalies (corrected for disequilibrium) - - - - -	9	1	1 or 2
<u>Borehole Log Format</u>			
Digitized (inch-deflection) readings, range codes apply to file RNETBL coding:			
Rectilinear logs - - - - -	A-E	1-9	1
Curvilinear logs - - - - -	A-E	1-9	2
Digitized (inch-deflection) readings, range codes apply to standard (Figure x) codes:			
Rectilinear logs only - - - - -	F	1	1
CPS readings, uncorrected for dead time - -	F	1	U
CPS readings, corrected for dead time - - -	F	1	C
Readings are actual estimated uranium grades:			
Uncorrected for disequilibrium - - - - -	F	1	Q
* Corrected for disequilibrium - - - - -	F	2	Q

* Uranium values may not be corrected for disequilibrium.
 ** "B" indicated field is left blank.
 *** For non-contiguous format: "1" denotes depths;
 "2" denotes elevations.

FIGURE 5.1
SUMMARY OF DATA REPRESENTED BY UDAT SAMPLE-TYPE CODES
(IN COLUMNS 13-15 OF SAMPLE-SET HEADER RECORDS)

UDAT SYSTEM: FILES DESCRIPTION

TABLE OF FACTORS AND CODES FOR UDAT BOREHOLE GAMMA-RAY LOG DATA. DATE:

GAMMA LOG TYPE CODE	TYPE OF UNIT & PROBE TYPE (MODEL NO.)	RECORDER MANUFACTURER	RECRD TYPE	TYPE READ-OUT	FULL SCALE INCHES	K-FACTOR & READOUT INTERVAL	DEAD TIME (ms)	
A1	Logmaster# LM6-12	Falling-weston	Rect	cps	10.00	.0000033	3#	
TYPE OF PROBE	CRYSTAL SIZE (IF SCINTIL.)	NO. TUBES (IF GEIGER)	TYPE PROBE HOUSING	HOUSING THICKNESS	K-FACTOR BASE			
Scintil.	.75" x 1.0"		Steel	.120"	HOLE MEDIUM: water LOGGING RATE: 5 ft/sec TIME CONSTANT: 2 secnds HOLE DIAM: 2.5 inches			
CORRECTION FACTORS			CASING		RANGE DESIGNATION	CPS FULL-SCALE	CPS OR MR/HR PER INCH	RANGE CODES FOR "A-E" FORMATS. "CE-FIELD" ENTRY POS 5 : POS 7
HOLE DIAM. INCHES	WATER	AIR	THICKNESS INCHES	FAC-TORS	* see below			
2.5#	1.00	.90	?	?	20	200	20	1
4.5	1.15	.94			40	400	40	2
6.5	1.28	.96			100	1000	100	3
8.5	1.16	1.08			200	2000	200	4
					400	4000	400	5
					500	5000	500	6
					1000	10000	1000	7
					2000	20000	2000	8
					4000	40000	4000	9
					5000	50000	5000	0
					10000	100000	10000	1
					20000	200000	20000	2
					40000	400000	40000	3
ADDITIONAL DETAILS: #Scales and factors have been modified from original.								

FIGURE 5.2A

EXAMPLE TABULATION OF GAMMA-LOG FACTORS, SCALES & RANGE CODES- TYPE B1

UDAT SYSTEM: FILES DESCRIPTION

TABLE OF FACTORS AND CODES FOR UDAT BOREHOLE GAMMA-RAY LOG DATA. DATE:

GAMMA LOG TYPE CODE	TYPE OF UNIT & PROBE TYPE (MODEL NO.)	RECORDER MANUFACTURER	REC'D TYPE	TYPE READ-OUT	FULL SCALE INCHES	K-FACTOR & READOUT INTERVAL	DEAD TIME (ms)	
A3	Century Model x †	Brown	Rect	cps	5.00	.0000033	3	
TYPE OF PROBE	CRYSTAL SIZE (IF SCINTIL.)	NO. TUBES (IF GEIGER)	TYPE PROBE HOUSING	HOUSING THICKNESS	K-FACTOR BASE			
Geiger		7 (1.357" ea)	Steel	.122"	HOLE MEDIUM: Air	LOGGING RATE: 5 ft/sec	TIME CONSTANT: 2? secnds	
CORRECTION FACTORS		CASING		RANGE DESIGNATION	CPS FULL-SCALE #	CPS OR MR/HR PER INCH †	RANGE CODES FOR "A-E" FORMATS. "CE-FIELD" ENTRY POS 5 : POS 7	
HOLE DIAM. INCHES	WATER	AIR	THICK-NESS INCHES	FAC-TORS				
4.5	1.00	1.28	.0625	1.21	5	25	5	1
			.1250	1.38	10	50	10	2
			.1875	1.55	25	125	25	3
			.2500	1.71	50	250	50	4
			.3750	2.03	100	500	100	5
			.5000	2.39	250	1250	250	6
					500	2500	500	7
					1000 (1K)	5000	1000	8
					2500 (2.5K)	12500	2500	9
					5000 (5K)	25000	5000	0
					10000 (10K)	50000	10000	1
					50000 (50K)	250000	50000	2
					100000 (100K)	500000	100000	3
ADDITIONAL DETAILS:		† Hypothetical unit: Factors and ranges entered are hypothetical; they simply provide order of magnitude of values, but do relate to test data.						

FIGURE 5.2B

EXAMPLE TABULATION OF GAMMA-LOG FACTORS, SCALES & RANGE CODES- TYPE A3

UDAT SYSTEM: FILES DESCRIPTION

TABLE OF FACTORS AND CODES FOR UDAT BOREHOLE GAMMA-RAY LOG DATA. DATE:

GAMMA LOG TYPE CODE	TYPE OF UNIT & PROBE TYPE (MODEL NO.)	RECORDER MANUFACTURER	RECRD TYPE	TYPE READ-OUT	FULL SCALE INCHES	K-FACTOR & READOUT INTERVAL	DEAD TIME (ms)	
E1	LP-1 UNIT 2 probe # 102	Westronics	Rect: linear	cps	10.00	.00000463	5	
TYPE OF PROBE	CRYSTAL SIZE (IF SCINTIL.)	NO. TUBES (IF GEIGER)	TYPE PROBE HOUSING	HOUSING THICKNESS	K-FACTOR BASE			
Scintil.	1.0" x 3.0"		Aluminum	.125"	HOLE MEDIUM: air LOGGING RATE: 5 ft/sec TIME CONSTANT: 2 secnds HOLE DIAM: 4.5 inches			
CORRECTION FACTORS			CASING		RANGE	CPS	CPS OR	RANGE CODES FOR
HOLE DIAM. INCHES	WATER	AIR	THICKNESS INCHES	FAC-TORS	DESIGNATION	FULL-SCALE	MR/HR PER INCH	"A-E" FORMATS. "CE-FIELD" ENTRY POS 5 : POS 7
2.25	1.03	.99	?	?	250	250	25	1
4.50	1.10	1.00			500	500	50	2
6.50	1.18	1.05			1K	1000	100	3
8.50	1.27	1.04			5K	5000	500	4
					10K	10000	1000	5
					25K	25000	2500	6
					50k	50000	5000	7
					100K	100000	10000	8
ADDITIONAL DETAILS:		Data are valid for this logging unit.						

FIGURE 5.2C

EXAMPLE TABULATION OF GAMMA-LOG FACTORS, SCALES & RANGE CODES- TYPE E1

UDAT SYSTEM: FILES DESCRIPTION

TABLE OF FACTORS AND CODES FOR UDAT BOREHOLE GAMMA-RAY LOG DATA. DATE: Jan. 1988

GAMMA LOG TYPE CODE	TYPE OF UNIT & PROBE TYPE (MODEL NO.)	RECORDER MANUFACTURER	RECRD TYPE	TYPE READ-OUT	FULL SCALE INCHES	K-FACTOR & READOUT INTERVAL	DEAD TIME (ms)
EB	Mount Sopris Model II HLP-2375	Mt. Sopris	Rect.	cps analog	4.27 (120 #)	Variable	< 1.0
TYPE OF PROBE	CRYSTAL SIZE (IF SCINTIL.)	NO. TUBES (IF GEIGER)	TYPE PROBE HOUSING	HOUSING THICKNESS	K-FACTOR BASE		
Scint.	.5" x 1.5"		Steel	.125"	HOLE MEDIUM: air LOGGING RATE: 5 ft/sec TIME CONSTANT: 4 sec eff. HOLE DIAM: 4.5 inches		
CORRECTION FACTORS		CASING		RANGE	CPS	CPS OR	RANGE CODES FOR
HOLE DIAM. INCHES	WATER AIR	THICK-NESS INCHES	FAC-TORS	DESIGNATION	FULL-SCALE	MR/HR PER INCH	"A-E" FORMATS. "CE-FIELD" ENTRY POS 5 : POS 7
2.25	1.035	.0625	1.24	50	50	10.59	1
4.50	1.076	.1250	1.33	100	100	21.186	2
6.5	1.115	.1875	1.43	200	200	42.37	3
		.2500	1.67	500	500	105.93	4
		.3750	1.87	1000	1000	211.86	5
				2000	2000	423.73	6
				5000	5000	1059.3	7
				10000	10000	2118.64	8
				20000	20000	4237.3	9
				50000	50000	10593.	1 0
				100000	100000	21186.4	1 1
ADDITIONAL DETAILS:		Obtained by phone from Mount Sopris in Delta, Colo.					

FIGURE 5.2D

EXAMPLE TABULATION OF GAMMA-LOG FACTORS, SCALES & RANGE CODES- TYPE E8

UDAT SYSTEM: FILES DESCRIPTION

Record Format

column numbers	11111111112222222222333333333344444444445555555555666666666677777777778
	1234567890123456789012345678901234567890123456789012345678901234567890
Record 1	A1 20,40,100,200,400,500,1000,2000,4000,5000,10000,20000,40000,
2	A3 5,10,25,50,100,250,500,1000,2500,5000,10000,50000,100000,
3	E1 25,50,100,500,1000,2500,5000,10000
4	E9 10.59,21.186,42.37,105.93,211.86,423.73,1059.3,2118.64,4237.3,10593,21186.4,

FIGURE 5.3

EXAMPLE OF SAMPLE-TYPE CODES AND ASSOCIATED RANGE SCALES IN FILE "RNGTBL"

UDAT SYSTEM: FILES DESCRIPTION

Range #	Full Scale # of cps	Range #	Full Scale # of cps	Range #	Full Scale # of cps
1	.01	22	200. (.2K)	43	400,000. (400K)
2	.02	23	250. (.25K)	44	500,000. (500K)
3	.025	24	300. (.3K)	45	1,250. (1.25K)
4	.05	25	400. (.4K)	46	1,500. (1.5K)
5	.1	25	500. (.5K)	47	7,500. (7.5K)
6	.2	27	1,000. (1K)	48	800. (.8K)
7	.25	28	2,000. (2K)	49	750. (.75K)
8	.5	29	2,500. (2.5K)	50	800. (.8K)
9	1.0	30	3,000. (3K)	51	8,000. (8K)
10	2.0	31	4,000. (4K)	52	80,000. (80K)
11	2.5	32	5,000. (5K)	53	8,000. (8K)
12	3.0	33	10,000. (10K)	54	1,000,000. (1000K)
13	4.0	34	20,000. (20K)	55	12,500. (12.5K)
14	5.0	35	25,000. (25k)	56	1,600. (1.6K)
15	10.0	36	30,000. (30K)	57	3,200. (3.2K)
16	20.0	37	40,000. (40K)	58	640. (.64K)
17	25.0	38	50,000. (50K)	59	9,000. (9K)
18	30.0	39	100,000. (100K)	60	18,000. (18K)
19	40.0	40	200,000. (200K)	61	19,000. (19K)
20	50.0	41	250,000. (250K)	62	15,000. (15K)
21	100.0	42	300,000. (300K)		

FIGURE 5.4
 FULL SCALE CPS VALUES FOR "F"-TYPE RANGE NUMBERS (5/87)

UDAT SYSTEM: FILES DESCRIPTION

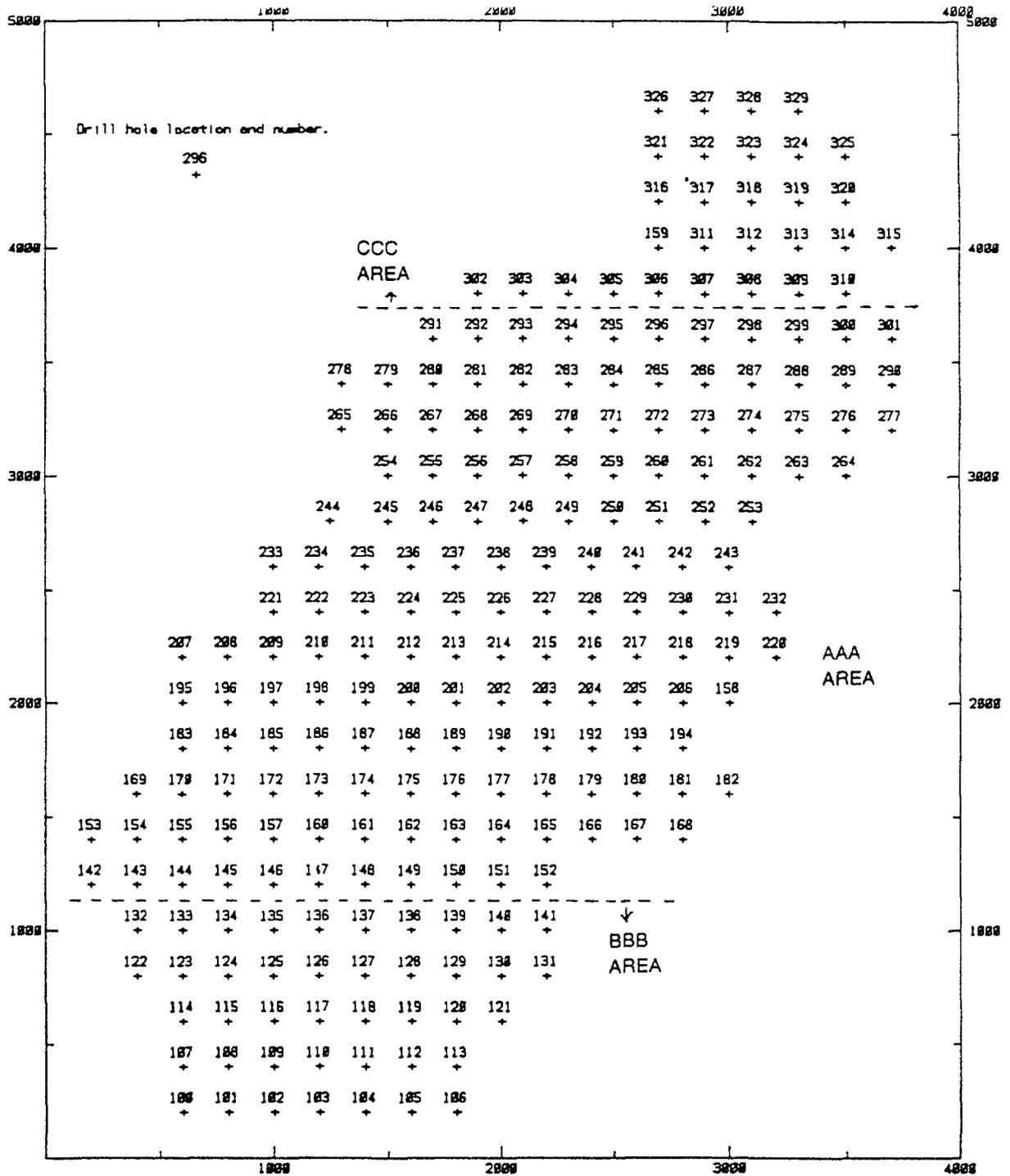


FIGURE 5.5
DRILL HOLE LOCATION MAP FROM DATA IN FILE STARDAT

6.0 UDAT SYSTEM -- PRIMARY FILES, INDIVIDUAL DATA FORMATS

The format chosen for sample data entry depends on the type and form of data received (Section 3.0). Figure 6.1, "a" through "l", shows all data formats described below. The carets between columns at the base of each format indicate the position of assumed decimals. No decimal points are actually entered in any of the sample data formats, with the exception of the dead time (Section 5.3.5), and the special entry code for time base change (Section 6.3.2.4)

Note: Refer to Figure 4.1a-b for actual examples of any of the formats described below.

Field descriptions for common header record data elements discussed in Section 5.0 are noted briefly, but the detailed descriptions are not repeated. The specific fields for common entries described under the contiguous, unimetal format are noted, but not described in detail, for the contiguous bimetal, non-contiguous, and borehole formats.

See Section 1.5 for review of abbreviations and symbols.

6.1 CONTIGUOUS SAMPLE FORMAT

The "contiguous" sample format provides a method for entering sample data as a list of contiguous sample intervals, with each interval referenced by a sample thickness and corresponding grade(s). Samples are listed in order of increasing distance from the point of origin referenced by the collar elevation. Any intervals of zero grade must be entered as such. The interval represented by the depth to first sample is assumed to be of zero grade. There is no entry for "total depth sampled"; if a barren interval is known to exist beyond the sampled interval, it should be entered at zero grade.

There are two variations of the contiguous format: one for uranium assays only ("unimetal"), Figures 6.1a & b, and one for both uranium and vanadium assays ("bimetal"), Figures 6.1c & d. The only differences between these two formats are the sample-type code and the sample entries. A given sample set must be entirely in one format or the other.

Note: In the contiguous format, the header card contains the beginning sample intervals.

6.1.1 Header Record, Descriptive Data

Figures 6.1a (unimetal) and 6.1c (bimetal) show the header record formats.

6.1.1.1 Record Count

C(1-3), E=N; see Section 5.1.4; leave blank or enter zero.

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6.1.1.2 Area Number

C(4-6), E=A; see Section 5.1.2.

6.1.1.3 Hole Number

C(7-12), E=A; see Section 5.1.1

6.1.1.4 Sample-Type Code 1

C13, E=A; see Section 5.2.1; for unimetal, enter "1", "2", "3", or "4"; for bimetal, enter "V".

6.1.1.5 Sample-Type Code 2

C14, E=N; see Section 5.2.1; for unimetal, leave blank; for bimetal, enter "1" if uranium assays are considered "uncorrected" for radiometric disequilibrium, enter "2" if they are considered as chemical equivalent.

6.1.1.6 Sample-Type Code 3

C15; leave blank.

6.1.1.7 North Coordinate

C(16-22), E=N, D=0; see Section 5.2.2.

6.1.1.8 East Coordinate

C(23-29), E=N, D=0; see Section 5.2.2.

6.1.1.9 Collar Elevation

C(30-35), E=N, D=1; see Section 5.2.3.

6.1.1.10 Pit-Bottom Depth

C(36-39), E=N, D=1; see Section 5.2.4.

6.1.1.11 Depth to Oxidized/Non-oxidized Contact

C(40-42), E=N, D=1; see Section 5.2.5.

6.1.1.12 Depth to Top of First Sample Interval

C(43-47), E=N, D=1; see Section 5.2.6.

6.1.1.13 Property Code

C(73-79), E=A; see Section 5.1.3.

UDAT PRIMARY FILES

6.1.2 Header Record, Sample Data

6.1.2.1 Unimetal Sample Interval Data

Each sample interval is represented by a thickness, (E=N, D=1) and a corresponding uranium grade (E=N, D=2). Thicknesses are entered to the nearest tenth of a foot. Up to 3 digits are allowed with a decimal assumed one place to the left of the right most digit (MV = 99.9 ft). Uranium grades are entered to the nearest one hundredth of one percent U308. Up to 3 digits are allowed with a decimal assumed two places to the left of the right most digit (MV = 9.99%U308).

The first four sample intervals entered in the header record starting in Column 49 (Figure 6.1a). The remainder are in continuation records (Figure 6.1b).

If a given sample interval is greater than 99.9 feet, then it must be split into 2 or more samples of the same grade, each of which is less than 100 feet.

Uranium assays of 10 percent or greater are not common, but if they are encountered, then the "non-contiguous" sample format (Section 6.2) must be used instead of the contiguous format.

6.1.2.2 Bimetal Sample Interval Data

Each sample interval is represented by a thickness (E=N, D=1), a corresponding vanadium assay (E=N, D=2), and a corresponding uranium assay (E=N, D=2). Thicknesses are entered to the nearest tenth of a foot. Up to three digits are allowed, with a decimal assumed one place to the left of the rightmost digit (MV = 99.9 ft). Vanadium grades are entered to the nearest one hundredth of one percent V205. Four digits are allowed with a decimal assumed 2 places to the left of the rightmost digit (MV = 99.99%V205). Uranium grades are entered to the nearest one hundredth of one percent. Three digits are allowed, with a decimal assumed two places to the left of the rightmost digit (MV = 9.99%U308).

The first 2 sample intervals are entered on the header record, (Figure 6.1c) starting in Column 53. (Columns 49 to 52 are not used). The remaining sample intervals are entered in continuation records.

If a sample interval is 100 feet or greater, the same procedure is used as described in Section 6.1.2. If a uranium grade is higher than 9.99%, then it must be "diluted" to a grade lower than 10.0% by combining it with adjoining samples.

6.1.3 Continuation Records

Figures 6.1b (unimetal) and 6.1c (bimetal) show the continuation record formats.

A maximum of 14 continuation records are allowed for the unimetal format and 24 continuation records for the bimetal format.

UDAT PRIMARY FILES

6.1.3.1 Record Count

C(1-2), E=N, D=0; see Section 5.1.4; enter the number of the continuation record; i.e., "1" for the first, "2" for the second, etc.

6.1.3.2 Area Number

C(3-6), E=A; must be exactly the same area number as that entered in the header record.

6.1.3.3 Hole Number

C(7-12), E=A; exactly the same hole number as in the header record.

6.1.3.4 Unimetal Sample Interval Data

The entries for sample intervals are exactly the same as for those on the header record (Section 6.1.2.1) except that up to 10 intervals are allowed per continuation record, starting in Column 13 (Figure 6.1b).

6.1.3.5 Bimetal Sample Interval Data

The entries for sample intervals are exactly the same as for those on the header record (Section 6.1.2.2) except that up to 6 intervals are allowed per continuation record, starting in Column 13 (Figure 6.1d).

6.1.3.6 Property Code

C(73-79), E=A; exactly the same property code as in the header record.

6.2 NON-CONTIGUOUS SAMPLE FORMAT

The "non-contiguous" format (Figures 6.1e and 6.1f) has the same entry forms as defined for the "contiguous" format (Section 6.1) except as follows:

1. The sample-type codes in the header record.
2. The representation of the sample intervals.
3. The entry, in the header record, for "total depth sampled" substitutes for "depth to first reading" since the latter is inferred to be the first of the sample interval entries.

Sample intervals are defined by: an elevation or depth to the top of the sampled interval; the thickness of the interval and corresponding grade of the interval. Sample-type code 3 denotes whether depths or elevations are involved. The sample intervals must be at successively greater distances from the point of origin referenced by the collar elevation.

This format is designed primarily for the entry of data which is received in such form that it is easier to use than the "contiguous" format. Example: if a set of radiometric logs has already been interpreted and the only sample data available are the

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depth (or elevation) of predefined anomalies, then the non-contiguous format is most appropriate.

Intervals of "barren" material need not be entered. Any implied interval between one entry and the next is assumed to be barren. Example: if one entry represents 125.5 feet in depth, 10 feet thickness and 0.10% U308; and the next entry represents 140.0 in depth, 5 feet in thickness and 0.20% U308; then actually 3 three intervals are generated as follows:

10.0 ft. @ 0.10% U308,
4.5 ft. @ 0.00% U308, and
5.0 ft. @ 0.20% U308.

Note: It is necessary to insure that the interval implied by one elevation or depth and corresponding thickness does not overlap onto the next interval, or the data will be rejected! Example: An interval represented by an elevation of 5000.0 feet and a thickness of 10.0 feet could not be followed by an interval with elevation of 4991 feet.

6.2.1 Header Record

The header record format is shown on Figure 6.1e.

6.2.1.1 Entries Identical to Those in the "Contiguous" Format

Data elements in the non-contiguous format which have the exact same format as for the contiguous format on header and/or continuation records (Section 6.2.1) are: record count, area number, hole number, north and east coordinates, collar elevation, pit-bottom depth, depth to oxidized/unoxidized contact, and property code.

Data elements which differ from those in the contiguous format are listed as follows:

6.2.1.2 Sample type code 1

C13, E=A; see Section 5.2.1; enter "6", "7", "8", or "9".

6.2.1.3 Sample type code 2

C14, E=A; see Section 5.2.1; enter a "1".

6.2.1.4 Sample type code 3

C15, E=A; see Section 5.2.1; enter a "1" or "2". If "1", the elevation/depth entry denotes elevation at the top of each sample interval; if "2", the elevation/depth entry denotes depths to the top of each sample interval from the point referenced by the collar elevation.

UDAT PRIMARY FILES

6.2.1.5 Total Depth Sampled

C(44-48), E=N, D=1; see Section 5.2.7; this entry is used in place of the depth-to-first reading used in the contiguous format.

6.2.1.6 Sample Interval Data

Each sample interval is represented by an elevation or depth (E=N, D=1), a thickness (E = N, D = 1), and a corresponding uranium grade (E=N, D = 2).

Elevation or depths are entered to the nearest tenth of a foot. Up to five digits are allowed with a decimal assumed 1 place to the left of the right most digit (MV = 9999.9 ft).

Thicknesses are entered to the nearest tenth of a foot. Up to 3 digits are allowed, with a decimal assumed 1 place to the left of the rightmost digit (MV = 99.9 ft).

Grades are entered to the nearest hundredth of a percent U308. Up to 4 digits are allowed with a decimal assumed 2 places to the left of the right most digit (MV = 99.99%U308).

The first two sample intervals are entered on the header record starting in column 49.

If a given sample interval is greater than 99.9 feet, it must be split into one or more intervals of less than 100 feet.

6.2.2 Continuation Records

The continuation format is shown on Figure 6.1f. A maximum of 29 continuation records are allowed.

6.2.2.1 Sample Interval Data

The entries for sample intervals are exactly the same as for those in the header records (Section 6.2.2.6), except that up to 5 intervals are allowed per continuation record, starting in column 13.

6.3 BOREHOLE LOG FORMAT

The borehole log format is utilized when entering data derived from continuous readings from borehole logs. The term "readings" is defined in Section 3.3. The term "range code" refers to numeric codes which are used on printed strip logs to denote the number of counts-per-second (cps) represented by a given amount of deflection of the radiometric amplitude curve. This is described in detail in Section 5.2.1.1.

There are several variations of the borehole log format: the "A-E", and the "F11", "F1U", "F1C", and "FnQ" formats. The choice of these formats depends primarily on the type of readings available for a given sample set.

1. Inch-deflections measured when digitizing radiometric strip logs (Section 3.3.4) may be entered in the "A-E" or "F11" formats.

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2. Counts-per-second from direct readout during logging procedures or measured from a strip log using hand/overlay techniques (Sections 3.3.1, 3.3.2, & 3.3.4) are entered in the "F1U" and "F1C" depending on whether they are uncorrected or corrected for dead time.

3. Estimated U308 grade values (Section 3.3.3) are entered in the "FnQ" format, where "n" indicates whether or not disequilibrium corrections have been applied.

Except for the sample-type codes (C13-15) on the header records, the variations in format primarily affect the form of the sample data entered in the continuation records. Therefore, the description of the header record (below) applies equally to all borehole log formats (except where specifically noted). Each of the types of continuation records are described separately.

6.3.1 Header Record

The header record format is shown by Figure 6.1g.

6.3.1.1 Entries Identical to Those in the "Contiguous" Format

Data elements in the borehole log format which have the exact same format as for the contiguous format on header and/or continuation records (Section 6.1.1) are: record count, area number, hole number, north and east coordinates, collar elevation, pit-bottom depth, depth to oxidized/unoxidized contact, and property code.

6.3.1.2 Sample-Type Code 1

C13, E=A; see Section 5.2.1;

1. For the "A - E" format, enter "A", "B", "C", "D", or "E", depending on the appropriate set of range codes in files RNGTBL. This code will be used in conjunction with the numeric code in column 14.

2. For the "F" format, enter "F"

6.3.1.3 Sample-Type Code 2

C14, E=A, see Section 5.2.1;

1. For the "A - E" format, enter a number from "1" to "9", depending upon the appropriate set of range codes in file "RNGTBL". This code is used in conjunction with the code in column 13.

2. For the "F (I,U,or,C)" format, enter a "1".

3. For the "FnQ" format, enter a "1" if grades in the continuation records are uncorrected for radiometric disequilibrium; enter "2" if they are corrected for disequilibrium.

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6.3.1.4 *Sample-Type Code 3*

C15, E=A; see Section 5.2.1;

1. For the "A - E" format, enter an "I" if the log is rectilinear; or enter a "Z", if the log is curvilinear.

Note: the data entry and usage of curvilinear gamma-log data is not described in this first version of the guide.

2. For the "F" format, enter an "I" if the log is rectilinear and readings are in inches of deflection; enter a "U" if the readings are in uncorrected (for dead time) cps; enter a "C" if readings are in corrected (for dead time) cps; or enter a "Q" if readings represent actual uranium grades based on previous interpretation of the borehole log data. The "Z" (curvilinear data) cannot be used with the "F" format.

6.3.1.5 *Total Depth Sampled (Logged)*

C(43-47), E=N, D=1; see Section 5.2.7.

6.3.1.6 *Readout Interval*

C(48-49), E=N, D=1; see Section 5.3.1.

6.3.1.7 *Depth to Hole Water*

C(50-52), E=N, D=0; see Section 5.3.2.

6.3.1.8 *K-Factor*

See Section 5.3.3; enter three significant digits of k-factor in C(53-55), E=N, D=0; enter exponent (assumed to be negative) of ten in C56, E=N, D=0).

6.3.1.9 *Air Correction Factor*

C(57-59), E=N, D=2; see Section 5.3.4.

6.3.1.10 *Water Correction Factor*

C(60-62), E=N, D=2; see Section 5.3.4.

6.3.1.11 *Dead Time*

C(63-66), E=N, D=0 unless decimal is actually entered; see Section 5.3.5.

6.3.1.12 *Full-Scale Deflection*

C(67-70), E=N, D=2; see Section 5.3.6; only used with "F11" format.

6.3.1.13 *Logging Unit Type Code*

C(71-72), E=A; see Section 5.3.7.

6.3.2 Continuation Records

Continuation record formats are shown on Figure 6.1 "h" through "k".

A maximum of 37 continuation cards are allowed. The entries for record count, area number, hole number, and property code are the same as those for the header record.

Columns 13 and 14 are not used. Columns 15 through 72 are subdivided into 8 fields which will be hereafter termed "continuation entry fields" or CE-fields. Each CE-field consists of seven columns; these will be referred to as positions one through seven, with the leftmost position being "1" and the rightmost being "7". Position 1 is usually left blank and only used under certain conditions.

The first CE-field begins in column 15. Eight CE-fields are allowed per record; fields should not be skipped (entire field left blank) unless they follow the last valid reading of a sample set.

A CE-field may contain either a "reading" (which denotes inches-deflection, cps, or grade) or a "special entry". The sample-type codes in the header record determine which type of reading is used; only one type can be used in any given sample set. Most of the special entries apply equally to all borehole log data types; one is used only for inch-deflection readings taken from strip logs (Section 6.3.2.4).

6.3.2.1 Readings in Inches-of-Deflection

An "inches-of-deflection" reading is the distance ("deflection") from the baseline of a printed log to a point on the radiometric amplitude of the log and is measured along a line perpendicular to the baseline. It is entered to the nearest hundredth of an inch in positions 2 through 4 of the CE-field. Up to three digits are normally entered with a decimal assumed between positions 2 and 3. The deflections on a strip log seldom extend beyond 10 inches from the baseline. However, position 1 of the field may be used if the deflection is 10 inches or greater.

In order to define how many counts-per-second are represented by the measured deflection, a range code (Sections 5.2.1.1 and 5.2.1.2) must be entered in positions 5 and 7 of the CE-field (Figures 6.1, "j" & "k"). Position 7 contains the "unit" digit of the range code and position 5 contains the "tens" digit. Range codes do not consist of more than 2 digits. If the range code is 2, then position 7 will contain a "2" and position 5 is left blank; if the range code is 13, then position 7 contains a "3" and position 5 will contain a "1".

The "inches-deflection" type reading is used when digitizing a log by hand/overlay or automatic methods. The type of range code used is determined by the Sample-Type Codes 1 and 2 (Section 5.2.1).

6.3.2.2 Readings in Counts-Per-Second

Counts-per-second ("cps") readings are obtained by direct measurement of the gross count radioactivity recorded by the logging sensor or by analysis of the deflection of the radiometric amplitude curve on printed logs. A "U" or "C" in column 15 (Sample-Type Code 3) on the header record automatically

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identifies all radiometric readings in the continuation records as being in uncorrected (U) or corrected (C) cps.

Cps readings are entered to the nearest unit, in position 2 through 7 of the CE-field (Figures 6.1, j & k). Note: on these figures, the carets) do not apply to cps readings and should be ignored.

Up to 6 digits are allowed (MV = 999999 cps). If a value exceeds 999999, then position 1 may be used for a "millions" digit.

6.3.2.3 Interpreted Uranium Values

"Interpreted values" represent actual estimates of uranium content (Section 3.3.3). They are entered to the nearest thousandth of one percent in positions 3 through 7 of the CE-fields as shown on Figures 6.1, j & k. The caret shows the position of the decimal assumed between positions 4 and 5 of the CE-fields.

6.3.2.4 Special Entries

The "special entries" (Figure 6.11) allow additional descriptive data to be entered in the the continuation records as well as providing for any changes, within a logged interval, in the original interpretation parameters which are entered in the header record.

During the course of logging procedures, certain segments of a borehole are sometimes logged using different parameters. This happens frequently when a borehole is only partially logged because of blockage in the hole or malfunctioning of the logging equipment: when the borehole is later reopened and/or logged again, the portion which was previously logged may be skipped and the remainder logged with a different logging unit than previously used.

Except for the "depth to first reading" (below), special entries may occur in any CE-field except the very first and very last CE-fields in a sample set. In addition, a given special entry cannot follow another like entry unless separated by at least one reading; for example, a special entry for time base change cannot immediately follow a previous time base change unless one or more readings intervene. One type of special entry may immediately follow a different special entry.

1. Depth to First Reading. The very first CE-field of the very first continuation record following any header record in the borehole log format must contain the value for the "depth to first reading". It is entered to the nearest tenth of a foot in position 2 through 6 with a decimal assumed between positions 5 and 6 (MV=9999.9 ft, see Figures 6.1h and 6.1j). A lower case dash ("-") must be entered in the 7th C-E field position.

2. Skipped Interval. Wherever readings have been deleted ("skipped") because of obvious lack of significant representative radioactivity, the thickness of the "skipped" interval is entered in the CE-field following the last reading entered. The thickness is entered to the nearest tenth of a foot in positions 2 through 5. Up to 4 digits may be entered, with a decimal assumed between positions 4 and 5, (MV=999.9 ft). The thickness of

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a skipped zone rarely exceeds this magnitude but if necessary, a "thousands" digit may be entered in position 1.

A CE-field for a skipped interval may be entered between any readings of the sample set except:

- at the beginning, since the depth to first reading is essentially a skipped interval,
- at the end, or,
- immediately following another skipped interval entry. Note that the decimal position in the CE-field for skipped intervals is not the same as that for the "depth to first reading".

Position 6 is not used and a lower-case dash ("-") must be entered in position 7.

3. Date Logged. An optional entry for the date on which the log was made is provided by the special CE-field for "date". The number of the month is entered in positions 2 and 3, and that for the day in positions 4 & 5. Position 6 is not used and a "D" must be entered in position 7.

4. Logging-Speed ("Time Base") Change Factor. The "logging speed" is the rate, in distance/time (feet/minute), at which the logging sensor travels along the borehole. If a hole is logged at a rate significantly different from that used when determining the k-factor (the "base" logging speed), an appropriate correction must be applied to the k-factor.

This may be done by entering a "time base change factor" (Figure 6.1k) in the CE-field of a continuation at the point where the change takes place. The factor is entered to the nearest hundredth of a unit in positions 2 through 6 of the appropriate CE-field. Up to 5 digits are allowed, with a decimal assumed between the positions 4 and 5 (MV=999.99). A "period" (".") must be entered in position 7.

The value of the change factor must be that necessary to properly correct the k-factor divided by base speed. Any recorded or calculated cps value following the logging-speed change entry will be automatically multiplied by the change factor.

For example: if a k-factor were determined at a logging speed of 5 feet per minute, but a change to a speed of 10 fpm was indicated on a log, then the entry for the logging speed change factor would "2.0", assuming that the number of counts per second recorded over a given interval was inversely proportional to the logging speed. This is not always true, so when changes in logging speed are encountered in borehole log data, the equipment manufacturer should be consulted to determine the actual effects of such changes.

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If and when it is indicated that the logging speed has reverted to the "base" speed, then another logging-speed change entry must be made, with the factor entered as "1.0".

The "base" logging speed for radiometric readings in a sample set is not entered as a data element, since it is assumed to be the one which was used in establishing the k-factor. However, it should be known and recorded for reference purposes (see Figures 5.2a & b).

The time base change factor entry can also be used to correct for other changes in logging conditions which may affect the validity of the given k-factor. Simply remember that it is a multiplicative factor applied directly to the value for counts-per-second.

The term "time constant" (see Section 17) refers to the electronic instrumentation of radioactivity-recording equipment and is the interval of time over which gamma-rays are actually "counted" internally before being recorded as (average) counts per second on an analog-chart or digital rate-meter.

If the time constant used in logging a hole is significantly different from that used when the k-factor was established, there will be differences in the configuration of the anomalies. A time constant increase will result in a dampening effect of the "highs" and "lows", while a decrease will intensify the "relief" of the anomalies. In general, the higher the time constant, the lower the logging speed should be.

Too high an increase in time constant may affect the validity of the k-factor, and as with the logging speed, the effects of such changes should be understood and taken into consideration. The "time-base change factor may be used to make the appropriate corrections.

5. Dead Time Change. The entry for the dead time in the header records provide for a value of up to 9999 microseconds or a decimal value of 3 significant digits (which covers most estimated dead times). However should the dead time: 1) exceed 9999 microseconds; 2) be reported as a decimal fraction with more than 3 significant digits, or 3) change within the logged interval; two special entries are provided.

The first is for dead times greater than 9999 microseconds. The dead time is entered to the nearest microsecond in positions 2 through 6 of the CE-field. Up to five significant digits may be entered with the decimal assumed to the right of position 6 (MV=99999 microseconds). A "plus" sign ("+") must be entered in position 7.

The other entry is for fractional dead times consisting of more than 3 digits to the right of the decimal. The dead time is entered in positions 2 through 6 of the CE-field. Up to five significant digits may be entered, with the decimal assumed between

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positions 2 and 3 (MV=9.9999 microseconds). An "S" must be entered in position 7.

6. K-Factor Change. The entry for K-factor in the header record provides up to three significant digits. If more than 3 significant digits are required, or if the k-factor should change within the the logged interval, a special entry is provided. The k-factor is entered in positions 2 through 5 of the CE-field and the exponent is position 6. Up to 4 significant digits may be entered with a decimal assumed to the right of position 5. Position 6 contains the (negative) exponent of 10 as described in Section 5.3.3. A "K" must be entered in position 7.

7. Readout Interval. Any change in the interval at which readings are recorded within given borehole are entered to the nearest tenth of a foot in positions 2 through 5 of a CE-field. Up to 4 digits may be entered, with a decimal assumed between positions 3 and 4 (MV=99.99 ft). An "I" must be entered in position 7.

8. Chart Baseline Change. This entry is useful when digitizing a radiometric strip log which contains one or more changes or "shifts" in its effective baseline. A shift to the right (towards the amplitude curve) is recorded as a positive change, and a shift to the left as a negative change. The distance of the shift from the original baseline is entered to the nearest hundredth of an inch in positions 3 to 5 of the CE-field. Up to three digits are allowed with a decimal assumed between positions 3 and 4. If the shift is negative (away from the amplitude curve) a negative or "minus" sign ("-") must be entered in position 2. A "B" must be entered in position 7.

This entry precludes the necessity of having to change deflection measurements from the original baseline to a new baseline if a shift occurs and is especially convenient when digitizing logs by automatic methods.

6.4 LITHOLOGIC DATA RECORDS

Lithologic data, in UDAT primary files, consist of:

1. 4-character alphanumeric codes that represent intervals identified as geologic units.
2. Corresponding depths, from the collar elevation reference point, to the top of each unit.

Lithologic units are usually determined in "bedded sandstone" type uranium deposits by examination of resistivity, self-potential, and other types of borehole geophysical logging data. Such data may be present on the same strip log that contains the gamma-ray log or they may be obtained from some other source. Geologic data may also be available as records of core or sample cuttings.

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The purpose of including lithologic data in the UDAT files is to provide a method of selecting particular samples from a total sample set during an ore reserve calculation. This is especially useful when the deposit consists of more than one ore "horizon" and it is desired to evaluate one particular horizon independently from the other(s).

Before deciding which units to identify for a group of sample sets, the geologic features of the entire area under evaluation should be reviewed with respect to their relationship to the uranium occurrences. Units should be selected beforehand so that they will be useful in segregating one integral portion of a deposit from other portions. This requires a reasonable amount of study of the correlation of units from one sample set to another (or one borehole log to another).

Once a series of units has been selected, the same 4-character code assigned to a given unit should be kept the same for all entries relating to that unit. There should not be any "gaps" in the series; i.e. no units should be left out between the starting (uppermost) and ending (lowermost) units of the series. Entirely barren units must be included as well as those containing evidence of uranium mineral. For each sample set which will include lithologic data, an entry must be made for every unit in the series. Special codes are provided for units which are missing or which lie below the bottom of the sampled interval. The same strict rules apply to entering lithologic codes as do the hole numbers, i.e. all code entries for the same unit must be identical.

Figure 6.2 shows the format for entering the lithologic data. The area number, hole number, and property code are entered exactly as on the header record for the given sample set. The record count or "index" number should start with 100 or 101. Sample-type code 1 (C13) must contain an "L". C(14-15) are blank.

Each record contains entries for up to 14 lithologic unit codes and corresponding depths to top of the unit ("top picks").

Units are entered by order of increasing distance from the collar elevation reference point. The 4-character code for the uppermost or closest unit is entered in C(16-19) and the corresponding top "pick" is entered, right-justified, to the nearest foot in C(20-23); MV=9999. Additional entries are made accordingly as shown on figure 6.2. If there are more than 14 units, another record may be entered. However, all entries in the first record must be filled before another "L" record is used. The maximum number of units is 28 or 4 "L" records.

For any unit of the established series which is missing, including the first and last unit, the unit lithologic code must still be entered in proper sequence and a "-1" entered in the last 2 positions of the corresponding depth entry. Lithologic units in the established series which lie (or are presumed to lie) below the lowest recognized unit in the sampled interval, must also be entered, in proper sequence with the code "-2" entered in the last 2 positions of the corresponding depth entry. In any given sample set, the same lithologic unit code must not be repeated.

As an example, Figure 6.3 shows three hypothetical drill holes -- "HYP1", "HYP2", and "HYP3" -- from a (hypothetical) area in which 8 lithologic units have been identified. The lithologic unit codes are, from top to bottom:

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"KMC ", "KBC ", "JMU1", "JMC ", "JML2", "JML1", "JSMV", and "JTDL". For each hole, the elevations of the collar, bottom, and intersection with the top of every unit encountered are noted.

Figure 6.4 illustrates the lithologic data ("L"-format) records which would be prepared and added to the sample assay data for each hole. For hole HYP1, the units and corresponding entries are recorded as follows: "KMC " is missing and the depth entry is therefore "-1"; the hole is collared in unit "KBC", so the depth entry is "0"; the depth from collar to the top of unit "JMU1" is 90 feet and is entered accordingly, as are the depths to units "JMC", "JML2", and "JML1"; units "JSMV" and "JTDL" have not been encountered, so their depth entries are both "-2".

For hole HYP2, unit "JMC" is missing and its depth entry is "-1". For hole HYP3, "JML1", "JSMV", and "JTDL" have not been encountered and their depth entries are "-2". Note that the unit codes are always entered in identical fashion and that "-1" and "-2" entries are always entered in the rightmost two digits of the depth entry field.

Note: Some of the sample sets in test file GAMDAT (Figure 4.1a-b) contain examples of lithologic records. Test file STARDATL also contains a set of UDAT sample assay data with lithologic records.

rcd. count	area no.	sample (hole) no.	sampl type codes 1 2 3	coordinates		collar or reference elevation	depth to pit bottom	depth to bot. oxid. zone	total depth sampled	r/o inter val	depth to hole H2O	k-factor	air corr. fact.	H2O corr. fact.	dead time, micro-seconds	full-scale defl. inches	log untcde	property identification
				north	east													
1:1:2:3	4:5:6	7:8:9:0:1:1:2	3:4:5	1:1:1:1:1:2:2:2 6:7:8:9:0:1:1:2	2:2:2:2:2:2:2:2 3:4:5:6:7:8:9	3:3:3:3:3:3:3 0:1:2:3:4:5	3:3:3:3:3 6:7:8:9	4:4:4:4:4:4 0:1:2	4:4:4:4:4:4 3:4:5:6:7	4:4:4:4:4:4 8:9	5:5:5:5:5:5 0:1:2	5:5:5:5:5:5 3:4:5:6	5:5:5:5:5:5 7:8:9	6:6:6:6:6:6 0:1:2	6:6:6:6:6:6 3:4:5:6	6:6:6:6:6:6 7:8:9:0	7:7:7:7:7:7:7:8 1:2	7:7:7:7:7:7:7:8 3:4:5:6:7:8:9:0

LL -> The interval represented by the readings or values.

FIGURE 6.16. Borehole Log Format, Header Record.

rcd. count	area no.	sample (hole) no.	X X X X X X X X X X X X	depth to top of 1st reading, in feet.	CORRECTED OR UNCORRECTED (for dead time) COUNTS/SECOND, U308 VALUES, OR SPECIAL ENTRIES (set)							property identification		
					1	2	3	4	5	6	7			
1:1:2:3	4:5:6	7:8:9:0:1:1:2	3:4:5	1:1:1:1:1:2:2:2 6:7:8:9:0:1:1:2	2:2:2:2:2:2:2:2 3:4:5:6:7:8:9	3:3:3:3:3:3:3:3 0:1:2:3:4:5:6	3:3:3:3:4:4:4:4 7:8:9:0:1:1:2:3	4:4:4:4:4:4:4:4 4:5:6:7:8:9:0:1:1:2:3	5:5:5:5:5:5:5:5 1:2:3:4:5:6:7	5:5:5:5:5:5:5:5 8:9:0:1:1:2:3:4	6:6:6:6:6:6:6:6 5:6:7:8:9:0:1	6:6:6:6:6:6:6:6 7:8:9:0:1	7:7:7:7:7:7:7:7:8 2	7:7:7:7:7:7:7:7:8 3:4:5:6:7:8:9:0

1 2 3 4 5 6 7 | 1 2 3 4 5 6 7 | 1 etc.
 <-CE-field -> | <-CE-field -> | <-etc.
 (numbers show field 'positions')

LL -> "e" represents position of code if CE-field is a 'special entry'. (If field is cps or U308 value, position contains last digit of value).
 -> "*" represents position of implied decimal if CE-field contains U308 value (i.e. is valid under the FIQ format only).
 For types of special entries ("set"), see FIGURE 6.11.

FIGURE 6.1H Borehole Log Format, Counts Per Second Or U308 Values; First Continuation Record.

rcd. count	area no.	sample (hole) no.	X X X X X X X X X X X X	CORRECTED OR UNCORRECTED (for dead time) COUNTS/SECOND, U308 VALUES, OR SPECIAL ENTRIES (set)							property identification			
				8,16,24,etc	9,17,25,etc	10,18,25,etc	11,19,26,etc	12,20,27,etc	13,21,28,etc	14,22,29,etc		15,23,30,etc		
1:1:2:3	4:5:6	7:8:9:0:1:1:2	3:4:5	1:1:1:1:1:2:2:2 6:7:8:9:0:1:1:2	2:2:2:2:2:2:2:2 3:4:5:6:7:8:9	3:3:3:3:3:3:3:3 0:1:2:3:4:5:6	3:3:3:3:4:4:4:4 7:8:9:0:1:1:2:3	4:4:4:4:4:4:4:4 4:5:6:7:8:9:0:1:1:2:3	5:5:5:5:5:5:5:5 1:2:3:4:5:6:7	5:5:5:5:5:5:5:5 8:9:0:1:1:2:3:4	6:6:6:6:6:6:6:6 5:6:7:8:9:0:1	6:6:6:6:6:6:6:6 7:8:9:0:1	7:7:7:7:7:7:7:7:8 2	7:7:7:7:7:7:7:7:8 3:4:5:6:7:8:9:0

1 2 3 4 5 6 7 | 1 2 3 4 5 6 7 | 1 etc.
 <-CE-field -> | <-CE-field -> | <-etc.
 (numbers show field 'positions')

LL -> "e" represents position of code if CE-field is a 'special entry'. (If field is cps or U308 value, position contains last digit of value).
 -> "*" represents position of implied decimal if CE-field contains U308 value (i.e. is valid under the FIQ format only).
 For types of special entries ("set"), see FIGURE 6.11.

FIGURE 6.1I. Borehole Log Format, Counts Per Second Or U308 Values; Additional Continuation Record.

rcd. count	area no.	sample (hole) no.	X X X X	depth to top of 1st reading, in feet.	READINGS IN INCHES OF DEFLECTION, OR SPECIAL ENTRIES (set)																					X X X X property identification
					1			2			3			4			5			6			7			
					inches	t	u	inches	t	u	inches	t	u	inches	t	u	inches	t	u	inches	t	u	inches	t	u	
1:2:3	4:5:6	7:8:9:0:1:2	3:4:5	1:1:1:1:1:2:2	2:2:2:2:2	2:2:2	3:3:3:3:3	3:3:3	3:3:3:4	4:4:4	4:4:4:4	4:4:5	5:5:5:5:5	5:5:5	5:5:6:6:6	6:6:6:6	6:6:6:6:6	6:6:7:7:7	7:7:7:7:7	7:7:7:7:7	7:7:7:7:7	8				

1 2 3 4 5 6 7 | 1 2 3 4 5 6 7 | 1 etc.
 <-CE-field -> <-CE-field -> <-etc.
 (numbers show field 'positions')

↳ "e" represents position of code if CE-field is 'special entry'. If field otherwise, position contains unit ("u") digit of range code.
 ↳ Position not used if CE-field contains inch-deflection entry.
 ↳ If entry is inch-defl. value, contains tens ("t") digit of range code.
 ↳ "u" represents position of implied decimal if CE-field contains inch-deflection reading.
 For types of special entries ("set"), see FIGURE 6.1L.

FIGURE 6.1J. Borehole Log Format, Inch-deflection Readings; First Continuation Record.

rcd. count	area no.	sample (hole) no.	X X X X	READINGS IN INCHES OF DEFLECTION, OR SPECIAL ENTRIES (set)															X X X X property identification									
				8, 16, 24, etc.			9, 17, etc.			10, 18, etc.			11, 19, etc.			12, 20, etc.				13, 21, etc.			14, 22, etc.			15, 23, etc.		
				inches	t	u	inches	t	u	inches	t	u	inches	t	u	inches	t	u		inches	t	u	inches	t	u	inches	t	u
1:2:3	4:5:6	7:8:9:0:1:2	3:4:5	6:7:8:9	0:1:2	3:4:5:6	7:8:9	0:1:2:3	4:5:6	7:8:9:0	1:2:3	4:4:4:4	4:4:5	5:5:5:5	5:5:5	5:5:6:6	6:6:6	6:6:6:6	6:6:7:7	7:7:7:7	7:7:7:7	7:7:7:7	8					

1 2 3 4 5 6 7 | 1 2 3 4 5 6 7 | 1 etc.
 <-CE-field -> <-CE-field -> <-etc.
 (numbers show field 'positions')

↳ "e" represents position of code if CE-field is 'special entry'. If field otherwise, position contains unit ("u") digit of range code.
 ↳ Position not used if CE-field contains inch-deflection entry.
 ↳ If entry is inch-defl. value, contains tens ("t") digit of range code.
 ↳ "u" represents position of implied decimal if CE-field contains inch-deflection reading.
 For types of special entries ("set"), see FIGURE 6.1L.

FIGURE 6.1K. Borehole Log Format, Inch-deflection Readings; Additional Continuation Record.

rcd. count	area no.	sample (hole) no.	TYPES OF SPECIAL ENTRIES (These may be in any CE-field except the 'depth to 1st reading')										X X X X property identification
			skip zone (to nearest 10th of a ft)	date logged (month - MM year - YY)	time base change factor (log. rate etc.)	dead time change "x", microseconds	dead time change "S", microseconds	k-factor change "p"	readout interval change, in feet	chart baseline change, inches; (to left, neg.)			
			x x x x x	M M Y Y : D	x x x x x	x x x x x	x x x x x	x x x x x	x x x x x	x x x x x			
1:2:3	4:5:6	7:8:9:0:1:2	3:4:5	6:7:8:9:0:1:2	3:4:5:6:7:8:9	0:1:2:3:4:5:6	7:8:9:0:1:2:3	4:5:6:7:8:9:0	1:2:3:4:5:6:7	8:9:0:1:2:3:4	5:6:7:8:9:0:1:2	3:4:5:6:7:8:9:0	8

↳ 7th field position always contains special entry code. ↳ Exponent (assumed to be negative) of k-factor
 ↳ Position of implied decimal.

FIGURE 6.1L. Special Entries For Borehole Log Continuation Record Formats.

r c	rd. count	area no.	sample (hole) no.	c o d e	X X X X	picks 1,8,etc.		2,9,etc.		3,10,etc.		4,11,etc.		5,12,etc.		6,13,etc.		7,14,etc.		X X X X	property identifi- cation
						lith. unit code	top depth (ft)	lith. unit code	top depth (ft)	lith. unit code	top depth (ft)	unit	top	unit	top	unit	top	unit	top		
	1 1 2 3	4 5 6	7 8 9 0 1 2	1 3	1 4 5	1:1:1:1:1:2:2:2:2	2:2:2:2:2:3:3	3:3:3:3:3:3:3	4:4:4:4:4:4:4	4:4:5:5:5:5:5	5:5:5:5:6:6:6:6	6:6:6:6:6:6:7:7	7:7:7:7:7:7:7	8	7:7:7:7:7:7:7	8					
	1 2 3	4 5 6	7 8 9 0 1 2	3	4 5	6:7:8:9:0:1:2:3	4:5:6:7:8:9:0:1	2:3:4:5:6:7:8:9	0:1:2:3:4:5:6:7	8:9:0:1:2:3:4:5	6:7:8:9:0:1:2:3	4:5:6:7:8:9:0:1	2 3:4:5:6:7:8:9 0								
				L																	

FIGURE 6.2. Lithologic Data Format.

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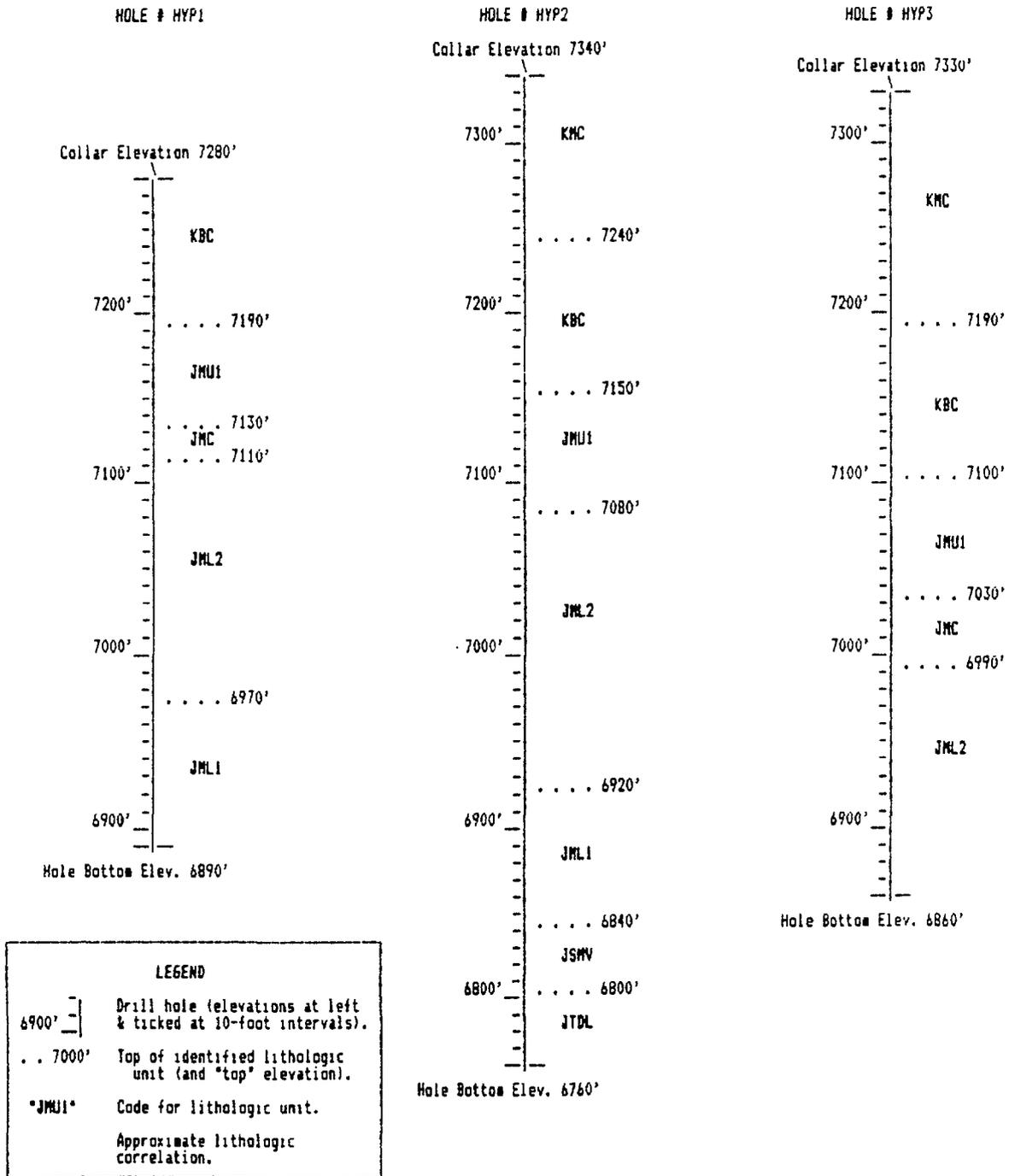


FIGURE 6.3. Illustration Used To Demonstrate Entry Of Lithologic Data.

UDAT PRIMARY FILES

Record Format

column	1111111111222222222233333333334444444444555555555566666666667777777778
numbers	>1234567890123456789012345678901234567890123456789012345678901234567890
Record 1	101 HYP1 L KMC -1KBC 0JMU1 90JMC 150JML2 170JML1 310JSMV -2 HYPAREA
2	102 HYP1 L JTDL -2 HYPAREA

Lithologic (*L*) records for hole number HYP1.

Record Format

column	1111111111222222222233333333334444444444555555555566666666667777777778
numbers	>1234567890123456789012345678901234567890123456789012345678901234567890
Record 1	101 HYP2 L KMC OKBC 100JMU1 90JMC -1JML2 260JML1 420JSMV 500 HYPAREA
2	102 HYP2 L JTDL 540 HYPAREA

Lithologic (*L*) records for hole number HYP2.

Record Format

column	1111111111222222222233333333334444444444555555555566666666667777777778
numbers	>1234567890123456789012345678901234567890123456789012345678901234567890
Record 1	101 HYP3 L KMC OKBC 140JMU1 230JMC 300JML2 340JML1 -2JSMV -2 HYPAREA
2	102 HYP3 L JTDL -2 HYPAREA

Lithologic (*L*) records for hole number HYP3.

FIGURE 6.4. Example: Data Entry Of Lithologic Information Illustrated In Figure 6.3.

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In order to process the uranium sample data, the URAD programs must be provided with the ability to: 1) specify the file(s) on which the sample sets reside, 2) indicate which of the sets are to be included in a given run. 3) perform any additional necessary operations on the samples, and 4) access the files and obtain the specified sample sets.

"UCON" (Uranium sample input CONTROL) is the name given to the system which controls these operations.

A "UCON file" is an independent set of data consisting of instructions which completely define all the sample set data which will be used in any RUN of a URAD program. A UCON file is in the "formatted" mode and contains records with length of 80 characters or less. Every time a URAD program is run, it simply requests the name of the particular UCON file designated for the given RUN; and during the RUN, the file is automatically interrogated for instructions until all sample data data designated by the file(s) have been processed.

An appropriate UCON file must be prepared by the user before any URAD program is run.

7.1 DEFINITION OF A "BLOCK"

A "block" is simply a group of UDAT sample sets defined by a set of instructions in a UCON file.

7.1.1 Block as Used With Program URDAT

In one RUN, program URDAT will process the sample sets (from one or more primary (basic) UDAT files) defined by one, and only one, UCON block, and (optionally) output the processed data onto a single secondary UDAT file.

7.1.2 Blocks as Used With the Ore Reserves Programs

In one RUN, programs RESUV, ORSAC, or SCOR may process the sample sets (from one or more intermediate UDAT files) defined by up to 26 blocks, and calculate reserves for each block. For these ore reserves programs, a "block" assumes the added significance of including the areal dimensions, in square feet, of the reserve block, as well as the sample information to be used in the calculations.

Within the computer programs themselves, there is no actual "connection" between the block and its designated area. It is up to the user to determine which sample sets apply to the chosen block area (or vice versa). Generally, this is done by visual examination of maps, cross-sections and associated sample and geologic data. A group of sample sets is chosen, the outline of an area is drawn around the chosen sets, and the areal dimension is measured by planimeter, or by some other method.

However, there is no restriction in a UCON block that all sample sets defined by the block fall exactly within the confines of a predetermined areal outline. For various reasons, the user may choose to include, in the sample set definition, sets that fall outside the drawn or implied areal outline representing the block area.

7.2 OVERALL STRUCTURE OF A UCON FILE

In a UCON file, a block is defined by a series of records (Figure 7.1) which comprise a "block control module" ("BCM"). Each record is identified by an instruction code in columns 1 and 2 (Section 7.3). The first record of a BCM is a "BCM identifier" and the last record is a "BCM terminator".

The BCM identifier record contains a block code, a block area and a block name used to identify the block in output listings. (These parameters are defined in detail in Section 7.4) The block code and block area are not entered when program URDAT is run. If present, they will be ignored.

The BCM terminator record simply contains the "BCM terminator" code -- "*B", unless it represents the last BCM of the UCON file (see below).

Within a BCM there are one or more "file control modules" ("FCM"). Each FCM specifies the name of a UDAT file which contains sample sets to be included in the block as well as optional instructions for editing those sample sets. The first record of an FCM is the "FCM identifier" which contains the name of the file to be processed (and optional additional information). The last record of an FCM is the "FCM terminator" which simply contains the "FCM terminator" code -- "* ", unless it represents the last FCM of the given BCM (see below). One BCM may contain an unlimited number of FCMs.

The last record of every UCON file must be the RUN terminator, which contains the "RUN terminator" code -- "**".

Figure 7.1 illustrates the general structure of a UCON file which contains one BCM which, in turn, contains one FCM. The "IC" records indicate optional additional edit instruction records (Section 7.6) within the FCM. If one terminator record follows another, the "lower-ranking" terminator records must be omitted as shown in Figure 7.1, where the RUN terminator record ("**") also serves as the BCM and FCM terminator records.

Figure 7.2 shows the overall structure of a UCON file which establishes three blocks. The first BCM contains three FCMs; the second, 1 FCM, and the third, 2 FCM's. An ore reserve program processing a UCON file having this structure will read the first BCM identifier record, and obtain sample data from each of the three files specified by the FCM's. When the first BCM terminator is encountered, the reserve program will complete calculations for the first block. It will then read the second BCM identifier, obtain sample data from the one specified file and complete another reserve calculation; and so forth. When the file terminator is encountered, the reserve program will complete calculations for the third block, complete any additional operations required, and terminate.

Note: in Figure 7.2, lesser-ranking redundant terminator records are omitted; i.e. the terminator record for the last FCM in each

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block is omitted and the block terminator record serves to both terminate the FCM and the BCM. Similarly the RUN terminator serves to terminate the last BCM as well as the last FCM in the last BCM.

Since the concept of ore reserve blocks underlies the operation of all the reserve programs, it is important to understand that any ore reserve block in URAD is implicitly defined both by the sample sets included in a UCON block control module and the area assigned to that module.

7.3 UCON INSTRUCTIONS, GENERAL

To review, a block control module (BCM) in a UCON file consists of a series of 80 (or less)-character records starting with a BCM identifier record and ending with a BCM terminator record. Every record may be considered to consist of one or more instructions, with each instruction generally followed by parameters (or "operatives", see below) pertaining to that given instruction. Some instructions do not require additional operatives or the operatives are optional.

The following descriptions of the types and uses of the instructions may seem detailed and complicated. However, once the principals are understood, the user will find that it is very easy to construct a UCON file and that any sample data from any UDAT file may be identified and selected. The ease with which this is done will depend to a large extent in the planning and organization that was used in preparing the applicable UDAT primary (basic) or intermediate sample data files.

Each UCON instruction consists of a 2-character "operator" code (OPcode) generally followed by one or more parameters or "operatives". The first character of the operator code is designated as the "primary" operator code (or "OPcode1"); the second character is the "secondary" operator code (or "OPcode2"). The OPcode1 is a unique character which specifies the generic type of instruction. OPcode2 refers to optional uses for the instruction or optional entries for the operatives. No spaces are permitted between the OPcode1 and OPcode2 of an instruction.

The instruction operator codes discussed below in the text are enclosed in double quotes. They may be shown as OPcode1 only or as both OPcode1 and OPcode2. However, quotes are never used with the operation codes when actually preparing a UCON file

Some operator codes must start at the beginning (first 2 columns) of a record. Others may appear anywhere in a record. Some secondary OPcodes are just "padding" (non-functional).

The operatives consist of numeric values or alphanumeric character "names". Alphanumeric names include: block codes, block names, file names, lithologic unit codes, hole numbers and area numbers. Block codes, block names, file names and lithologic unit codes must always be enclosed by single quotes (' '); the others are never enclosed.

Numeric operatives are: the block area, limiting elevations, disequilibrium coefficients, and limiting coordinates. A numeric operative must always include the decimal point if it is entered as a decimal fraction, but need not

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include the decimal if it is a whole number. This is in contrast to the entries in the UDAT files, where decimal fractions are implied by the formats. The block area and the coordinate values are entered to the nearest whole unit and must not contain a decimal point.

All individual entries for operatives must be followed by a comma (",") unless specifically noted (see "H" and "A" instructions) or unless the operative is the last one in a record. Instruction OPcodes are never directly followed by a comma, even if one instruction operator code is immediately followed by another with no intervening operative(s).

Figure 7.3 is a summary of UCON instructions and lists the primary OPcode for each instruction, the general type of secondary OPcode, the number and type of operatives, and the usage of the instruction. The secondary OPcodes vary, depending on the primary OPcode. Where an OPcode2 is applicable, it is shown as "n" or "a"; if entirely nonfunctional, it is shown as the symbol "#". The description under "usage" states if the operator code must begin in column one of a record. The secondary OPcodes and the operatives are described in detail in Sections 7.4 through 7.7.

The "B" instruction defines a BCM; the "F" instruction defines an FCM.

The "E", "L", "Q", "W", "A", "H", and "C" instructions are contained within a given file control module and apply to the file name entered in the FCM identifier record. They are termed "edit" instructions.

Examples, from Figure 7.3:

{ B B#; i=0 or 1 (A=3); Q=yes, C=yes } designates that "B" is the OP code1 used to establish a block control module; the OPcode2 is nonfunctional; there may be either no operative or one operative, and if there is an operative it consists of exactly 3 characters; the operative (if present) must be enclosed in (single) quotes and must be followed by a comma.

{ E En= 1,2,3,4,N; i=0 or 2 (N <= 7); D=yes(1)*, C=yes } designates that "E" is the OPcode1 for edit by elevation and/or position with respect to an open pit; the OPcode2 may be a single digit number from 1 through 4 or an "N"; there may be either no operatives or 2 operatives following the operator code; if there are (two) operatives, and they consist of up to 7 numeric digits (including a decimal, if present); a decimal is allowed with one digit to the right of the decimal (*unless otherwise noted in the text); the operatives must be separated by commas from themselves and from any succeeding instruction operator code in the same record.

{ A Aa= +,-,b,N; i<=26/rec (A=3), max. rec.=1; Q=no,C=no } designates that "A" is the OPcode1 for edit by sample set area number; the OP code2 may be the characters "+", "-" (negative sign), blank, or "N"; there may up to 26 operatives per record, each operative consisting of exactly 3 characters; a maximum of one record is allowed; operatives are not enclosed by quotes, and no commas are used as separators.

7.4 INSTRUCTIONS CONTAINED IN THE BCM (BLOCK) IDENTIFIER RECORD7.4.1 The "B" Instruction

The "B" instruction ("B#") denotes a BCM (block) identifier record; the OPcode2 is always "#". The "B" must always be entered in Column 1 (and of course the "#" in column 2). The operative is a 3-character block identification code, or simply "block code"; examples: 'A4', 'FGT', 'C14'. The block code is always encased by (single) quotes, and must be followed by a comma (',') if an area or block name instruction follows. If the block code is omitted in a BCM identifier record in a UCON file used for an ore reserve RUN, then a block code, simply containing the sequence position of the given block, is automatically generated. If a block code is included in UCON file used for a URDAT RUN, it will be ignored.

7.4.2 The ">" Instruction

The ">" instruction (">#") may only be entered in the BCM identifier record, following the block code operative. It denotes the block area. The OPcode2 is always "#".

The ">#" operator must be followed by an operative, which is a numeric value of up to 10 digits representing the area of the block, to the nearest square foot. Example "># 5000", "># 888000"; no decimal is required; it cannot have a zero or negative value. The operative must be followed by a comma if the ">" instruction is succeeded by a "!" instruction.

The block area instruction OPcode and operative must be present in every BCM identifier record if the UCON file is used with an ore reserve program. For UCON files which will be used by program URDAT, the ">" instruction is not needed. If present, it will be ignored.

7.4.3 The "!" Instruction

The "!" instruction ("!#") may only be on the BCM identifier record. It immediately follows the block area instruction, if the latter is present. Otherwise it follows the BCM identifier instruction. "!" denotes a block name; the OPcode is always "#". The operative is a name assigned to the block and may consist of up to 74 characters. It must be encased in single quotes.

The "!" instruction is optional for programs RESUV, ORSAC, and SCOR; if not entered, a name will be created for the given block. When running program URDAT, however, if the block name is missing, an interactive request will be made to supply a block name, since: 1) it is the only way of identifying the run on output listings, and; 2) it will be used as a file identification on the first record of an intermediate file, if such a file is created. Lack of this identification will not stop program execution, but will make it difficult to identify the output and/or intermediate file at a later date.

Since the block name instruction ("!#") is always the last operative on the BCM identifier record, it is never followed by a comma.

7.4.4 Summary of Usage of the BCM Identifier Record

The first record of any UCON file will be a BCM Identifier Record with a "B#" entered in columns 1 and 2.

If the UCON file is used for a URDAT RUN, there will only be one BCM identifier record in the file and the record need not contain any block code operative or area instruction. If the UCON file is used for an ore reserve program, there may be more than one BCM identifier record in the file and each must contain an area instruction following the "B#" instruction. "!" instructions may optionally follow either the ">" instruction, or the "B" instruction, if the ">" instruction is not present. Figure 7.4A shows the following examples of block identifier records.

Ex.1. Block code is "G2 ", block area is 7000 square feet, name is 'Example 1, Block Identifier Record'.

Ex.2. Block code is "A2", block area is 777,777 square feet, block name instruction omitted.

Ex.3. Block code omitted, block area is 70,007 square feet, block name is 'example 3, Block Identifier Record'.

Ex.4. Block code is absent, block area instruction omitted, block name is 'Example 4, Block Identifier Record'.

Ex.5. Block code is "A4", block area instruction omitted, block name instruction omitted.

Examples 4 and 5 would only apply to UCON Files used for URDAT RUNS, since there is no ">" instruction; the block code in example 5 would be ignored.

The last record of a BCM must be block terminator record unless superceded by a (UCON) RUN terminator record.

7.5 INSTRUCTIONS CONTAINED IN THE FCM (FILE) IDENTIFIER RECORD

7.5.1 The "F" Instruction

The "F" instruction denotes an FCM identifier record which specifies the name of the UDAT file from which sample data will be extracted; the OPcode2 is "#". The "F" must always be entered in column 1. The operative is a DOS file name, consisting of up to 14 characters, which must be enclosed in single quotes. Some examples are: 'filename', 'filename.xxx', 'A:filename.xxx'. DOS path reference names are not permitted for URAD files.

The file name must reference a UDAT sample assay file. If URDAT is being run, then the file must be of the primary (basic) type. If the reserves programs are being run, the file must be of the intermediate type. If the device name (i.e. 'A:', 'B:', etc.) is used, the program will assume that the file is in the root directory of the disk on the designated drive. If not, the program will assume that the file is in the current working directory of the disk on the default drive (Section 2.2.2).

7.5.2 Other Instructions on the FCM Identifier Record

"E", "L", "W", and /or "Q" instructions (see below) may also be included on an FCM identifier record, if space allows. If such are included, the file name operative must be followed by a comma.

7.5.3 Summary of Usage of the FCM Identifier Record

A BCM identifier record must always be followed by an FCM identifier record. If multiple files are to be processed for a block, then additional FCM identifier records will be included within the BCM. The file name is crucial in identifying the data which will be processed.

An FCM identifier record is the first record of a file control module and always has "F#" in columns 1 and 2. Figure 7.4B illustrates some examples of FCM identifier records:

Ex.1. File 'STARDAT' is the UDAT file requested and is assumed to be on the current working directory of the default disk drive.

Ex.2. File 'STARDAT.B' is the UDAT file requested and is assumed to be on the default drive as above.

Ex.3. File 'GAMDAT' is the UDAT file requested and is assumed to be in the root directory of the floppy disk on the 'A' drive. Some edit instructions are also entered in this record.

The last record of an FCM must be an FCM terminator record unless superceded by a BCM or RUN terminator record.

7.6 EDIT INSTRUCTIONS WITHIN A FILE CONTROL MODULE

7.6.1 General Characteristics

The instructions described in this section are all used for editing or correction of sample data. They are all optional and are only included within a file control module as needed.

The "E", "L", "W", and "Q" instructions all affect editing or correction of samples within sample sets. More than one of these may be included on the same record, including an FCM identifier record (see example 3, Figure 7.4B. However, whenever one of these instructions is the first instruction of a record, it must start in column 1 of the record. "E", "L", "W", or "Q" instructions may not be entered on the same record as "C", "A", or "H" instructions.

The "C", "A", and "H" Opcodes must always begin in column 1 of a record, and no other instructions may appear on that record. These instructions apply to entire sample sets and determine whether an entire set is to be included or rejected during the processing of a file.

There is no specific order of entry of these instructions within a file control module, except that if two "Q" instruction are contained within one

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FCM, the first is assumed to apply to samples in the "non-oxidized zone" and the second for samples in the "oxidized zone".

A FCM may simply consist of an FCM identifier record -- containing only the "F#" OPcode and file name -- and an FCM terminator record; no edit instructions are required if not applicable. On the other hand, an FCM may include any combination of the edit instructions, except that the "E" and "L" instructions cannot be both be in effect during the processing of a given file.

During the processing of the sample sets, there is a hierachy of editing instructions as described in Section 7.6.10.

7.6.2 Carry-over or Negation of Edit Instructions

The following "carry-over or negation" rules apply to all the UCON edit instructions but not to the "B", "F", ">", "!" or "*" (terminator) instructions. If more than one FCM is contained within a given BCM, the edit instructions in one FCM will carry over into (i.e. remain in effect for) the following FCM within the same BCM unless they are negated in a succeeding FCM(s) or new, similar instructions are provided in the succeeding FCM(s).

However, instructions do not carry over from one BCM to the next. Each new BCM automatically cancels all instructions from a previous BCM, and the first FCM of each BCM must contain a fresh set of instructions.

Any of the edit instructions in an FCM having an OPcode2 of "N", will cancel (or "negate") any similar instruction, i.e. an instruction having the same OPcode1, in a preceding FCM within the same BCM will be negated.

Examples:

1. If the first FCM in a BCM contains an "E1" instruction, and the second FCM within the same block contains an "EN" instruction, then, after the first file is processed, the original "E1" instruction will be cancelled and there will be no E-edit in effect while processing the second file; other instructions will not be affected.

2. If the second FCM contains no "E" instruction, then the original "E1" instruction in the first FCM will remain in effect while the second file is being processed. If the second FCM contains, say, an "E2" instruction, the latter will supercede the original "E1" during processing of the second file. An entry, in the second FCM, of "E1" with different operatives will cause the new operatives to be in effect while the second file is being processed.

Notes: Any instruction having an OPcode2 of "N" should never be followed by any operatives, nor should it follow a similar instruction within the same FCM.

Any new edit instruction entered in a given FCM automatically cancels a similar instruction in a preceding FCM (within the same BCM) and in this situation, a negation OPcode must not be used.

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The "N" OPcode2 does not apply to, and must not be used with, the "B", ">", "!", "F", or "*" instructions.

If an FCM contains an "E" instruction, and a succeeding FCM within the same BCM contains an "L" instruction, the previous "E" instruction will be automatically cancelled (and vice versa).

7.6.3 The "E" Instruction

The "E" instruction is used to edit samples within sample sets according to their elevation and/or with respect to the bottom of an open pit (if such exists). The OPcode2 determines the type of edit and may be "1", "2", "3", "4", (or "N"). There is either no operative or 2 operatives (see below). If entered, the operatives define, respectively, an upper limiting elevation ("TOPEL") and a lower limiting elevation ("BOTEL"). Elevation values are in feet and may be up to 7 significant digits, including a decimal point, if applicable. (Remember that the elevations in the original sample sets are entered to the nearest 10th of a foot.)

Negative elevations are allowed. All elevations used in the elevation edit controls must refer to the same datum elevation as those in the sample sets which are subject to the given edit.

The carry-over and negation rules (Section 7.6.4) apply.

A non-zero entry for TOPEL will cause all samples above TOPEL to be ignored; a zero entry will establish the collar elevation of each sample set as the upper limit. A non-zero entry for BOTEL will cause all samples below BOTEL to be ignored; a zero entry will set the bottom depth sampled as the lower limit. These limits may be further modified if edits "2", "3", or "4" (be low) are used.

The operatives must either both be entered, or both omitted, if they are both omitted, their value is assumed to be zero. If they are entered, TOPEL is always first. If one or the other is not applicable, it must be entered as zero. For this reason an actual limiting elevation of 0 feet (with respect to the datum plane) cannot be entered; it must be entered as a positive number less than 0.1 feet (Example: 0.01 or 0.001).

Notes: The "E" instruction cannot be used in conjunction with the "L" instruction (Section 7.6.4) within any given file control module.

The "E" instruction with an OPcode greater than "1" cannot be used with programs RESUV, ORSAC, or the underground option of SCOR.

The significance of the secondary OPcodes is as follows:

7.6.3.1 OPcode2 = "1"

The edit is by elevation control only and depends on TOPEL and BOTEL. If both TOPEL and BOTEL are non-zero, only samples between these two elevations will be submitted to the calling program. If TOPEL = 0, then the upper limit will be the collar elevation of the sample set. If BOTEL = 0, the lower limit will be the bottom depth sampled. If both are zero, then, of course,

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no editing will effectively take place at all. This edit is not affected by the presence of entries for pit-bottom in the sample sets.

7.6.3.2 OPcode2 = "2"

Only sample sets lying within a pit (i.e., sample sets having a pit-bottom depth ("PITBT") entered in their header records) will be accepted; all others will be completely rejected from the file. For those accepted, only samples lying below the PITBT will be included. If TOPEL and BOTEL are entered as operatives, TOPEL will be ignored, if it lies above the PITBT.

7.6.3.3 OPcode2 = "3"

Only sample sets having a PITBT entry will be accepted and furthermore, only samples above the PITBT will be accepted. If TOPEL and BOTEL are entered as operatives, BOTEL will be ignored if it lies below the PITBT.

7.6.3.4 OPcode2 = "4"

All hole sample sets are accepted. However, for any sample set containing an entry for PITBT, only those samples lying below the PITBT will be accepted; and, if the operatives are included TOPEL will be ignored if it lies above the PITBT. For those sample sets not having a PITBT entry, TOPEL and BOTEL will be applied as described for an secondary OPcode of "1".

Note: There are two important factors to remember with respect to entries for PITBT in the primary (basic) UDAT files:

1. In the processing of the sample sets during a SCOR open pit RUN, if no "E" edit is in effect, the procedure described above for an OPcode2 of "4" is automatically implemented since it is assumed that all material above the PITEL has been removed. An "E1" instruction, with or without operatives, must be used override this condition.

2. The "E" pit-bottom control edits (secondary OPcodes = 2, 3, or 4) will only be recognized when running the SCOR program for open pit analysis. When RUNs are made on RESUV, ORSAC, or SCOR-underground- option, the PITBT entries, or edits pertaining to them, are completely ignored!

Examples of entry for the "E" instruction are shown in Figure 7.4C.

Ex.1. Select only sample sets which have a non-blank entry for PITBT (depth to pit bottom); select only samples below the PITBT and above 200 feet in depth.

Ex.2. Cancel any previous "E" instruction within the given BCM.

7.6.4 The "L" Instruction

The "L" instruction is used to edit data on the basis of lithologic information associated with the sample sets, as described in Section 6.4. It provides the most versatile method of isolating mineralized zones within a

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deposit. The secondary OPcodes are "#" and "N". The carry-over and negation rules (Section 7.6.4) apply.

The "L" instruction cannot, however, be used in conjunction with the "E" edit instruction within a block control module; in effect, the L-edit, itself, establishes the upper and lower boundaries for sample selection. Sample set entries for PITBT are ignored when the L-edit is in effect.

The operatives are the 4-character lithologic codes for an "upper lithologic unit" ("TLTH") and a lower lithologic unit ("BLTH") within the range of which samples will be selected. The lithologic codes for TLTH and BLTH must always both be present, and each must be encased in single quotes (' ') and separated by a comma. TLTH cannot be a unit which is lower than BLTH in the established "lithologic sequence" (Section 6.4).

This edit is extremely useful in separating ore zones on the basis of attitude or lithologic environment. It is most useful in bedded deposits but can also be used to represent selected zones in other deposits, providing that some forethought has been given to this when establishing the primary (basic) UDAT data bases. It is especially useful in statistical analysis of a deposit when it may be desired to run an analysis of (likely) individual sample populations which include only portions of the total samples in the sample sets.

The edit assumes that specific lithologic (or psuedo-lithologic) intervals have been designated and entered in the "L" format with each of the applicable sample sets. TLTH and BLTH are 4-character codes chosen from the total list of lithologic codes entered with the sample sets.

The preparation of the "L" format records is described in Section 6.4. To review: the 4-character alphanumeric code for each lithologic unit is entered along with the corresponding "top pick", i.e. the depth from the collar elevation of the sample set to the top of the given lithologic unit. The unit code/depth entries are made in order of increasing distance from the point indicated by the collar elevation.

The depths are all positive numbers, except that:

1. For the lithologic unit in which the sample set is "collared" (i.e. in which the top of the sample set is positioned) the depth is entered as zero.
2. Lithologic units with the flag "-1" (Section 6.4) in their corresponding depth entries are considered to be missing (absent) above or within the total interval represented by the sample set. Lithologic units with the flag "-2" in their corresponding depth entries denote units assumed to lie below the lowest recognized lithologic unit present in the interval represented by the given sample set.

Once a total sequence of lithologic units has been selected as being significant for the region which includes the deposit(s) under evaluation, the "L" records in each sample set must include entries for every lithologic unit included in the total sequence. When the lithologic edit is in effect, and a unit represented by either TLTH or BLTH is not found, then the entire sample set is rejected.

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The edit is simple. As each sample set is processed, the TLTH operative is compared to all the lithologic unit codes in the sample set list and, if a match is made, the depth corresponding to the matched unit becomes the top limiting depth; all samples above that point are excluded. The BLTH is similarly compared, and if a match is made, the depth of the unit succeeding the matched unit becomes the bottom limiting depth and all samples below that depth are excluded.

If sample selection is desired from one particular unit only, then the code for that unit is entered both for TLTH and BLTH. Whenever either of the limits "splits" an integral sample, only the portion within the limits is accepted. Example: if there is a sample of 5 feet @ 0.20% U308 lying in the elevation range of 2005 - 2000 feet, and the TLTH is determined at 2002 feet, only 2 feet @ 0.20%U308 will be included as an "accepted" sample.

The following operations also take place during the matching process:

1. Whenever a BTLH edit operative represents the last (lowest) unit recognized within a sampled interval, whether the very last unit of the entire sequence or the last to contain a positive depth entry), the bottom-depth-sampled automatically becomes the lower limiting elevation.
2. Whenever a BLTH edit operative is matched to a sample set unit which lies below the bottom depth sampled for the given set, the bottom depth sampled automatically becomes the lower limiting depth.
3. Whenever a TLTH or BLTH edit operative is matched with a corresponding (sample set) unit which has a depth entry of "-1" (missing), the depth of the first succeeding unit which contains a positive depth value becomes the upper (or lower) limiting depth. If all units are missing in the range specified by TLTH and BLTH, then the interval is automatically considered "barren".

The following examples of the "L" instruction are shown on Figure 7.40; Figures 6.3 and 6.4 may be used as references.

Ex.1. TLTH and BLTH are entered as 'JMU1' and 'JML2' respectively. For Hole # HYP1, the top and bottom limiting depths would be 90' (7280 minus 7190) and 310' (7280 minus 6970), respectively. For Hole HYP2, they would be 190' and 420'.

Ex.2. TLTH and BLTH are 'JML2' and 'JML1'. For Hole HYP1, the top and bottom limits would be 170' and 390' (depth to bottom of the hole). For Hole HYP3, the limits would be 340' and 470' (the hole bottom).

Ex.3. TLTH and BLTH are 'JMC ' and 'JMC ' (same unit). For Hole HYP1, the limits would be 150' and 170'. Hole HYP2 would be considered "barren" since the unit is not present.

Ex.4. TLTH and BLTH are 'JSMV' and 'JTDL'. For Hole HYP2, the limits would be 500' and 580'. Holes HYP1 and HYP3 would be considered barren since both units are either missing or presumably lie below the bottom of these holes.

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Ex.5. TLTH and BLTH are 'KMC ' and 'KBC '. For Hole HYP1, the limits would be 0' and 90'; unit 'KMC ' is missing and the hole is collared in unit 'KBC '.

Ex.6. TLTH and BLTH are 'JMC ' and 'JML2'. For Hole HYP3, the limits would be 300' and 470'. For Hole HYP2, they would be 260' (top of unit 'JML2' since unit 'JMC ' is missing), and 420'.

The characters making up the lithologic code (including blocks) must exactly match those in the data, or the hole is rejected entirely. For example: ' JMC' would not match 'JMC '. For this reason it is wise to use 4 character combinations for lithologic codes rather than using one or more blanks. This has not been done in the examples expressly for illustrative purposes!

If the L-edit is in effect for a run, and there are no lithologic data (L-records) associated with a sample set, the entire set is rejected.

Test file "STARDATL" (Section 4.1) may be used to test the effects of the "L" instruction.

7.6.5 The "W" Instruction

The "W" instruction is used to edit samples by their position relative to the depth to oxidized/non-oxidized contact (Section 5.2.5). The secondary OPcode is either "1" or "2". If "1", only samples below the contact will be selected. If "2" only samples above the contact will be selected. A "WN" operator negates any previous "W" instruction within a block control module.

If sample sets have no entry for "depth-to-oxidized/non-oxidized contact", then the depth will be assumed to 0, indicating that all samples are assumed to lie below the contact. An operator code of "W2" will eliminate all such samples. Therefore this instruction must be used with care. There is no operative required with the "W" instruction. Example 2, Figure 7.4B, shows the entry of the "W" instruction with an OPcode2 of "2".

7.6.6 The "Q" Instruction

The "Q" instruction is used for correcting radiometric assays for disequilibrium. The OPcode2 is "1", "2", or "N". Operatives are numeric values which may contain up to 6 significant digits, including a decimal point. These values are the coefficients used in the "correction" equation (Section 3.4) designated by the OPcode2. Two functions are used:

1. If OPcode2 is 1, the equation is a polynomial of the form:

$$y = A + BX + CX **2 + DX **3 + EX **4$$

where,

X is the radiometric grade, and
Y is the corrected grade,

and the operatives are the coefficients A, B, C, D, and E.

The degree of the equation is implicitly denoted by the number of coefficients (operatives) following the instruction code. If 2 coefficients are entered, the degree of the polynomial is 1, etc. The operatives are entered in the sequence -- A, B, etc. Any zero

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coefficient of lesser rank than the last non-zero coefficient entered must be entered.

Example: if the equation is

$$Y = 1.3X + 0.04X^{**3},$$

then the operatives must be "0", "1.3", "0", and ".04" (See Example 1, Figure 7.4E)

2. If OPcode2 = "2", the equation is a logarithmic function of the form:

$$\text{LOGeY} = A + B \times \text{LOGeX}$$

Only 2 operatives, i.e. the "A" and "B" coefficients, are required. If "A" is zero, it must be entered as "0". Example 2, Figure 7.4E, shows the coefficients entered for the equation:

$$\text{LOGeY} = 0.188 + 0.994 \times \text{LOGeX}$$

The form and coefficients of the equations must be previously determined by statistical analysis of the applicable sample assay data (Section 3.4)

Two "Q" instructions are permitted in one FCM (example 3, Figure 7.4E). If only one "Q" instruction (and associated operatives) is entered in a given FCM, it will apply to all samples of a sample set. If two "Q" instructions are entered, the first will be applied to all sample assays assumed to be in a "non-oxidized" environment, and the second to all those in an "oxidized" environment. The value for "depth to oxidized/non-oxidized" contact in sample set header records will determine the position of the individual samples with respect to that contact.

Remember that if the entry for depth-to-ox./non-ox.-contact is entered as 0 (or left blank) in a header record, it is assumed that all samples represented by that record lie in the unoxidized environment.

If corrections are to be made only to samples in the oxidized zone, then a "dummy" "Q" instruction must be entered, first, for the non-oxidized zone. Example: "Q1 0,1", where "Y = 0 + X" is assumed. This "correction" will be made to samples in the unoxidized zone, but, of course, no change in value will result.

The carry-over and negation rules (Section 7.6.2) apply.

Note: If two "Q" instructions are entered in an FCM, a "QN" instruction OPcode in a following FCM in the same BCM will negate both previous instructions; a single "Q" instruction in a following FCM also negates both previous instructions and establishes a new correction equation which will be applied to all samples.

7.6.6 The "D" Instruction

Note: this instruction is not operative in this first version of the Guide

A "D" instruction causes all the sample sets processed by one block control module to be checked for duplicate hole number. This option results in longer running time and need only be utilized if there is concern that duplicate hole numbers exist. It would normally be utilized in running URDAT, after which, if duplicate numbers did, in fact, exist, they would be corrected in the primary (basic) data files before any secondary files were created.

7.6.7 The "H" Instruction

The H-edit, used alone or in conjunction with the A-edit and/or the C-edit (below), is used for deleting entire sample sets during the processing of a file. Use of the H-edit saves considerable time and effort which might otherwise be expended in the original selection and manipulation of the sample data to be included both in primary (basic) and secondary UDAT files.

The "H" instruction provides edit by the sample set identification codes (called "hole numbers", Section 5.1.1) which appear in columns 7 through 12 of every sample set record in the UDAT files. The "H" operator must be entered in column 1 of a UCON record. The secondary Opcodes are "+", "-", blank or "N". The operatives consist of a list of up to thirteen 6-character hole numbers.

Following an "H+" or "H-" Opcode, is a list of hole numbers. Each hole number must be exactly 6 characters in length, including blanks, so that they will correspond exactly to the 6-character hole numbers entered in the sample set drill hole records. In order to be functional, the characters (including blanks) must be exactly equal to the corresponding hole number, in the sample set record, to which the edit is directed. Otherwise, no match can be made during a run and the entry is useless.

The hole numbers must be entered contiguously; they cannot be separated by blanks or commas nor can they be encased in quotes.

An Opcode2 of "+" will cause only those sample sets having a hole number which matches one of the numbers listed in the "H" instruction record to be included when processing the file named in the FCM identification record; all others will be rejected. An Opcode2 of "-" acts in reverse, i.e. a sample set having a hole number matching one on the "H" record list will be rejected; all others will be included.

The first character of the first hole number of the list is entered in column 3 and the last character in column 8; the first character of the 2nd hole number must be in column 9 and the last in column 14; and so forth. Thirteen hole numbers may be entered in an "H" (instruction) record. If there are more than 13 numbers to be entered then additional "H" records are used.

If there more than one "H" record is required within one file control module, each additional record must still contain the "H" instruction Opcode(s)

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in columns 1 and 2. The secondary OPcode of the first "H" record must be "+" or "-". Any following "H" record may have a blank as OPcode2 or the OPcode2 may be the same as that in the first "H" record. But they cannot be mixed "-" and "+" since only one of the options (not both) can be in effect while processing a given file.

Blank entries for hole numbers at the end of the last "H" (instruction) record of the FCM will be ignored but other, "embedded", blank hole numbers (all 6-character blank) will be included. Since blank hole numbers are not recommended as sample set identifiers, it is not likely that blank hole numbers in the "H" lists would have any effect on the edits. Nevertheless, before adding additional "H" records, it is practical to fill each "H" record with 13 hole numbers, unless there are not enough hole numbers to fill the last "H" record in the FCM. The maximum number of hole numbers is 299, or 23 records of 13 hole number operatives per record.

Figure 7.5A shows an example of an "H" instruction which specifies the inclusion of the first 27 holes from UDAT file 'STARDAT'. In Figure 7.5B, the H-edit excludes the same holes.

The rules of carry-over and negation (Section 7.6.2) apply; an OPcode2 of "N" will negate an entire H-edit established in a previous FCM within the same BCM.

No other instructions may be entered in an "H" instruction record.

7.6.8 The "A" Instruction

The "A" instruction operates exactly as does the "H" instruction, except that it is used to edit sample sets based on the area number (Section 5.1.2) instead of the hole number. Following a "A+" or "A-" instruction OPcode is a list of sample set area numbers. Each area number must be exactly 3 characters in length, including blanks, so that it will correspond exactly to the area number entered in column 4-6 of the sample set records in the UDAT files.

The first character of the first area number of the "A" instruction list must be entered in column 3 and the last in column 5; the first character of the second area number must be in column 6 and the last character in column 8; and so forth. The maximum number of area numbers is 26 and only one record is allowed. Example 1, Figure 7.5C shows an "A" instruction that specifies the inclusion of all sample sets from UDAT file 'STARDAT' which have the area numbers 'AAA' or 'CCC'. The "A" instruction in Example 2 would exclude all sample sets having area numbers 'AAA' or 'BBB'.

The rules of carry-over and negation (Section 7.6.2) apply; an OPcode2 of "N" will negate an entire previous A-edit.

No other instructions may be entered in a "A" instruction record.

7.6.9 The "C" Instruction

The C-edit is the most powerful of the sample set inclusion/exclusion edits. It provides the identification of sample sets on the basis of their coordi-

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nate relationship to a specified polygon. The polygon may have up to 20 vertices and may be of any degree of irregularity providing that it is "closed" and no sides intersect any other sides. The vertices of the polygon must be referenced by the same coordinate system as the sample set data to which the C-edit will be applied.

The operatives following a "C+" or "C-" operator comprise a list of coordinate pairs, each pair representing one vertex of the polygon enclosing the area from which sample sets are to be included ("C+") or excluded ("C-") if they lie within the specified polygon. Any sample set lying exactly on the perimeter of the polygon is considered to be "outside" the polygon. A single coordinate value is considered as one operative.

The pairs (north coordinate first and east coordinate second) must be entered in clockwise sequence of vertices; any vertex may be chosen as the starting point. No vertex should be repeated, i.e. the number of pairs entered must exactly match the number of vertices (the starting point (vertex) must not be entered twice). The value of the coordinate may not exceed 7 digits (MV = 9999999); coordinates must be entered to the nearest foot, and no decimals are allowed. A maximum of 4 coordinate pairs are entered per "C" instruction record and each record must contain 4 coordinate pairs except the last record - if it cannot be filled.

The format is flexible except that columns 1 and 2 are reserved for the instruction OPcodes. Each value (operative) must be immediately followed by a comma, but leading blanks are ignored. The coordinate values, of course, may not contain any imbedded blanks. Since the polygon is limited to 20 vertices -- 20 coordinate pairs -- the maximum number of instruction records is 5. Zero values may be entered for coordinates, but the last pair entered must not be (0,0); if so, it will be ignored. Coordinates must all be positive (no negative values.).

Figure 7.5D is an example of C-edit instructions which would cause inclusion of all holes in the 'STARDAT' data file which lie within the polygon outlined on the drill hole location map on Figure 7.6.

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The vertices of the polygon are numbered and circled on the map and their coordinates (in feet) are listed as follows:

Vertex Number	North Coordinate	East Coordinate
1	700	1500
2	1100	1500
3	1100	1700
4	1300	1700
5	1300	1100
6	1700	1100
7	1700	1800
8	2400	1150
9	3100	1700
10	3100	3050
11	2600	2650
12	2200	3050
13	1700	2600
14	1700	2100
15	1300	2100
16	1300	1900
17	700	1900

If the instruction in the first C-edit record was "C-" instead of "C+", only the holes outside the polygon would be included.

The rules of carry-over/negation (Section 7.6.2) apply; an OPcode2 of "N" will negate an entire C-edit in a previous FCM within the same BCM. No other instructions may be entered in a "C" instruction record.

7.6.10 Hierarchy of Edit Operations

The order in which the edits specified in a file control module take place during program execution is listed below.

1. C-edit.
2. A-edit.
3. H-edit.
4. Q-corr.
5. L-edit or E-edit.
6. W-edit.

This order is especially important to keep in mind when planning sample set selection ("C", "A", and "H" edits). If the C-edit is in effect, A- or H-edits will only be performed on the sample sets which meet the C-edit requirement (inside or outside the polygon). If the A-edit is in effect, only sample sets which meet A-edit specifications will be subject to any H-edit requirements. Example: if a sample set is designated for inclusion by an H-edit specification, but has an area number which is designated for exclusion by a A-edit specification, the sample set will be excluded.

7.7 THE "*" TERMINATOR RECORDS

The "*" instruction is entered in terminator records used to signal the end of integral modules of a UCON file. The "*" must always be in column 1 of the record. The secondary Opcodes are:

- Blank for the end of a file control module (FCM).
- "B" for the end of a block control module (BCM).
- "*" for the end of a RUN (which is also the end of the UCON file).

The FCM terminator record for the last FCM in a block control module must always be omitted (Figure 7.2), and the BCM terminator for the last BCM in a RUN must always be omitted (Figure 7.2).

The "*" is the only instruction recognized on a terminator record.

7.8 SUMMARY EXAMPLE

Figure 7.7 shows a test UCON file, called "UCON2", designed to show various combinations of the UCON instructions described above. These instructions are used strictly for illustrative purposes and it is not suggested that they have any practical application.

"UCON1" is established for a URDAT RUN. It consists of one block control module (BCM) which contains three file control modules (FCMs); the requested files are primary UDAT test files.

The first FCM requests file STARDAT and calls for the E-edit, the Q-edit, the C-edit, the A-edit and the H-edit; the second FCM requests file STARDATL (a small file in which hypothetical lithologic data have been added to selected STARDAT sample sets); and the third FCM requests data from file GAMDAT.

The first FCM excludes all holes outside the polygon used as the example in Section 7.6.10, as well as those holes within the polygon which are included in file STARDATL. It corrects the radiometric assays, from included holes, for disequilibrium, and then limits accepted samples from each sample set to an elevation range of 1770' down to 1750'.

The second FCM includes all holes in file STARDATL which lie within the polygon except for 2 holes by cancelling the A-edit and restating the H-edit. It does not correct for disequilibrium (the Q-edit in the first FCM is cancelled) and cancels the previous E-edit with an L-edit which selects samples, from each included sample set, which occur in lithologic units 'JMUI' and 'JMC'.

The third FCM cancels all previous edits and processes all the holes in file GAMDAT. It also contains two Q-edits which act to correct all assays above the oxidized/non-oxidized contact for disequilibrium, but leave assays below the contact uncorrected.

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```
Column 1      ("IC" = "edit instruction code")
/ Column 2
//
B# - - - block control (module) identifier record
F# - - - - file control (module) identifier record
IC - - - - - }
IC - - - - - } edit-instruction records
** - - - RUN terminator record (also terminates block control
and file control modules)
```

FIGURE 7.1
GENERAL STRUCTURE OF A UCON FILE FOR ONE BLOCK

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```

Column 1      ("IC" = "edit instruction code")
/ Column 2
( /
B# - - - 1st block control (module) identifier record
F# - - - - 1st file control (module) identifier record (of block 1)
IC - - - - - - - - - - }
                        } edit-instruction records
IC - - - - - - - - - - }
* - - - - 1st file control (module) terminator record
F# - - - - 2nd file control ID record (of block 1)
IC - - - - - - - - - - } edit-instruction record
* - - - - 2nd file control terminator record
F# - - - - 3rd file control ID record (of block 1)
IC - - - - - - - - - - } edit-instruction record
$B - - - 1st block control (module) terminator record,
        (also terminates 3rd file control module)
B# - - - 2nd block control ID record
F# - - - - 1st file control ID record (of block 2)
$B - - - 2nd block control terminator record,
        (also terminates file control module)
B# - - - 3rd block control ID record
F# - - - - 1st file control ID record (of block 3)
IC - - - - - - - - - - } edit-instruction record
*          1st file control terminator record
F# - - - - 2nd file control ID record (of block 3)
IC - - - - - - - - - - }
                        } edit-instruction records
IC - - - - - - - - - - }
** - - - RUN terminator record (also terminates last block
        control and file control modules)

```

FIGURE 7.2
GENERAL STRUCTURE OF A UCON FILE FOR MULTIPLE BLOCKS

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Primary OPcode	Primary & Secondary OPcodes†	Number and Type of Operatives‡		Usage
B	B#	1=0 or 1 ('A' =3)	Q=yes C=yes	BCM (block) identifier (must begin in column 1 of record)
>	>#	1=1 (N ≤ 10)	D=no C=yes	block area (follows "B" instruction)
'	'#	1=1 ('A' ≤ 74)	Q=yes C=no	block name (follows ">" instruction)
F	F#	1=1 ('A' ≤ 15)	Q=yes C=yes	file control (column 1)
L	La = #, or N	1=2 ('A' = 4)	Q=yes C=yes	lithologic edit
E	En = 1,2,3,4, N	1=0 or 2 (N ≤ 7)	D=yes(1)‡‡ C=yes	elevation (or open pit) edit
W	Wn = 1,2,N	1=0		oxidized / non-oxidized contact edit
Q	Qn = 1,2, or N	1=1-5 (N ≤ 6)	D=yes(5) C=yes	disequilibrium correction(s)
C	Ca = +,-,b,N	1 ≤ 8/rec (N ≤ 7) max. rec. = 5	D=no C=yes	sample set coordinate edit (must begin in column 1)
A	Aa = +,-,b,N	1 ≤ 26/rec (A = 3) max. rec. = 1	Q=no C=no	sample set area number edit (must begin in column 1)
H	Ha = +,-,b,N	1 ≤ 13/rec (A = 6) max. rec. = 5	Q=no C=no	sample set hole number edit (must begin in column 1)
‡	‡a = b,B,‡ ‡ ‡B ‡‡			terminator (column 1), where: is file terminator is block terminator is RUN terminator

† For secondary OPcodes: "n" is numeric and allowable numbers are shown.
"a" is character and allowable forms are shown; "b" = blank.
"‡" is non-functional (padding).

‡‡ For operatives: "1" is the number of operatives;
"A" or "N" is number of characters or numeric digits (including decimal, if applicable);
" ≤ " indicates maximum limit, "=" indicates exact number of characters.
"D=yes or no" indicates whether numeric operative can be a decimal fraction.
(number in parens is number of places to right of decimal)
"Q=yes or no" indicates whether alphanumeric operative must be encased in quotes.
"C=yes or no" indicates whether commas must separate operatives from themselves
and from succeeding instructions on the same record.
"max. rec" indicates maximum number of records allowed for multi-record instructions.

‡‡‡ See documentation text.

FIGURE 7.3
SUMMARY OF UCON INSTRUCTIONS

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Record Format	
column numbers	11111111112222222222333333333344444444445555555555666666666677777777778
Example 1	B# 'S2', # 7000, !# ' EXAMPLE 1, BLOCK IDENTIFIER RECORD.'
2	B# 'A2', # 777777
3	B# ' 70007, '# ' EXAMPLE 3, BLOCK IDENTIFIER RECORD.'
4	B# '# ' EXAMPLE 4, BLOCK IDENTIFIER RECORD.'
5	B# 'A4'

FIGURE 7.4A. Examples Of UCON Block (BCM) Identifier Records.

Record Format	
column numbers	11111111112222222222333333333344444444445555555555666666666677777777778
Example 1	F# 'STARDAT'
2	F# 'A:STARDAT.B'
3	F# 'SAMDAT',E1 5000,5000, Q1 .01,1.4, W2

FIGURE 7.4B. Examples Of UCON File (FCM) Identifier Records.

Record Format	
column numbers	11111111112222222222333333333344444444445555555555666666666677777777778
Example 1	E2 0, 200
2	EN

FIGURE 7.4C. Examples Of The UCON "E" Instruction.

Record Format	
column numbers	11111111112222222222333333333344444444445555555555666666666677777777778
Example 1	L# 'JMU1', 'JML2'
2	L# 'JML2', 'JML1'
3	L# 'JMC', 'JMC'
4	L# 'JSMV', 'JTDL'
5	L# 'KMC', 'KBC'
6	L# 'JMC', 'JML2'

FIGURE 7.4D. Examples Of The UCON "L" Instruction.

Record Format	
column numbers	11111111112222222222333333333344444444445555555555666666666677777777778
Example 1	Q1 0, 1.3, 0, .04
2	Q2 .188, .994
3	Q2 .188, .994, Q1 -.01, 1.5, -.06

FIGURE 7.4E. Examples Of The UCON "Q" Instruction.

FIGURE 7.4A-E
 EXAMPLES OF "B", "F", "E", "L", AND "Q" UCON INSTRUCTIONS

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Record Format	
column numbers	11111111122222222223333333334444444445555555556666666667777777778
Record 1	H+ 142 143 144 145 146 147 148 149 150 151 152 153 154
2	H 155 156 157 158 160 161 162 163 164 165 166 167 168
3	H 169

FIGURE 7.5A. Example Of The UCON "H+" Instruction.

Record Format	
column numbers	11111111122222222223333333334444444445555555556666666667777777778
Record 1	H- 142 143 144 145 146 147 148 149 150 151 152 153 154
2	H 155 156 157 158 160 161 162 163 164 165 166 167 168
3	H 169

FIGURE 7.5B. Example Of The UCON "H-" Instruction.

Record Format	
column numbers	11111111122222222223333333334444444445555555556666666667777777778
Example 1	A+AAA BBB
2	A-AA C C C

FIGURE 7.5C. Examples Of The UCON "A" Instruction.

Record Format	
column numbers	11111111122222222223333333334444444445555555556666666667777777778
Record 1	C+ 700,1500,1100,1500,1100,1700,1300,1700,
2	C 1300,1100,1700,1100,1700,1800,2400,1150,
3	C 3100,1700,3100,3050,2600,2650,2200,3050,
4	C 1700,2600,1700,2100,1300,2100,1300,1900
5	C 700,1900,

FIGURE 7.5D. Example Of The UCON "C" Instruction.

FIGURE 7.5A-D
EXAMPLES OF THE UCON "H", "A", AND "C" INSTRUCTIONS

THE UCON SYSTEM

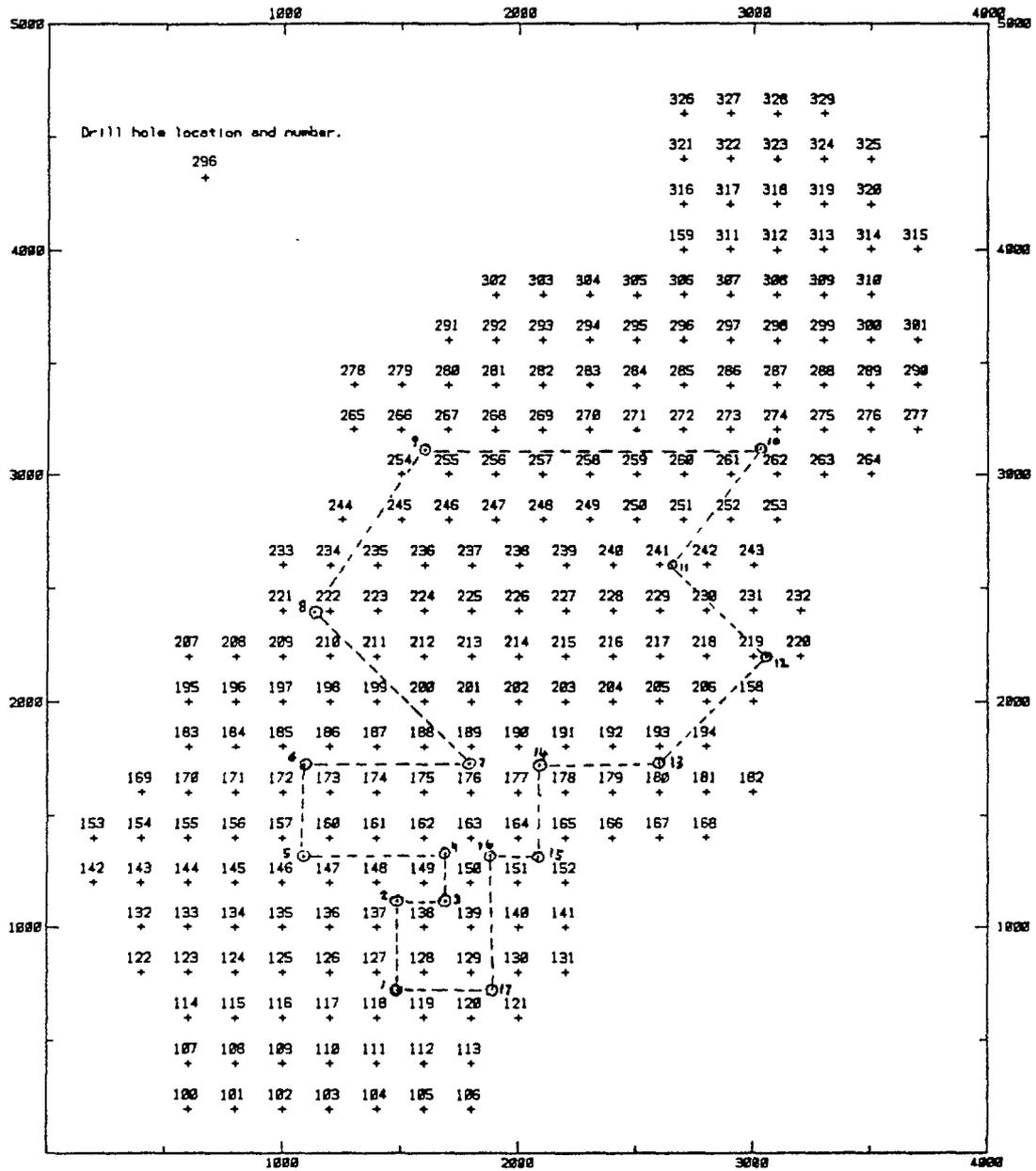


FIGURE 7.6
STARDAT DRILL HOLE LOCATION MAP WITH EXAMPLE POLYGON FOR "C-EDIT"

THE UCON SYSTEM

Record Format

column	11111111112222222222333333333344444444445555555555666666666677777777778
numbers	12345678901234567890123456789012345678901234567890123456789012345678901234567890
Record	<pre> 1 B# 'VARIOUS COMBINED UCON INSTRUCTIONS; 3 FCMs.' 2 F# 'STARDAT',E1 1770,1750, B1 .01,1.4 3 A-BBB 4 H- 201 202 203 204 213 214 215 216 5 C+ 700,1500,1100,1500,1100,1700,1300,1700, 6 C 1300,1100,1700,1100,1700,1800,2400,1150, 7 C 3100,1700,3100,3050,2600,2650,2200,3050, 8 C 1700,2600,1700,2100,1300,2100,1300,1900, 9 C 700,1900, 10 # 11 F# 'STARDATL', QN L# 'JMU1','JMC ' 12 AN 13 H- 215 216 14 # 15 F# 'SANDAT',Q1 0.0,1.0, Q1 -0.02,1.4,-.005, LN 16 HN 17 CN 18 ## </pre>

FIGURE 7.7
 EXAMPLE OF UCON FILE REQUESTING MULTIPLE FILES AND VARIOUS OUTPUTS

8.0 PROGRAM URDAT

8.1 GENERAL CONCEPTS AND OPERATIONS

URDAT is a "front-end" program designed to select and edit any combination of data from the UDAT primary sample-assay files and:

1. Create listings (Section 8.3.1) and summaries (Section 8.3.2) of the selected data for review and evaluation purposes.
2. Interpret gamma-log data (Section 8.4).
3. Create standardized intermediate UDAT files which may be accessed by any of the ore reserves programs (Section 8.5).

8.1.1 Requirements

To run program URDAT, it is only necessary that a UCON file (Section 7.0) be available and that the data files requested in that UCON file exist as primary UDAT files. If any of the latter contain data in the borehole log "A-E" format, then file "RNGTBL" must also be available and it must contain the set(s) of range-scale values corresponding to the particular "A-E" code(s) in the data (see Sections 5.2.1.1 and 5.2.1.2).

File "RNGTBL" must be in the same working directory as the URDAT program execute module ("URDAT.EXE"). If the UCON file is on the default drive, it must also be in the same directory as "URDAT.EXE".

All other control information needed for URDAT is submitted interactively during the URDAT RUN (Section 8.6).

The data listings and summaries are output to a "print-output" file (Section 8.2).

8.1.2 Importance of Reviewing Data

Once a certain familiarity has been gained with a particular computer-based ore reserve data and calculation system, there is a tendency for many users to review the data at increasingly lower frequencies! They come to trust the data implicitly, simply because it seems so well organized, and also find it tedious to review sometimes seemingly overwhelming quantities of listings. If large amounts of data are involved in an ore reserves calculation, the attitude may prevail that a few errors will not influence the results.

Such a point-of-view can cause problems, especially when the ore reserve analyst becomes more and more separated from the beginning of the data preparation stream by borehole-log-analysis specialists, automatic-digitizing systems, data-entry operators, computer experts, and others. It is easy for difficult-to-detect errors to occur in data files. Just one or

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two small errors in basic borehole-log interpretation factors, for example, wreck havoc on a final reserves estimate.

Therefore, it is recommended that listings be made (and carefully reviewed) of all new or edited UDAT primary data files before creating intermediate files for use as input to the ore reserves programs.

URDAT is designed to make data review as easy as possible. Listings may be condensed to use relatively little space; sample assay values are flagged; and data summaries are available. A quick scan of the latter is warranted every time an intermediate data file is created.

There are other measures not in the scope of the URAD system at this time which can be taken to minimize data errors. These include quality control of digitizing operations and utility computer programs which flag various parameters if they lie outside given value ranges.

8.2 THE PRINT-OUTPUT FILE

8.2.1 General URAD Usage of the Print-Output File

The "print-output" ("p-o") file, in all the URAD programs, is designated as the file on which formatted output from a program RUN will be placed. Print-output includes detailed and summary results which are used for purposes of analysis. It also includes error or end-of-RUN messages, but not scratch or intermediate data files intended as input to other programs.

The p-o file may be a hard or floppy disk file or the printer itself. To avoid the creation of a large number of p-o files over an extended period, all URAD programs provide for use of a default p-o file named "OUTPUT"; however, any other file name may be designated as the p-o file for any given RUN. All the URAD programs also provide the option of sending output directly to the printer during program execution by assigning 'LPT1' as the p-o file.

A p-o file is always created when a URAD program is run, regardless of the type of RUN specified. Even if an output listing is not requested, the default file "OUTPUT" (or any other file selected) will be newly created and any previous information on the given file will be destroyed.

When the p-o is placed on a disk file, all the FORTRAN-generated printer-driver controls are preserved; if it is later desired to print such output, program FORPRINT (Section 8.2.3) may be used, and all the original output specifications (pagination, line spacing, etc.) will still be in effect. Execution of the programs is much slower if printing is done "on-line", so this feature provides the capability of making repeated "test" RUNS for a given problem, sending the p-o to a disk file, scanning the results each time, and then actually printing the output when satisfied with the results (or at a more convenient time, or even on a different computer system).

8.2.1.1 Naming and Location of P-O files

There is a maximum of 15 characters permitted for URAD file names. Directory or subdirectory names are not recommended in naming p-o files; any

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p-o file created on the default drive will be in the same directory as the URDAT program execute module. P-o files created on a floppy disk should be in the latter's root directory.

If the p-o file is not on the default drive, make sure the device name d: is included as part of the file name; examples, "A:FILENAME" or "B:URDP01.SAV".

It is prudent to check the intended p-o file before making any RUN to insure that it does not contain information which should be saved. If it does, then rename the file or copy it to another file using standard DOS commands -- before making the RUN.

8.2.2 URAD Printing Protocol

URAD printer controls are compatible with the EPSON FX Series, or with any printers which may set to emulate the EPSON ("Standard Printing Mode"). Print-output listings may be generated for various combinations of paper page size, line spacing, and/or character size.

8.2.2.1 Vertical Print Control

"Standard" printing paper page length (vertical) is considered by URAD to be 11" (inches). However, any other length may be specified, to the nearest 10th of an inch.

"Standard" line spacing is 6 lines per inch (lpi), or 66 lines per page (lpp) with 11"-inch paper page length. Optionally, 6, 7, 8, or 9 lpi line spacing may be requested for any print output.

8.2.2.2 Horizontal Print Control

"Standard" paper page width (horizontal, excluding the perforated strips) is considered to be 8.5"; however any width (5" minimum) may be optionally specified, to the nearest 10th of an inch.

The "character width" here defines both the character size and horizontal spacing. Three character widths are available: "Standard Pica" -- 10 characters per inch (cpi); "Standard Elite" -- 12 cpi; and "Condensed Pica" -- 17.2 cpi.

8.2.2.3 Test for Character Width Versus Page Width

The lines in the various sections of URAD print-output are formatted to either 80 (maximum) or 132 (maximum) columns. If the combination of page and character width, established interactively, does not allow printing of the lines, at the maximum format width used by a program, without overlap (to the next line), a width adjustment is automatically attempted and a message is displayed.

For example, the URDAT program provides a special option for an 80- or 132-character per line format; if the paper width is 8.5" and the 132 cpl format is chosen, the character width is automatically changed to 17.1 cpi.

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In those sections of the other URAD programs which are partly in the 132-column format mode, the character width is automatically condensed, if necessary, and then restored to the initial conditions for the 80-column sections.

8.2.2.4 *Pagination*

The term "pagination", as used here, refers to the numbering of output pages, entering headings at the top of each new page, and the structuring of output to fit within each page; it is provided as an option in some of the programs. If pagination is not used then the output lines are simply printed consecutively without regard to pages and the full number of available lines per page are used, except for a small margin at the top and bottom of each page.

Under the "testing" option (example: Section 8.6.2.1) printing is all done at 8 lpi, 17.2 cpi (condensed), with no pagination, and no top or bottom margins.

When the pagination option is in effect, the maximum number of lines per page are determined as follows:

$$mlpp = (lpi * pl) - lpi \quad \text{where,}$$

mlpp = maximum number of lines per page (to nearest integer);

lpi = lines per inch (entered interactively);

pl = page length in inches (entered interactively).

For example, with a paper length of 11 inches, there is a maximum of 60 lines per page printed at 6 lpi and 80 lines at 10 lpi. This provides a minimum total top/bottom margin of approximately one inch. The margin placement can be controlled when setting the position of the top of the first page with respect to the typewriter ribbon before a RUN is made.

An interactive option is provided to over-ride the default number of lines per page, if desired; only a reduction of lpp is allowed.

8.2.2.5 *Limiting Output Lines*

URAD programs provide the option of placing an approximate limit to the total number of p-o lines in a RUN. This is useful for testing data, for examining p-o layouts, or for avoiding output of an accidental or unwanted extremely large number of p-o lines due to unchecked errors in data or controls. If the number of output lines exceeds the limit, the RUN is simply terminated; all data processed to that point will be available on the p-o file, but summaries will not be available. If an intermediate data file is being created when such a break occurs, the file will contain all sample set data created up to the point of termination.

8.2.2.6 *Limiting Sample Sets Processed*

The programs also provide the option of placing a limit to the number of sample sets to be processed. Conditions are the same as for limiting output lines (above).

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8.2.3 Program FORPRINT

Program FORPRINT is used to print any print-output (p-o) file generated by a URAD program. When URAD listings are directed to a p-o file other than 'LPT1', the first output record is a print-control identification record which contains the following:

1. Name of the URAD program which generated the output; record columns (rc) 2-6; ie. "URDAT", "ORSAC", "RESUV", or "SCOR_".
2. Pagination code; rc 9; 0 if output not paginated, 1 if paginated.
3. Format mode code; rc 10; 1 if maximum number of characters per line is 80, 2 if 132.
4. Character width code; 1 if 10 cpi, 2 if 12 cpi, or 3 if 17.1 cpi.
5. Paper length (vertical); rc 11-15; length to nearest 10th of inch.

If the p-o header record has been "disturbed", FORPRINT will display an appropriate message.

Note: All the printer-driver commands are included in the output so that the file may be later printed exactly as specified during the original RUN. If any of these commands are disturbed, the listing may be garbled!

FORPRINT simply requests the name of the p-o file to be printed and provides the opportunity to check on paper size requirements before continuing.

8.2.3.1 Program RESTPRN

If any listing of a URAD program is aborted before normal termination, program RESTPRN should be run to restore the printer.

8.3 URDAT PRINT-OUTPUT

8.3.1 Detailed Data Listings

The detailed data listings identify all the parameters for each selected sample set in a form designed for easy review. If corrections for radiometric disequilibrium have been made, the applicable coefficients are shown. If sample editing has been carried out, the selected intervals are noted, but the entire sample set is still listed. Lithologic are listed.

The position, thickness, and grade of each sample interval are shown. Reference positions are the bottom the sample intervals, denoted by depth (from collar) or by elevation, depending on the option chosen.

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Uranium grades are listed to the nearest thousandth of a percent, with certain ranges of values marked as follows for quick identification:

"*"	0.100 to 0.199	%U308
"**"	0.200 to 0.499	"
"\$"	0.500 to 0.999	"
"\$\$"	1.000 and over	"

8.3.1.1 Format Mode

URDAT provides the option of printing the detailed data listing in an 80- or 132-column-per-line format. The latter allows more data to be printed on each line and is useful for saving paper space. This mode may be used at 10 cpi or 12 cpi if the paper width is sufficient.

8.3.1.2 Examples of Listings

The following examples illustrate the various formats:

Figure 8.1 is a listing of a "uranium-only" sample set in the 80-column mode, with both editing and disequilibrium corrections applied.

Figure 8.2 shows the same set in the 132-column, condensed mode.

Figure 8.3 lists a bimetal sample set in the 80-column mode.

Note that the 132-column, condensed mode, used with 8.5-inch paper will save considerable space. The 132-column mode may also be used with a character width of 10 cpi if 14 3/4-inch printing width is available.

8.3.1.3 Page Headers

The heading for each listing contains the name of the primary UDAT file from which the data were obtained, the date of the RUN, the name of the user/operator, the "block name" entered in the UCON file, the names of the UCON and print-output files, and the name of the intermediate data file, if such has been created. If no pagination is requested, the heading will only appear each time a new primary UDAT file is accessed. If pagination is in effect, a heading will appear at the beginning of each new page.

8.3.2 Data Summaries

At the end of each URDAT run, a summary review of all sample sets processed is always listed. The summary consists of two parts as described below. For each part, the number of sample sets processed in each of the defined categories is provided, and there is also an option to list the actual sample numbers of all sets in each category. The latter option is termed a "detailed" summary. Data summaries use the 80-column format.

8.3.2.1 *Sample Set Status Summary*

The status of sample sets is summarized by the following categories:

Sets Included as Valid for RUN.

1. Samples are available in given set.
2. Samples are available, but some deleted due to edit.
3. Samples are available, but none in interval selected by edit; the interval is assumed to be barren
4. No samples are available; the entire set is assumed barren for the total interval sampled.

Sets not included as valid for RUN.

5. Set deleted by coordinate edit.
6. Set deleted by hole or area number edit.
7. Set deleted from run due to non-applicability or invalid data.

An example of the detailed sample set status summary is shown in Figure 8.4.

8.3.2.2 *"Peak-Grade" Summary*

From those sample sets considered to be valid for the given RUN, the assays in each set are then tested to determine the highest of the following categories into which they fall:

Grade Range (%U308)	or	GT (%U308 x Thickness)
4 feet @ 0.001 to 0.049		0.001 to 0.199
" 0.050 to 0.069		0.200 to 0.299
" 0.070 to 0.099		0.300 to 0.399
" 0.100 to 0.199		0.400 to 0.499
" 0.120 to 0.149		0.500 to 0.599
" 0.150 to 0.199		0.600 to 0.799
" 0.200 to 0.249		0.800 to 0.999
" 0.250 to 0.299		1.000 to 1.199
" 0.300 to 0.399		1.200 to 1.599
" 0.400 to 0.499		1.600 to 1.999
" 0.500 & over		2.000 & over

Testing is done starting with the highest category. The samples need not be contiguous. The only criterion is that any of the samples used in meeting either the four-foot or GT criteria have a grade value at least as great as the grade cutoff for the given category; this cutoff is represented by the left-most grade for each category in the above list.

This summary is not intended for ore reserves analysis purposes but simply to provide a quick review of the approximate "peak" level of uranium values

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in the sets of data processed in a given URDAT RUN. Figure 8.5 gives an example of the "peak-grade" summary.

8.3.2.3 Example of Uranium "Intensity" Plot

If appropriate plotting equipment and software are available, the results of the peak-grade summaries may be used to create plots which provide a preliminary overview of the "insensity" of uranium mineralization represented by a set of basic data. Figure 8.6 shows the drill hole location plot of the file "STARDAT" data, with each hole location symbol reflecting the peak-grade of the given sample set. (The grade categories have been combined into wider ranges.)

8.4 GAMMA-LOG INTERPRETATIONS

During a URDAT RUN, all sample data in the "borehole log" format (Section 6.3) are converted to estimated uranium values using the GAMLOG iterative interpretation technique. Data in the "xxQ" format are exempted, since they represent already interpreted values.

8.4.1 Calculation of Sample Interval Depths

The protocol for measuring the depths of readings of representative radioactivity during the "production" logging of boreholes is usually to initiate such readings at positions which represent even divisions of the given measurement system. One-foot readings are theoretically positioned at even increments of one foot in depth (from the collar), for example, depths of, say, 10, 11, - - 20 feet, rather than 10.35, 11.35, - - 12.35 feet. Similarly, one-half foot readings are positioned at even foot and half-foot increments of depth. This method is also used for convenience when digitizing from borehole "strip" log charts.

In most techniques for interpreting gamma-log data, it is assumed that any given measurement (or "reading") of radioactivity taken in a borehole is actually at the midpoint of the interval which it represents. Therefore, if readings have been taken at one-half-foot intervals, and a reading at a depth of, say, 100 feet is ultimately converted to an estimated uranium value by some interpretive method, the interval represented by that estimated uranium value is actually between 99.5 and 100.5 feet in depth.

For a sample set in the "borehole" format, the "depth-to-first-reading" ("d-t-f-r") is considered by URDAT to be the depth to the position of the interval represented by the first reading, but the depth to the top of the first sample interval generated at that point is recognized to be the d-t-f-r minus one-half of the applicable readout interval.

Therefore, if the readout interval is 1 foot, the top depth of the first sample interval is calculated to be one-half foot less than the d-t-f-r. If the d-t-f-r is entered as zero, then the subtraction does not take place, and the depth to top of the first sample interval is calculated also as zero.

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If the readout interval is one-half foot, however, no subtraction is ever made, the top depth of the first sample interval is the same as the d-t-f-r, and all sample intervals are assigned depths which are 3 inches lower than they theoretically should be. This is done to avoid having to record depths to the nearest hundredth of a foot, and, in practice, it does not appear that the depths can really be measured to that degree of accuracy under most logging conditions, except for relatively "shallow" holes.

The thickness of any "skipped" intervals (Section x.x) is reduced by a quantity equal to the readout interval, again, since each cps or inch-deflection "reading" is assumed to represent the "mid-point" of its representative thickness, i.e. the value of the readout interval. For example, if (proceeding downward) the last reading preceding a skipped interval of 10 feet is at 900 feet in depth, and the first interval following the "skip" is at 910 feet, then (assuming the readout interval at 0.5 feet) the actual "skip" must be represented by only 9.5 feet since the bottom of the interval represented by the upper reading is actually assumed at 900.25 feet in depth, and that of the lower reading at 909.75 feet.

8.5 INTERMEDIATE UDAT FILES

8.5.1 Usage of the Intermediate UDAT Files

One of the primary functions of the URDAT program is to create standardized data files from the mix of various formats which comprise the primary data files. Then any program which requires the sample set data need only have a simple input routine to read them in. The standardized files created by URDAT are termed "intermediate" UDAT files and are in sequential binary mode.

Naming and location of the intermediate files follows the same protocol as described for the p-o files (see Section 2.8.1.1). There is no default name for intermediate files and the printer (LPT1) must not be used. It is recommended that the extensions "B" or "BIN" be used with intermediate file names; examples: "FILENAME.B" or "A:FILENAME.BIN".

8.5.2 Description of the Intermediate Files

The intermediate files are described in detail in the event that they may be useful as input to other programs besides those in URAD.

All records are in binary mode.

8.5.2.1 File Identification Record

The first record of any intermediate UDAT file is always an 80-character identification record containing the "block name" which was entered in the block identifier record (Sections 7.3 & 7.4) of the UCON file used in generating the given intermediate file. All other records contain sample set data. Comment records ("C" in column 1) in the source primary UDAT files are not placed on the intermediate files.

8.5.2.2 Sample Set Header Record

Each sample set is represented by a "header" record. If there are any sample data for the sample set, the header record is followed by a "sample" record. If there are lithologic data, the sample record is followed by a "lithologic" record; if there is no sample record, the lithologic record immediately follows the header record.

All header records are of the same length. Sample and lithologic records are of variable length.

In the following description of the record variables, "I" is integer, "R" is real, and "Ch" is character. The number following the "*" is the number of bytes. The abbreviation in quotes is that displayed when the sample set data from an intermediate file is output during execution of one of the ore reserves programs (Section 8.5.3).

The header record contains:

"C13"; Ch*1; sample-type code in column 13 of original header record.
 "C14"; I*2; sample-type code in column 14 of original header record.
 "NDAT"; I*2; basic data type: 1 = contiguous format, U only; 2 = non-contiguous format (U-only); 3 = borehole-log format; 4 = contiguous format, U and V.
 "ICQ"; I*2; code defining original disequilibrium status of U assays (see Figure 5.1:
 if non-borehole format and NDAT=1, or 2, then ICQ is:
 1 -- if not subject to disequilibrium correction;
 2 -- if subject to correction;
 if non-borehole format and NDAT=4, then ICQ is:
 3 -- if not subject to disequilibrium correction;
 4 -- if subject to correction;
 if borehole format, NDAT=3, then ICQ is:
 1 -- if format type (column 15) was "C";
 2 -- if format type was "U";
 3 -- if format type was "Z";
 4 -- if format type was "I";
 (types "C", "U", "Z", and "I" are always subject to correction)
 5 -- if format type was "Q", not subject to correction;
 6 -- if format type was "Q", subject to correction;
 if the code is not applicable, ICQ = 7.
 "IDQ"; I*2; code defining current status of "correctable" data:
 0 -- if diseq. correction has not been applied in URDAT;
 1 -- if diseq. correction has already been applied in URDAT,
 or data not subject to disequilibrium correction.
 "A#"; Ch*3; area number (columns 4-6 of original header).
 "H#"; Ch*6; hole (sample set) number (columns 7-12 of header).
 "P#"; Ch*7; property code (columns 73-79 of header).
 "NC"; R*4; north coordinate.
 "EC"; R*4; east coordinate.
 "EL"; R*4; original collar elevation.
 "PE"; R*4; elevation at pit bottom; a "-9999." indicates no depth to pit bottom was entered in original data.
 "DPO"; R*4; original depth to first sample interval; 0 if no samples.
 "DSM"; R*4; depth sampled (from original collar).
 "WTB"; R*4; depth to oxid./non-oxid. contact (from original collar).
 "IC2"; I*2; elevation/lithologic edit status code ("control zone" is

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that defined by upper and lower edit elevation limits):
if 1, data not edited.
if 2, data edited; sample set barren; control zone assumed barren.
if 3, data edited; samples available, but some have been deleted.
4, will not occur; sample set has already been deleted.
if 5, data edited; samples available, but control zone is barren.
6, will not occur; sample set has already been deleted.
if 7, data edited; samples available, and none deleted.
"E1"; R*4; if edited, new elevation at top of total sample interval;
if not, same as "EL".
"E2"; R*4; if edited, new elev. at bottom of total sample interval;
if not, elevation represented by "DSM".
"DPC"; R*4; if edited, new depth to 1st sample interval -- from "E1";
if not, same as "DPO".
"NA"; I*2; number of sample intervals in set; 0 if none. If NA is set
to a negative value, the grade variables are I*4 instead of
I*2. This only occurs when at least one uranium grade exceeds
a value of 32%U308.

"NL"; I*2; number of lithologic units in sample set; 0 if none.

8.5.2.3 Sample Set Sample Record

The sample record will be present if "NA" (above) is non-zero; it contains "NA" number of sample intervals. If "NDAT"=1,2, or 3, each interval consists of thickness (R*4) and grade %U308 x 1000 (I*2). If "NDAT" = 4, each interval consists of thickness (R*4), grade %V205 x 100 (I*2), and grade %U308 x 1000 (I*2). In order to save space in the intermediate data files, the uranium and vanadium grades are converted, in program URDAT, to INTEGER*2 by multiplying by 1000 and 100 respectively to preserve the original precision. The integer values are rounded to the nearest whole number (using the intrinsic function NINT).

A uranium-only sample record has the form:

(T(1),IA(1)), (T(2),IA(2)), - - - (T(NA),IA(NA)) where,

T(1) and IA(1) are the thickness and integer representative of the U grade, respectively, of the first sample interval, etc.

A uranium & vanadium sample record has the form:

(T(1),IV(1),IA(1)), (T(2),IV(2),IA(2)), - - - (T(NA),IV(NA),IA(NA))

where, IV(1) is the integer representative of the V grade of the 1st sample interval, etc; T and IA are as above.

If the value of any uranium grade in the sample set exceeds 32%U308, the U-grade variables are stored on the intermediate files as I*4 and the value of NA is set to negative. Any input routine which processes the intermediate data files must have two arrays to handle the integer representations of the uranium grades -- one an I*2 array and the other an I*4 array. The sign of "NA" must be checked and the uranium assays initially read into the appropriate I*2 array (if NA is positive) or the I*4 array (if NA is negative). This requires alternate read statements. Either array of integers may then be reconverted to REAL by setting NA=abs(NA) and carrying out:

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$A(i) = \text{float}(IA(i)) / 1000.$ where,

A = the array of grades reconverted to R*4;
IA = the 1*2 or 1*4 array into which the U grades are read;
i = the element number of the grade arrays, for i = 1 to NA.

V-values are simply handled by reading them into an INTEGER*2 array and carrying out:

$V(i) = \text{float}(IV(i))/100.$ where,

V = the array of grades reconverted to R*4;
IV = the 1*2 array into which the V grades are read
i = same as above.

8.5.2.4 Sample Set Lithologic Record

The lithologic record will be present if "NL" is non-zero, and has the form:

$((UN(1),DU(1)), (UN(2),DU(2)), - - - (UN(NL),DU(NL)))$ where,

UN(1) (Ch*4) is the code for the 1st (topmost) lithologic unit and
DU(1) (R*4) is the depth to the top of the 1st unit from the original
collar elevation (see Section 6.2).

8.5.3 "Dumping" of the Intermediate Data Files

Programs RESUV, ORSAC, and SCOR each provide the option to list a brief summary of the sample set data from the intermediate UDAT files which they are processing during a given RUN. This is primarily useful for examining the data during test runs. The header data is referenced by the abbreviations listed in Section 8.5. The sample data are simply shown by a sequential listing of the thickness, and grade of each sample interval as shown in Figure 11.1.

It is not recommended that the above option be taken with long production runs since it requires a great deal of printing, and the primary data file should have been printed at least once when processing with URDAT. If it is taken, the resulting listing will be non-paginated.

8.6 URDAT INTERACTIVE ENTRIES

The URDAT interactive entries and various options are described below in the approximate order in which they occur during program execution. The "minor" (4-number) paragraph headings below refer to the prompts which appear on the console monitor. Many of the entries and options are also used in programs RESUV, ORSAC, and SCOR.

See Section 10 for general interactive-entry procedures.

8.6.1 Establishing Files and Desired Output*8.6.1.1 Print-Output File*

Enter the name of the print-output file (Section 8.2.1.1). Leave entry blank, and press RETURN, if default file "OUTPUT" is desired.

Do not use quotes when entering the p-o file name.

8.6.1.2 UCON file

Enter the name of the UCON file to be used to control selection of primary UDAT sample data. If it is on the default drive, insure that it is in the same directory as "URADT.EXE"; if not on the default drive, remember to include the device "d:" name. If the file is named "UCON" (the default name), leave entry blank and press RETURN.

8.6.1.3 Type of Output

Enter the code for type of output desired. There are four options:

Option 1. A detailed listing of the sample data (Section 8.3.1) will be output onto the p-o file along with a data status summary (Section 8.3.2). An option to include a detailed list of holes falling under each summary category is provided later. No intermediate data file will be created.

Option 2. An intermediate data file (Section 8.5) will be created, but no data listing will be made. The data status summaries will automatically be provided on the p-o file.

Option 3. Options "1" and "2" will be combined; a p-o listing and summaries and an intermediate UDAT file will all be created.

Option 4. No data listing or intermediate file will be created, but a detailed data status and peak grade summary will be output. This option is useful when the data have already been reviewed, but it is desired to check the status of a large number of sample sets prior to creating an intermediate data file.

8.6.1.4 Intermediate UDAT file

Enter the name to be assigned to the intermediate UDAT file (review Sections 8.5.1 and 8.1.2). This prompt is only given if options "2" or "3" (Section 8.6.1.3) are taken.

8.6.1.5 Print Summary in Condensed Mode?

If options "2" or "4" (Section 8.6.1.4) were taken option is provided to print the summary in condensed mode Y/N response .

Note: Following this prompt: if option "2" was taken, the next prompt is for limiting the number of sample sets to be processed (Section 8.6.3.2); if option "4" was taken, the next prompt is for the sample interval reference position (Section 8.6.5).

8.6.2 Print Controls for Data Listing

If options "1" or "3" (Section 8.6.1.3) were taken, then there is a series of options available for establishing the form of the detailed data listing.

8.6.2.1 Detailed Print-Output Control or "Test" Mode?

Enter Y to specify the print output in detail; enter N for a simple non-paginated, non-margin, condensed listing (Section 8.2.2.4). The latter is useful for saving paper when a more structured listing is not needed. When the N option is taken, the next prompt is for limiting the number of lines to be printed (Section 8.6.3.1).

8.6.2.2 Pagination Requested?

Enter Y (yes) or N (no) to request for pagination (Section 8.2.2.4).

8.6.2.3 Paper Page Length & Line Spacing: "Standard" or Other?

Enter "1" for paper page length (vertical) of 11 inches and spacing of 6 lines per inch; enter "2" to specify optional length and line spacing. If option 1 is taken, the next prompt is for paper width (Section 8.6.2.6).

8.6.2.4 Specify Actual Page Length

This prompt is given if option 2, Section 8.6.2.4, was taken.

Enter, to the nearest 10th of an inch, the actual length (vertical, Section 8.2.2.1) of the pages of printing paper to be used. If value is a whole number, the decimal point is not required. Make sure the length is accurately measured.

8.6.2.5 Line Spacing?

Enter "6", "7", "8", or "9" lines per inch; "7" actually results in 7.2 lpi.

8.6.2.6 Paper Page Width?

This entry refers to the actual width (horizontal, Section 8.2.2.2) of the pages of printing paper to be used. Enter "1" (or blank) if 8.5"; enter "2" if 14 3/4" or greater; enter "3" if page width is other than these. If options 1 or 2 are taken, the next prompt will be for character width (Section 8.6.2.8).

8.6.2.7 Specify Actual Page Width

This prompt is given if option 3, Section 8.6.2.6, was taken.

Enter, to the nearest 10th of an inch, the actual width (horizontal, Section 8.2.2.2) of the pages of printing paper to be used. If value is a whole number, the decimal point is not required. Make sure the width is accurately measured.

8.6.2.8 Specify Print Width

This entry specifies the character width and size in characters per inch (cpi, horizontal) as described in Section 8.2.2.2.

Enter "1" (or blank) for 10 cpi; "2" for 12 cpi; or "3" for 17.1 cpi.

8.6.2.9 Format Mode?

Enter "1" for listing format designed for maximum of 80 columns per line; enter "2" for maximum of 132 columns per line (Section 8.3.1.1).

8.6.2.10 Option to Continue, Reset Print Controls, or Abort

Once the page width, character width, and format mode have been set, a test is made to determine if page width is sufficient to contain the print lines, as described in Section 8.2.2.3. If the character width must be adjusted to meet the specified page width, a prompt is given for 3 options.

Enter "Y" to continue RUN with revised character width; enter "N" to restart the whole print control sequence; enter "*" to abort program.

If the paper width is insufficient to contain the lines, even in the condensed-width mode, the RUN will terminate. Wider paper will be required.

8.6.2.11 Option to Reduce Number of Lines Per Page

If the pagination option (Section 8.6.2.2) has been selected, the option is provided here to reduce number of lines per page as explained in Section 8.2.2.4. Enter "Y" if a reduction is desired; "N" if not.

8.6.2.12 Lines Per Page

If the Y option was taken in Section 8.6.2.11, the prompt is given to enter the number of lines per page desired.

8.6.3 Limiting Output Listing*8.6.3.1 Limit Number of Output Lines?*

Enter "Y" to limit output lines (Section 8.2.2.5); next prompt will be for number of lines. Enter "N" if no limit desired.

8.6.3.2 Limit Number of Sample Sets Processed?

Enter "Y" to limit sample sets processed (Section 8.2.2.6); next prompt will be for number of sets. Enter "N" if no limit desired.

8.6.4 Sample Data Status and "Peak Grade" Summaries

See Section 8.3.2 for description of the data summaries. The summaries are always printed, unless a RUN is cut short because of output limits. The following options relate to whether or not a complete (or "detailed") listing is desired of all sample sets included in each summary category. Ten sample set numbers are printed in an output line.

8.6.4.1 Detailed Summary Listings?

Enter: "1" (or leave blank) for no detail (listing of sample set numbers); "2" for detail on sample set status only (Section 8.3.2.1); "3" for detail on peak grade summary only (Section 8.3.2.2); "4" for options 2 and 3 combined.

8.6.5 Method of Referencing Sample Set Position

In the sample set data listings (Section 8.3.1), each sample interval is referenced by the position at the "bottom" of the interval, i.e. the end of the interval furthest from the collar. This position may be referenced either as an elevation or by depth from the collar.

8.6.5.1 Sample Interval Position Reference?

Enter "1" (or blank) for reference by depths, "2" for elevations.

8.6.6 Header Information

The following entries are used for identification purposes and are entered on page headings, but program execution will not be affected if they are left blank.

8.6.6.1 Name of RUN Submittor

Enter the name of the person making the RUN. There cannot be more than 20 characters, including blanks.

8.6.6.2 Date

Enter the date of the run. There cannot be more than 8 characters, including blanks; any characters are permissible.

PROGRAM URDAT

```

*****
/
COLLAR : NORTH   EAST   : PIT : DPTH: BOT: SMPL:          PRPTY : AREA   : HOLE
ELEV. : COORD.  COORD. : DEPTH: SMPL: D: B: CODE:          CODE : NO.   : (SAMPLE)
:         :         :         :         :         :         :         :         :         :
: 7203.0:  7930   9376:    15189:100: F1U:          URDAT : BBB   : TEST 3
/
H2O : K-FACTOR: DEAD : CRIT: H2O: AIR: CPS/INCH: LOG- : FULL :
DPTH: (LAST) : TIME : FACT: CORR: CORR: (LAST) : TYPE : SCALE:
:         :         :         :         :         :         :         :         :
: 2301.00000330:  3.01 NO : 1.28: 1.00:         : A3   :         :
/
*****/
/GAMMA LOG INTERPRETED VALUES; DATA:  UNCORRECTED CPS.      DATE LOGGED: 0/ 0 \
/
BOT DPTH      THK. GRADE : BOT DPTH      THK. GRADE : BOT DPTH      THK. GRADE
(FT.)        (FT.) U308 : (FT.)        (FT.) U308 : (FT.)        (FT.) U308
-----
1591.5      .50 .004 : 1599.5      .50 .130* : 1607.5      .50 .000
1592.0      .50 .000 : 1600.0      .50 .047 : 1608.0      .50 .013
1592.5      .50 .032 : 1600.5      .50 .081 : 1608.5      .50 .059
1593.0      .50 .008 : 1601.0      .50 .035 : 1609.0      .50 .009
1593.5      .50 .000 : 1601.5      .50 .002 : 1609.5      .50 .000
1594.0      .50 .041 : 1602.0      .50 .008 : 1610.0      .50 .005
1594.5      .50 .035 : 1602.5      .50 .005 : 1610.5      .50 .003
1595.0      .50 .029 : 1603.0      .50 .005 : 1623.0     12.50 .000
1595.5      .50 .008 : 1603.5      .50 .003 : 1623.5      .50 .001
1596.0      .50 .016 : 1604.0      .50 .005 : 1624.0      .50 .009
1596.5      .50 .022 : 1604.5      .50 .006 : 1624.5      .50 .027
1597.0      .50 .035 : 1605.0      .50 .006 : 1625.0      .50 .008
1597.5      .50 .174* : 1605.5      .50 .011 : 1625.5      .50 .005
1598.0      .50 .296** : 1606.0      .50 .007 : 1626.0      .50 .006
1598.5      .50 .106* : 1606.5      .50 .005 : 1626.5      .50 .008
1599.0      .50 .137* : 1607.0      .50 .003 : 1627.0      .50 .002
/

```

FIGURE 8.1
 URDAT LISTING SHOWING THE 80-COLUMN FORMAT MODE (U-ONLY)

PROGRAM URDAT

```

*****
COLLAR : NORTH EAST : PIT : DPTH:BOT:SMPL:
ELEV. : COORD. COORD. : DEPTH:SMPL:DXD:CODE:
11000.5 : 8000 5000:150.0: 466:100: V1 :
PRPRTY : AREA : HOLE
CODE : NO. : (SAMPLE)
VDATA : VVV : TEST 2
*****
/ U308 EQUIV. RADIMETRIC (UNCORR. FOR DISEQUIL.) AND V205 ASSAYS.
*****
BOT DPTH THK. GRADE GRADE BOT DPTH THK. GRADE GRADE BOT DPTH THK. GRADE GRADE BOT DPTH THK. GRADE GRADE
(F.T.) (F.T.) U308 V205 (F.T.) (F.T.) U308 V205 (F.T.) (F.T.) U308 V205 (F.T.) (F.T.) U308 V205 (F.T.) (F.T.) U308 V205
401.0 1.00 .050 1.050 414.0 2.00 .020 2.000 435.5 2.00 .020 .020 451.0 2.00 .500* 1.000
403.0 2.00 .020 1.020 424.0 10.00 .010 .050 437.5 2.00 .010 2.000 453.0 2.00 .020 .100
408.0 5.00 .040 2.090 424.5 .50 .200** 1.000 447.5 10.00 .010 .200 455.0 2.00 .550* 2.000
410.0 2.00 .100* 5.550 429.5 5.00 .040 4.000 448.0 .50 .250** 5.000 465.0 10.00 .010 .200
412.0 2.00 .150* .500 433.5 4.00 .500* 5.550 449.0 1.00 .020 .100 465.5 .50 .020 .200
*****
COLLAR : NORTH EAST : PIT : DPTH:BOT:SMPL:H2O : K-FACTOR: DEAD :CRIT: H2O: AIR:CPS:INCH:LOG- :FULL: PRPRTY : AREA : HOLE
ELEV. : COORD. COORD. : DEPTH:SMPL:DXD:CODE:DPTH: (LAST) : TIME :FACT:CDRR:CDRR: (LAST) :TYPE :SCALE: CODE : NO. : (SAMPLE)
7203.0 : 7930 9376 : 15189:100: F1U: 230:1.00000330 : 3.0 : NO :1.28:1.00 : :A3 : (IN) : URDAT : BBB : TEST 3
*****
/ GAMMA LOG INTERPRETED VALUES; DATA: UNCORRECTED CFS. DATE LOGGED: 0/ 0
*****
BOT DPTH THK. GRADE BOT DPTH THK. GRADE BOT DPTH THK. GRADE BOT DPTH THK. GRADE BOT DPTH THK. GRADE
(F.T.) (F.T.) U308 (F.T.) (F.T.) U308 (F.T.) (F.T.) U308 (F.T.) (F.T.) U308 (F.T.) (F.T.) U308
1591.5 .50 .004 1596.5 .50 .022 1601.5 .50 .002 1606.5 .50 .005 1623.5 .50 .001
1592.0 .50 .000 1597.0 .50 .035 1602.0 .50 .008 1607.0 .50 .003 1624.0 .50 .009
1592.5 .50 .032 1597.5 .50 .174* 1602.5 .50 .005 1607.5 .50 .000 1624.5 .50 .027
1593.0 .50 .008 1598.0 .50 .296** 1603.0 .50 .005 1608.0 .50 .013 1625.0 .50 .008
1593.5 .50 .000 1598.5 .50 .106* 1603.5 .50 .003 1608.5 .50 .059 1625.5 .50 .005
1594.0 .50 .041 1599.0 .50 .137* 1604.0 .50 .005 1609.0 .50 .009 1626.0 .50 .006
1594.5 .50 .035 1599.5 .50 .130* 1604.5 .50 .006 1609.5 .50 .000 1626.5 .50 .008
1595.0 .50 .029 1600.0 .50 .049 1605.0 .50 .006 1610.0 .50 .005 1627.0 .50 .002
1595.5 .50 .008 1600.5 .50 .081 1605.5 .50 .011 1610.5 .50 .003
1596.0 .50 .016 1601.0 .50 .035 1606.0 .50 .007 1623.0 12.50 .000

```

FIGURE 8.2
 URDAT LISTING SHOWING THE 132-COLUMN FORMAT MODE

PROGRAM URDAT

```

*****
/
|COLLAR | NORTH  EAST  | PIT |DPTH|BOT|SMPL|          FRPRTY | AREA | HOLE |
| ELEV. | COORD. COORD. |DEPTH|SMPL|OXD|CODE|          CODE | NO. | (SAMPLE)|
|      |      |      |      |      |      |      |      |      |
|11000.5| 6000  5000|150.0| 466|100| V1 |          VDATA | VVV | TEST 2 |
|-----|-----|-----|-----|-----|-----|-----|-----|
/ USQB EQUIV. RADIOMETRIC (UNCORR. FOR DISEQUIL.) AND V205 ASSAYS.
|
|-----|-----|-----|-----|-----|-----|-----|-----|
|BOT DPTH  THK. GRADE  GRADE |BOT DPTH  THK. GRADE  GRADE |
| (FT.)   (FT.)  U308   V205 | (FT.)   (FT.)  U308   V205 | | | | |
|---|---|---|---|---|---|
| 401.0   1.00   .050   1.050 | 435.5   2.00   .020   .020 |
| 403.0   2.00   .020   1.020 | 437.5   2.00   .010   2.000 |
| 408.0   5.00   .040   2.000 | 447.5  10.00   .010   .200 |
| 410.0   2.00   .100*   5.550 | 448.0    .50   .250**  5.000 |
| 412.0   2.00   .150*   .500 | 449.0   1.00   .020   .100 |
| 414.0   2.00   .020   2.000 | 451.0   2.00   .500$   1.000 |
| 424.0  10.00   .010    .050 | 453.0   2.00   .020   .100 |
| 424.5    .50   .200**  1.000 | 455.0   2.00   .550$   2.000 |
| 429.5   5.00   .040   4.000 | 465.0  10.00   .010   .200 |
| 433.5   4.00   .500$   5.550 | 465.5    .50   .020   .200 |
|-----|-----|-----|-----|-----|-----|
/

```

FIGURE 8.3
URDAT LISTING SHOWING THE 80-COLUMN FORMAT MODE (U AND V)

PROGRAM URDAT

DATA ANALYSIS OF PRIMARY U-ASSAY FILE 'STARDAT ', DATE: JAN 88
 ID: STARDAT DATA FULL RUN: NO DISEQ.
 NO INTERMEDIATE FILE OUTPUT REQUESTED. RUN BY:PDV

**** SUMMARY OF HOLE STATISTICS ****

TOTAL NUMBER OF HOLES PROCESSED FOR RUN/BLOCK = 230;

OF THESE:

179 HAD SAMPLE ASSAY DATA.

143	144	145	147	150	153	154	155	156	157
158	160	161	162	163	164	169	170	171	172
173	174	175	176	177	178	179	180	181	182
183	184	185	186	187	188	189	190	191	192
193	194	195	197	198	199	200	201	202	203
204	205	206	208	209	210	211	212	213	214
215	216	217	218	219	221	222	223	224	225
226	227	228	229	230	231	232	233	234	235
236	237	238	239	240	241	243	245	248	249
250	252	256	257	258	259	260	261	262	263
264	265	266	267	268	269	270	271	272	273
274	275	276	279	280	281	282	283	284	285
286	287	288	289	290	291	292	293	294	296
297	298	299	300	108	109	110	111	112	114
115	116	117	118	119	120	121	124	125	126
127	128	129	130	131	134	138	302	303	304
305	306	307	308	309	312	317	314	315	316
317	318	319	320	321	322	323	324	325	

51 HAD NO ASSAYS REPORTED ("BARREN").

142	146	148	149	151	152	165	166	167	168
196	207	220	242	244	246	247	251	253	254
255	277	278	295	301	300	101	102	103	104
105	106	107	113	122	123	132	133	135	136
137	139	140	141	159	310	311	326	327	328
329									

FIGURE 8.4
 SAMPLE SET STATUS SUMMARY FROM FILE STARDAT

PROGRAM URDAT

DATA ANALYSIS OF PRIMARY U-ASSAY FILE "STARDAT" , DATE: JAN 88
 ID: STARDAT DATA FULL RUN: NO DISED.
 NO INTERMEDIATE FILE OUTPUT REQUESTED. RUN BY:FDV

*** SUMMARY OF HOLE STATISTICS ***

"PEAK-GRADE-67" SUMMARY; HOLES WITH SAMPLES, AT OR ABOVE THE INDICATED CUTOFF GRADE, TOTALING, AT LEAST, EITHER 4 FEET OR THE INDICATED GT.

CUTOFF GRADE = <u>.05</u> ZU308, MIN. GT = <u>.20</u> ; # HOLES = 24									
154	162	181	195	217	226	257	261	266	276
285	296	297	110	115	118	115	126	129	305
306	308	314	323						
CUTOFF GRADE = <u>.07</u> ZU308, MIN. GT = <u>.30</u> ; # HOLES = 17									
143	144	163	169	189	229	245	250	263	264
280	286	292	293	300	319	322			
CUTOFF GRADE = <u>.10</u> ZU308, MIN. GT = <u>.40</u> ; # HOLES = 5									
187	193	231	240	272	273	279	284		
CUTOFF GRADE = <u>.12</u> ZU308, MIN. GT = <u>.50</u> ; # HOLES = 19									
155	171	175	177	199	202	212	216	227	235
236	241	249	287	289	299	116	128	302	
CUTOFF GRADE = <u>.15</u> ZU308, MIN. GT = <u>.60</u> ; # HOLES = 18									
159	160	161	174	191	197	206	211	213	214
216	223	224	225	234	260	288	125		
CUTOFF GRADE = <u>.20</u> ZU308, MIN. GT = <u>.80</u> ; # HOLES = 8									
190	215	239	258	262	269	271	298		
CUTOFF GRADE = <u>.25</u> ZU308, MIN. GT = <u>1.00</u> ; # HOLES = 9									
186	201	206	219	228	230	237	238	268	
CUTOFF GRADE = <u>.30</u> ZU308, MIN. GT = <u>1.20</u> ; # HOLES = 10									
157	172	176	188	192	205	222	259	271	274
CUTOFF GRADE = <u>.40</u> ZU308, MIN. GT = <u>1.60</u> ; # HOLES = 6									
156	185	198	203	210	283				
CUTOFF GRADE = <u>.50</u> ZU308, MIN. GT = <u>2.00</u> ; # HOLES = 10									
173	179	180	204	248	275	109	111	117	127

SAMPLES AT INDICATED "PEAK" GRADE ARE NOT NECESSARILY CONTIGUOUS;
 IF SAMPLES EDITED, PEAK GRADE VALUES APPLY ONLY TO SELECTED SAMPLES.

FIGURE 8.5
PEAK GRADE SUMMARY FROM FILE STARDAT

PROGRAM URDAT

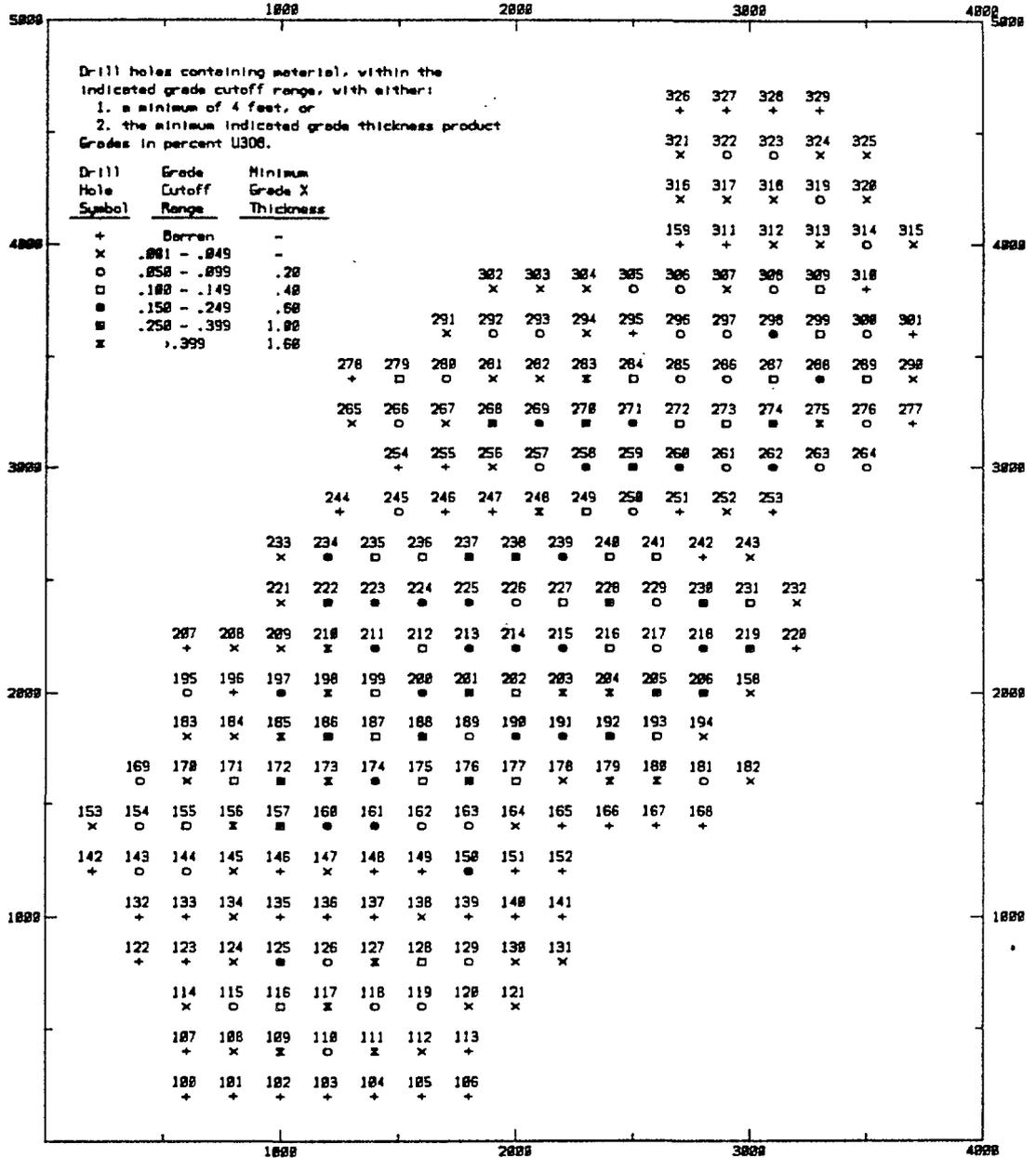


FIGURE 8.6
 PEAK GRADE INTENSITY PLOT FROM URDAT RUN ON FILE STARDAT

9.0 DEFINITION OF ORE RESERVE TERMS AS USED IN THIS GUIDE**9.1 PHYSICAL PARAMETERS****9.1.1 Reserves**

In this guide, a reserve will be considered simply as a quantity of material estimated to be available for some current or future use. The modifying terms used along with the word "reserve" will define it more specifically.

An in-place ore reserve or simply "ore reserve" will apply to the estimate of the volume (area x thickness) of material, in the ground, which is characterized by a given minimum (mining) thickness (Section 9.1.3) and a minimum mineral content or value (Section 9.1.4) at that thickness. The material within the ore reserve volume is defined as ore and expressed in estimated tons of ore and average grade of contained mineral. The volume is converted to tons by the tonnage factor, which is the density of the material, expressed in cubic feet per ton.

The average grade is expressed in hundredths (or thousandths) of a percent U308 and may be converted to pounds of uranium by:

$$\text{pounds U308} = \text{tons ore} \times 20. \times \text{grade}$$

An ore reserve may be additionally defined according to the method used in calculating it; examples: "diluted" or "undiluted" (Section 9.1.8.2), "geostatistical", "area-of-influence", "general outline", etc.

An extractable (ore) reserve is that portion of an in-place ore reserve which is expected to be actually removed from the ground and be available for mineral processing. It is also expressed in tons and average grade. A recoverable (ore) reserve is the quantity of mineral from the in-place ore reserve which is expected to be ultimately available in concentrate after both extraction and processing have occurred. Recoverable reserves are expressed in weight of mineral product (tons or pounds of U308).

Up to this point, there have been no economic criteria attached to the term "reserves". Such criteria may be applied by further defining an ore reserve as being "profitably recoverable at a given market price and given production costs", where the production costs may be "forward costs" (all future expenses from some given point in time) or "economic recovery costs" (basically all past and future expenses).

The term "profit" may simply mean that the value of the mineral in the reserve exceeds the cost of producing it, or, the definition may be further expanded by stipulating that a particular minimum rate of return must be realized over the period of production. The "value" of the contained mineral depends on the circumstances of sale to a buyer (Section 9.2.1).

A discussion of the pros and cons of various definitions are beyond the scope of this guide. The URAD programs are simply "mechanical" methods of estimating mineral quantities using certain rules and procedures. With the appropriate physical and economic input parameters, results may be generated

DEFINITION OF TERMS

to fit a great variety of economic situations. However, the programs contain no capability for analysing "discounted cash flow rate of return".

9.1.1.1 General Characteristics of URAD Reserve Estimates

The ore reserves estimated by the URAD system fall into the "measured", indicated, and inferred" or "reasonably assured resource" categories.

They are based on the "general outline" method, wherein an ore reserves "entity" is simply defined by circumscribing a real or imagined boundary around the area within which the reserve will be calculated. Such a boundary is usually placed such that it reflects, to the extent possible, the margin of a mineral (or "ore") deposit or the separation of one part of a deposit from another. The most critical regions are those around the apparent periphery of the deposit where it must be decided how further out from the last "significant" sample set the actual boundary is located. The definitions of the terms "ore deposit", "boundary", and "significance" of samples set vary widely depending on the experience of the ore reserves analyst, the geologic characteristics of the area involved, and the spacing of the sample assay data.

The smallest ore reserves entity considered in URAD is a block (Section 7.1), which is defined both by a specific area value (in square feet) and by those samples which are used in estimating the thickness and average grade of ore within the area boundaries.

Reserves estimated by the general outline method are most likely to have a higher reliability if the sample sets represent either truly random spacings or, conversely, regular spacings. Therefore, care must be taken to recognize "biased" spacing of sample sets, i.e. different "density" of sample set spacing based on deposit characteristics.

It is not unusual to find that more sampling has been carried out, for example, in higher grade or more accessible portions of a deposit than others, and it is prudent to establish block outlines which take such situations into account. If one area of a deposit has been sampled at 50-foot intervals and another at 200-foot intervals, then each area should be analysed separately and the relative reliability of results accordingly recognized.

The methodology of reserves analysis (and associated terminology) used in the URAD ore reserves programs was originally oriented towards relatively thin-bedded and approximately horizontal uranium deposits of the bedded sandstone type, with individual ore zones varying from around two to fifty feet. However, it could be used with other types of deposits.

Evaluation of a reserve calculated by the URAD programs actually consists of a two-phase analysis. The first is the calculation of the reserve with the restriction imposed by a cost-vs-value cutoff that stipulates that no material which cannot support production operating costs will be included in the reserve. The second is the overall analysis of the reserve calculated by the first step to compare its total value with the total cost of production, including all applicable capital costs. If "arbitrary" grade cutoffs are used instead of cost-vs-value cutoffs, then the economic implication of the first phase does not apply. In program SCOR, both steps are included; in programs ORSAC and RESUV, the second step must be carried out by some other means.

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9.1.1.2 "In-place Reserves, Additional"

Estimates of ore reserves calculated by ORSAC and RESUV are considered "in-place" or "geologic" reserves. These estimates do not include mining or processing losses. However, for many studies, it is not feasible to take such losses into account.

9.1.2 Ore Interval

An ore interval is represented by one or more contiguous samples characterized by mineral grades or values which are generally not less than some pre-assigned cutoff (Section 9.1.4). Samples below cutoff may be included in an ore interval only under certain conditions (Section 9.1.4), however, the average grade of the total interval must still be equal to or greater than the cutoff.

The interval is assumed to be linear and roughly perpendicular to the local mean plane of the mineral deposit. In addition, it must be at least equal in thickness to the minimum mining thickness. An ore zone is the actual or inferred projection of ore from one identified ore interval to another.

9.1.3 Minimum Mining Thickness

The minimum mining thickness is generally considered as the minimum thickness of material which can or will be physically be removed by the anticipated mining method; it is determined both by the capability of available equipment and methods as well as by cost considerations. Generally, the "thinner" the minimum mining thickness, the more expensive the mining cost.

The minimum thickness may also be affected by mine safety considerations. In large open pit operations, the minimum mining thickness is usually not less than 2 feet. Underground workings are usually 8 to 10 feet in height. However, underground mining of thin, high-grade zones may be carried out by "split" shooting; first blasting out and removing either the ore or the waste and then removing the other. This, of course, is more expensive than blasting the entire face and removing the all the material together.

The determination of minimum mining thickness should somewhat reflect the thickness of the available sample intervals on which the ore reserves estimate is based. If samples are, say, a minimum of 10 feet in thickness, it is not very practical to try to determine ore intervals at a minimum mining thickness of 2 or 3 feet.

In any case, the minimum mining thickness is one of the most critical parameters in any ore reserve estimation. For programs SCOR and RESUV, it specifically represents the minimum thickness which can be attained by an ore interval. In ORSAC, it is the thickness to which samples are combined to form the elements of the sample population to be statistically analyzed.

9.1.4 Ore Cutoff

The term "cutoff", as used in URAD, is a preassigned or calculated mineral grade or value, below which sample intervals are generally not included when delineating an ore interval. "Value" is defined here as the estimated dollar

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value of the contained or recoverable mineral represented by a sample (or an interval or an entire deposit). Intervals of material representing grades (or values) below the cutoff are not included in an ore interval unless:

1. They are required to bring the interval up to minimum mining thickness (Sections 9.1.3 and 9.1.8.1).
2. They lie between ore intervals, but are so thin that they could not be physically or economically separated from the ore during the course of mining (Section 9.1.7).
3. They are included as upper and/or lower dilution (Section 9.1.8.2).

The RESUV and SCOR programs provide two basic methods for assigning cutoffs. In the ORSAC program, cutoffs are not assigned. Reserves are calculated for a spectrum of grade cutoffs, which are not determined by economic factors, and the reserves at each cutoff are based on a statistically-derived grade-tonnage distribution of an entire deposit; the desired cutoff is determined independently of the program, and then the ORSAC results are checked to determine how much ore is available at that cutoff.

9.1.4.1 Value-vs-Cost Cutoff

In programs RESUV and SCOR, a cutoff grade or value may theoretically represent the break-even point in cost versus value (of contained or recoverable mineral) at which material may be extracted, carried to some given location, and, optionally, processed.

This is based on the reasoning that it is not generally feasible to extract a quantity of material which, when delivered to the point at which payment is made, will not be at least equal in value to the total cost of delivery. This is called a "break-even" or "marginal cost" cutoff principle and is utilized in all cases (in URAD) when cutoffs are determined by cost versus value. Programs RESUV and SCOR provide the option of calculating cost-versus-value cutoffs based on economic data supplied as program input parameters.

9.1.4.2 Arbitrary Cutoff Grade

An "arbitrary" cutoff is one which is simply assigned without any necessary regard to economic relationships. Programs RESUV and SCOR provide the option of submitting arbitrary cutoffs.

Additional discussions of cutoff are included in the Sections describing the individual ore reserves programs.

9.1.5 Overburden Waste

Overburden waste is only considered in the SCOR open pit mode.

The term "overburden waste thickness" (or simply "overburden thickness") is used to define the distance from the ground surface to the top of the upper most ore interval defined in a sample set. "Direct overburden" is the mate-

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rial, directly overlying the area defined by a block, which must be removed during an open pit operation. In a SCOR open pit RUN, it is assumed that the implied perimeter of the block area represents the base of the pit. The direct overburden, in cubic yards, is calculated by multiplying the average overburden thickness by the block area (not the "ore area") and dividing by 27 - even though the average overburden thickness is based only those sample sets having ore intervals.

"Total overburden" includes the direct overburden plus the backslope overburden (see below).

9.1.5.1 "Backslope Overburden"

The term "backslope overburden" refers to the additional material which must be removed to maintain a proper pit wall slope. In a SCOR open pit RUN, the "pit slope angle" refers to the acute angle formed by the intersection of the base of an open pit and the slope of the pit wall, and the "pit perimeter length" is the length of the outside perimeter of the area of the given block. SCOR uses these two variables, in conjunction with the calculated average depth to the bottom of the lowest defined ore intervals, to estimate the cubic yards of backslope overburden.

The backslope calculation includes the additional excavation needed for a ramp which is 40 wide and slopes down at a 10 degree angle from the ground level.

The backslope approximation function is developed as follows:

$$\text{BKSLPF}(A, Y, P) = (V1 + Vc) / 27 \quad \text{where,}$$

V1 = volume along the (linear) length of the perimeter,
Vc = volume needed to account for the net perimeter curvature.

$$V1 = P \times 1/2 \times Y \times X$$
$$Vc = 1/3 \times 3.14159 \times X^2 \times Y$$

A = pit slope angle (degrees)
P = perimeter (feet) along base of pit
(i.e perimeter of block area)
Y = average total depth (feet) to base of ore
S = length of ramp = Y / sin(10.) feet

$$X = (Y \times \cot(A)) + (40 \times S/P) \quad (\text{feet})$$

9.1.6 Mining Waste

A mining waste interval, as defined herein, represents material below ore cutoff which lies between ore intervals ("inter-ore") and must be removed in order to mine the ore; mining waste is calculated in tons. Two types of waste ("type1" and "type2") are defined in the SCOR program and they have

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different connotations depending on whether an open pit or underground operation is being evaluated.

Waste materials removed during primary development (i.e. shaft sinking, haulageway construction, and other "access" operations) are not included as mining waste.

9.1.7 Minimum Waste Thickness

The minimum waste thickness is the minimum thickness of material below ore cutoff which can be physically separated from ore intervals during mining operations.

9.1.7.1 Underground

For underground operations, the type1 mining waste is that material which must be removed (when mining thinly separated ore intervals) because it is not sufficiently competent to stand in place even with support, or is cheaper to remove than support. The type1 waste ("stoping" waste) minimum thickness may be less than the minimum mining thickness. An upper limit must be placed on the type1 thickness; this limit reflects the minimum thickness of material, between more or less horizontal ore zones, which would be left in place (with or without support) during ore extraction. The type2 designation is not used.

9.1.7.2 Open Pit

For open pit operations, the mining waste is defined as any physically separable material between ore intervals and may, optionally, be subdivided into type1 and type2 for costing purposes (Section 9.2.4.6).

The minimum type1 waste thickness is automatically the same as the minimum mining thickness. If no type2 waste category is requested, then all inter-ore waste is categorized as type1.

However, when a "minimum type2 waste thickness" is assigned, mining waste less than this thickness (and equal to or greater than the minimum mining thickness) is placed in the "type1" category, and that greater than the minimum type2 thickness in "type2". The type2 waste option allows the charging of lower waste removal costs to thick zones of inter-ore waste.

Example: if a deposit to be mined by open pit methods consists of 3 ore zones, with the uppermost zone 200 feet below the surface, the middle zone 10 to 15 feet below the first, and the lowest 2 to 6 feet below the middle zone, then very large-scale earth-removal methods and equipment would be used in stripping (at relatively low cost) the overburden to the first ore zone, while the cost for removing waste between the lowest two zones would be close to the mining cost. The cost for removing the material below the upper zone would probably be somewhere in between the two extremes.

The decision to treat type2 waste (as defined above) as an additional operating cost, as opposed to a primary development (capital) cost, is open to question. It depends largely on the mine operator's method of handling mine expenditures and would mainly be affected by tax considerations.

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In ORSAC, the minimum mining waste thickness is implied as the minimum mining thickness as a result of the method used to determine the sample population.

9.1.8 Dilution Thickness and Grade

Any cutoff mineral grade or value as used in the URAD ore reserve programs theoretically represents some minimum limit below which, for some reason, it is not desired to transport and process the materials comprising the given mineral deposit (see also Section 9.2.4.6.). However, during the ore extraction process, it is not always possible to exclude all the "sub-cutoff" materials, some of which may become mixed with the "true" ore and cause the resulting grade of the total extracted material to be lessened, or diluted.

Two types of dilution are considered in the URAD reserves programs. For both types, ore intervals are tested after (as well as before) the diluting material is added, and, if the diluted interval does not meet cutoff requirements, that interval is no longer considered as an ore interval.

9.1.8.1 Diluting to Minimum Mining Thickness

In both the SCOR and RESUV programs, if one or more consecutive sample intervals meet cutoff grade, but their combined thickness (T_c) is less than the minimum mining thickness (T_m), then the difference ($T_d = T_m - T_c$) is added to T_c at a grade which is called the "dilution grade" (G_d), and the average grade (G_m) of the total interval (T_m) is determined by:

$$G_m = ((T_c \times G_c) + (T_d \times G_d)) / T_m$$

where,

G_c is the average grade of the initial interval T_c

In program RESUV, the diluting grade (G_d) is an arbitrary value submitted as a program input parameter. In SCOR, it is determined by the actual grade of samples adjoining (above and/or below) T_c .

9.1.8.2 Mining Dilution

In program SCOR, the option is also provided to add, both above and/or below defined ore intervals, a specified thickness of sub-ore-grade material which represents the average thickness of materials which are likely to be unavoidably mixed with the ore and cause dilution of ore interval grades in spite of all reasonable precautions. This type of dilution is generally caused by either the type of mining method employed or by the physical characteristics at the boundary between the ore host rock and the adjoining waste material.

Some workers prefer the method of assigning an arbitrary dilution grade, along with an arbitrary percentage which will be prorated to the total reserve after it is calculated. Example: with arbitrary dilution of 10 percent at zero grade, a reserve of 100,000 tons of ore at 0.20 %U308 would be diluted to 110,000 tons at 0.192 %U308. While this method is simple and is feasible in localities of long time mining experience, it is also sometimes

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used as a "hedge" against the possibility of strong recrimination if the eventual ore production grade is lower than that of the original reserve estimate. If the latter situation arises frequently, it is better, in the long run, to find out the actual cause rather than to gloss over it.

9.1.9 Protore

During the process of removing overlying material to reach targetted ore intervals in an open pit operation, there may be a relatively low additional cost for stockpiling (for possible future processing) some of the materials which contain mineral values below ore cutoff grade, as opposed to simply treating such material as complete "waste". The relative costs involved depend on the removal methods and waste destination.

The SCOR open pit analysis provides an option to calculate the amount of material ("protore") which may be available at grades below the ore cutoff grade, but is equal or greater than some other specified grade, termed the protore cutoff grade.

Protore intervals must meet the same minimum-mining-plus-dilution thickness requirements as ore intervals.

Protore cutoffs, like ore cutoffs, may be arbitrary or based on cost vs price considerations; this is further described in Sections 9.2.3 and 14.

9.1.9.1 Protore Processing Cost and Percent Recovery

When the protore option is specified, the estimated future cost per ton and percent recovery for protore processing must be entered. These factors are likely to differ sharply from those associated with the processing of the ore estimated at the higher cutoffs.

9.1.9.2 Treatment of Protore in SCOR

In the SCOR program, protore is considered as simply as waste material which may have some additional value. The in-place and extractable tons of protore are calculated and listed, as well as the potential net value of the recoverable protore pounds U308 determined on the basis of the protore processing costs and recovery rates (Section 9.1.9.2). However, these do not enter into the final reserve economic analysis. The cost of removing protore is assumed to be the same as that for typel waste (Section 9.1.7.2).

9.1.10 Mine Extraction Losses

In most mining operations, there is some loss of ore due to unforeseen inaccessibility or, in the the case of underground operations, the necessity of leaving ground support which cannot be recovered. The percentage of the total estimated in-place reserve which is expected to be eventually extracted from the ground is termed the "percent extraction".

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9.1.11 Ore Processing Recovery

If an ore reserve is to be considered as "recoverable", then the percentage of the total contained mineral which will be available after processing must be estimated. This is termed the percent recovery from ore processing, or simply "percent recovery".

9.2 ECONOMIC PARAMETERS

9.2.1 Integrated Versus Independent Operations

An operation is "integrated" if both mining and processing are both considered as part of a single integral operation, and the end product is uranium in concentrate. In an integrated operation, the mining and processing functions and facilities are usually controlled by a single organization. Cutoff calculations and value of ore are based on recoverable U308.

An operation is "independent" if the mining activities are completely separate from the processing function as, for example, when a mine operator sells ore to a processing plant controlled by a different organization. In this case, the end product is usually considered uranium in ore and value and cutoff computations are performed accordingly. Processing costs and recoveries are generally not considered for independent operations.

9.2.2 Operating Versus Capital Costs

9.2.2.1 Operating Costs

"Operating" costs are those which must directly be applied to each ton of ore which is handled and are expensed accordingly. Operating costs include (but are not necessarily limited to) those for labor, materials, power, fuel, royalties, insurance, and local ongoing administrative, technical, and clerical activities.

9.2.2.2 Capital Costs

"Capital" costs are those which must be essentially expensed before actual ore mining and processing take place or in the early phases of production. Such costs include (but are not limited to) those for property acquisition, exploration, construction of mine and processing facilities, and activities necessary to gain access to the ore, preparatory to mining, such as shaft sinking and mine primary development.

Aside from good mine accounting practice, the primary reason for sharply separating these two types is for investment and tax purposes; the timing of the capital expenditures strongly affects the eventual profitability of a mining operation.

Capital costs are generally applied "in toto" to an entire operation, and then the breakout of cost/ton of ore for the various cost elements is made. In SCOR, the capital costs should be determined by: 1) running a preliminary ore reserves analysis on a prospective operation; 2) determining the magnitude of the operation and size and total cost of required facilities, 3) di-

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viding the total cost for each capital-cost element by the estimated reserve tons, and; 4) entering the capital costs on a cost-per-ton basis (see also Sections 9.2.2.4 and 9.2.4, and Section 14.3 - capital cost entries).

9.2.2.3 Mine-Mill Reclamation, Shutdown Costs

The methods used for expensing costs for shutdown and reclamation of mine and processing facilities, as well as mill tailings, vary widely. Such costs may be included as operating costs, capital costs, or partly as both. It is up to the judgement of the ore reserves analyst to place them in the most reasonable categories. They may be included in operating categories such as direct mining, applicable indirect mining, or processing, or in appropriate capital cost categories.

9.2.2.4 SCOR Cost Elements

The cost elements described in Sections 9.2.3 through 9.2.5 are those which are specifically required as input parameters to the SCOR program. These elements have been somewhat simplified for the URAD system but have been established so that any applicable costs may be included in one of the elements. In program RESUV, total operating costs are as a single value; capital costs are generally not included.

9.2.2.5 Preliminary Estimates

Mineral production costs are, of course, a function of the size and scope of the mining and processing operations. The URAD ore reserves programs do not have the capability of carrying out the type of analysis necessary to determine the optimal size and capacity of production facilities and associated production costs. Such a computer model requires a degree of size, complexity, and availability of data which would be several orders of magnitude greater than URAD.

However, by first using the URAD programs to obtain preliminary reserves estimates for a given deposit, the scope of operations may be more clearly defined, and then additional RUNS may be made using cost data determined as a result of the preliminary analyses.

9.2.3 Operating Costs

The following operating costs are identified in the URAD system and are used in cutoff determinations. All unit costs are expressed in dollars per ton of material (ore or waste) handled.

1. The "direct" mining cost involves all operations necessary for extracting ore from the ground and loading it preparatory to transportation, or "haulage". The amount of transportation cost included in the direct mining cost varies according to the type of operation. In an integrated operation where the processing facilities are close to the mine, the direct mining cost may include the moving of ore to the processing site.

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2. The "haulage" cost involves any required costs of transportation of ore from one specified point to another (unless such costs are already included in the direct mining cost.

3. The "royalty" cost is the amount of money which must be paid to a third party for production of the uranium. Methods of determining royalty payments vary considerably and are frequently quite complicated. Most are based on the amount of mineral in ore or the amount of mineral produced.

For the URAD programs it is necessary to make an estimate of the average royalty that will be paid over the life of the operation and then convert this in terms of average dollars per ton of ore mined. Since royalties are generally most affected by the average production grade over a reasonable time period, preliminary reserves analyses are useful to estimate the average grade of various blocks (Section 9.2.2.5); these grades may be then used as a basis for estimating the royalties.

4. The "ore processing cost" includes all ongoing costs for processing the ore to obtain uranium in concentrate.

5. "Applicable Indirect" costs include any other costs which may be directly charged to the mining and or processing of the ore. These may include local production taxes and any mine and/or processing plant reclamation expenses which are to be charged as operating costs.

9.2.4 Capital Costs

The following capital costs are specifically identified in the SCOR program and must be expressed in dollars per ton of ore. In order to do this, an estimate must first be made of the size and scope of the projected production operations (Section 9.2.2.2 and 9.2.2.3). If capital cost data are not available or not needed for a SCOR RUN, they may be entered as zero values.

1. "Mine plant and equipment" costs are self-explanatory.

2. "Underground primary development" includes all costs required to gain access to ore preparatory to underground mining. This is only used in SCOR underground RUNS.

3. The "overburden removal" cost is considered a primary development cost and is treated somewhat differently (in program SCOR) than the other capital costs. Since the quantity of overburden which must be removed is directly calculated by the program, the cost is expressed in dollars per cubic yard and the total cost for overburden removal is calculated within the program on that basis. This cost element is used only for open pit RUNS.

4. "Processing plant" capital expenses are self-explanatory.

5. "Other" capital expenses may include any capital expenses which are not specifically defined above but which the user may desire

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to include, such as property acquisition, exploration, mine and processing site preparation, and any mine or processing reclamation activities which are to be treated as capital expenditures.

9.2.4.1 Inter-ore Mining Waste-Costs

Mining waste is defined in Section 9.1.6, and the costs for mining waste removal are discussed separately here because there are several methods of treating such costs. Program SCOR provides options for charging costs using either of the methods described below. Mining waste removal costs are expressed in dollars per ton

1. The mining waste costs are sometimes included in the direct mining costs, especially when there is sufficient backlog of experience, in mining a given type of deposit, to estimate the average amount of waste which will be removed for every ton of ore mined. In this situation the waste cost is said to be "pro-rated" to the mining cost. In estimating costs for "split-shooting" underground operations (Section 9.1.3), for example, one method is to estimate the average ratio of waste to ore assuming mine workings of, say, 8 feet in height; calculate the total cost for removing both ore and waste; use a small (one to two feet) minimum mining thickness; and consider the ore + waste cost as direct mining cost. Example: if the ore-to-waste ratio is one ton of ore for every 3 tons of waste, and the ore mining cost is \$50 per ton and waste removal is \$10 per ton then the direct mining cost for ore mining would be charged at \$80 per ton.

When waste removal costs are prorated, they are implicitly included in cost vs value cutoff calculations.

2. In other situations, it is preferred to separately estimate the quantity of mining waste and charge its removal as a independent cost element. In underground operations, the cost will depend primarily on whether the waste must be brought to the surface or whether it be simply moved into "mined out" portions of the underground workings.

Similarly, in open pit operations, mining waste removal costs depend largely on the distance that the waste must be moved as well as the size of equipment used. In addition, where ore zones are separated by relatively thick waste zones ("type2" waste, see Section 9.1.7), it is generally cheaper to remove such waste material than that (type1 waste) which is between closely separated ore zones. An identified type1 waste mining cost should always include the cost of moving it to its destination.

When costs are assigned to specific waste types, such costs are not included in the cutoff calculations but are applied to the economic evaluation of the reserves as a whole.

When the SCOR protore option is in effect, the cost/ton for mining the protore is included in the protore cutoff calculation (if the latter is determined by cost vs price) and the type1 mining waste removal cost is used as the protore cost.

10.0 INTERACTIVE ENTRY10.1 GENERAL PROCEDURES

Each of the programs require some "interactive" (I/A) entry of program parameters. For every I/A entry, a data request message (termed a "prompt") will appear and this prompt will clearly indicate the type of data needed. The prompt will be immediately followed by an arrow (" -> ") or one or more "framers", which are dashed line segments (---.--) or (----.-), etc. Entries are made simply by using the console typewriter to key in the appropriate response immediately to the right of the arrow or (approximately) under the framer(s). Some prompts only require a "Y" (for "yes") or a "N" (for "no") response. When the complete entry has been made for a prompt, the RETURN key is pressed.

The arrow is used when data consist of either a numeric integer code, a Y or N response, or an alphanumeric name. Framers are used for decimal numbers or for multiple entries. A multiple entry is one where several values are requested for a given prompt.

The framers will indicate the maximum number of significant digits and the maximum number of places to the right of the decimal point (if applicable) to which numbers may be entered. They will also have a reference heading if such is appropriate. Examples are shown on Figure 10.1. Note that the numeric entries need not be directly under the framers since the latter are used primarily to apprise the user-operator of the general form of entry as well as of how many entries are required. Even if the framer, as well as the guide text material, indicates a certain number of digits to the right of the decimal point to which a particular numeric value may be entered, such numbers need not be entered if not applicable. For example, a cost value of thirty dollars may be entered as "30" instead of "30.00". All significant digits to the left of the decimal must, of course, be included.

Each prompt indicates exactly what options are available for a given entry (or entries). The values are either specifically identified or a range of values is provided in brackets. Example "(>0, <50 ft)" indicates that the entry values must be greater than zero but less than fifty (feet). Entries outside the specified range or mistakenly-entered alphabetic characters in numeric fields will be caught and the opportunity will be provided for re-entering the values. A few basic guidelines are suggested:

1. For multiple entries under "framers" be sure that each numeric value is separated by at least one blank space, but do not use any other "separators" such as a comma (,).
2. Do not enter any numeric value with "imbedded blanks", i.e. the number "one thousand five hundred and sixty two point two five" must be "1562.25", not "1562 .25", or "1 562.25" or "1562 . 25", etc. Any blank within a numeric value will cause it to be read by the computer as 2 numeric values.
3. For numeric entries use only numeric digits and a decimal point, if required. Do not use commas (,), percent signs (%),

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dollar signs (\$), or any other non-numeric character, including plus (+) or minus (-) signs. No negative entries are required for any of the URAD interactive prompts.

4. Do not use quotes (') when entering file names or other alphanumeric data interactively. Keep in mind that the URAD procedures for interactive data entry differ from those used in establishing the "UCON" file and edit instructions discussed in Section 7.0.

5. There is no way for the programs to determine if file names are correct or not. Therefore, after a file name is entered, the opportunity is provided to examine the name and re-enter it, if it is incorrect.

6. Keep the console keyboard in the "CAPS LOCK" mode during I/A entry. The URAD system assumes that any alphabetic letters in data will be uppercase ("A", not "a").

7. Most "single-digit code" entries do not provide the option of re-entry if they lie within the range of acceptance; such entries should be made with care. "Y" or "N" responses fall in this category. Any numeric data entered under framers are automatically displayed when they fall within their acceptable range; if an erroneous number is seen by the operator, the entire set (defined by the given framer(s)) may be re-entered.

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"1" for detailed analysis; "2" for summaries only:->
 ! MUST BE Y (yes) OR N (no); TRY AGAIN !

 Do you want BLOCK RESERVES calculations? (Y/N):Y

 TYPE OF OPERATION; enter 1 for OPEN PIT, 2 for UNDERGROUND:->

 THIS RUN IS FOR AN OPEN PIT OPERATION.

 Enter NUMBER OF CUTOFFS to be run (1-5)->5

 Is GRADE CUTOFF to be determined by PRICE vs COST? (Y/N):N

 Enter ORE CUTOFF GRADE (%), (<2.00%:308):

1	2	3	4	5
---ZU308	---ZU308	---ZU308	---ZU308	---ZU308
.05	.06	.07	.08	.09

YOUR ENTRY FOR ORE CUTOFF GRADE IS AS FOLLOWS:

.050	.060	.070	.080	.090
------	------	------	------	------

IF OK, ENTER Yes; IF NOT, ENTER No FOR ANOTHER TRY.->Y

 Is operation INTEGRATED (processing facilities included)? (Y/N):Y

 Enter PROCESSING COST in \$ per ton ore (%), (<\$200):

1	2	3	4	5
\$---	\$---	\$---	\$---	\$---
25	26	27	28	29

YOUR ENTRY FOR PROCESSING COST/TON IS AS FOLLOWS:

25.00	26.00	27.00	28.00	29.00
-------	-------	-------	-------	-------

IF OK, ENTER Yes; IF NOT, ENTER No FOR ANOTHER TRY.->Y

 Enter PROCESSING RECOVERY in PERCENT (%), (0-100):

1	2	3	4	5
---%	---%	---%	---%	---%
90	90	91	91	92

YOUR ENTRY FOR % PROCESSING RECOVERY IS AS FOLLOWS:

90.00	90.00	91.00	91.00	92.00
-------	-------	-------	-------	-------

IF OK, ENTER Yes; IF NOT, ENTER No FOR ANOTHER TRY.->Y

 Enter PRICE PER POUND USGB, (%), (<\$200 PER LB. USGB):

1	2	3	4	5
\$---	\$---	\$---	\$---	\$---
30	30	30	30	30

! INVALID CHARACTER(S) IN FIELD;
 TRY AGAIN !

 Enter PRICE PER POUND USGB, (%), (<\$200 PER LB. USGB):

1	2	3	4	5
\$---	\$---	\$---	\$---	\$---
30	30	30	30	30

YOUR ENTRY FOR PRICE PER POUND USGB IS AS FOLLOWS:

30.00	30.00	30.00	30.00	30.00
-------	-------	-------	-------	-------

IF OK, ENTER Yes; IF NOT, ENTER No FOR ANOTHER TRY.->Y

FIGURE 10.1
EXAMPLE OF INTERACTIVE PROMPTS (FROM SCOR PROGRAM)

11.0 GENERAL PROCEDURES FOR RUNNING THE RESERVES PROGRAMS

There are three ore reserves programs in the URAD system - RESUV, ORSAC, and SCOR. These are discussed in Sections 12.0, 13.0, and 14.0, respectively. The description of each program includes:

1. General concepts and operations of the program
2. Optional features
3. How to run the program, including interactive entry procedures
4. Examples of output.

11.1 PRELIMINARY STEPS

Each program is run on a block-by-block basis and must access a UCON file (Section 7.0) to process the appropriate sample data. Before running any reserve program, the following procedures should be implemented. The sequence of the following steps may depend up on particular circumstances. For example, it is assumed the work on steps 2, 3 and 5 will have been carried out well in advance of the reserves analysis.

1. Review the applicable sample data, and using whatever means available - preferably sample or drill hole location maps, and cross sections - outline and compute the area of each block (Section 7.1) for which a reserve estimate is desired. For SCOR open pit RUNs which will request a final reserve estimate and economic analysis, the length of the perimeter of the pit base (Section 9.1.5.1) must be measured (or estimated).
2. Review the sample sets to be included in each block and insure that they are available on one or more "intermediate" UDAT files. If not, run program URDAT (Section 8.0) to select the necessary samples from the appropriate "primary" (basic) UDAT files and to create the intermediate file(s).
3. If the required sample sets are not in the primary file(s), they must of course be entered (Sections 4.0 through 6.0) before any programs can be run at all.
4. Before establishing a UCON file, examine the sample sets to determine the feasibility of using area number, hole number, and/or coordinate control for selecting the assay sets to be included in each block.
5. If the uranium deposit is "multi-horizonal", and it is desired to analyse zones separately, determine which zone(s) are to be included within each block and how samples within such zones are to be selected from the sample sets. For relatively flat-lying deposits, elevation control (Section 7.6.3) can be utilized. For erratic or steeply-dipping deposits, lithologic controls (Section 7.6.4) are more efficient, providing that lithologic data are included with the sample sets and that the breakdown of lithologic is adequate to select the desired zones.

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6. Determine if any of the samples need to be corrected for disequilibrium (Sections 3.4 and 7.6.6) If so, obtain the equation form and necessary coefficients. If these are not available it will be necessary to derive them before any further analysis is carried out.
7. Prepare a UCON file (Section 7.0) and give it the name of the standard default file "UCON" or some other file name. The block identification records (Section 7.3) contain the block number, the area, and a title, if desired. Make sure that each file identification record (contains the exact name of the intermediate file on which the required data resides, and that names for files which are not on the default disk drive include the device names ("A:", "B:", etc.).
8. Review the standard and optional control parameters under which the program is to be run. These will be requested interactively and it is useful to have them already written down, especially when first learning to use the program. The standard control parameters are described in Section 11.2.
9. Review Section 8.2 and determine where the output is to be generated. If output is to be on a floppy disk, review the files which may already exist on the disk. If there is any material on file OUTPUT that should not be wiped out, copy it to another file, or use a different print-output file name. (File OUTPUT is the "default" file for all print-output from the programs. LPT1 is the name submitted for direct output to the printer.
10. If it desired to test just a few sample sets, consider placing a limit on the number of sample sets or output lines.
11. Review Section 10.0 for the methods of the interactive data entry.

11.2 RUNNING THE PROGRAMS - STANDARD INTERACTIVE ENTRIES

The following standard entries are not all necessarily listed in the order in which they occur during program execution.

1. To execute any program, simply enter the name of the applicable reserves program to the right of the systems prompt (example "C:\>" and press return.
2. A request will be made as to whether a printout of the assay data on the current intermediate UDAT file is desired. This option should not be taken unless there is some question on the data and the user-operator wishes to determine what data are on the intermediate file(s) being processed. When a considerable number of sample sets are involved, then it is wise to put a limit on the number of lines to be output. See Section 11.3 for additional information on the contents of the intermediate data file.
3. A request will be made for the name of the file on which the output is to be generated.

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If results are to be output directly on the printer, make sure that the printer is on and that the paper is properly positioned at the top of a fresh page; enter "LPT1" and press RETURN.

If results are to be entered on the standard default file "OUTCON", simply press RETURN (do not enter any characters).

If results are to be entered on some file other than OUTCON, check once more to be sure the file name is correct; if the output file does not reside on the default disk drive, make sure that the device name ("A:", "B:", etc.) is included.

Enter the file name, and press RETURN. An opportunity will be provided to check the file name and re-enter it, if desired.

4. A request will be made for the name of the applicable UCON file. If the UCON control data are on the default file "UCON", then simply press RETURN. If on some other file, enter the file name and press RETURN. Observe the device name precautions. An opportunity will be provided to check the file name and re-enter it if desired.

5. Additional standard initial requests will be:

-> Print-output control options for pagination, character width, and line spacing. These are essentially as described for program URDAT in Section 8.6.2; any variations are self-explanatory. For programs RESUV and ORSAC, the only option is paper width; if less than 14 1/2 inches, printing will be compressed.

-> Detailed sample set summary listing. The short summary lists the number of holes included, those rejected, the number excluded by edit, the number meeting cutoff, etc. The full (detailed) summary lists the actual sample set identification numbers for each category.

-> Name of user or operator (up to 20 characters).

-> Date (up to 8 characters; the forms XX/XX/XX or XX-XX-XX are recommended, but any characters are allowed).

-> Title (RUN description) of up to 75 characters which will be used on output headings.

-> Each program will then have a series of requests for RUN program control and program parameters: these are described under the sections for the appropriate programs. When first running the programs, it is wise to list the prospective options and data entries on paper before executing.

11.3 CONTENTS OF THE INTERMEDIATE DATA FILE

In Section 8.5.2, the data elements and formats of the intermediate UDAT files are described. When the option is taken to "dump" the data from an intermediate file during an ore reserve RUN, the data from each sample set

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are listed as shown in Figure 11.1, which shows output from a uranium-only sample set and a uranium-vanadium set.

11.3.1 Intermediate Data Header Output

The sample-set header data are dumped in three lines. Each variable is preceded by an alphanumeric abbreviation which defines the record. These are explained in Section 8.5.2.2 and will not be repeated here. Most of the data have been discussed in detail in Sections 4.0 through 6.0. The area, sample-set, and property codes (A#, H#, and P#) are placed within double asterisks ("**").

Some data need further explanation, especially if they are affected by any edits which may take place when running URDAT.

"DSM", the total depth sampled, is always the same as the original value entered for "depth sampled" in either barren or non-barren gamma-log data. If the original data were non-gamma-log data, it is the depth to the bottom of the last sample interval. For any barren sample-set which originally did not have any entry for depth sampled, it is set to zero. For non-barren gamma-log data which originally did not have an entry for "depth sampled", DSM is set to the bottom of the last (lowest) interval, and then that value is set to negative. Any DSM which is zero or negative is "undefined".

"DPO" is always the depth from the original collar elevation to the top of the first sample interval. For barren holes, it is set to zero.

"EL" is always the collar elevation of the sample set.

"PE" is always set to the elevation at the pit surface if a "depth-to-pit-bottom" was originally entered in the sample-set data. If not, it is set to -9999 (undefined).

"E1" is always initially set to "EL" in URDAT. If a sample set is subjected to a lithologic and/or elevation edit, E1 is reset to the top of the "edit-interval". The edit-interval is that portion of the original sample set which remains after the edit is carried out. E1 is considered as the "working" elevation of a sample set.

"E2" is always set to the elevation implied by EL and DSM, if the latter is positive. If DSM is undefined, then E2 is set to -9999 (also undefined).

Whenever a sample set subjected to a lithologic and/or elevation edit, E2 is set to the bottom of the edit-interval if the latter is defined. If the bottom of the edit interval is undefined, then E2 is left (or set) to -9999.

"DPC" is originally set to DPO, but if a lithologic and/or elevation edit cuts out any of the upper portion of the sample set, it is reset as the depth from E1 to the top of the first sample of the edit-interval.

"IC2" always reflects the status of the sample following the most recent edit.

Note: When SCOR is run in the open pit mode, with no edits, the working elevation of any sample set having a defined pit elevation

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is automatically set to that pit elevation, and any sample intervals originally above that position are deleted.

11.3.2 Sample Interval and Lithologic Data

Sample interval data are listed horizontally and sequentially, from left to right. There are 6 intervals per line for uranium-only data, with each interval represented by depth and grade %U308. There are four intervals per line for uranium-vanadium data with each interval represented by thickness, grade %V205, and grade %U308.

The actual grades are the same as those appearing in the URDAT output listing, but may sometimes appear to differ by 0.01 %U308 because of output rounding problems; they are only listed to the nearest hundredth of one percent.

Any lithologic codes and depths are also listed horizontally and sequentially from left to right.

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(Example of uranium - vanadium data)
 C13=V *C14*=1 *NDAT*=4 *IC1*=4 *IDQ*=0 **A#-H#-P#*=VVV TEST 2 VDATA **
 NC-EC= 6000. 5000. *EL-PE*=11000.510850.5 *DPO*= 400.0 *DSM*= 465.5
 WTB= 100. *IC2*=1 *E1-E2*=11000.510535.0 *DPC*= 400.0 *NA-NL*= 20 0

FT-ZV205-ZU308(1), (2), (3) ETC; SEQUENTIALLY FROM LEFT TO RIGHT.
 1.00- 1.04- .05! 2.00- 1.01- .02! 5.00- 2.00- .04! 2.00- 5.55- .10!
 2.00- .50- .15! 2.00- 2.00- .02! 10.00- .05- .01! .50- 1.00- .20!
 5.00- 4.00- .04! 4.00- 5.55- .50! 2.00- .02- .02! 2.00- 2.00- .01!
 10.00- .20- .01! .50- 5.00- .25! 1.00- .10- .02! 2.00- 1.00- .50!
 2.00- .10- .02! 2.00- 2.00- .55! 10.00- .20- .01! .50- .20- .02!

(*Barren* sample set)
 C13=2 *C14*=0 *NDAT*=1 *IC1*=7 *IDQ*=0 **A#-H#-P#*=AAA TESTA1 URDATA **
 NC-EC= 5000. 5000. *EL-PE*= 7000.5 6850.5 *DPO*= .0 *DSM*= .0
 WTB= 100. *IC2*=1 *E1-E2*= 7000.5-9999.0 *DPC*= .0 *NA-NL*= 0 0

(Example of uranium-only data)
 C13=A *C14*=3 *NDAT*=3 *IC1*=4 *IDQ*=0 **A#-H#-P#*=CCC TEST 6 URDATA **
 NC-EC= 7890. 9198. *EL-PE*= 7211.0-9999.0 *DPO*=1583.0 *DSM*=5185.0
 WTB= 100. *IC2*=1 *E1-E2*= 7211.0 2026.0 *DPC*=1583.0 *NA-NL*= 83 0

FT-ZU308(1), FT-ZU308(2), ETC; SEQUENTIALLY FROM LEFT TO RIGHT.
 .50- .01! .50- .00! .50- .01! .50- .01! .50- .02! .50- .02!
 .50- .04! .50- .11! .50- .09! .50- .00! .50- .02! .50- .01!
 .50- .03! .50- .02! .50- .01! .50- .01! .50- .04! .50- .13!
 .50- .93! .50- .46! .50- .67! .50- .51! .50- .01! .50- .07!
 .50- .10! .50- .09! .50- .22! .50- .42! .50- .36! .50- .38!
 .50- .25! .50- .09! .50- .04! .50- .06! .50- .02! .50- .03!
 .50- .03! .50- .03! .50- .06! .50- .36! .50- 1.88! .50- 2.95!
 .50- 3.45! .50- 3.42! .50- 3.73! .50- 1.57! .50- .44! .50- .05!
 .50- .00! .50- .01! .50- .01! .50- .01! .50- .01! .50- .00!
 .50- .01! .50- .00! .50- .01! .50- .03! .50- .11! .50- .07!
 .50- .52! .50- .93! .50- .56! .50- .83! .50- 1.56! .50- 1.06!
 .50- 1.30! .50- 1.40! .50- 1.48! .50- 1.37! .50- 2.22! .50- .63!
 .50- .26! .50- 1.52! .50- 1.43! .50- .00! .50- .13! .50- .05!
 .50- .10! .50- .00! .50- .03! .50- .00! .50- .01!

FIGURE 11.1
 PARTIAL LISTING FROM "DUMP" OF AN INTERMEDIATE UDAT FILE

12.0 PROGRAM RESUV

12.1 GENERAL CONCEPTS AND OPERATIONS

Program RESUV (Reserves for Uranium and Vanadium) is designed to calculate uranium and, optionally, vanadium reserves for predetermined underground blocks. The blocks are first outlined as described in Section 7.1. After blocks, block areas, and associated UDAT intermediate data files have been defined in the appropriate UCON file (Section 7.0), RESUV is then executed and all control parameters are read interactively.

The parameters include: title of run, minimum mining thickness, minimum waste thickness, uranium and vanadium dilution grades, tonnage factor, the type of cutoff option desired, and depending on this option, either uranium grade cutoff(s) or mineral value(s) and production cost(s).

RESUV then processes the sample data and calculates reserves for all blocks, one cutoff at a time. There may be up to seven cutoffs at which reserves are calculated (for each block) depending on the control parameters submitted. The cutoffs are based on either arbitrary uranium grades or production cost versus contained mineral value.

For each cutoff, the procedures are as follows. Each sample set chosen by the UCON controls for the given block is analyzed to determine the thickness of "ore" represented by the set. "Ore" (Section 9.1) is defined as material which will need minimum thickness and cut-off requirements. Samples are grouped into "preliminary" intervals which may consist of one or more samples meeting grade cutoff requirements.

If such zones do not meet minimum mining thickness requirements, then sufficient material is added (at the dilution grades) to bring the interval up to minimum thickness, such zones are further tested against the cutoff and if they meet cutoff requirements, they are included as "ore"; otherwise they are rejected. No additional dilution is made.

Example: if grade cutoff, minimum mining thickness, and uranium dilution grade have been submitted as 0.20 %U₃₀₈, 8 feet and 0.02 %U₃₀₈ respectively, an interval of 6 feet @ 0.25 hundredths would be diluted to 8ft. @ 0.238 %U₃₀₈ and would pass the cutoff test. An interval of 4 ft. @ 0.20%U₃₀₈ would be diluted to 8 ft. @ 0.11 %U₃₀₈ and not be included as an ore interval.

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All ore zones defined in a given sample set are combined to obtain a total thickness and average grade of ore represented by the set. When all sample sets for a given block have been processed at a given cutoff, the thickness and average grade of that portion of the block which contains ore is determined by:

$$T_b = S\{T_i\}/N \quad (i=1-N), \text{ and}$$

$$G_b = S\{T_i \times G_i\}/S\{T_i\} \quad (i=1-N)$$

where,

N = total number of sample sets containing ore zones,

i = an individual sample set,

S{Ti} = summation of thicknesses of all ore intervals,

S{Ti x Gi} = summation of grade x thickness of all ore intervals.

Tb = average thickness of ore in the block,

Gb = average grade of ore in the block.

The "ore area" (AREA0) of the block is determined by:

$$AREA0 = AREAAB \times N/N_t$$

where,

AREAAB = the total block area,

Nt = total number of sample sets in the block.

Total tons of ore (TNb) and total pounds of U3O8 (LBb) in the block are determined by:

$$TN_b = T_b \times AREA0 / TF, \text{ and,}$$

$$LB_b = TN_b \times G_b \times 20.$$

where,

TF = the tonnage factor in cubic feet per ton.

The reserves and associated factors are (optionally) printed after reserves for a given cutoff have been calculated for each block. When all blocks have been processed for one cutoff, then the next cutoff is analysed. When all cutoffs have been analysed, a summary of reserves at each cutoff is printed.

The reserves are considered in-place reserves with no dilution except that needed to bring ore intervals up to minimum mining thickness.

12.2 RESERVES-ANALYSIS-OPTIONS

There are four main options in running RESUV; these depend primarily on the type of cutoff desired. Option 3 is the same as option 2 except for the method of handling vanadium values. Option 4 is the same as Option 1 except that vanadium is included in Option 4.

12.2.1 Option 1

Reserves are only calculated for uranium. The cutoff is an arbitrary uranium grade which is submitted as a program control parameter. Up to 7 cutoff grades are permitted for one run. The grade may be entered to the nearest one thousandth of a percent U308.

12.2.2 Option 2

Reserves are calculated for uranium and vanadium. The cutoff is determined by a comparison of total production operating cost with the value of uranium and vanadium represented by the samples, i.e. the cost (C = total cost per ton) for producing a ton of ore versus the estimated combined value of uranium and vanadium in that ton. The latter is determined by:

Value (V) equals pounds per ton times value per pound, or

$$V = ((G_u \times P_u) + (G_v \times P_v)) \times 20.$$

where,

G_u = uranium grade,

P_u = uranium price per pound U308,

G_v = vanadium grade,

P_v = vanadium price per pound U308.

(The factor 20. is used since grades are expressed as percentages).

For any interval comprising one or more samples, V (Value per ton) is compared against C (cost per ton); if C is less than V, then the interval meets cutoff requirements. The production cost per ton and uranium and vanadium prices (in dollars per pound) are submitted as program control parameters.

Note: In this option and Sections 12.2.3 and 12.2.4, a vanadium dilution grade is used in the same manner as the uranium dilution grade described in Section 12.1.

Up to 7 entries each may be made for cost, uranium price and vanadium price. However, all combinations of these parameters are run for each block and the total number of combinations may not exceed 50; i.e:

costs x # U prices x # v prices cannot be greater than 50.

If entries are made such that the number of combinations is greater than 50, the program will automatically terminate with an appropriate message.

PROGRAM RESUV

12.2.2.1 Calculation of Vanadium Grades

In Option 2 vanadium grades are calculated as a function of the uranium grade. The function equation may be one of the two following forms.

$$V = a + bU + cU^{**2} + dU^{**3}, \text{ or}$$
$$\text{LOGe}(V) = a + b \times \text{LOGe}(U)$$

where,

V = percent V205

U = percent U308

a,b,c, and d = appropriate coefficients.

The coefficients must be determined previously by statistical evaluation of the relationships between uranium and vanadium grades. The methods are more or less the same as discussed for disequilibrium factors (Section 3.4).

If Option 2 is selected, RESUV will request the coefficients to be entered interactively as part of the program control parameters.

12.2.3 Option 3

Option 3 is exactly the same as Option 2, except that actual values for vanadium are used. Therefore, this option may only be run on sample data which includes vanadium assays, i.e. were originally entered in the contiguous bimetal format (Section 6.0).

In running this option, this program will be terminated if assay sets are encountered which contain no vanadium entries.

12.2.4 Option 4

In this option, reserves are calculated for both uranium and vanadium, but the cutoff is based on an arbitrary uranium grade. Only the uranium cutoff grade is used to determine ore zones; the vanadium reserves are calculated from vanadium assays associated with the uranium grade which meet cutoff requirements. This option should also be run only if the sample set data contain vanadium assays.

12.3 RUNNING THE PROGRAM - INTERACTIVE INPUT REQUESTS

12.3.1 Standard Initial Entries

Program Name: Enter "RESUV" to the right of the systems prompt; i.e.

"C:\> RESUV".

Other standard entries are as described in Section 11.2.

When RESUV is executed, the sequence of program-specific interactive entry requests (denoted below by "->") is as follows:

12.3.2 For All Options

->Title of Run; This is a title or run description of up to 75 characters that will be used for output headings.

->Minimum Mining Thickness; Section 9.1.3; up to three significant digits; to the nearest tenth of a foot; must be 1 foot or greater.

->Minimum Waste Thickness; Section 9.1.7.1; up to three significant digits; to the nearest tenth of a foot; must be 1 foot or greater.

->Tonnage Factor; Section 9.1.1; up to 4 significant digits; to the nearest hundredth of a cubic foot per ton; may not be 0.

->Uranium Dilution Grade; Sections 9.1.8.1 and 12.1; up to 3 significant digits; to the nearest one thousandth of a percent U₃₀₈; may be 0, but not greater than 0.20 %U₃₀₈.

->Reserve-Analysis Option; Section 12.2; enter 1,2,3 or 4; may not be 0.

12.3.3 Options Depending On Reserve-Type

The following requests will depend on the Reserves-Analysis option chosen (just above, and Section 12.2)

12.3.3.1 Option 1

->Number of Uranium Cutoff Grades; Section 12.2.1; may be up to 7.

->List of Cutoff Grades; entries for the number of grades entered above; up to 4 significant digits; to the nearest one thousandth of a percent U₃₀₈; no 0 entries.

12.3.3.2 Option 2

->Number of Production Costs to be Evaluated; Section 12.2.2; up to 7.

->List Production Costs; Section 12.2.2; may be up to 7 total production costs; number of values will depend on previous entry; up to 5 significant digits; to the nearest one hundredth of a dollar; no 0 entries.

->Number of Uranium Prices to be Evaluated; Section 12.2.2; may be to 7.

->List of Uranium Prices; Section 12.2.2; may be up to 7 uranium prices; number of values will depend on previous entry; up to 5 significant digits; to the nearest one hundredth of a dollar; no 0 entries.

->Number of vanadium prices to be Evaluated; Section 12.2.2; may be to 7.

->List of Vanadium Prices; Section 12.2.2; may be up to 7 prices; number of values will depend on previous entry; up to 5 significant digits; to the nearest one hundredth of a dollar; no 0 entries.

->Type of Vanadium Ratio Equation. Section 12.2.2.1; enter 1 for polynomial and 2 for exponential.

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->Coefficients for Vanadium Ratio Equation. Section 12.2.2.1; enter coefficient as indicated. If coefficients are zero, enter 0.

12.3.3.3 Option 3

The entries will be exactly as for Option 2 except no request will be made for vanadium ratio coefficients.

12.3.3.4 Option 4

The entries will be exactly as for Option 1.

12.3.4 Vanadium Dilution Grade

If Options 2, 3, or 4 are chosen there will be the entry:

->Vanadium Dilution Grade; Note - Section 2.2.2; up to 3 significant digits; to the nearest one thousandth of a percent U308; may be 0, but not greater than 0.50 %V205.

12.3.5 Output Options

->; Enter 0 for block-by-block and Summary results, or 1 for summary results only.

Figures 12.1 and 12.2 illustrate examples of the output from RESUV.

PROGRAM RESUV

TEST ON 5 BLOCKS, URANIUM-ONLY CALCULATION (TYPE RUN = 1).

CUT-OFF BLOCK NUMBER	GRADE TOTAL HOLES	.05 DRE HOLES	MIN THICK TOTAL AREA OF BLOCK	6.0 MINABLE AREA AT CUTOFF	WASTE THICK AVG MINING THICKNESS	2.0 BLOCK TONNAGE	AVG GRADE U308	POUNDS U308 IN ORE	MAX ELEV	MIN ELEV
BV1	7	5	100000.	71429.	44.3	210857.	.16	686368.	6999.	6864.
BV2	5	4	200000.	160000.	50.3	536000.	.17	1788384.	6978.	6873.
BV3	6	4	50000.	33333.	36.0	80000.	.18	286329.	6981.	6891.
BV4	14	12	250000.	214286.	17.2	245238.	.21	1052707.	6951.	1725.
BV5	15	10	100000.	66667.	9.9	44222.	1.10	972947.	5630.	1750.
TOTALS	47	35		545714.	30.7	1116318.	.21	4786736.		

HOLES ABOVE CUTOFF - 35

TEST 2	TEST 3	TEST 5	TEST 6	TEST 2	TEST 7	TEST 9	TEST10	TEST11	TEST13
TEST14	TEST15	TEST16	202	203	214	C216	204	213	214
201	215	216	TEST 1	TEST2	126	128	129	TEST 3	TEST 4
TEST 5	TEST 6	TEST 7	TEST10	TEST11					

CUT-OFF BLOCK NUMBER	GRADE TOTAL HOLES	.10 DRE HOLES	MIN THICK TOTAL AREA OF BLOCK	6.0 MINABLE AREA AT CUTOFF	WASTE THICK AVG MINING THICKNESS	2.0 BLOCK TONNAGE	AVG GRADE U308	POUNDS U308 IN ORE	MAX ELEV	MIN ELEV
BV1	7	5	100000.	71429.	29.5	140381.	.20	569500.	6988.	6864.
BV2	5	4	200000.	160000.	36.1	385333.	.20	1577234.	6978.	6873.
BV3	6	4	50000.	33333.	26.1	58056.	.22	258212.	6981.	6891.
BV4	14	10	250000.	178571.	14.4	172024.	.27	938206.	6951.	1725.
BV5	15	6	100000.	40000.	11.8	31333.	1.52	950787.	5628.	1750.
TOTALS	47	29		483333.	24.4	767127.	.27	4293940.		

HOLES ABOVE CUTOFF - 29

TEST 2	TEST 3	TEST 5	TEST 6	TEST 2	TEST 7	TEST 9	TEST10	TEST11	TEST13
TEST14	TEST15	TEST16	202	203	C216	204	213	201	215
216	TEST 1	TEST2	126	128	129	TEST 4	TEST 6	TEST11	

----- detailed results for .15, .20 and .25 U308 omitted to save space -----

SUMMARY OF RESERVE COMPUTATION

CUT-OFF	TONS	AVG GRADE	POUNDS U308
.05	1116318.	.21	4786736.
.10	767127.	.27	4293940.
.15	474825.	.37	3492711.
.20	324452.	.45	2946379.
.25	227270.	.54	2455328.

FIGURE 12.1
EXAMPLE OUTPUT FROM PROGRAM RESUV
URANIUM-ONLY RUN. (RUN-TYPE = 1)

PROGRAM RESUV

TEST ON FIVE BLOCKS, USING URANIUM-VANADIUM RATIO (TYPE RUN = 2).

PAGE 1

MINIMUM COMBINED METAL VALUE CUTOFF- 80.00 URANIUM PRICE- 35.00 VANADIUM PRICE- 5.00
CUTOFF THICK - 6.00 TONNAGE FACT -15.00

$$V205 = .000 + (5.000)U308 + (.000)U308*2 + (.000)U308*3$$

BLOCK NUMBER	TOTAL HOLES	ORE HOLES	TOTAL AREA OF BLOCK	MINABLE AREA AT CUTOFF	AVG THICK	BLOCK TONNAGE	AVG GRADE U308	POUNDS U308 IN ORE	AVG GRADE V205	POUNDS V205 IN ORE	MAX ELEV	MIN ELEV
BV1	7	5	100000.	71429.	37.2	177143.	.19	673539.	.95	3367696.	7000.	6902.
BV2	5	4	200000.	160000.	38.0	405333.	.21	1667049.	1.03	8335243.	7008.	6906.
BV3	6	4	50000.	33333.	23.5	52222.	.26	268279.	1.28	1341394.	7014.	6923.
BV4	14	12	250000.	214286.	11.5	163690.	.31	1016588.	1.56	5116391.	7001.	1733.
BV5	15	10	100000.	66667.	9.3	41111.	1.19	975334.	5.93	4876672.	7211.	1755.
TOTALS	47	35		545714.	23.1	839500.	.27	4600789.	1.37	23037400.		

HOLES ABOVE CUTOFF - 35 (Hole Numbers Omitted)

MINIMUM COMBINED METAL VALUE CUTOFF- 80.00 URANIUM PRICE- 35.00 VANADIUM PRICE- 3.00
CUTOFF THICK - 6.00 TONNAGE FACT -15.00

$$V205 = .000 + (5.000)U308 + (.000)U308*2 + (.000)U308*3$$

BLOCK NUMBER	TOTAL HOLES	ORE HOLES	TOTAL AREA OF BLOCK	MINABLE AREA AT CUTOFF	AVG THICK	BLOCK TONNAGE	AVG GRADE U308	POUNDS U308 IN ORE	AVG GRADE V205	POUNDS V205 IN ORE	MAX ELEV	MIN ELEV
BV1	7	5	100000.	71429.	32.2	153333.	.21	629881.	1.03	3149407.	7000.	6902.
BV2	5	4	200000.	160000.	34.4	366667.	.22	1599101.	1.09	7995508.	7008.	6906.
BV3	6	4	50000.	33333.	20.6	45833.	.29	263212.	1.44	1316062.	7014.	6923.
BV4	14	12	250000.	214286.	10.8	153571.	.32	990123.	1.62	4973890.	7001.	1733.
BV5	15	10	100000.	66667.	9.3	41111.	1.19	975334.	5.93	4876672.	7211.	1755.
TOTALS	47	35		545714.	20.9	760516.	.29	4457652.	1.47	22315400.		

HOLES ABOVE CUTOFF - 35 (Hole Numbers Omitted)

----- Detailed Results Of Various Combinations Omitted In Illustration to Save Space -----

MINIMUM COMBINED METAL VALUE CUTOFF-100.00 URANIUM PRICE- 25.00 VANADIUM PRICE- 3.00
CUTOFF THICK - 6.00 TONNAGE FACT -15.00

$$V205 = .000 + (5.000)U308 + (.000)U308*2 + (.000)U308*3$$

BLOCK NUMBER	TOTAL HOLES	ORE HOLES	TOTAL AREA OF BLOCK	MINABLE AREA AT CUTOFF	AVG THICK	BLOCK TONNAGE	AVG GRADE U308	POUNDS U308 IN ORE	AVG GRADE V205	POUNDS V205 IN ORE	MAX ELEV	MIN ELEV
BV1	7	5	100000.	71429.	20.3	96857.	.26	494530.	1.28	2472649.	7000.	6902.
BV2	5	4	200000.	160000.	25.8	274667.	.25	1391659.	1.27	6958297.	7008.	6906.
BV3	6	4	50000.	33333.	17.5	38889.	.30	232957.	1.50	1164783.	7014.	6923.
BV4	14	10	250000.	178571.	9.2	109524.	.39	854253.	1.95	4271264.	7001.	1733.
BV5	15	5	100000.	33333.	12.5	27778.	1.70	945125.	8.51	4725626.	7211.	1757.
TOTALS	47	28		476667.	17.2	547714.	.36	3918523.	1.79	19592620.		

HOLES ABOVE CUTOFF - 28 (Hole Numbers Omitted)

SUMMARY OF RESERVE COMPUTATION

MIN THICK 6.00

CUTOFF \$ VALUE	U308 PRICE	V205 PRICE	TONS	AVG GRADE U308	POUNDS U308	AVG GRADE V205	POUNDS V205	\$ VALUE (\$1000)
80.00	35.00	5.00	839500.	.27	4600789.	1.37	23037400.	276215.
80.00	35.00	3.00	760516.	.29	4457652.	1.47	22311540.	222952.
80.00	25.00	5.00	760516.	.29	4457652.	1.47	22311540.	222999.
80.00	25.00	3.00	686357.	.31	4304226.	1.57	21521130.	172149.
100.00	35.00	5.00	760516.	.29	4456350.	1.47	22305020.	267497.
100.00	35.00	3.00	686357.	.31	4304226.	1.57	21521130.	215211.
100.00	25.00	5.00	686357.	.31	4304226.	1.57	21521130.	215211.
100.00	25.00	3.00	547714.	.36	3918523.	1.79	19592620.	156741.

FIGURE 12.2
EXAMPLE OUTPUT FROM PROGRAM RESUV
URANIUM-VANADIUM RUN (RUN-TYPE = 2)

13.0 PROGRAM ORSAC

13.1 GENERAL CONCEPTS AND OPERATIONS

Program ORSAC (Uranium Ore Reserve Estimation by Standard Methods and Computer) is designed to calculate uranium ore reserves for predetermined blocks using a theoretical statistical model. Each block consists of a total volume defined by an assigned area and the average of the total thickness of mineralized material in each sample set. The mineralized material is defined by an initial minimum grade cutoff (usually 0.01%U₃O₈). The grade of material within the total volume are "fit" to a log on normal distribution and the fractional tons and average grade of material in the block available at cutoffs of 0.01 %U₃O₈ to 0.60 %U₃O₈ are calculated. A detailed description of the theoretical concepts of the ORSAC method is available from RME-183 (Section 1.2).

The blocks are first outlined as described in section 7.1 and then a UCON file (Section 7.0) must be prepared to identify the block area and the appropriate sample data to be processed for each block.

Review Section 11.0 before running the program.

Since the results from ORSAC are most reliable if the total sample population of a deposit is included in a block, it is best not to truncate low grade portions of a deposit or to break up continuous portions of a deposit in defining the blocks. However, if the total deposit is actually comprised of several smaller integral mineralized entities, each such entity should be analyzed separately.

ORSAC has proven especially effective in obtaining reserve estimates where relatively sparse sample data are available and/or if sample points are far apart. It generally provides better results in analyses for underground deposits than for deposits which will be mined by open pit methods, primarily because of the lesser minimum mining (combining) thickness required, and also, possibly, because the original distribution of mineral values in shallow deposits has been altered by considerable remobilization.

In addition to the "standard initial parameters" (Section 11.2), the program input parameters include "combining" thickness, initial minimum cutoff grade, tonnage factor, and, optionally, an additive constant "ALPHA1" (Section 16.0) used in the statistical analysis. There are several ways of combining the sample data (Section 13.3.1), and several output options are provided (Section 13.3.2).

For each block, ORSAC processes all the sample sets provided by UCON, combines consecutive samples in each set into an interval of minimum mining thickness, and determines the average grade of that interval. If the average grade is equal or greater than the assigned initial cutoff grade, the interval is considered as part of the representative sample population of the total volume of material and is saved; otherwise it is rejected. If the last interval graded is less than the minimum mining thickness, it is expanded to the minimum thickness by combining with zero grade material. The total

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thickness of material above cutoff represented by the sample set is calculated.

When all sample sets in the block have been processed, the average grades of all intervals that have met cutoff become the elements of the sample population on which all statistical analysis will be performed. Figure 13.1 is a listing of the combined intervals.

These grades are arranged into ascending order and the 10th, 50th, and 90th percentiles are calculated (Note: this differs from the discussion in Section 16) which refers to the 20th, 50th, and 80th percentiles.).

The additive constant ALPHA is calculated for the transformation:

$$X = \text{LOGe}(z + A) \text{ (Section 16) .}$$

The calculation should be such that the value of ALPHA should be equal to or greater than zero. Negative skewness of the assay data may sometimes cause ALPHA to be computed as a negative value. Therefore, an option is provided to enter a program parameter -- ALPHA1 - (Section 13.2.3) which will be substituted for ALPHA if a negative value for ALPHA is computed. If no value is submitted for ALPHA1 and ALPHA is negative, ALPHA is set to zero.

The arithmetic mean, standard deviation, variance, skewness and kurtosis are calculated.

The grades are then converted to the logarithmic (to the base e) values by:

$$G1 = \text{LOGe}(G+A)$$

where,

G = original grade,

A = additional constant ALPHA (or ALPHA1),

G1 = logarithm of the original grade.

The statistical parameters of the logarithmic values (mean, standard deviation, variance, etc) are determined and a chi-square test is applied to the converted grades to determine their goodness-of-fit to a log normal distribution (i.e. a normal distribution of the logarithmic values).

Sichels t-estimator of the mean is determined and the "fractional" tonnage and average grade at cutoffs from 0.01 to 0.60% U308 are calculated and optionally printed. The statistical parameters of the arithmetic and log-normal distributions are printed as well as the results of the chi-square test. Figure 13.2 shows an example of the chi-square test results.

The "actual" estimated tons and average grade at each cutoff are then calculated and printed; an example is shown on Figure 13.3.

When the last block has been processed, a summary of estimated reserves for all blocks in the given run are presented at cutoffs of 0.01 to 0.60 percent U308.

13.2 PROGRAM INPUT PARAMETERS

13.2.1 Combining Thickness

The combining thickness chosen for a run should approximate the minimum mining thickness anticipated in mining operations. It may be from 2 to 50 feet, to the nearest tenth of a foot.

13.2.2 Minimum Grade Cutoff

This cutoff determines the minimum average grade at which combined intervals will be accepted into the sample population. It should not be confused with the mining grade cutoffs used in the RESUV and SCOR programs. The results of the ORSAC program provide the amount of material available at various mining cutoff grades.

The minimum grade cutoff may be from 0.005 to 0.20 percent U308 or V205. If the sample data are not truncated, best results are obtained at around 0.01 or 0.02 percent U308 or V205. For both uranium and uranium, some experience must be gained in evaluating a deposit using ORSAC. Evaluation of the "goodness-of-fit" of the chi-square test for varying parameters is necessary.

13.2.3 Tonnage Factor

The tonnage factor is entered in cubic feet per ton, to the nearest one hundredth of a cubic foot.

13.2.4 ALPHA Constant

If an entry is made for the alpha constant (Section 13.1), it will be used, providing the value for ALPHA determined in the program is negative. If no entry is made, it will be determined in the program>

13.3 OPTIONS

13.3.1 Program Run Options

The program provides four options for establishing the intervals of "combined" assays which will comprise the sample population on which the statistical analyses will be performed. The relative merits of these options is discussed below.

13.3.1.1 Option 1: Uranium, Combined Intervals at Equal Thickness

All uranium samples of each sample set are combined into intervals, the thickness of which are established by the "combining thickness".

If the sample data represent equal sample intervals or the intervals are sufficiently small that they may be combined into larger intervals without

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"splitting" samples, then the results of the analyses will be statistically "pure", i.e. will conform to the theoretical model as it was originally derived. Incremental equal readings from gamma-log data, therefore, provide the best sample assay types with which to run the ORSAC program. Uranium assay data consisting of unequal sample intervals may be analyzed by ORSAC but the results cannot be considered statistically "valid". If the sample intervals are equal but at thicknesses of, say, 4 feet, then the combining thickness should be an even multiple of the the sample interval thickness, i.e. 4, 8, 12 (etc.) feet.

13.3.1.2 Option 2: Uranium, Total Sample Interval Above Minimum Cutoff

All samples of a sample set are combined into one interval. Any contiguous intervals, having thickness equal to or greater than the combining interval and averaging less than the minimum grade cutoff, are deleted. The "grade x thickness" products of the total sample intervals become the elements of the ORSAC sample population. The average thickness of the combined intervals is used as the average thickness of the deposit

This option provides a means of using ORSAC with sample data which are at intervals of uneven thicknesses. The results provide a good estimate of the average grade and thickness of the entire deposit, but do not equate the mineral distribution to the method by which the deposit will be mined. It is therefore most useful for evaluating deposits which are either "massive" or relatively uniform in thickness, but will not accurately represent the eventual extraction of ore from thinly-bedded deposits of varying thickness.

13.3.1.3 Option 3: Vanadium, Combined Intervals at Equal Thickness

This option is the same as Option 1 (above), but uses vanadium assays. It may only be used, of course, if vanadium sample data are present in the applicable sample data file(s). If the sample data represents equal sample intervals, and the combining thickness is as stipulated under Option 1, then the results may be considered valid.

13.3.1.4 Option 4: Vanadium, Total Sample Interval Above Minimum Cutoff

This option is the same as Option 2 (above), but uses vanadium assays, if present in the applicable sample assay data file(s).

13.3.2 Program Output Options

There are five output options. These are listed below in hierarchy of ascending operation, i.e. whichever option is chosen, all the higher (but not lower) options will automatically take effect.

13.3.2.1 Option 1: Output of Combined Assays

All the combined intervals used in the sample population will be listed for each block processed.

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13.3.2.2 Option 2: Output Fractional Tonnage

The percent of total tons available at each mining grade cutoff will be listed for each block.

13.3.2.3 Option 3: Output of Statistical Parameters and Chi-Square Test

The statistical parameters for both arithmetic and log-normal distribution "fits" will be listed for each block.

13.3.2.4 Option 4: Output of Tons and Average Grade

The estimated tons (and average grade) available at each mining grade cutoff (from 0.01 to 0.60%U308/V205 will be listed for each block.

13.3.2.5 Option 5: Summary For All Blocks

The total combined estimated tons (and average grade) for all blocks will be listed. If there is only one block, and Option 4 is also in effect, this summary is not necessary and will be automatically deleted

13.4 RUNNING THE PROGRAM - INTERACTIVE ENTRY

13.4.1 Standard Initial Entries

Standard entries are as described in Section 11.2.

13.4.2 Program Control Entries

13.4.2.1 ->Reserves Analysis Option

Section 13.3.1; enter "1", "2", "3", or "4" depending on which of the corresponding options described in Section 13.3.1 is desired. Do not request options 3 or 4 if the data on the intermediate data file(s), specified in the appropriate UCON file, do not contain vanadium sample assay data!

13.4.2.2 -> Combining Thickness

Section 13.2.1; enter the thickness of the interval into which sample will be combined; up to 3 significant digits; to the nearest tenth of a foot; may not be 0.

13.4.2.3 -> Minimum Cutoff Grade

Section 13.2.2; enter the minimum grade at which combined intervals will be accepted; up to 3 significant digits; to the nearest thousandth of one per cent U308; may be 0, but 0.01 generally gives better results.

13.4.2.4 -> Tonnage Factor

Section 13.2.3; enter the tonnage factor; up to 3 significant digits; to the nearest hundredth of a cubic foot per ton; between 5 and 60 cu. ft. per ton.

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13.4.2.5 -> *Additive Constant*

Section 13.2.4; enter the "ALPHA" constant; up to 2 significant digits; to the nearest thousandth of one percent U308; may be 0.

13.4.2.6 -> *Output Option*

Section 13.3.2; enter "1", "2", "3", "4", or "5".

PROGRAM ORSAC

ORSAC STATISTICAL ANALYSIS BASED ON COMPOSITED URANIUM ASSAY VALUES.

CUTOFF 8. FEET OF .010
 TOTAL FOOTAGE OF SAMPLES ABOVE CUTOFF 1664.0
 AVERAGE THICKNESS 46.22
 TOTAL AREA 2000000.
 TONNAGE FACTOR 15.0

**** SUMMARY OF HOLE STATISTICS ****

TOTAL NUMBER OF HOLES PROCESSED FOR RUN/BLOCK = 47;

OF THESE:

27 HAD INTERVALS ABOVE MINIMUM CUTOFF GRADE.
 202 203 214 C216 TEST 2 TEST 3 TEST 5 TEST 6 TEST 7 TEST 8
 TEST 9 TEST10 TEST11 TEST13 TEST14 TEST15 TEST16 TEST 1 TEST 2 TEST2
 TEST 3 TEST 4 TEST 5 TEST 6 TEST 7 TEST10 TEST11

9 HAD INTERVALS > MIN. CUTOFF. SOME ASSAYS DELETED BY EDIT.
 204 213 214 201 215 216 126 128 129

10 COMPLETELY "BARREN". (NO ASSAYS REPORTED FOR HOLE).
 A216 136 137 139 TEST 1 TEST 4 TEST12 TEST17 TESTA1 TEST 9

1 HAD ASSAYS, BUT INTERVAL DEFINED BY EDIT SPECS WAS BARREN.
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ARITHMETIC ESTIMATORS-	COUNT	MEAN	STD. DEV.	VARIANCE	SKWENESS	KURTOSIS	PCI10	PCI50	PCI90	ALPHA
	209	.159	.5563	.3080	12.7689	175.8257	.023	.077	.236	.005
ORDERED ASSAY DATA										
	.010	.010	.010	.010	.014	.015	.017	.017	.018	
	.018	.018	.019	.019	.019	.019	.020	.022	.022	
	.023	.025	.025	.025	.025	.025	.026	.026	.028	
	.029	.029	.029	.030	.031	.031	.032	.032	.033	
	.034	.034	.035	.035	.036	.036	.036	.038	.039	
	.039	.039	.039	.039	.039	.039	.040	.040	.040	
	.046	.047	.047	.048	.049	.050	.051	.052	.053	
	.054	.054	.054	.055	.056	.056	.058	.058	.058	
	.059	.059	.059	.060	.061	.061	.063	.064	.064	
	.065	.068	.069	.070	.070	.070	.071	.071	.075	
	.075	.075	.076	.076	.077	.079	.079	.080	.081	
	.082	.082	.083	.086	.097	.100	.100	.101	.102	
	.102	.103	.103	.104	.106	.108	.110	.110	.110	
	.111	.113	.113	.116	.119	.120	.121	.121	.123	
	.126	.130	.131	.132	.132	.132	.133	.133	.133	
	.136	.136	.137	.138	.140	.140	.142	.145	.154	
	.155	.158	.160	.164	.165	.166	.169	.174	.174	
	.175	.176	.178	.179	.181	.183	.184	.195	.199	
	.207	.217	.217	.219	.220	.222	.233	.236	.239	
	.242	.242	.245	.253	.295	.295	.297	.305	.318	
	.378	.414	.454	.809	.809	.929	1.132	1.133	7.841	

FIGURE 13.1
EXAMPLE OF RESULTS OF ORSAC RUN ON 1 BLOCK
INITIAL SUMMARY AND ORDERED COMBINED INTERVALS

PROGRAM ORSAC

ORSAC STATISTICAL ANALYSIS BASED ON COMPOSITED URANIUM ASSAY VALUES.

CHI SQUARE NORMALITY TEST

SUMMARY STATISTICS

		ARITHMETIC VALUE
NO. POINTS	209	
MEAN	-.24484840E+01	.08642453
VARIANCE	.82803190E+00	
STD. DEV.	.91214740E+00	
SKEWNESS	.78459260E+00	
KURTOSIS	.52784340E+01	
MAX VALUE	.20600000E+01	7.84597300
MIN VALUE	-.42141390E+01	.01478505
RANGE	.62741390E+01	7.83118800

VALUE OF ALFA USED IN ANALYSIS - .005

CLASS INTERVAL (LOGS)	OBSERVED FREQUENCY	THEORETICAL FREQUENCY	CLASS INTERVAL (ARITH- U308)
LESS THAN			LESS THAN .004
-.54129630E+01	0	.00000000E+00	.004 .007
-.49568890E+01	0	.00000000E+00	.007 .011
-.45008150E+01	0	.00000000E+00	.011 .018
-.40447420E+01	4	.83725400E+01	.018 .028
-.35886680E+01	16	.13708310E+02	.028 .044
-.31325940E+01	31	.25284820E+02	.044 .069
-.26765210E+01	39	.36503940E+02	.069 .109
-.22204470E+01	34	.41260780E+02	.109 .171
-.17643730E+01	42	.36503940E+02	.171 .270
-.13082990E+01	28	.25284820E+02	.270 .426
-.085222580E+00	9	.19526870E+02	.426 .673
-.039615200E+00	0	.00000000E+00	.673 1.062
-.059921650E-01	6	.25539800E+01	1.062 1.675
-.51599540E+00	0	.00000000E+00	GREATER THAN 1.675
GREATER THAN	0	.00000000E+00	

COMPUTED CHI SQUARE .16850540E+02
 DEGREES OF FREEDOM 6
 PROBABILITY LEVEL .99637510E-02
 (i.e. PROBABILITY OF A LOWER CHISQR VALUE ("WORSE" FIT) FOR THE CORRESPONDING DEGREES OF FREEDOM)

LOGARITHMIC ESTIMATORS -	LOG MEAN	LOG VAR.	SICHEL-T	16TH PCT	50TH PCT	84TH PCT	ALPHA
	-2.4485	.828	.126	.035	.086	.215	.005

FIGURE 13.2
 EXAMPLE LISTING OF THE ORSAC CHI-SQUARE TEST

PROGRAM ORSAC

ORSAC STATISTICAL ANALYSIS BASED ON COMPOSITED URANIUM ASSAY VALUES.

ORSAC GRADE-TONNAGE DISTRIBUTION BY CUTOFF; SUMMARY FOR BLOCK.

TONNAGE CALCULATIONS -

TOTAL TONS = TOTAL AREA * AV. THICK * NUMBER MIN. HOLES / TOTAL NUMBER HOLES / TON. FACTOR
 CUTOFF TONS = TOTAL TONS * FRACTIONAL TONNAGE (FROM STAT. ANALYSIS)
 POUNDS U308 = CUTOFF TONS * AV. GRADE * 20

TOTAL TONS - 4720568. AT AN AVERAGE GRADE OF .126- TOTAL POUNDS U308 - 11882530.

CUTOFF GRADE	TONNAGE ABOVE CUTOFF GRADE	AVERAGE GRADE	POUNDS U308	CUTOFF GRADE	TONNAGE ABOVE CUTOFF GRADE	AVERAGE GRADE	POUNDS U308
.010	4595718.	.129	11867310.	.310	369301.	.508	3748778.
.020	4317184.	.136	11782360.	.320	346217.	.520	3603762.
.030	3969082.	.146	11608200.	.330	324903.	.533	3465615.
.040	3608704.	.157	11356730.	.340	305197.	.546	3333963.
.050	3263675.	.169	11047600.	.350	286955.	.559	3208457.
.060	2945525.	.182	10699260.	.360	270049.	.572	3088770.
.070	2657724.	.194	10326760.	.370	254361.	.585	2974589.
.080	2399850.	.207	9941632.	.380	239788.	.598	2865618.
.090	2169931.	.220	9552463.	.390	226235.	.610	2761584.
.100	1965496.	.233	9165462.	.400	213618.	.623	2662220.
.110	1783718.	.246	8785065.	.410	201860.	.636	2567282.
.120	1621960.	.259	8414337.	.420	190892.	.649	2476540.
.130	1477828.	.273	8055324.	.430	180650.	.661	2389776.
.140	1349194.	.286	7709310.	.440	171079.	.674	2306780.
.150	1234174.	.299	7377033.	.450	162125.	.687	2227363.
.160	1131124.	.312	7058797.	.460	153742.	.700	2151339.
.170	1038603.	.325	6754624.	.470	145887.	.712	2078536.
.180	955364.	.338	6464321.	.480	138519.	.725	2008794.
.190	880318.	.351	6187529.	.490	131604.	.738	1941959.
.200	812520.	.365	5923864.	.500	125109.	.750	1877884.
.210	751145.	.378	5672994.	.510	119003.	.763	1816439.
.220	695475.	.391	5434380.	.520	113259.	.776	1757489.
.230	644884.	.404	5207457.	.530	107852.	.789	1700916.
.240	598822.	.417	4991657.	.540	102757.	.801	1646604.
.250	556810.	.430	4786446.	.550	97955.	.814	1594448.
.260	518423.	.443	4591275.	.560	93425.	.827	1544343.
.270	483292.	.456	4405641.	.570	89148.	.839	1496193.
.280	451088.	.469	4229039.	.580	85109.	.852	1449907.
.290	421521.	.482	4060993.	.590	81291.	.864	1405398.
.300	394334.	.495	3901051.	.600	77680.	.877	1362586.

FIGURE 13.3
 EXAMPLE OF THE ORSAC GRADE-TONNAGE DISTRIBUTION BY GRADE CUTOFF

14.0 PROGRAM SCOR**14.1 CONCEPTS AND GENERAL OPERATIONS**

Program SCOR (System for Calculating Ore Reserves) is designed to calculate open pit or underground uranium reserves for predetermined blocks, using the general outline method. Two types of reserve calculations are made. One is based on the strict analysis of ore intervals defined by cutoffs (Sections 14.2.1 -14.2.5), resulting in estimate of quantities, cost, and value of recoverable pounds of U3O8. The other is a general grade-tonnage ("G-T") vs cutoff analysis based on combined sample intervals (Section 14.2.6). The latter is useful for preliminary evaluation and does not distinguish between open pit and underground modes; it does not utilize cost data and results in an in-place reserve estimation.

For most effective use, SCOR should be run in two phases; the first by using the grade-tonnage vs cutoff distribution for obtaining a preliminary overview of the deposit(s), and the second by using the ore-interval analysis for making a final ore reserves calculation.

Selection of sample assay data for a SCOR RUN is done by creating an appropriate UCON file (Section 7.0) which will specify the area of each block and the sample assay data to be included in the block. The designated UDAT files must be "intermediate" files, i.e. they must have been previously created by a URDAT RUN. For both the ore-interval and G-T distribution analysis, reserves are calculated one block at a time.

All other program controls and data are entered interactively at the beginning of the RUN and vary according to the options desired. Input parameters may be generally classified as:

1. Program controls which specify the type of calculations and output.
2. "Physical" data, including:

Minimum mining thickness, type1 and type2 waste thicknesses, upper and lower dilution thicknesses, tonnage factor, ore grade cutoff(s), protore grade cutoff(s), processing recovery rates, mine extraction, and, for open pit calculations, the pit slope angle and the estimated length of the perimeter at the base of the pit.

3. "Economic" data, including:

Operating costs: direct mining, applicable indirect mining, haulage, royalty, processing, overburden removal, and mining waste removal.

Mineral value: price per pound U3O8.

Capital Costs: mine plant and equipment, primary development, processing facilities, and additional capital costs.

4. Standard entries as described in Section 11.2.

General descriptions of the "physical" and "economic" data are provided in Section 9.0 and should be reviewed before running the SCOR program. Some of these data apply to all cutoffs being evaluated; others must be repeated for each cutoff (the interactive prompts will indicate if multiple entries are required).

Figure 14.1 illustrates the general flow of SCOR. When the ore-interval analysis option is requested, all or most of the physical and economic data are requested. If only the G-T distribution analysis is requested, then there are no requests for economic data, and physical data consist simply of a combining thickness, a tonnage factor, and an "area-of-influence".

The RUN options and interactive entry are described in Section 14.3.

14.2 ORE RESERVES ANALYSIS METHODOLOGY

SCOR has two methods for calculating reserves; the ore-interval analysis and the grade-tonnage distribution analysis. These may be run together or separately. The methodology and results of the ore-interval analysis are described in Sections 14.2.1 through 14.2.55, and those for the G-T distribution in Section 14.2.6.

14.2.1 Ore Interval Analysis, General

The ore-interval analysis must be specified for either open pit (Section 14.2.1) or underground (Section 14.2.2) mode. A summary of the data entered interactively for an ore-interval analysis is automatically output on the p-o file at the beginning of each block analysis. Figures 14.2 and 14.3 show print-output summaries for an open pit and underground run, respectively.

The ore-interval analysis requires that grade cutoffs (Section 9.1.4) be established. At least one cutoff must be specified; up to five are permitted. Cutoff calculations are described in Section 14.2.1.

After the cutoff grades are determined, they, and all their associated data, are sorted in increasing order of grade (%U308) so that once a cutoff, at which there are no ore intervals, is reached no further processing or output of sample set results will be needed.

The ore-interval analysis for one block is carried out in two stages.

1. Each selected sample set is evaluated to determine the ore intervals (Section 9.1.2) and associated factors (waste, etc.) that may exist at each of the cutoff grades (Sections 9.1.4 and 14.2.1.1 specified during interactive entry. All pertinent calculations for each sample set are stored. Results of the sample set analysis are (optionally) listed on the p-o file.
2. If a final reserve estimate has been requested, the results of stage 1 are used to calculate the reserves and associated econom-

ics; these are automatically summarized and listed on the p-o file (Section 14.2.4).

14.2.1.1 Cutoff Grade Determination

SCOR provides two methods for establishing grade cutoffs, in percent U308, for ore (Section 9.1.2) and protore (Sections 9.1.9 and 14.2.2.2) intervals. The first is simply to enter one or more arbitrary cutoff values; the second is to determine cutoff based on break-even cost-versus-value. Only one of the methods may be used in any given RUN, except that arbitrary protore cutoffs may be used with cost/value ore cutoffs. The choice of the number and type of cutoffs is made during interactive entry.

Protore cutoffs are only used in the open pit "mode", and only if specifically requested.

There is no conceptual distinction made between ore cutoffs for the open pit mode and those for the underground mode. For open pit analysis, the concept of overburden-to-ore ratio is not considered, although this ratio may, of course, be calculated from the results of a RUN. To determine the effect of overburden, ore (and protore, if applicable) intervals are determined first, and then the net value of the intervals is tested to see if it is sufficient to support overburden.

Arbitrary cutoffs for both ore and protore are simply entered according to the choice of the user and will not be affected by any of the other data - cost, recovery, etc.

Cost/value cutoffs, however, are based strictly on other data, and are determined as follows.

1. For ore cutoff ("COG"), the equation for an integrated operation is:

$$\text{COG} = (\text{CMN} + \text{CMNI} + \text{CHL} + \text{CML} + \text{RLT}) / (\text{PPP} * 0.2 * \% \text{RCV}/100)$$

(For an independent operation, the term "CML" is null)

2. For protore cutoff ("COGP"), the equation is:

$$\text{COGP} = (\text{CMNW} + \text{CMLP} + \text{RLTP}) / (\text{PPP} * 0.2 * \% \text{RCVP}/100)$$

where,

CMN = direct operating ore mining cost/ton.

CMNI = applicable indirect operating mining cost per ton.

CHL = cost/ton of hauling ore to processing plant.

CML = operating cost/ton for ore processing.

RLT = ore royalty cost/ton.

PPP = price (\$) per pound U308.

%RCV = ore processing recovery, in percent.

CMNW = cost/ton for waste removal (to waste destination).

CMLP = estimated future total protore processing cost/ton.

RLTP = estimated future protore royalty cost
(arbitrarily = $0.5 * \text{RLT}$).

%RCVP = estimated future protore processing recovery, in percent.

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Note: the protore cutoff is estimated on the basis that, during mining operations, it would be handled in the same manner as waste, but would later be available for processing. Protore does not enter into the final reserves economic calculations.

14.2.2 Open Pit Analysis

14.2.2.1 Determine Ore Intervals

Ore intervals meeting minimum grade and thickness requirements are delineated according to the criteria discussed in Sections 9.1.2, 9.1.3, 9.1.4, 9.1.6, and 9.1.7.

In bringing ore intervals up to minimum mining thickness, actual sample grades are used (i.e. there is no assigned "dilution grade"). After dilution, the average grade of each interval is again tested against the cutoff grade and the interval is rejected if the cutoff grade is not met. Any adjacent samples which comprise a interval equal to or greater than the minimum mining thickness and are less than cutoff are not included in the ore intervals but are considered as waste intervals (Section 9.1.7) or (optionally) potential protore intervals (Section 9.1.9).

If upper and/or lower dilution thicknesses (Section 9.1.8.2) have been submitted, ore intervals are diluted by the appropriate thickness at the grade of the sample adjacent to those comprising the ore interval and are again checked. The interval-generating algorithm always attempts to obtain the highest grade-thickness product possible within the limits of the prescribed criteria.

For example, assume two intervals ("#1" and "#3") meeting cutoff, but each less than minimum mining thickness, and separated by a sub-cutoff interval ("#2") which would be less than minimum mining thickness after dilution were added to the bottom of #1 and the top of #3 (the diluting material would have to come out of #2, of course). In such a case, the following combinations would be tested: #1, only, diluted to minimum mining thickness with the highest adjacent materials; #3, only, with same procedure as #1; #1, #2, and #3 combined and diluted. The combination meeting cutoff grade requirements, and with the highest GT, would be chosen. If no combination was found to meet cutoff, then all the intervals would be placed in a waste category!

14.2.2.2 Determine Protore Intervals

When all ore intervals have been defined, then, if the protore option (Section 14.3.16) has been chosen, the inter-ore waste intervals are analyzed to determine if they contain any intervals of material at minimum mining thickness, plus dilution, with an average grade between the protore cutoff grade and the ore cutoff grade. If so they are assigned as protore. However, protore intervals cannot be separated from ore or other protore intervals by any sub-protore-cutoff waste intervals which are less than minimum mining thickness.

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14.2.2.3 Determine Category of Mining Waste Intervals

Any waste intervals between ore intervals (or remaining between ore and/or any defined protore intervals) are categorized as "type1" or "type2" mining waste as follows:

If a type2 waste minimum thickness has been submitted, then all inter-ore waste intervals are tested against that thickness. Any waste intervals equal to or greater than the type2 waste thickness are assigned accordingly. Lesser intervals are assigned as type1 waste. If no type2 waste thickness has been submitted, then all waste is assigned to type1 waste.

14.2.2.4 Cost Vs Value (Unit Value)

At each cutoff, the value of the ore intervals (and protore intervals, if defined) is then compared to the cost for mining these intervals as well as removing a representative column of total overlying materials including both mining waste and overburden. For a simple case (no protore or type2 waste designation) the comparison is made by determining TCOST (unit total cost) and TVAL (unit total value).

Total unit cost is expressed as:

$$\text{TCOST} = (D \times \text{CR}) + (\text{TO}(1) \times \text{CM}) + ((\text{TW}(1) \times \text{CW}) + (\text{T}(2) \times \text{CM})) + ((\text{TW}(2) \times \text{CW}) + (\text{TO}(3) \times \text{CM})) \dots + ((\text{TW}(N-1) \times \text{CW}) + (\text{TO}(N) \times \text{CM})) \quad (1)$$

where,

D = Depth from surface to first ore interval

CR = Cost of overburden removal per yard divided by 27.

N = Number of ore intervals

TO(j) = Thickness of the jth ore interval (j = 1,N)

CM = Total operating cost per ton divided by TF

TW(j) = Thickness of the jth type1 waste interval (j = 1,N-1)

CW = Cost of mining type1 waste per ton divided by TF

TF = Tonnage factor (cubic feet per ton)

Total unit value is expressed as:

$$\text{VO}(j) = 0.20 \times \text{GO}(j) \times \text{price} \times \text{RCV}/100. \quad , \text{ and}$$

$$\text{TVAL} = (\text{TO}(1) \times \text{VO}(1) + ((\text{TO}(2) \times \text{VO}(2)) \dots + ((\text{TO}(N) \times \text{VO}(N)) \quad (2)$$

where,

TO(j) = Thickness of the jth ore interval (j = 1,N)

GO(j) = Trade in %U308 of TO(1), (j = 1,N)

Price = Dollars per pound U308 (price)

VO(1) = Dollar per ton value of ore, (j = 1,N)

RCV = Ore processing recovery (in percent).

The ore intervals are evaluated successively downward and the net cumulative TVAL(j) - TCOST(j) values at the bottom of each jth interval are saved. If any of the value are positive, the ore interval are considered to "carry" the representative overburden, otherwise they do not "carry" the overburden.

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If protore and/or type2 waste are added to the analysis, then, for cost, the terms of the interval in brackets ("()") in equation (1) are expanded to:

$$((TY(j-1) \times CY) + (TP(j-1) \times CW) + (TW(j-1) \times CW) + (TO(j) \times CM)) ,$$

and, for value, those in brackets in equation (2) to:

$$((TP(j-1) \times VP(j-1)) + (TO(j) \times VO(j)) \text{ for value,}$$

where,

$$VP(j-1) = 0.20 \times GP(j-1) \times \text{price} \times \text{PRCV}/100.$$

N = Number of ore intervals,

TY(j-1) = Thickness of type2 waste, above the jth ore interval,

CY = cost/ton for removing type2 waste divided by TF

TW(l-1) = Thickness of type1 mining waste, also above the jth ore interval,

CW = cost/ton for removing type1 waste (or protore) divided by TF (if for protore, includes protore processing cost/ton)

TP(j-1) = Thickness of protore between the jth and (j-1)th ore interval.

VP(j-1) = Dollar per ton value of protore

GP(j-1) = Average grade in %U308 of TP(j-1)

PRCV = Protore processing recovery (in percent)

Note: The results of the unit value analysis provide a source of data for additional analyses beyond those currently carried out in this version of the SCOR program (see Section 14.2.5)

14.2.2.5 Sample-Set Output from Open Pit Analysis

The resulting ore intervals determined from each sample set may be optionally printed to show either details of each zone or summaries for the sample set.

14.2.2.6 Detailed sample-set output

Figure 14.4 shows the detailed out put from two sample sets - one contains ore intervals, and the other is barren. The input data used for the ore interval analysis are the same as shown in Figure 14.2. Most of the listing is self-explanatory. For each sample set, there are two header lines which list hole number, coordinates, etc. If ore intervals are defined, they are listed below the header lines.

Three elevations are shown in the header lines - the original collar elevation of the sample set; the pit elevation, if such exists, and; the "edit" or "working" elevation. The latter is the elevation from which all depths to ore and other intervals are currently referenced. If no editing has taken place and there is no pit elevation, the working elevation will be the same as the collar elevation; if there has been no editing, but a pit elevation exists, then the working elevation will be the same as the pit elevation. In an open pit RUN, any pit elevation automatically becomes the working elevation (unless an edit is made) since, by definition, all material down to the current pit bottom has been removed (Section 5.2.4).

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For reference (and plotting) purposes, an asterisk is placed beside either the collar elevation or the pit elevation to indicate which should represent the "ground" surface. The header entry for "DEPTH" indicates the total depth sampled from the collar elevation.

The top of each ore interval is designated by elevation or depth from the working elevation (see Section x.x). The thickness and average grade of each ore interval is shown, as well as the cumulative unit value (Section 14.2.2.4) at the base of the ore interval. Individual waste and protore thicknesses are not shown. Following the listing of the individual ore intervals is a summary which includes total thickness and average grade of ore, total waste thickness, and total thickness and average grade of protore. Type2 waste and protore are not indicated if not requested interactively.

14.2.2.7 Summary sample-set output

Figure 14.5 shows the summary sample-interval output for several sample sets, including the ones shown in Figure 14.4. The purpose of this output (in contrast to the detailed output described above) is to save printing space when a large number of sample sets is processed and a printout of the results for individual sample sets is desired.

For each sample set, there is always one 64-column header entry. If ore intervals are calculated for one cutoff, they will appear on the same line as the header information. Ore interval data for the second and third cutoffs will be on a second line, and those for fourth and fifth cutoffs on a third line. If no intervals have been defined for a requested cutoff, no entry will be made for that cutoff.

Each data value is preceded by a single upper- or lower-case alphabetic code. The codes for the header data are:

- "b"= block code,
- "a"= area number,
- "h"= hole (sample set) number,
- "p"= property code,
- "Y"= north coordinate,
- "X"= east coordinate,
- "C"= reference elevation if it is the collar elevation or
- "P"= reference elevation if it is the pit elevation,
- "E"= working (edit) elevation,

and following the latter is a single-digit number indicating the number of cutoffs for which ore intervals were determined. The interactive-input data summary (Figure 14.2) must be referenced for cutoffs and prices.

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Ore-interval data for each cutoff is preceded by an asterisk ("*") followed by the "sequence" number of the cutoff, i.e. the numerical sequence, from left to right, in which it is listed on Figure 14.2. The alphabetic codes are:

"D"= depth from working elevation to top of first ore interval,
"T"= total thickness of all ore for the sample set at given cutoff,
"G"= average grade (%U308) of the combined ore intervals,
"\$"= cumulative dollar value of the ore intervals,
"w"= total thickness of type1 waste,
"W"= total thickness of type2 waste,
"t"= total protore thickness, and,
"g"= average grade (%U308) of combined protore.

Note: when the the ore intervals "carry" the overburden, the dollar value ("\$") represents the lowest ore interval which reflects a break-even or positive net unit value.

14.2.3 Underground Analysis

The sample sets are analyzed and listed the same way as for the open pit analysis (Section 14.2.2), with the following exceptions.

1. The minimum (type1) waste thickness between ore zones may be less than the minimum mining thickness.
2. Waste thickness greater than the "upper" type1 waste thickness (Section 9.1.7.1) are taken into account, but not stored or listed.
3. There is no protore calculation.
4. Pit elevations are ignored and the collar elevation is always the reference elevation.
6. In the unit value analysis, the net value of each zone is calculated and listed separately and not cumulated.

Figures 14.6 and 14.7 show, respectively, detailed and summary sample interval output from the the same sample sets used as illustrations in Section 14.2.2, but analyzed on an underground basis. The input data used for the ore interval analysis are the same as shown in Figure 14.3.

14.2.4 Block Ore Reserves Summary

Figures 14.8 and 14.9 show listings of final ore reserves summaries from the ore interval analysis for open pit and underground reserves, respectively. The results are developed as described in Sections 14.2.4.1 and 14.2.4.2.

14.2.4.1 Ore Reserve Quantities

After all sample sets in a block have undergone the ore-interval analysis, a final ore reserve estimate is calculated at each cutoff grade as follows:

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"SUM" is the summation function. If options have not been taken to compute certain variables, then their value will be null.

"s-s" is equivalent to "sample set(s);
 "tn" = tons;
 "lb" = pounds U308,
 "yd" = cubic yards.

"NT" is the total number of s-s utilized in the block analysis.
 "N1" = number of s-s having ore intervals at the cutoff.
 "NW1" = number of s-s having type1 waste intervals.
 "NW2" = number of s-s having type2 waste intervals.
 "NP" = number of s-s having protore intervals.

"Ti" and "Gi" may be considered as the total thickness and weighted average grade of the ore intervals in each s-s of N1.

"TVi" = depth to 1st ore interval in each s-s of N1.
 "TW1i" = total thickness of type1 waste intervals in each s-s of NW1.
 "TW2i" = total thickness of type2 waste intervals in each s-s of NW2.
 "TPi" and "Gpi" = total thickness and weighted average grade of the protore intervals in each s-s of NP.
 "TF" = tonnage factor in cubic feet per ton.
 "%XTRC" = percent ore extraction.
 "%RCV" = percent ore processing recovery.
 "%PRCV" = estimated future percent protore processing recovery.
 "OT" = average thickness of ore in the block = $\text{SUM}(T_i, i=1, N1) / N1$.
 "OG" = average grade of ore = $\text{SUM}(T_i \times G_i, i=1, N1) / \text{SUM}(T_i, i=1, N1)$.
 "BA" = the assigned area of the block
 "OA" = ore area = $BA \times N1 / NT$.

"TONSIP" = tn ore in-place = $OA \times OT / TF$.
 "LBSIP" = lb (in ore) in-place = $TONSIP \times OG \times 20$.
 "TONSXT" = tn ore extractable = $TONSIP \times \%XTRC/100$.
 "LBSXT" = lb (in ore) extractable = $LBSIP \times \%XTRC/100$.
 "LBSRC" = lb recoverable from ore = $LBSXT \times \%RCV/100$.
 (For an "independent" operation, if the value is based strictly on uranium contained in ore, then $LBSRC = LBSXT$.)

For open pit:

"TWT1" = average type1 thickness, prorated over OA = $\text{SUM}(TW1, i=1, NW1) / N1$.
 "TWT2" = average type2 thickness, prorated over OA = $\text{SUM}(TW2, i=1, NW2) / N1$.
 "TONSW1" = tn type1 waste extractable = $TWT1 \times OA \times (\%XTRC/100) / TF$.
 "TONSW2" = tn type2 waste extractable = $TWT2 \times OA \times (\%XTRC/100) / TF$.
 "POT" = average protore thickness, prorated over OA = $\text{SUM}(TP_i, i=1, NP) / N1$.
 "POG" = average grade of protore = $\text{SUM}(TP_i \times GP_i, i=1, NP) / \text{SUM}(TP_i, i=1, NP)$.
 "PTONSXT" = tn protore extractable = $POT \times OA \times (\%XTRC/100) / TF$.
 "PLBSXT" = lb (in protore) extractable = $PTONSXT \times 20 \times POG$.
 "PLBSRC" = lb recoverable from protore = $PLBSXT \times \%PRCV/100$.

"TOV" = average direct overburden thickness = $\text{SUM}(TV_i, i=1, N1) / N1$.
 (The overburden thickness is based on s-s having ore intervals, but is assigned to the entire block area, see Section 9.1.5.)
 "OVBYD" = yd overburden directly overlying block-area = $BA \times TOV / 27$.
 "TTOT" = average thickness to bottom of pit = $TOV + OT + TWT1 + TWT2 + POT$.
 "ANGL" = pit slope angle.

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"P" = length of pit perimeter (same as block area perimeter).
"BKSLPF" = backslope function (see Section 9.1.5.1).
"BSLP" = yd overburden in backslope = BKSLPF(ANGL,TTOT,P).
"OVBTOT" = total yd overburden = OVBYD + BSLP.

For underground:

"TWT1" = average type1 thickness, prorated over OA = $SUM(TW1,i=1,NW1) / NI$.
"TONSW1" = tn type1 waste extractable = $TWT1 \times OA \times (\%XTRC/100) / TF$.

14.2.4.2 Ore Reserve Economics

After the quantities (Section 14.2.3.1) have been determined, then costs are applied as follows:

The "cost" is in dollars and the variable names defined in Section 14.2.3.1 are not redefined.

Operating costs:

"CM" = direct mining cost/ton.
"CMI" = applicable indirect cost/ton.
"CH" = haulage cost/ton.
"CML" = ore processing cost/ton.
"CRLT" = ore royalty cost/ton.
"CW1" = type1 waste removal cost/ton.
"CW2" = type2 waste removal cost/ton.
"CP" = protore removal cost/ton = CW1 (open pit only).
"CPML" = protore processing cost/ton (open pit only).
"CPRLT" = protore royalty cost/ton = $CRLT \times 0.5$ (open pit only).
(This cost is an approximation of the total capital and operating cost per ton estimated for future protore processing.)
"TOCPT" = total ore mining operating cost/ton =
= $CM + CMI + CH + CML + CRLT$
(If operation is "independent", CML = null.)
"TMOC" = total ore mining operating cost = $TONSXT \times TOCPT$.
"TW1C" = total type1 waste removal cost = $TONSW1 \times CW1$.
For open pit/protore option,
"TW1C" = $(PTONSXT + TONSW1) \times CW1$
(the protore is considered as waste in the cost calculation and is not included in the final cost vs value comparison.)
"TW2C" = total type2 waste removal cost = $TONSW2 \times CW2$
"TOC" = total operating cost = $TMOC + TW1C + TW2C$

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Capital costs:

"CPYD" = overburden removal cost/yd (open pit only).
"COVB" = total overburden removal cost = DVBTOT x CPYD
(open pit only).
"CPL" = mine plant and equipment cost/ton (prorated to TONSXT).
"CPML" = processing plant construction cost/ton (prorated as above).
(If operation is "independent, CPML is null.)
"COH" = "other capital" cost/ton (prorated as above)
"CPD" = Primary development cost/ton
(prorated as above, underground only).
"TCC" = Total capital cost:
For open pit operation,
"TCC" = COVB + (CPL + CPML + COH) x TONSXT.
For underground operation,
"TCC" = (CPD + CPL + CPML + COH) x TONSXT.

Overall cost:

"TCOST" = total operating cost + total capital cost = TOC + TCC

Total value from ore:

"PPP" = price in dollars per pound U308.
"TVAL" = total value = PPP x LBSRC

Net value from ore:

"NVAL" = total value less total cost = TVAL - TCOST.
"NVPT" = net value per ton = NVAL / TONSXT.
(If NVPT is less than -999, it is set to -999.)
"NVPPP" = net value per pound U308 = NVAL / LBSRC

The potential net value per ton of any protore, as it sits, is:

"NVPTP" = ((PPP x PLBSRC) - (PTONSXT x (CPRLT+CPML))) / PTONSXT
"NVPPP" = net value per pound protore =
((PPP x PLBSRC) - (PTONXT x (CPRLT+CPML))) / PLBSRC

14.2.5 SCOR Plot File

One of the most useful applications of the ore-interval analysis has been that of creating a sample-set location plot (or "drill-hole location map") which shows the position, sample number, and ore-interval attributes of each sample set. Such plots can be created for each cutoff, or, with appropriate symbols, certain attributes may be shown for all cutoffs at once.

Using such plots: blocks may be revised and measured; open pit outlines may be delineated on the basis of the "carry" or "not carry" determinations for each sample set; ore interval thickness, grade, grade-thickness-product, and unit value may be isopached and contoured.

Additionally, cross sections may be plotted to show the relative vertical positions of the various ore intervals.

It was not within the scope of the current URAD project to include plotting programs. However, the option is provided to create a summary output plot file containing data from which plots can be generated if a plotter and appropriate software are available. This file is termed a "SCOR plot file" and

may be optionally created any time that SCOR is run in the ore-interval analysis mode.

14.2.5.1 Structure of the Plot File

The plot file consists entirely of 80- (or less) column, formatted records. Figure 14.10 is plot file made during the same run that created the output listed in Figure 14.4. Each file will begin with two "heading" records and data for each block will begin with a "block identification" record. Following each block record is a series of sample-set records. The number of sample-sets will correspond to the number of valid sample sets processed for the block. For each sample set there is one header record, followed a number of records equivalent to the number of cutoffs for which ore intervals were established in the given sample set.

1. The first "heading" record of the plot file contains a 3-character code followed by the title (RUN description) used in making the RUN (Section 11.2). The 3-character code indicates whether the RUN was made in the open pit ("O-P") mode or the underground mode ("U-G").

2. The second "heading" record indicates the associated price (\$ per pound U308) and grade ("P-C:") of each cutoff used in the RUN i.e. for two cut offs, the first at 30 dollars per pound and a grade value of 0.124 %U308, and the second at 25 dollars per pound and value of 0.146 %U308, the record would be:

P-C: \$ 30.00- 0.124%. \$ 25.00- 0.146%. \$

The price-cutoff sets are separated by a period(".") and the last dollar sign ("\$\$") may be ignored.

3. The block identification record contains the block code, block sequence number and the block area (square feet). The following record:

BLK:BK1; SEQ#:1; AREA: 1000000.

indicates that the block code is "BK1", the block was the first in the sequence of blocks processed, and the block area is 1000000 square feet.

4. If the sample set records (following each block identification record) in Figure 14.10 are compared with the sample set summary records listed in Figure 14.5, it is plain that the record formats of both header and ore-interval records in the plot file correspond almost exactly to the corresponding entries in the summary printout. The only differences are that in the plot file: a) the asterisk ("*") at the the beginning of each ore interval record is deleted, and; b) the header and ore-interval entries are on individual records instead of two per line!

With these two exceptions in mind, the format descriptions discussed in Section 15.2.2.5 may be directly applied to the the sample-set data in the plot file.

14.2.6 Grade-Tonnage Distribution Analysis

SCOR provides the option of combining samples from each sample set into an interval of predetermined thickness (termed the "combining thickness") and classifying the average grade of each interval by grade intervals of 0.01 %U308. The intervals are actually (0.001 - 0.009, 0.01 - 0.019, 0.02 - 0.029, etc), up to 2.999, then they are at 0.50% U308 up to 5% and all greater than 5% are lumped together. Beyond 0.50, only class intervals containing values are listed.

The combining thickness is specified during interactive entry.

After all the sample sets from a block have been processed, the number of intervals falling into each class will have been automatically calculated. Tons of "ore" in each class interval is obtained by:

$$T0 = NCI \times CT \times AREA/TF,$$

and pounds U308 (LB) are obtained by:

$$LB = T0 * 20 \times GA \text{ where,}$$

NCI is the number of combined intervals falling into the given class.

CT is the combining thickness

AREA is either a designated "area-of-influence" or the total block area divided by the number of valid sample sets processed for the block; the option is specified during interactive entry.

TF is the tonnage factor.

GA is the average grade of the class interval.

From this base, a cumulative distribution of in-place tons of ore and pounds of U308 is constructed (Figure 14.11).

The estimate of reserves obtained in this fashion is only a rough approximation, but it provides some initial insight into the overall grade-tonnage distribution of a given set of data. It may be used in estimating initial tonnages and average grades, at various grade cutoffs, to apply when attempting to establish royalties, processing recovery rates, and capital and operating costs which depend on the magnitude of operations.

SCOR may be run to obtain that incremental analysis without any other analysis being carried out.

14.3 OPTIONS AND INTERACTIVE ENTRIES

This section combines discussion of the options and interactive entries required when running the program.

Specific entries are noted by "->"; no entry reference is made for obvious "Yes" or "No" responses. For additional information on any of the variables, review applicable descriptions in Sections 9.0, 10.0, 11.0, 14.1, and 14.2. WARNING! The interactive entries for SCOR are somewhat extensive if the ore-interval analysis mode is chosen. Therefore, make sure that you have de-

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cided on input and output files and interactive entry options and data before proceeding with a RUN.

14.3.1 Standard Entries

The standard entries and options described in Section 11.2 will not be repeated here. The term "request" used below denotes an interactive prompt.

14.3.2 Plot Output File

A plot output file (or "plot file") will be generated only on request. If the option is taken, a request will be made for the desired file name. File naming procedures and precautions are the same as for other URAD output files. Each time a plot file is generated, it will destroy any previous data on any existing file of the same name.

14.3.3 Output Of Ore-Interval Analysis

The results of the ore-interval analysis of each sample set may be printed or suppressed:

- >0 to suppress. If to be printed, the options are:
- >1 to output detailed listing (Section 14.2.1.5.1) on the p-o file.
- >2 to output summary listing (Section 14.2.1.5.2) on the p-o file.

14.3.3.1 Choice of Ore Interval Position Reference

If the detail listing (option 1 above) is chosen, then there is also the choice of whether the position of the ore intervals (Figures 14.4 & 14.6) are to be referenced by elevation or depth from the working elevation.

- >blank for depths;
- >1 for elevations.

14.3.4 Calculation And Output Of The G-T Distribution Analysis

The grade-tonnage distribution analysis is only calculated on request. When calculated, it is automatically printed on the p-o file; if requested, the following additional requests for area-of-influence method and combining thickness will be made.

14.3.4.1 Choice of Area-of-Influence Method

The area-of-influence (Section 14.2.6) to be assigned to each combined interval may be determined either by:

- >1 to enter a specific value for the area of influence; or,
- >2 to divide the block area entered in the UCON block identifier record by the total number of sample sets included within the block; this is done internally by the program.

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If option "1" is chosen, there will be a request to enter the value of the area-of influence;

-> area-of-influence; up to 8 significant digits; to (reasonably) nearest square foot

14.3.4.2 Combining Thickness

-> combining thickness ("CT"), Section 14.2.6).

14.3.5 Option For Reserves Calculation By Ore-Interval Analysis

If this option is taken, reserves will be calculated using the ore-interval analysis methods described in Section 14.2.4. A summary of the reserve analysis for each block will be automatically output on the p-o file.

Note: If this option is taken, there will be a later request for underground or open pit capital cost data, as well as for all the required physical and economic data needed for the ore-interval analysis. If it is not taken, but output of the sample-set analysis (detail or summary) and/or the plot file is requested, there will be no request for capital cost data, but the physical/economic data will be requested. If none of the above are requested, and the G-T analysis is not requested, the program will terminate! If only the G-T analysis is requested, then, most of the physical/economic data will not be required.

14.3.6 Open Pit Versus Underground Analysis

If the ore-interval sample-set output, ore-interval reserves analysis, or plot file output are requested, the RUN must be designated as "open pit" or "underground". Whichever mode is chosen will apply to all blocks included in the RUN. The open pit option assumes that the block areas outline the bottom of postulated open pits.

->1 for open pit mode;
->2 for underground mode.

14.3.7 Integrated Versus Independent Options

The ore-interval analysis must be run in the "integrated" or "independent mode (Section 9.2).

If ->Y (integrated), processing costs and recovery rates will be requested and used in all applicable portions of the analysis.

If ->N (independent), processing costs will not be requested or included in the reserves analysis, but the option will be later provided as to whether or not an ore processing recovery rate (other than 100%) should be applied in determining ore cutoff or pounds U308.

14.3.8 Ore Cutoff Grades

14.3.8.1 Number of Cutoff Grades

A request is made for the number of cutoffs to be run; at least one is mandatory, and up to five may be chosen; -># cutoffs.

14.3.8.2 Arbitrary versus Cost/Price Cutoff

The choice is provided as to whether (->Y) cutoff grades will be calculated as function of cost vs price (Sections 9.1.4.1 and 14.2.1.1), or whether (->N) they will be directly submitted as arbitrary values (Sections 9.1.4.2 and 14.2.1.1).

If the "arbitrary" option is chosen, then: ->ore cutoff(s) in tenths, hundredths, or thousandths of one percent U308; a decimal point is mandatory; a zero cutoff grade is not allowed.

If the cost/price option is chosen, the cutoffs are calculated internally.

14.3.9 Standard Physical Parameters and Operating Cost Entries

If the ore-interval analysis option has been chosen, the entries for this section will all be requested regardless of whether the run is designated as "open-pit" or "underground". For some data elements, the number of entries will be equivalent to the number of cutoffs requested (Section 14.3.8.1); these are indicated by the term ("for # cutoffs"). For others, only one entry will be required.

Even if arbitrary cutoffs have been submitted, and the given RUN is being made simply to determine ore reserve quantities at those cutoffs, it is nevertheless prudent to submit reasonable values for costs and price.

14.3.9.1 Ore Processing Operating Cost

->Processing Cost; up to 5 significant digits; to the nearest hundredth of a dollar; for # cutoffs.

14.3.9.2 Ore Processing Recovery Rate

->Ore processing recovery rate; up to 5 significant digits; to the nearest hundredth of one percent; for # cutoffs; may not be zero.

14.3.9.3 Uranium Prices

->Price per pound U308; up to 5 significant digits; to nearest hundredth of a dollar; for # cutoffs, no zero entries allowed.

14.3.9.4 Minimum Mining Thickness

->Minimum mining thickness; up to 3 significant digits; to nearest 10th of a foot; must be at least 1 foot. In the open pit mode, this will also be used as the protore minimum mining thickness, as well as the minimum type1 waste thickness.

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14.3.9.5 Upper Dilution Thickness

->Upper dilution thickness; up to 3 significant digits; to nearest 10th of a foot; may be zero. This is the thickness of "diluting" material adjacent to and above defined ore intervals which will be added to the intervals at the grade of the diluting material.

14.3.9.6 Lower Dilution Thickness

->Lower dilution thickness; same criteria as "upper dilution thickness" (above). Material is adjacent to and below ore intervals.

14.3.9.7 Tonnage Factor

->Tonnage factor in cubic feet per ton; up to 4 significant figures; to nearest hundredth of a cubic foot; may not be zero. This will be used to convert volumes of ore, waste, and protore into tons.

14.3.9.8 Direct Mining Cost

->Direct mining cost/ton; up to 5 significant digits; to nearest hundredth of a dollar; may be zero; for # cutoffs. Includes all cost for mining a ton of ore and moving to the point where it will be first loaded and transported to a processing plant, i.e. to the point where the "haulage" cost comes into effect.

14.3.9.9 Applicable Indirect Mining Cost

->Applicable indirect mining cost/ton; up to 5 significant digits; to nearest hundredth of a dollar; may be zero; for # cutoffs. Any operating cost not included in direct mining, haulage, royalty, or processing, but which is affected by the ore "production" rate.

14.3.9.10 Haulage Cost

->Haulage cost /ton; up to 5 significant digits; to nearest hundredth of a dollar; may be zero; any cost of transporting material which is not included in the direct mining cost.

14.3.9.11 Ore Royalty Cost

->Royalty cost in dollars per ton of ore; up to 5 significant digits; to nearest hundredth of a dollar; may be zero; for # cutoffs. Value of remuneration to a third party directly or indirectly based on the uranium content of the ore itself.

14.3.10 Open-Pit-Specific Factors

The following requests will only be made if RUN has been designated in the open pit mode.

14.3.10.1 Overburden Removal Cost

->Overburden removal cost per cubic yard; up to 4 significant digits; to nearest hundredth of a dollar; may be zero.

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14.3.10.2 Option for Charging Open Pit Type1 Waste Removal Cost

->Y if type1 waste removal is prorated to direct mining cost.

->N if not.

If ->Y, the type1 waste intervals will be calculated, but not costed.

If ->N, then there will be a request for entry of the type1 waste cost, and,

->Type1 waste removal cost/ton (of waste); up to 4 significant digits; to nearest hundredth of a dollar; may be zero; for # cutoffs.

14.3.10.3 Option for a Type2 Waste Removal Cost

This option provides for the designation of a minimum thickness of type2 waste.

->Y to assign a type2 waste category;

->N if no such waste breakdown is desired.

If yes, requests for the minimum thickness and removal cost of type2 waste will follow. The maximum type1 waste thickness is set equal to the minimum Type2 waste thickness, and waste intervals at that thickness will be charged to Type 1 waste.

->minimum type2 waste thickness; up to 3 significant digits; to nearest 10th of a foot; must be greater than minimum mining thickness.

->cost/ton for removing Type2 waste; up to 5 significant digits; to nearest hundredth of a dollar; may not be zero.

14.3.10.4 Protore Option

The number of protore cutoffs entered will be equivalent to the number of ore cutoffs established. The protore cutoff established at any given ore cutoff must be less than that ore cutoff.

The protore option is provided in two modes: 1) if ore cutoffs have been submitted arbitrarily, and; 2) if determined by cost vs price.

For mode 1:

->0 for no protore analysis;

->1 for arbitrary protore cutoffs.

For mode 2:

->0 for no protore analysis;

->1 for arbitrary protore cutoffs;

->2 for protore cutoffs calculated by cost vs price as described in Section 14.2.1.1.

If the protore option is not taken, the next three requests will be omitted

Protore Processing Cost:

->Protore Processing cost per ton of protore; up to 5 significant digits; to nearest hundredth of a dollar; may be zero; for # cutoffs. To be useful,

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this value should reflect the best estimate of the total cost per ton which will be incurred in the future for processing the protore.

Protore Processing Recovery Rate:

->Anticipated protore recovery rate, in percent; up to 5 significant digits; to nearest hundredth of a percent; may not be zero; for # cutoffs.

Protore Cutoffs:

If the choice has been made (Section 14.3.10.4) for protore calculations by arbitrary cutoff, then:

->Protore cutoff(s), in tenths, hundredths, or thousandths of one percent U308; a decimal point is mandatory.

If the choice is for the protore cutoffs to be determined by cost versus price, they will be calculated internally.

After protore cutoffs are established, each is displayed on the monitor along with its corresponding ore cutoff. This provides the opportunity to compare the two, and a "prompt" option is provided to reconsider the protore cutoffs. If ->Y, interactive entry flow will return to the very beginning of the protore sequence. If ->N, the entry sequence will continue, but if any protore cutoff is not less than its corresponding ore cutoff, an error message will be displayed and the flow will return to the beginning of the protore sequence, so that the protore option may be reconsidered.

Following the completion of the protore option procedures, the program will branch to the open pit capital costs option.

14.3.11 Underground-Specific Operation Factors

The following requests will only be made if the RUN has been designated in the underground mode.

14.3.11.1 Option for Charging Underground Type1 Waste Removal Cost

->Y if type1 waste removal is prorated to direct mining cost. ->N if not.

14.3.11.2 Minimum Type1 ("Stope") Waste Thickness

->Minimum thickness of type1 waste intervals; up to 4 significant digits; to nearest 10th of a foot; must be at least 2 feet; may be less than minimum mining thickness.

The minimum Type1 waste thickness is always considered in the ore interval calculations. However, if its removal cost is prorated to the direct mining cost (Section 14.3.11.1), no type1 waste will be calculated or costed, and the next two requests will be omitted.

14.3.11.3 Maximum Type1 ("Stope") Waste Thickness

->Maximum thickness of type1 waste intervals; up to 4 significant digits; to nearest 10th of a foot; must be greater than minimum type1 thickness.

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14.3.11.4 Cost for Removal of Typel Waste

->Cost/ton for removing typel waste; up to 5 significant digits; to nearest hundredth of a dollar.

14.3.12 Open-Pit-Specific Capital Cost Factors

If the option has been selected for reserves calculation (Section 14.3.5), the following requests will be made relating to open pit capital costs.

14.3.12.1 Pit Slope Angle

->The pit slope angle; up to 4 significant digits; to the nearest hundredth of a degree. Must be from 30 to 90 degrees. If it is entered as 90 degrees, no backslope will be calculated, and the next two requests, calling for pit perimeter data will not be made.

14.3.12.2 Pit Perimeter Length

If the valid pit slope angle (between 30 and 90 degrees) is entered (above), then there will be two requests. The first is for the number of blocks to be processed for a given RUN, as defined by the applicable UCON file.

Then, for each block, there will be a request for the corresponding pit perimeter to be used for the backslope calculation. The block numbers in the "prompts" correspond to the sequence in which the blocks are arranged in the UCON file, and do not refer to any block "code" identifications which may be assigned to the blocks. The first "B#" instruction record represents the first block; the second "B#" record, the second block; and so forth. For each block prompt, enter:

->The total length, in feet, of the perimeter at the base of the pit; up to 6 significant digits; to nearest foot; may not be zero This should be the perimeter of the block area. If there are any other primary development costs besides the overburden removal, they must be included in "other capital costs" (below).

14.3.12.3 Underground-Specific Capital Cost

If the option has been selected for reserves calculation (Section 14.3.5), the following request will be made relating to undergorund capital costs.

14.3.13 Primary Development Cost

->Primary development cost/ton of ore; up to 5 significant digits; to nearest hundredth of a dollar; may be zero; for # cutoffs.

14.3.14 General Capital Costs

If the option has been selected for reserves calculation (Section 14.3.5), the following requests will be made relating to both open pit and underground modes.

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14.3.14.1 Ore Processing Capital Cost

This request will not be made, if RUN is in the "independent" mode.

->Capital cost for ore processing, per ton of ore; up to 5 significant digits; to nearest hundredth of a dollar; may be zero, for # cutoffs.

14.3.14.2 Mine Plant and Equipment Capital Cost

->Capital cost for mine plant and equipment, per ton of ore; Up to 5 significant digits; to nearest hundredth of a dollar; may be zero; for # cutoffs.

14.3.14.3 "Other" Capital Cost

->Any other applicable capital cost, per ton ore; up to 5 significant digits; to nearest hundredth of a dollar; may be zero; for # cutoffs.

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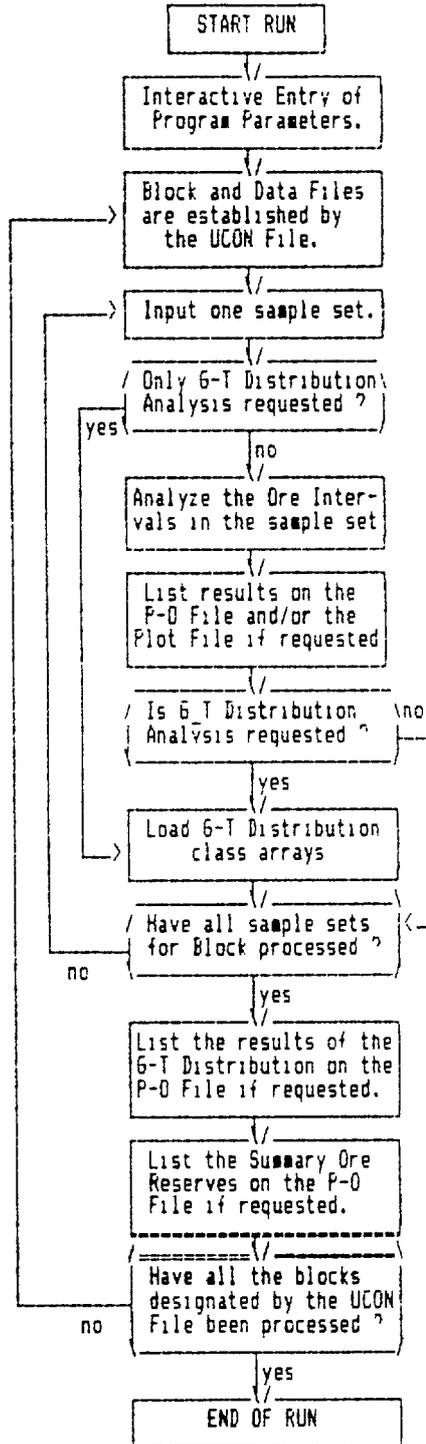


FIGURE 14.1
GENERALIZED FLOW OF THE SCOR PROGRAM

URAD ORE RESERVE SYSTEM

*** "SCOR" ORE RESERVES CALCULATION ***

BEGIN 1ST BLOCK; RUN BY: P DEVERGIE ; DATE: MAR 88 . PAGE 1
 RUN:1 BLOCK WITH ALL HOLES; 1 BLOCK EXCLUDING AREA VVV; UDATCB.B FILE.

THE FOLLOWING ANALYSIS IS BASED ON AN OPEN PIT OPERATION

LISTED BELOW IS A REVIEW OF THE COSTS AND OTHER MINING FACTORS:

OPERATION IS INTEGRATED.

TYPE1 WASTE COST IS NOT PRORATED TO MINING COST.

VALUE/PRICE PER LB U3O8	\$ 35.00	\$ 30.00	\$ 25.00
SURFACE MNG CUTOFF PCT U3O8	.114	.139	.173
PROTORE MNG CUTOFF PCT U3O8	.029	.033	.040
PROTORE PROCESS. RECVRY (%)	50.00	60.00	70.00
PROTORE PROCESS. COST/TON	\$ 10.00	\$ 12.00	\$ 14.00
EST. PROTORE RLTY COST/TON	\$ 2.50	\$ 2.00	\$ 1.50
DIRECT ORE MINING COST/TON	\$ 50.00	\$ 55.00	\$ 60.00
APPLICABLE INDRCT COST/TON	\$ 3.00	\$ 2.00	\$ 1.00
TYPE1 MNG. WASTE COST/TON	\$ 12.00	\$ 14.00	\$ 16.00
MIN. TYPE1 WASTE THICKNESS	2.00		
TYPE2 MNG. WASTE COST/TON	\$ 2.00	\$ 2.00	\$ 2.00
MIN. TYPE2 WASTE THICKNESS	8.00		
OVERBURDEN REMOVAL COST/YD	\$.50	\$.60	\$.75
ORE PROCESSING COST PER TON	\$ 15.00	\$ 17.00	\$ 19.00
ORE PROCESSING RECOVERY (%)	93.00	95.00	97.00
ORE ROYALTY COST/TON	\$ 5.00	\$ 4.00	\$ 3.00
HAULAGE COST/TON	\$ 1.00		
TONNAGE FACTOR, (FT**3/TON)	15.00		
UPPER DILUTION (FEET)	.50		
LOWER DILUTION (FEET)	.50		
MINIMUM MNG. THICKNESS (FT.)	2.00		
PERCENT MINE EXTRACTION (%)	90.00		
CAP. COST/TON PROC. PLANT	\$ 15.00	\$ 17.00	\$ 19.00
CAP. COST/TON MINE PL & EQP.	\$ 5.00	\$ 4.00	\$ 3.00
OTHER CAPITAL COSTS/TON	\$ 3.00	\$ 3.00	\$ 3.00
PIT SLOPE ANGLE (DEGREES)	60.00		
PERIMETER AT PIT BASE (FT)	5000.		

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FIGURE 14.2
EXAMPLE OF THE SUMMARY OUTPUT OF THE "INTERACTIVE DATA AND CONTROLS
(FOR OPEN PIT MODE)

URAD ORE RESERVE SYSTEM

*** "SCOR" ORE RESERVES CALCULATION ***

BEGIN 1ST BLOCK; RUN BY: P DEVERGIE ; DATE: MAR 88 . PAGE 1
 RUN: TEST ON ONE BLOCK, ALL DATA FROM UDATCB.B FILE.

THE FOLLOWING ANALYSIS IS BASED ON AN UNDERGROUND OPERATION

LISTED BELOW IS A REVIEW OF THE COSTS AND OTHER MINING FACTORS:

OPERATION IS INDEPENDENT.
 TYPE1 WASTE COST IS NOT PRORATED TO MINING COST.

VALUE/PRICE PER LB U308	\$ 35.00	\$ 30.00	\$ 25.00	\$ 20.00
UNDERGRD MNG CUTOFF PCT U308	.114	.139	.173	.200

NO PROTORE CALCULATION REQUESTED.

DIRECT ORE MINING COST/TON	\$ 60.00	\$ 65.00	\$ 70.00	\$ 75.00
APPLICABLE INDRCT COST/TON	\$ 1.00	\$ 2.00	\$ 3.00	\$ 4.00
STOPE MNG. WASTE COST/TON	\$ 15.00	\$ 15.00	\$ 15.00	\$ 15.00
MIN. STOPE WASTE THICKNESS	2.00			
MAX. STOPE WASTE THICKNESS	10.00			
ORE PROCESSING COST PER TON	\$.00	\$.00	\$.00	\$.00
ORE PROCESSING RECOVERY (%)	100.00	100.00	100.00	100.00
ORE ROYALTY COST/TON	\$ 2.00	\$ 3.00	\$ 4.00	\$ 5.00
HAULAGE COST/TON	\$ 2.00			

TONNAGE FACTOR, (FT**3/TON)	15.00
UPPER DILUTION (FEET)	.00
LOWER DILUTION (FEET)	.00
MINIMUM MNG. THICKNESS (FT.)	8.00

PERCENT MINE EXTRACTION (%)	95.00
CAP. COST/TON PRIM. DEVL.P.	\$ 5.00 \$ 5.00 \$ 5.00 \$ 5.00
CAP. COST/TON MINE PL & EQP.	\$ 3.00 \$ 3.00 \$ 3.00 \$ 3.00
OTHER CAPITAL COSTS/TON	\$ 2.00 \$ 2.00 \$ 2.00 \$ 2.00

FIGURE 14.3
EXAMPLE OF THE SUMMARY OUTPUT OF THE "INTERACTIVE DATA AND CONTROLS"
(FOR UNDERGROUND MODE)

URAD ORE RESERVE SYSTEM

TYP	N-COORD	E-COORD	ELEV.	PIT-ELV.	ED-ELV.	DEPTH	PRPTY	AREA-#	HOLE-#
D-P	6000	5000	11000.5	10850.5	10850.5	465.5	VDATA	VVV	TEST 2
WILL ORE CARRY OVERBURDEN			YES	YES	YES				
GRADE CUTOFF, PERC U3O8.			.114	.139	.173				
MAX COST / LB U3O8			\$ 35.00	\$ 30.00	\$ 25.00				
DEPTH TO FIRST ORE ZONE			259.5	279.0	279.0				
ELEV. AT TOP OF 1ST ZONE			10571.0	10571.5	10571.5				
*** ORE ZONE, THICKNESS			3.00	5.00	5.00				
GRADE OF ORE, %U3O8.			.120	.406	.406				
CUMUL. NET UNIT VALUE.			\$ -4.0	\$ 44.6	\$ 29.9				
*PROTORE, THICKNESS			5.00	.00	.00				
GRADE OF PROTORE %U3O8			.056	.000	.000				
DEPTH TO TOP OF ORE			279.00	297.00	297.00				
*** ORE ZONE, THICKNESS			5.00	8.50	8.50				
GRADE OF ORE, %U3O8.			.406	.270	.270				
CUMUL. NET UNIT VALUE.			\$ 56.3	\$ 85.3	\$ 54.8				
*PROTORE, THICKNESS			.00	.00	.00				
GRADE OF PROTORE %U3O8			.000	.000	.000				
DEPTH TO TOP OF ORE			297.00	.00	.00				
*** ORE ZONE, THICKNESS			8.50	.00	.00				
GRADE OF ORE, %U3O8.			.270	.000	.000				
CUMUL. NET UNIT VALUE.			\$ 112.2	\$.0	\$.0				
OVERBURDEN THICKNESS (FT)			259.50	279.00	279.00				
TOTAL ORE THICKNESS (FT)			16.50	13.50	13.50				
ORE, AVERAGE GRADE (%U3O8)			.284	.320	.320				
TOT. PROTORE THICKNESS (FT)			5.00	.00	.00				
PROTORE, AVG GRADE (%U3O8)			.056	.000	.000				
TOTAL TYPE1 WASTE (FT)			.00	.00	.00				
TOTAL TYPE2 MNG. WASTE			24.50	13.00	13.00				

TYP	N-COORD	E-COORD	ELEV.	PIT-ELV.	ED-ELV.	DEPTH	PRPTY	AREA-#	HOLE-#
D-P	5000	5000	7000.5	6850.5	6850.5		URDAT	AAA	TESTA1

THIS SAMPLE SET IS BARREN FOR THE INTERVAL TESTED.

FIGURE 14.4
EXAMPLE OF DETAILED LISTING OF ORE INTERVALS ANALYSIS BY SAMPLE SET
(FOR OPEN PIT MODE)

URAD ORE RESERVE SYSTEM

SCOR ANALYSIS OF INTERMED. UDAT FILE 'UDATCB.B', DATE: MAR 86
 RUN: OPEN PIT ORE INTERVAL ANALYSIS; COMPARE SUMMARY VS DETAIL P-C.
 BLK: BLK1, TWO HOLES, FILE UDATCB.B, FOR COMPARISON.
 NO PLOT-DATA OUTPUT REQUESTED RUN BY: P DEVERGIE

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bbk1	aVVV	hTEST 2	pVDATA	Y	6000	X	5000P10850.5	E10850.5	3	#1	D	259.5	T	16.50	G	.284	*	112.2	W	.0	M	24.5	t	5.0	g	.056							
#2	D	279.0	T	13.50	G	.320	*	85.3	W	.0	M	13.0	t	.0	g	.000	#3	D	279.0	T	13.50	G	.320	*	54.8	W	.0	M	13.0	t	.0	g	.000

bbk1	aAAA	hTESTA1	pURDAT	Y	5000	X	5000P 6850.5	E 6850.5	0																
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FIGURE 14.5
EXAMPLE OF SUMMARY LISTING OF ORE INTERVALS ANALYSIS BY SAMPLE SET
(FOR OPEN PIT MODE)

URAD ORE RESERVE SYSTEM

TYP	N-COORD	E-COORD	ELEV.	PIT-ELV.	ED-ELV.	DEPTH	PRPTY	AREA-#	HOLE-#
UND	6000	5000	11000.5	10850.5	11000.5	465.5	VDATA	VVV	TEST 2
GRADE CUTOFF, PERC U3O8.			.114	.139	.173	.200			
MAX COST / LB U3O8			\$ 35.00	\$ 30.00	\$ 25.00	\$ 20.00			
DEPTH TO FIRST ORE ZONE			410.0	424.0	424.0	424.0			
ELEV. AT TOP OF 1ST ZONE			10590.5	10576.5	10576.5	10576.5			
*** ORE ZONE, THICKNESS			23.50	9.50	9.50	9.50			
GRADE OF ORE, %U3O8.			.117	.242	.242	.242			
NET UNIT VALUE FOR ZONE \$			26.0	46.4	26.6	6.9			
ELEV. AT TOP OF ORE			10553.50	10553.50	10553.50	10553.50			
*** ORE ZONE, THICKNESS			8.00	8.00	8.00	8.00			
GRADE OF ORE, %U3O8.			.286	.286	.286	.286			
NET UNIT VALUE FOR ZONE \$			72.2	53.2	34.2	15.2			
TOTAL ORE THICKNESS (FT)			31.50	17.50	17.50	17.50			
ORE, AVERAGE GRADE (%U3O8)			.160	.262	.262	.262			
TOTAL STOPE WASTE (FT)			.00	.00	.00	.00			

TYP	N-COORD	E-COORD	ELEV.	PIT-ELV.	ED-ELV.	DEPTH	PRPTY	AREA-#	HOLE-#
UND	5000	5000	7000.5	6850.5	7000.5		URDAT	AAA	TESTA1
THIS SAMPLE SET IS BARREN FOR THE INTERVAL TESTED.									

FIGURE 14.6
EXAMPLE OF DETAILED LISTING OF ORE INTERVALS ANALYSIS BY SAMPLE SET
(FOR UNDERGROUND MODE)

URAD ORE RESERVE SYSTEM

SCOR ANALYSIS OF INTERMED. UDAT FILE *UDATCB.B *, DATE: MAR 88 PAGE 3
 RUN: 1 BLOCK WITH ALL HOLES; 1 BLOCK EXCLUDING AREA VVV; UDATCB.B FILE.
 BLK: BLK1, TEST ON FILE UDATCB.B, ALL HOLES
 PLOT-DATA OUTPUT ON FILE *A:SCORPLOT.P *. RUN BY: P DEVERGIE

*** SUMMARY OF RESERVES ANALYSIS FOR BLOCK BK1, OPEN PIT OPERATION. ***
 (Note: when "No. Sample Points in Ore" = 0, values null at given cutoff.)

ORE CUTOFF, [%U308]	.114	.139	.173
PROTORE CUTOFF, [%U308]	.029	.033	.040
VALUE PER POUND U308 (\$)	35.00	30.00	25.00
TOTAL BLOCK AREA (SQ. FT.)	2000000	2000000	2000000
NUMBER OF SAMPLE POINTS	45	45	45
NUMBER OF SAMPLE POINTS IN ORE	33	33	29
TOTAL ORE AREA, (SQ. FT.)	1466667	1466667	1288889
ORE, AVERAGE THICKNESS (FT)	11.04	9.09	8.70
ORE, TONS IN PLACE	1079111	888889	747556
ORE, AVERAGE GRADE [%U308]	.487	.568	.655
ORE, TONS EXTRACTABLE	971200	800000	672800
ORE, POUNDS U308 EXTRACTABLE	9461760	9093046	8815360
PROTORE, AVERAGE THICKNESS (FT)	2.8	3.0	3.8
PROTORE, TONS EXTRACTABLE	250667	261333	290667
PROTORE, AVERAGE GRADE [%U308]	.067	.077	.050
PROTORE, LBS U308 EXTRACTABLE	337098	401179	289907
TYPE1 WASTE, AVERAGE THICKNESS (FT)	.9	.7	.7
TYPE1 WASTE, TONS EXTRACTABLE	82667	57333	53333
TYPE2 WASTE, AVERAGE THICKNESS (FT)	2.6	1.9	1.7
TYPE2 WASTE, TONS EXTRACTABLE	232000	170667	133333
OVERBURDEN, AVERAGE THICKNESS (FT)	395.8	396.9	372.6
OVERBURDEN, DIRECT (CU. YDS.) (x10**3)	29321	29400	27601
BACKSLOPE & RAMP (CU. YDS.) (x10**3)	10924	10828	9544
TOTAL OVERBURDEN (CU. YDS.) (x10**3)	40246	40229	37145
RECOVERABLE POUNDS U308 (ORE)	8799438	8638394	8550900
RECOVERBL POUNDS U308 (PROTORE)	168549	240707	202935
TOTAL RECOVERABLE POUNDS U308	8967986	8879102	8753834
TOT. OPERATING COST (\$/TON)	74.00	79.00	84.00
OPERATING COST, TOTAL \$.	(x10**3) 71869	63200	56515
TYPE1 WASTE (+ PROT), TOTAL \$.	4000000	4461333	5504000
TYPE2 WASTE COST, TOTAL \$.	464000	341333	266667
OVERBRDN REMOVAL COST, TOTAL \$ (x10**3)	20123	24137	27859
REMAINING CAP. COST (\$/TON)	23.00	24.00	25.00
TOTAL CAPITAL COST, TOTAL \$.	(x10**3) 42461	43337	44679
\$ VALUE, EXTRACT. LBS U308 (ORE) (x10**3)	331162	272791	220384
\$ VALUE, RCVRBL LBS U308 (ORE) (x10**3)	307980	259152	213772
NET \$ VALUE FOR BLOCK.	(x10**3) 189187	147812	106807
NET VALUE, \$ PER POUND U308 IN ORE	21.50	17.11	12.49
NET VALUE, \$ PER LB U308 IN PROTORE	16.41	14.80	2.80

*** SUMMARY OF HOLE STATISTICS ***

TOTAL NUMBER OF HOLES PROCESSED FOR RUN/BLOCK = 47;

OF THESE:

12 HAD INTERVALS ABOVE LOWEST CUTOFF GRADE USED FOR THE RUN.
 21 HAD INTERVALS > MIN. CUTOFF, SOME ASSAYS DELETED BY EDIT.
 1 HAD ASSAYS, BUT NO INTERVALS ABOVE LOWEST CUTOFF GRADE.
 1 HAD ASSAYS, BUT NO INTERVALS; SOME ASSAYS DELETED BY EDIT.
 10 WERE "BARREN". (NO ASSAYS REPORTED FOR HOLES).
 2 WERE TOTALLY REJECTED BY ELEV, OR LITH/ELEV EDIT.

FIGURE 14.8
 EXAMPLE OF ORE RESERVES SUMMARY FROM THE ORE INTERVAL ANALYSIS
 (FOR OPEN PIT MODE)

URAD ORE RESERVE SYSTEM

SCOR ANALYSIS OF INTERMED. UDAT FILE 'UDATCB.B', DATE: MAR 88
 RUN: TEST ON ONE BLOCK, ALL DATA FROM UDATCB.B FILE.
 BLK: BLK1, TEST ON FILE UDATCB.B, ALL HOLES
 NO PLOT-DATA OUTPUT REQUESTED RUN BY: P DEVERGIE

*** SUMMARY OF RESERVES ANALYSIS FOR BLOCK Bk1, UNDERGROUND OPERATION. ***
 (Note: when "No. Sample Points in Ore" = 0, values null at given cutoff.)

ORE CUTOFF, (%U308)	.114	.139	.173	.200
VALUE PER POUND U308 (%)	35.00	30.00	25.00	20.00
TOTAL BLOCK AREA (SQ. FT.)	2000000	2000000	2000000	2000000
NUMBER OF SAMPLE POINTS	47	47	47	47
NUMBER OF SAMPLE POINTS IN ORE	26	24	22	21
TOTAL ORE AREA, (SQ. FT.)	1106383	1021277	936170	893617
ORE, AVERAGE THICKNESS (FT)	26.52	23.29	19.22	16.55
ORE, TONS IN PLACE	1956028	1585532	1199433	985916
ORE, AVERAGE GRADE (%U308)	.329	.384	.467	.536
ORE, TONS EXTRACTABLE	1858227	1506255	1139461	936525
ORE, POUNDS U308 EXTRACTABLE (x10**3)	12220	11560	10640	10047
STOPE WASTE, AVERAGE THICKNESS (FT)	1.4	1.2	.6	.0
STOPE WASTE, TONS EXTRACTABLE	101064	78156	33688	0
TOT. OPERATING COST (\$/TON)	65.00	72.00	79.00	86.00
OPERATING COST, TOTAL \$.	(x10**3) 120785	108450	90017	80541
STOPE MNG WASTE COST, TOTAL \$.	1515958	1172341	505319	0
TOTAL CAPITAL COST (\$/TON)	10.00	10.00	10.00	10.00
TOTAL CAPITAL COST, TOTAL \$.	(x10**3) 18582	15063	11395	9365
\$ VALUE, EXTRACT. LBS U308 (ORE) (x10**3)	427691	346805	265995	200932
NET \$ VALUE FOR BLOCK.	(x10**3) 286808	222120	164078	111025
NET VALUE, \$ PER POUND U308 IN ORE	23.47	19.21	15.42	11.05

*** SUMMARY OF HOLE STATISTICS ***

TOTAL NUMBER OF HOLES PROCESSED FOR RUN/BLOCK = 47;

OF THESE:

- 20 HAD INTERVALS ABOVE LOWEST CUTOFF GRADE USED FOR THE RUN.
- 6 HAD INTERVALS > MIN. CUTOFF. SOME ASSAYS DELETED BY EDIT.
- 8 HAD ASSAYS, BUT NO INTERVALS ABOVE LOWEST CUTOFF GRADE.
- 3 HAD ASSAYS, BUT NO INTERVALS; SOME ASSAYS DELETED BY EDIT.
- 10 WERE "BARREN". (NO ASSAYS REPORTED FOR HOLE).

FIGURE 14.9
EXAMPLE OF ORE RESERVES SUMMARY FROM THE ORE INTERVAL ANALYSIS
(FOR UNDERGROUND MODE)

URAD ORE RESERVE SYSTEM

D-P:1 BLOCK WITH ALL HOLES; 1BLOCK EXCLUDING AREA VVV; UDATCB.B FILE.
P-C: \$ 35.00- .1142. \$ 30.00- .1391. \$ 25.00- .1732. \$
BLK: BK1; SEQ#: 1; AREA: 2000000.

```

bBk1 aAAA h 202 pSTARMSA Y 2000 X 2000C 2142.0 E 2142.0 3
1 D 367.5 T 7.00 6 .138 $ .6 w .0 W .0 t .0 g .000
2 D 367.5 T 5.00 6 .151 $ .0 w .0 W .0 t .0 g .000
bBk1 aAAA h 203 pSTARMSA Y 2000 X 2200C 2143.0 E 2143.0 3
1 D 370.0 T 5.00 6 .436 $ 63.2 w .0 W .0 t .0 g .000
2 D 370.0 T 5.00 6 .436 $ 48.4 w .0 W .0 t .0 g .000
3 D 370.0 T 5.00 6 .436 $ 32.3 w .0 W .0 t .0 g .000

```

----- Plot file data deleted here for space -----

```

bBk1 aVVV hTEST15 pVDATA Y 5400 X 5200P 6938.6 E 6938.6 3
1 D 22.5 T 7.00 6 .244 $ 39.3 w .0 W .0 t .0 g .000
2 D 22.5 T 5.00 6 .305 $ 31.0 w .0 W .0 t .0 g .000
3 D 22.5 T 5.00 6 .305 $ 20.6 w .0 W .0 t .0 g .000
bBk1 aVVV hTEST16 pVDATA Y 5600 X 5200P 6934.9 E 6934.9 3
1 D 12.4 T 2.00 6 .347 $ 20.0 w .0 W .0 t .0 g .000
2 D 12.4 T 2.00 6 .347 $ 15.6 w .0 W .0 t .0 g .000
3 D 12.4 T 2.00 6 .347 $ 10.9 w .0 W .0 t .0 g .000
bBk1 aVVV hTEST17 pVDATA Y 5500 X 5200P 6933.4 E 6933.4 0
bBk1 aAAA hTESTA1 pURDAT Y 5000 X 5000P 6850.5 E 6850.5 0
bBk1 aVVV hTEST 2 pVDATA Y 6000 X 5000P10850.5 E10850.5 3
1 D 259.5 T 16.50 6 .284 $ 112.2 w .0 W 24.5 t 5.0 g .056
2 D 275.0 T 13.50 6 .320 $ 85.3 w .0 W 13.0 t .0 g .000
3 D 279.0 T 13.50 6 .320 $ 54.8 w .0 W 13.0 t .0 g .000
bBk1 aAAA hTESTB2 pURDAT Y 5055 X 6055P 6850.0 E 6850.0 3
1 D 4.5 T 33.00 6 .486 $ 535.3 w .0 W 24.0 t 15.0 g .084
2 D 4.5 T 33.00 6 .486 $ 435.0 w .0 W 24.0 t 15.0 g .084
3 D 4.5 T 33.00 6 .486 $ 328.7 w .0 W 24.0 t 15.0 g .084

```

--- Data deleted; beginning of next block shown below ---

```

bBk1 aBBB hTEST11 pURDAT Y 7780 X 9198C 7211.0 E 7211.0 3
1 D1582.5 T 5.00 612.538 $ 2666.7 w .0 W .0 t .0 g .000
2 D1582.5 T 5.00 612.538 $ 2320.6 w .0 W .0 t .0 g .000
3 D1582.5 T 5.00 612.538 $ 1955.0 w .0 W .0 t .0 g .000
BLK: BK2; SEQ#: 2; AREA: 3000000.
bBk2 aAAA n 202 pSTARMSA Y 2000 X 2000C 2142.0 E 2142.0 2
1 D 367.5 T 7.00 6 .138 $ .6 w .0 W .0 t .0 g .000
2 D 367.5 T 5.00 6 .151 $ .0 w .0 W .0 t .0 g .000
bBk2 aAAA h 203 pSTARMSA Y 2000 X 2200C 2143.0 E 2143.0 3
1 D 370.0 T 5.00 6 .436 $ 63.2 w .0 W .0 t .0 g .000
2 D 370.0 T 5.00 6 .436 $ 48.4 w .0 W .0 t .0 g .000
3 D 370.0 T 5.00 6 .436 $ 32.3 w .0 W .0 t .0 g .000

```

FIGURE 14.10
EXAMPLE OF DATA ON SCOR PLOT FILE.

URAD ORE RESERVE SYSTEM

SCOR ANALYSIS OF INTERMED. UDAT FILE "UDATCB.B", DATE: MAR 88
 RUN:1 BLOCK WITH ALL HOLES; 1BLOCK EXCLUDING AREA VVV; UDATCB.B FILE.
 BLK:BLK1, TEST ON FILE UDATCB.B, ALL HOLES
 PLOT-DATA OUTPUT ON FILE "A:SCORPLOT.P". RUN BY:P DEVERGIE

GRADE-TONNAGE DISTRIBUTION ANALYSIS:

EVALUATION OF DEPOSIT BASED ON FREQUENCY OF VALUES IN INCREMENTAL GRADE RANGES
 WITH ASSAYS COMBINED INTO 4.0-FOOT INTERVALS. TOTAL NO. OF VALID HOLES USED IN THE ANALYSIS = 45.
 AVERAGE AREA-OF-INFLUENCE = 4444. SQ.FT. TONNAGE FACTOR = 15.00 CU.FT. PER TON.
 THE AREA-OF-INFLUENCE WAS DETERMINED BY THE ASSIGNED TOTAL AREA- 2000000.SG. FEET,
 DIVIDED BY THE TOTAL NUMBER OFHOLES INCLUDED IN THE ANALYSIS.
 (These results should not be considered as a final reserve estimate!)

OCUTOFF GRADE U308	FREQUENCY SCALE - NO. OF VALUES PER 5 SPACES.					NO. COMBND ASSAYS IN CLASS	TONS IN CLASS	POUNDS U308 IN CLASS	CUMUL. TONS ORE	AVG GR AT CUTOFF	CUMUL. POUNDS U308
	5	1 0	1 5	2 0	2 5						
.00	XXXXXXXXXXXXXXXXXXXXXXXXXXXX					29	343703	34370	3365926	.178	12013809
.01	XXXXXXXXXXXXXXXXXXXXXXXXXXXX					41	485925	145777	3022222	.198	11979439
.02	XXXXXXXXXXXXXXXXXXXXXXXXXXXX					40	474074	237037	2536296	.233	11833661
.03	XXXXXXXXXXXXXXXXXXXXXXXXXXXX					19	225185	157629	2062222	.281	11596624
.04	XXXXXXXXXXXX					11	130370	117333	1837037	.311	11438994
.05	XXXXXXXXXXXX					11	130370	143407	1706667	.332	11321661
.06	XXXXXXXXXX					8	94814	123259	1576296	.355	11178254
.07	XXXXXXXXXX					10	118518	177777	1481481	.373	11054995
.08	XXXXXX					6	71111	120888	1362963	.399	10877217
.09	XXXXXXXXXXXX					12	142222	270222	1291852	.416	10756328
.10	XXXXXX					7	82962	174222	1149629	.456	10486106
.11	XXXXXXXXXXXX					13	154074	354370	1066666	.483	10311884
.12	XXXXX					5	59259	148148	912592	.546	9957514
.13	XX					2	23703	64000	853333	.575	9809366
.14	XX					2	23703	68740	829629	.587	9745366
.15	XXXXXX					6	71111	220444	805926	.600	9676625
.16	X					1	11851	39111	734815	.643	9456181
.17	XXXX					4	47407	165925	722963	.651	9417070
.18	XXXXXX					6	71111	263111	675555	.685	9251144
.19	XXXX					4	47407	184888	604444	.743	8988033
.20						0	0	0	557037	.790	8803144
.21	XXXX					4	47407	203851	557037	.790	8803144
.22	XX					2	23703	106666	509629	.844	8599292
.23	X					1	11851	55703	485925	.874	8492625
.24	XXXXX					5	59259	290370	474074	.890	8436921
.25	XXXX					4	47407	241777	414814	.982	8146550
.26	XX					3	35555	188444	367407	1.076	7904772
.27						0	0	0	331851	1.163	7716328
.28	XXXX					4	47407	270222	331851	1.163	7716328
.29	XX					2	23703	139851	284444	1.309	7446105
.30						0	0	0	260740	1.401	7306253
.31						0	0	0	260740	1.401	7306253
.32	X					1	11851	77037	260740	1.401	7306253
.33	X					1	11851	79407	248888	1.452	7229216
.34	X					1	11851	81777	237037	1.508	7149809
.35	XX					2	23703	168296	225185	1.569	7068031
.36						0	0	0	201481	1.712	6899734
.37	X					1	11851	88888	201481	1.712	6899734
.38	XX					2	23703	189629	189629	1.796	6810845
.39						0	0	0	165925	1.997	6628327
.40						0	0	0	165925	1.997	6628327
.41	XX					2	23703	196740	165925	1.997	6628327
.42						0	0	0	142222	2.261	6431586
.43	XX					2	23703	206222	142222	2.261	6431586
.44	X					1	11851	105481	118518	2.626	6225364
.45						0	0	0	106666	2.869	6119882
.46						0	0	0	106666	2.869	6119882
.47	X					1	11851	112592	106666	2.869	6119882
.48						0	0	0	94814	3.168	6007290
.49						0	0	0	94814	3.168	6007290
.50						0	0	0	94814	3.168	6007290
.65	X					1	11851	155259	94814	3.168	6007290
.87	X					1	11851	207407	82962	3.527	5852030
1.03	X					1	11851	245333	71111	3.969	5644623
1.37	XX					2	23703	651851	59259	4.556	5399289
2.18	XX					2	23703	1035851	35555	6.676	4747437
5.00	X					1	11851	3711585	11851	15.658	3711585

FIGURE 14.11
 EXAMPLE OF THE RESULTS OF THE GRADE-TONNAGE DISTRIBUTION ANALYSIS

15.0 APPENDIX A: THE GAMLOG METHOD

15.1 INTRODUCTION

The GAMLOG method is essentially a trial-and-error iterative process of log interpretation used to determine U308 grades for a series of 1/2 or 1 foot layers comprising the ore zone under analysis. The GAMLOG program was first developed by Scott, 1962 and is cited in the following reference:

GAMLOG (J.H. Scott, 1962) The interpretation of gamma-ray log data using a digital computer. U.S. Atomic Energy Commission, GJO, RME-143.

The objective of the process is to find a grade for each separate gamma-ray log anomaly (one from each separate layer) which could be composited to form an overall anomaly that would closely match the real anomaly under analysis. Iterations are performed until sufficient accuracy is achieved.

To develop the GAMLOG program it was necessary to establish "type" anomalies for 1/2 and 1 foot thick layers of homogeneous uranium ore. The deflection amplitudes at various points along the type anomalies were determined at percentages of peak amplitude and therefore were independent of grade. Since no homogeneous ore layers exactly 1/2 and 1 foot thick were available for actual logging, the type anomalies were derived through numerical differentiation from the log of a 4 foot thick test ore zone composed of homogeneous ore (test pit N-3, AEC compound, Grand Junction, Colorado, U.S.A.).

The method can be understood by imagining that the 4-foot layer is composed of several contiguous 1/2 foot thick layers all having the same grade as shown in Figure 1. If hypothetical individual anomalies are plotted for all 1/2 foot layers, the sum of the amplitudes of all overlapping individual anomalies will equal the amplitude of the 4 foot anomaly at any depth.

Referring to Figure 1, if we examine the 4 foot anomaly deflections A, B, C, D, E ..., a series of points 1/2 foot apart, we see that by subtracting successive adjacent deflections of the 4 foot anomaly we obtain the amplitude a, b, c, d, c, b, a of the 1/2 foot anomaly: that is $B - A = a$; $C - B = b$; $D - C = c$, etc.

Therefore, if we simply subtract successive readings 1/2 foot apart along the large anomaly, we will obtain the desired points along the 1/2 foot anomaly. This procedure was used to obtain the 1/2 foot type anomaly. The 1 foot type anomaly was obtained by subtracting successive readings 1 foot apart along the 4 foot anomaly.

Since small percentage errors in the 4 foot anomaly can lead to large errors in the 1/2 and 1 foot type anomalies, it was necessary to obtain very accurate deflection amplitudes for the 4 foot anomaly. In practice this was accomplished by connecting a scaler to a SR-300 logger and measuring cumulative counts at fixed depths for periods of time long enough to give sufficiently accurate calculated count rates.

Successive scaler readings were made at 0.1 foot intervals, starting near the bottom of the 4 foot ore zone and working upward. All count rates ob-

APPENDIX A: GAMLOG METHOD

tained by this method were corrected for dead-time loss. Figure 2 is a plot of these corrected count rates. The 1/2 and 1 foot type anomalies derived from the 4 foot anomaly are shown in Figures 3 and 4.

15.2 CONCEPTS

15.2.1 Relating Type Anomalies to Grade

The calibration factor for gamma-ray logging units has been called the k-factor and appears as the constant of proportionality in the equation:

$$\bar{GT} = kA \quad (1).$$

In this equation G is the average grade of an ore zone expressed as percent U308 by weight, T is the thickness of the zone, A is the area under the curve obtained by summing individual log deflections from one extremity of the anomaly to the other at 1/2 foot intervals. By convention the units of the log deflections are understood to be counts per second corrected for dead-time loss, and the area A is understood to be corrected errors due to absorbing fluids in the hole and any other nonstandard conditions.

In a homogeneous, infinitely thick ore zone all log deflections will be equal, and any one of them can be represented by N . If we make log readings at 1/2 foot intervals, the number of readings will be $2T$.

$$\begin{array}{ll} \text{Therefore} & A = 2 NT \\ \text{and} & GT = 2 k NT \\ & G = 2 kN \end{array} \quad (2)$$

So, for an anomaly representing an infinite thickness of homogeneous ore, the ore grade can be determined by multiplying the peak deflection in corrected counts per second by twice the k factor.

In Figure 1 the deflection of the peak of the 1/2 foot type anomaly is one-half the peak deflection of the infinite thickness anomaly. Combining this information with knowledge of the shape of the anomaly, we can establish equivalent grades at key positions along the 1/2 foot type anomaly. These equivalent grades are expressed in Table 1 as fractions of G , the grade of an imaginary infinite-thickness anomaly composed of an infinite number of identical type anomalies. Table 2 gives corresponding values for the 1 foot anomaly.

APPENDIX A: GAMLOG METHOD

TABLE 1. EQUIVALENT GRADES AT 1/2 FOOT INTERVALS
ALONG THE 1/2 FOOT TYPE ANOMALY.

Distance from center of anomaly (feet)	Equivalent grade
0.0	$(1.00/2)G = 0.50G$
+0.5	$(0.40/2)G = 0.20G$
+1.0	$(0.08/2)G = 0.04G$
+1.5	$(0.02/2)G = 0.01G$

TABLE 2. EQUIVALENT GRADES AT 1 FOOT INTERVALS
ALONG THE 1 FOOT TYPE ANOMALY

Distance from center of anomaly (feet)	Equivalent grade
0.0	$(1.00/1.294)G = 0.7728G$
+1.0	$(0.14/1.294)G = 0.1082G$
+2.0	$(0.007/1.294)G = 0.0054G$

15.3 MATCHING REAL AND SYNTHETIC ANOMALIES

If we know the grade distribution of a complex layered uranium ore zone, we can break it down into series of simple hypothetical 1/2 or 1 foot layers of homogeneous ore as shown in Figure 5. After individual log anomalies are plotted and composited for these hypothetical layers, the resulting synthetic anomaly will match the real anomaly quite closely.

On the other hand, if we do not know the grade distribution of a uranium ore zone but are given only a gamma-ray log of the zone, it is possible to deduce the grades of hypothetical layers whose individual anomalies can be composited to match the given log. The result is a 1/2 by 1/2 foot or 1 by 1 foot interpretation of the log. The program GAMLOG produces this kind of an interpretation by a trial-error method.

First, the deflection of the log to be interpreted are converted to equivalent grades using equation (2) after correcting for dead-time loss and other errors. These equivalent grades are also taken as the first approximation of grades of the hypothetical layers are established using the relationships for type anomalies set forth in Table 1 and 2. The hypothetical anomalies are then composited to form a synthetic anomaly that is compared with the real anomaly at each log reading position.

After the comparison a second approximation of the grades of the hypothetical layers is established by increasing or decreasing the first approximation grades, depending on whether the synthetic anomaly is lower or higher

APPENDIX A: GAMLOG METHOD

than the real anomaly. Anomalies for the hypothetical layers are reestablished and recomposited, and another comparison is made between the real anomaly and the new synthetic anomaly.

This process is repeated up to ten times. If the comparative results indicate that the absolute values of all discrepancies are less than 0.005 percent U308, the process is stopped short of ten iterations. The rate at which the synthetic anomaly approaches a good fit with real anomaly for a typical complex ore zone (AEC test pit N-5) is shown in Figure 6 where average absolute error is plotted for each successive iteration.

The iterative anomaly-matching method used in GAMLOG was based on type anomalies derived for AEC gamma-ray logging equipment. Presumably the response characteristics of certain commercial logging equipment are close enough to that of AEC equipment to validate GAMLOG interpretation of these other logs.

However, one should avoid using GAMLOG to interpret logs which show appreciable distortion due to logging at a speed too high for the time constant. Well logs used by the petroleum industry commonly fall into the latter category. However, it would be possible to modify GAMLOG so that these oil company logs could be interpreted if proper type anomalies were derived.

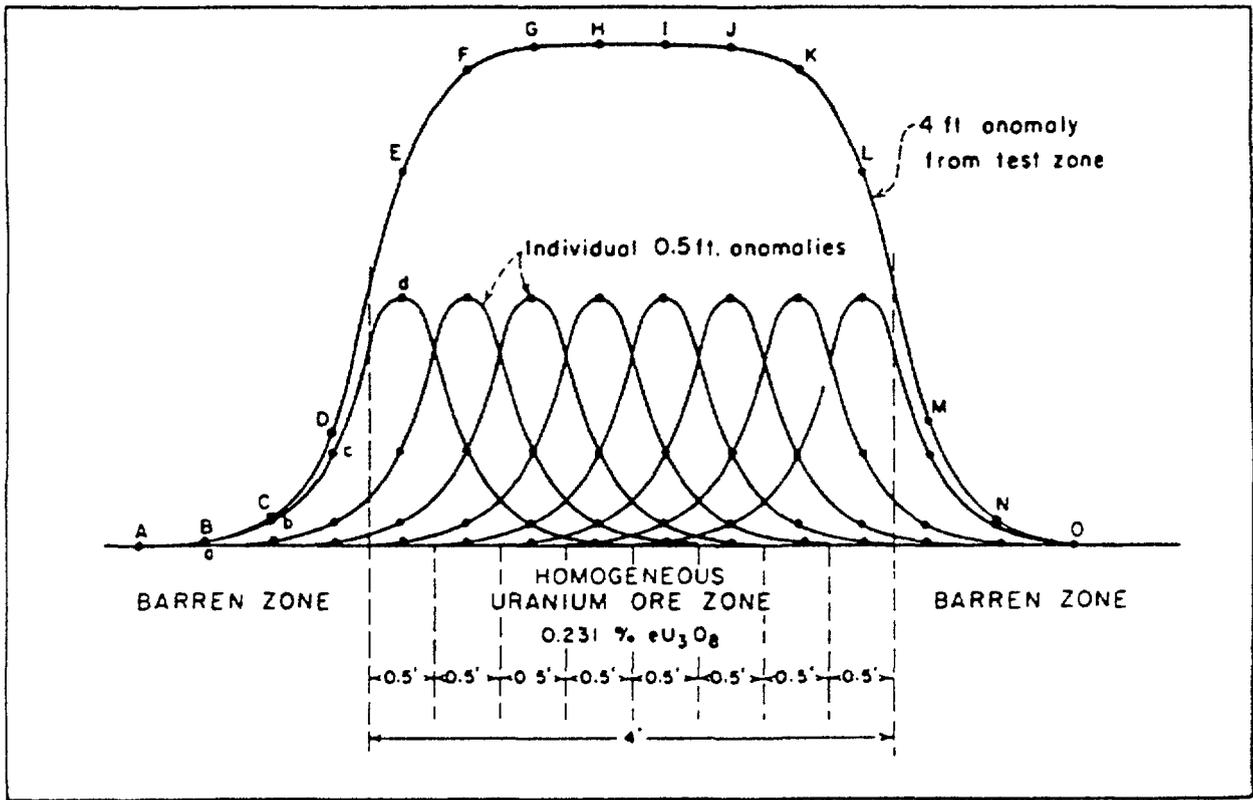


FIGURE 1
REAL ANOMALY FROM 4 FT. ZONE AND HYPOTHETICAL ANOMALIES
FROM 0.5 FT. ORE ZONES

APPENDIX A: GAMLOG METHOD

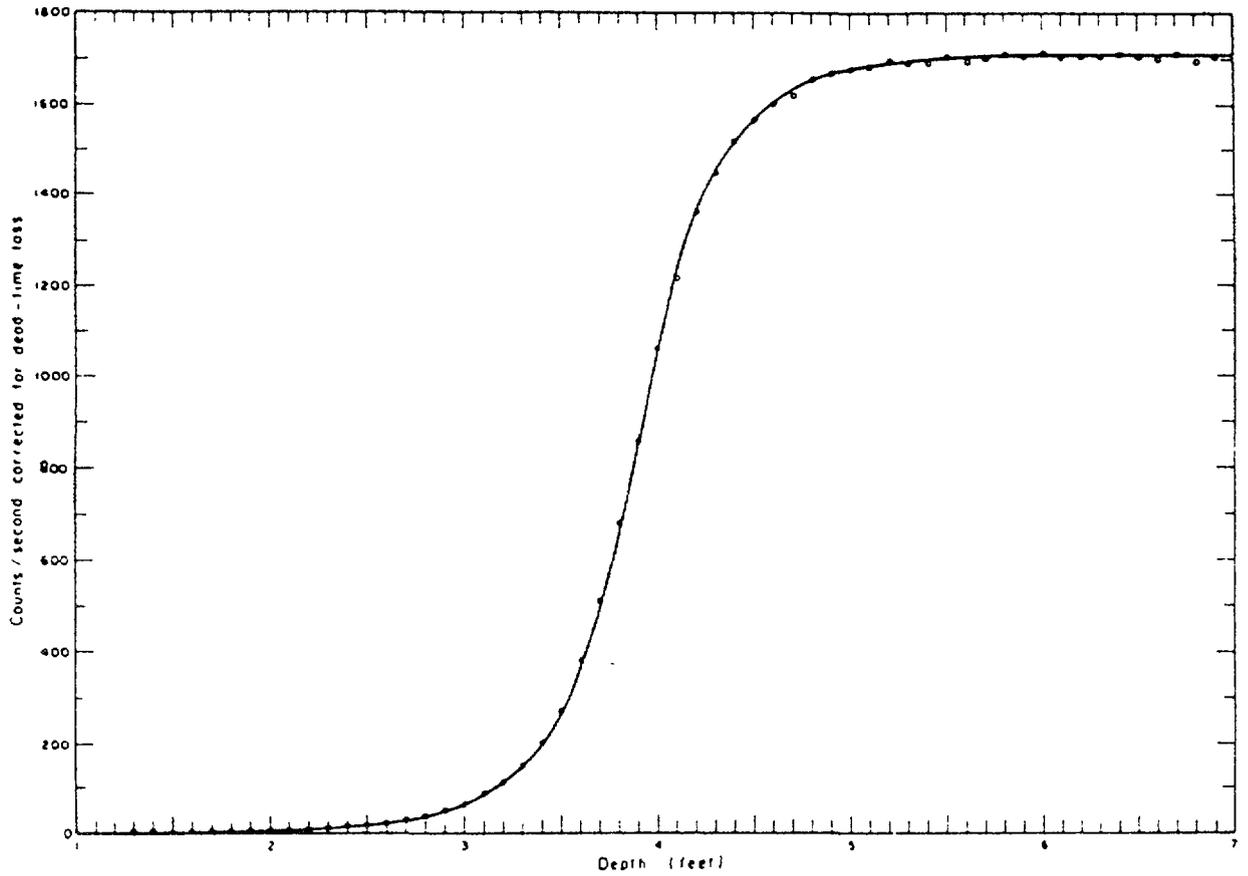


FIGURE 2
COUNT RATES CALCULATED FROM SCALER READOUT (SR-300 LOGGER)
FOR UPPER PART OF 4 FT. TEST ZONE (N-3).

APPENDIX A: GAMLOG METHOD

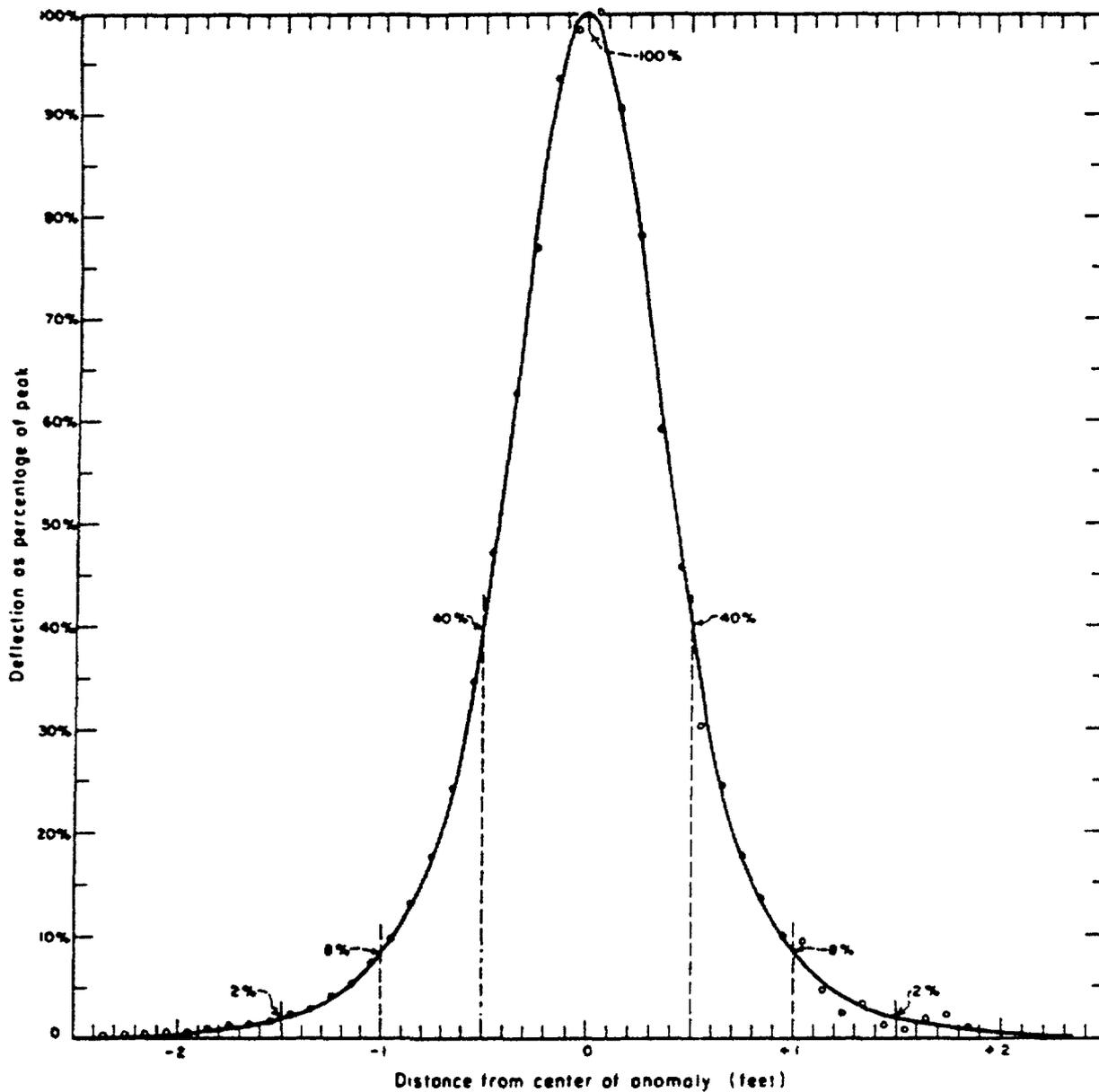


FIGURE 3
"TYPE" ANOMALY FOR 0.5 FT. ORE ZONE.

APPENDIX A: GAMLOG METHOD

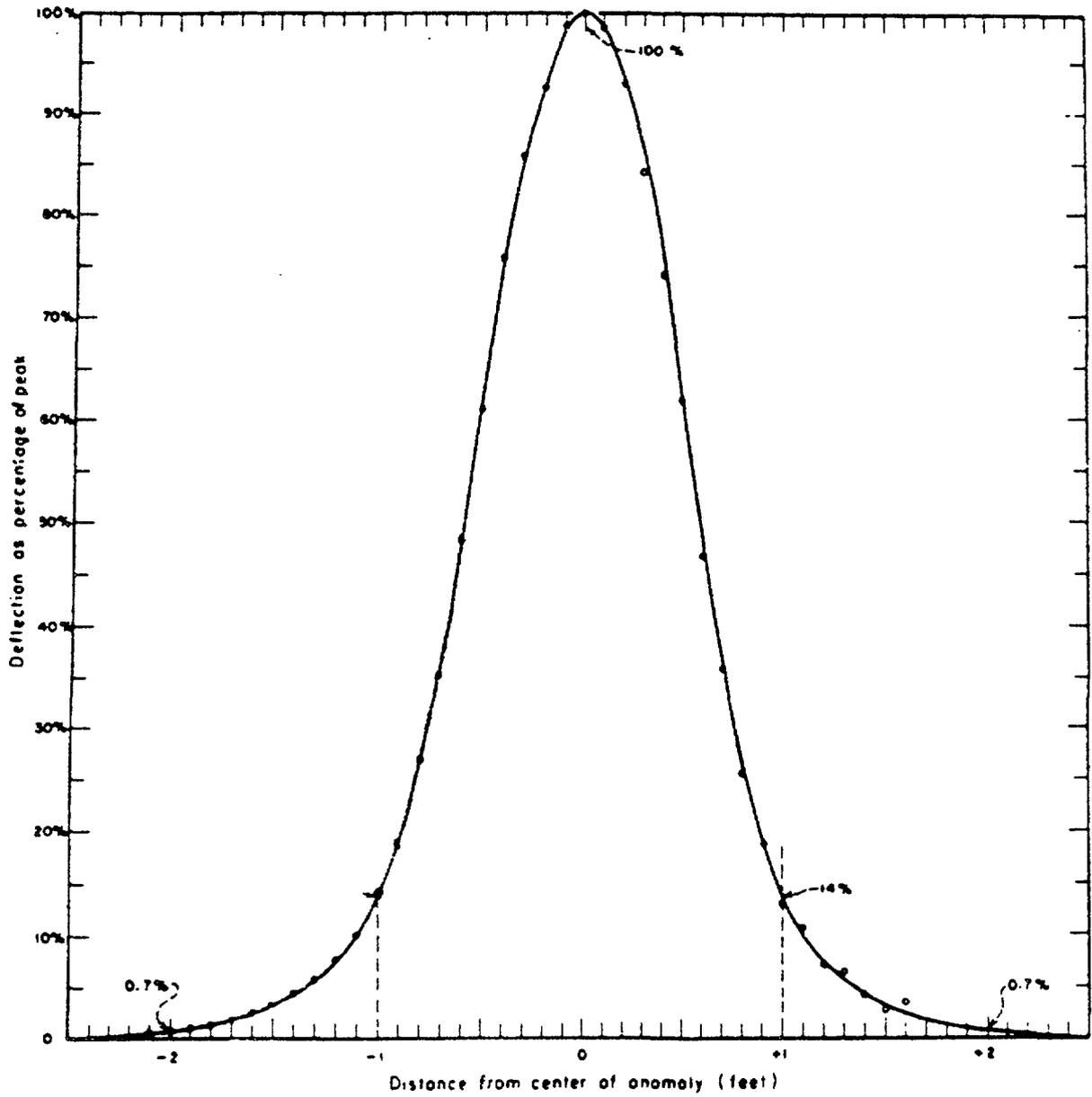


FIGURE 4
"TYPE" ANOMALY FOR 1 FT. ORE ZONE.

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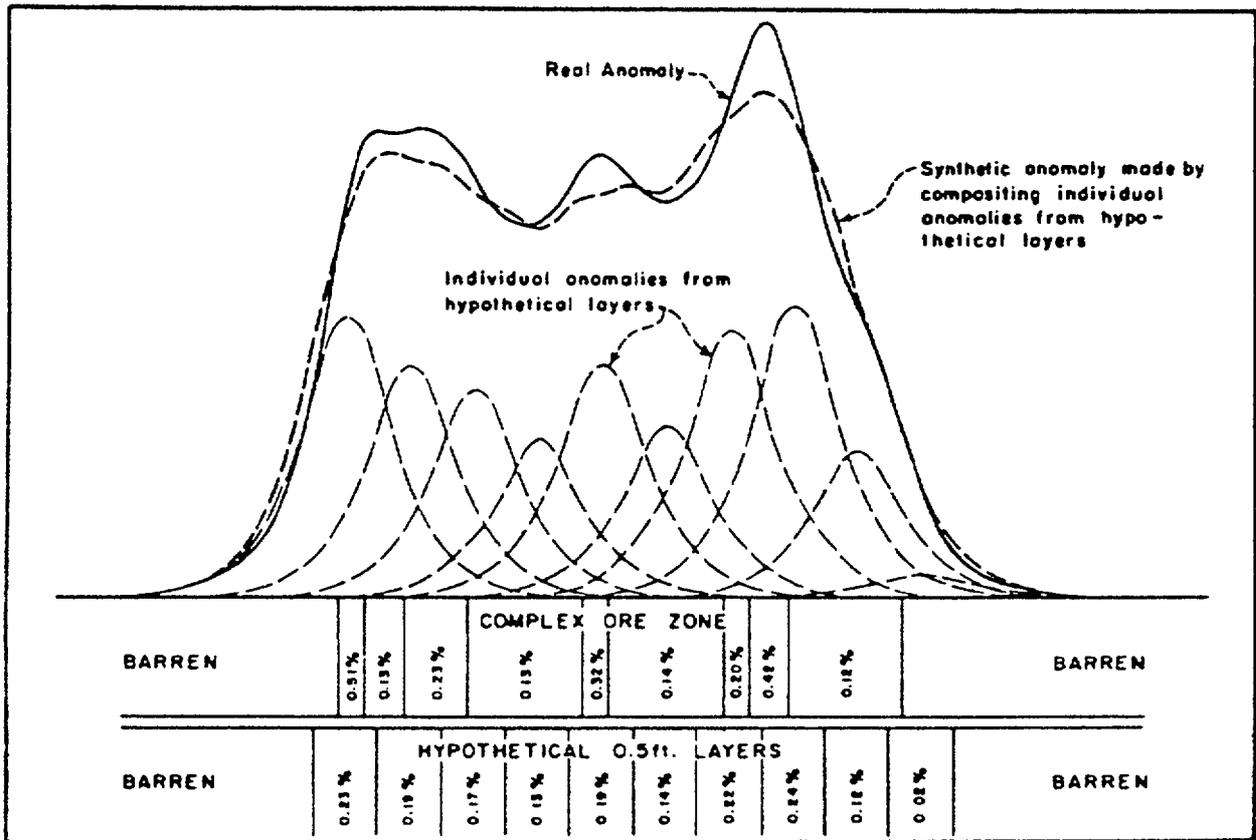


FIGURE 5
COMPLEX ORE ZONE BROKEN DOWN INTO HYPOTHETICAL 0.5 FT. LAYERS
WITH RESULTING ANOMALIES.

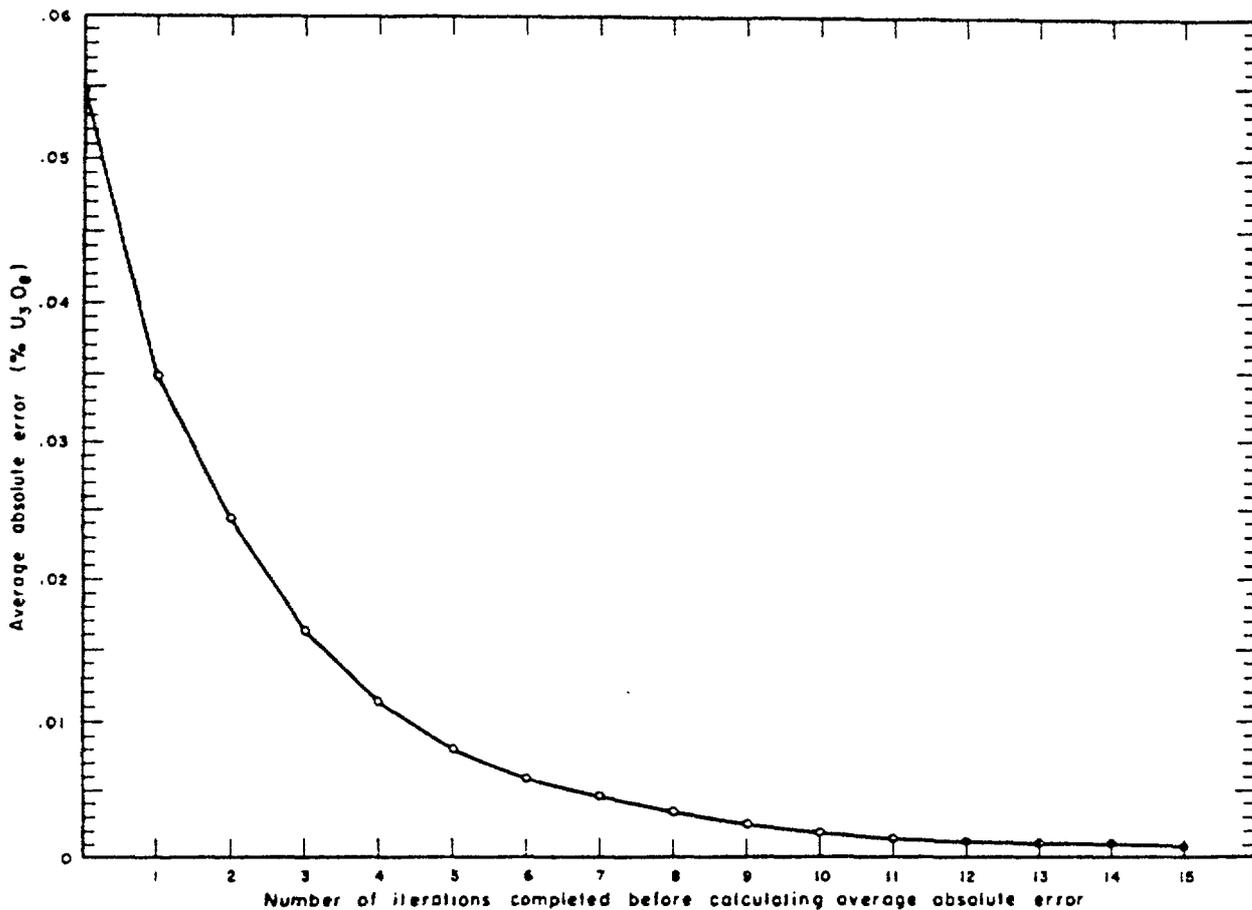


FIGURE 6
AVERAGE ABSOLUTE ERROR OF FIT BETWEEN SYNTHETIC ANOMALY AND
REAL ANOMALY - A TYPICAL EXAMPLE.

16.0 APPENDIX B: STARDAT DATA - PROCESSED GAMMA LOG DATALISTING OF STARDATX _ INPUT DATA SET
OF COMPUTED ORE GRADES IN HALF-FOOT INTERVALS

	151F1U				0 515 5 256187	0106	6		STARMS	
1	151	4400-	000040	000051	000082	000142	000229	000162	000094	STARMS
2	151	000087	000084	000100	000151	000189	000260	000490	001006	STARMS
3	151	001026	000895	000817	000742	000601	000675	000813	000923	STARMS
4	151	000878	000565	000349	000366	000360	000334	000253	000150	STARMS
5	151	000126	000135	000157	000184	000146	000089	000058	000052	STARMS
6	151	000047	000056	000071	000095	000132	000157	000141	000126	STARMS
7	151	000141	000181	000302	000685	001405	001707	001893	001836	STARMS
8	151	001458	000424	000526	000892	000725	000313	000236	000253	STARMS
9	151	000326	000634	000601	000509	000603	000556	000569	000673	STARMS
10	151	001036	001364	001605	001397	001017	001230	000776	000421	STARMS
11	151	000411	000401	000340	000385	000531	000902	001302	001826	STARMS
12	151	002199	001441	001082	001015	000876	000773	175 -	000029	STARMS
13	151	000033	000054	000090	000147	000133	000120	000128	000109	STARMS
14	151	000053	000023	000025	000027					STARMS
	152F1U				0 516 5 236187	0106	6		STARMS	
1	152	4470-	000051	000057	000089	000145	000215	000230	000164	STARMS
2	152	000119	000109	000101	000102	000103	000109	000110	000111	STARMS
3	152	000123	000164	000238	000340	000508	000766	000972	001145	STARMS
4	152	001083	000871	000490	000336	000242	000196	000195	000215	STARMS
5	152	000258	000335	000719	001045	001496	002226	002959	002566	STARMS
6	152	001410	000676	000390	000271	000240	000232	000205	000165	STARMS
7	152	000136	000103	000098	000094	000090	000094	000108	000109	STARMS
8	152	000110	000115	000110	000098	000108	000138	000199	000322	STARMS
9	152	000781	002291	003512	004226	003785	002503	001467	000999	STARMS
10	152	000529	000364	000593	000585	000205	000171	000185	000199	STARMS
11	152	000211	000256	000244	000200	000242	000195	000147	000093	STARMS
12	152	000092	000117	000148	000151	000158	000111	000095	000092	STARMS
13	152	000053	000033	000032	000028	000032	000033	000036	000041	STARMS
14	152	000055	000093	000179	000293	000309	000211	000135	000112	STARMS
15	152	000098	000082	000056	000040	000034	000035	000033	000031	STARMS
	153F1U				0 515 5 246187	0106	6		STARMS	
1	153	4160-	000028	000053	000095	000117	000055	000027	000027	STARMS
2	153	25 -	000055	000061	000080	000100	000098	000071	000052	STARMS
3	153	130 -	000087	000110	000190	000255	000347	000559	000633	STARMS
4	153	000565	000355	000167	000154	000144	000145	000139	000135	STARMS
5	153	000125	000120	000112	000100	000089	000094	000123	000130	STARMS
6	153	000125	000136	000142	000137	000133	000189	000183	000163	STARMS
7	153	000220	000206	000169	000123	000137	000177	000188	000208	STARMS
8	153	000270	000347	000357	000364	000336	000265	000257	000232	STARMS
9	153	000181	000239	000381	000329	000314	000379	000260	000166	STARMS
10	153	000148	000171	000240	000259	000207	000187	000184	000204	STARMS
11	153	000270	000371	000471	000456	000444	000406	000196	000160	STARMS
12	153	000102	000103	000110	000102	000103	000118	000179	000244	STARMS
13	153	000192	000129	000055	000038	000035	90 -	000039	000064	STARMS
14	153	000123	000264	000451	000433	000308	000153	000103	000058	STARMS
15	153	000046	000036							STARMS
	154F1U				0 516 5 276187	0106	6		STARMS	
1	154	4325-	000094	000093	000079	000079	000107	000192	000347	STARMS

APPENDIX B: STARDAT DATA

2	154	000463	000358	000276	000223	000243	000292	000332	000371	STARMS
3	154	000267	000239	000192	000173	000150	000149	000141	000120	STARMS
4	154	000096	000084	000074	000068	000059	25 -	000044	000054	STARMS
5	154	000094	000124	000086	000062	000058	30 -	000049	000045	STARMS
6	154	000047	000058	000085	000114	000148	000115	000086	000072	STARMS
7	154	000079	000095	000128	000225	000356	000417	000353	000223	STARMS
8	154	000181	000211	000252	000284	000269	000249	000291	000417	STARMS
9	154	000449	000457	000535	000626	000736	001207	002133	002199	STARMS
10	154	001795	001446	001529	001561	001291	000930	000702	000527	STARMS
11	154	000357	000234	000277	000483	000873	000985	001489	001966	STARMS
12	154	001836	001293	001033	001110	001412	001395	001090	000918	STARMS
13	154	000765	000627	000558	000446	000342	000337	000162	000050	STARMS
14	154	000050	000051	000055	000013	000005	000010	000015	000020	STARMS
15	154	000016	000032	000038	000011	000021	000037	000051	000087	STARMS
16	154	000273	000464	000470	000322	000207	000127	000087	000061	STARMS
17	154	000042	000031							STARMS
	155F1U				0 514	5 306187	0106	6		STARMS
1	155	4460-	000076	000109	000152	000293	000411	000401	000505	STARMS
2	155	000519	000582	000711	000479	000113	000075	000062	000039	STARMS
3	155	85 -	000056	000084	000134	000123	000123	000117	000119	STARMS
4	155	000105	000098	000103	000109	000117	000123	000127	000128	STARMS
5	155	000134	000150	000154	000132	000132	000227	000466	000556	STARMS
6	155	000285	000229	000273	000334	000459	000639	000984	001504	STARMS
7	155	001528	001006	000518	000494	000182	000074	000049	000051	STARMS
8	155	000061	000069	000082	000115	000137	000140	000175	000194	STARMS
9	155	000190	000084	000061	000050	40 -	000077	000138	000236	STARMS
10	155	000453	000277	000135	000105	000120	000170	000118	000092	STARMS
11	155	000089	000072	000038						STARMS
	156F1U				0 515	5 236107	0106	6		STARMS
1	156	4340-	000074	000082	000092	000096	000099	000099	000096	STARMS
2	156	000097	000093	000097	000110	000129	000155	000161	000161	STARMS
3	156	000150	000112	000100	000087	000109	000159	000213	000250	STARMS
4	156	000187	000186	000175	000139	000140	000197	000230	000132	STARMS
5	156	000102	000065	000068	000073	000090	000113	000157	000240	STARMS
6	156	000217	000157	000171	000163	000144	000130	000109	000097	STARMS
7	156	000104	000126	000187	000264	000343	000452	000557	000617	STARMS
8	156	000632	.0586	000545	000586	000717	000913	001088	001227	STARMS
9	156	001141	000986	001044	001343	001269	001379	001506	001717	STARMS
10	156	001873	002080	002566	003361	003538	003863	003830	004072	STARMS
11	156	003900	003058	002033	001106	000713	000567	000549	000488	STARMS
12	156	000419	000328	000313	000267	000217	000177	000182	000188	STARMS
13	156	000166	000135	000121	000118	000125	000112	000105	000130	STARMS
14	156	000177	000351	000401	000186	000177	000153	000120	000087	STARMS
15	156	000066	000065	000058	000068	000074	000074	000148	000253	STARMS
16	156	000542	000816	000808	000643	000291	000237	000222	000112	STARMS
17	156	000076	000073	000118	000084	000035	000031			STARMS
	157F1U				0 895	5 276317	0106	6		STARMS
1	157	4370-	000065	000096	000129	000166	000122	000040	000031	STARMS
2	157	000040	000050	000049	000052	000061	000073	000083	000071	STARMS
3	157	000056	000040	000037	000041	000065	000087	000102	000115	STARMS
4	157	000095	000081	000082	000079	000091	000110	000194	000551	STARMS
5	157	001500	002031	000894	001057	001581	001534	000416	000175	STARMS
6	157	000126	000105	000121	000134	000106	000070	000063	000068	STARMS
7	157	000090	000102	000104	000098	000089	000100	000108	000120	STARMS
8	157	000153	000215	000280	000244	000312	000361	000420	000641	STARMS
9	157	001104	001221	000771	000477	000319	000206	000201	000309	STARMS

APPENDIX B: STARDAT DATA

10	157	000269	000238	000204	000182	000182	000385	000448	000397	STARMS
11	157	000184	000119	000117	000095	000105	000108	000067	000050	STARMS
12	157	000051	000054	000055	000044	000033	60 -	000032	000047	STARMS
13	157	000068	000092	000159	000313	000323	000261	000146	000099	STARMS
14	157	000051	000039	000026	000022	000019				STARMS
	158	F1U			0 430	5 286107	0106	6		STARMS
1	158	3505-	000064	000093	000117	000159	000185	000214	000247	STARMS
2	158	000143	000074	000064	000063	000076	000105	000114	000100	STARMS
3	158	000072	000054	000052	000051	000059	000095	000146	000139	STARMS
4	158	000100	000136	000209	000180	000089	000051	000035	000030	STARMS
5	158	000036	000049	000074	000068	000038	000039	000031	000032	STARMS
6	158	000040	000051	000069	000078	000104	000089	000063	000047	STARMS
7	158	000045	100 -	000138	000167	000194	000247	000395	000665	STARMS
8	158	001125	001401	001221	000934	000756	000678	000647	000636	STARMS
9	158	000797	001101	001474	001952	002038	001868	001073	000583	STARMS
10	158	000314	000221	000207	000164	000166	000203	000202	000176	STARMS
11	158	000187	000199	000222	000259	000232	000206	000199	000197	STARMS
12	158	000180	000166	000146	000139	000139	000132	000101	000074	STARMS
13	158	000111	000341	000644	000605	000252	000203	000293	000319	STARMS
14	158	000150	000089	000091	000055	000043	000032	000032	000030	STARMS
15	158	000028	000027	000030	000038	000040	000054	000076	000141	STARMS
16	158	000305	000407	000650	000632	000401	000244	000249	000254	STARMS
17	158	000233	000141	000119	000080	000039	000017	000016	000016	STARMS
	159	F1U			0 436	5 196107	0106	6		STARMS
1	159	3580-	000055	000066	000098	000100	000066	000077	000112	STARMS
2	159	000136	000087	000069	000077	000097	000103	000094	000108	STARMS
3	159	000057	000045	50 -	000067	000095	000166	000197	000153	STARMS
4	159	000134	000154	000200	000179	000114	000114	000109	000085	STARMS
5	159	000071	000057	000042	000037	000048	000062	000058	000054	STARMS
6	159	000051	000050	000041	000029	000025	000021	000028	000035	STARMS
7	159	000057	000104	000170	000136	000084	000076	000078	000130	STARMS
8	159	000280	000525	000724	000672	000884	001105	000981	001667	STARMS
9	159	002523	001693	000672	000487	000390	000287	000257	000272	STARMS
10	159	000297	000286	000269	000255	000212	000213	000209	000205	STARMS
11	159	000206	000196	000178	000166	000148	000140	000136	000086	STARMS
12	159	000089	000125	000170	000191	000151	000088	000051	000038	STARMS
13	159	000029	75 -	000056	000078	000106	000184	000292	000627	STARMS
14	159	000619	000438	000357	000109	000083	000060	000049		STARMS
	160	F1U			0 426	5 196107	0106	6		STARMS
1	160	3500-	000043	000053	000067	000094	000133	000204	000211	STARMS
2	160	000172	000140	000116	000098	000100	000124	000169	000156	STARMS
3	160	000133	000114	000087	000084	000074	000071	145 -	000036	STARMS
4	160	000051	000072	000143	000142	000111	000054	000043	000072	STARMS
5	160	000139	000134	000095	000090	000109	000150	000236	000470	STARMS
6	160	000605	000790	000656	000325	000266	000321	000593	001162	STARMS
7	160	001731	001070	001020	001467	001453	001421	001412	001249	STARMS
8	160	001128	001276	001123	000941	001047	001164	001286	001394	STARMS
9	160	001737	001577	000775	000442	000442	000515	000373	000268	STARMS
10	160	000228	000438	000746	000753	000410	000095	000057	000049	STARMS
11	160	65 -	000030	000036	000058	000080	000109	000147	000206	STARMS
12	160	000347	000434	000375	000235	000196	000148	000112	000065	STARMS
13	160	000050	000035	000027	000026					STARMS
	161	F1U			0 420	5 296107	0106	6		STARMS
1	161	3585-	000054	000095	000093	000071	000078	000111	000155	STARMS
2	161	000191	000230	000237	000270	000231	000098	000067	000055	STARMS
3	161	000052	000059	000070	000114	000123	000141	000238	000306	STARMS

APPENDIX B: STARDAT DATA

4	161	000280	000245	000271	000311	000339	000275	000352	000335	STARMS
5	161	000215	000159	000133	000118	000116	000132	000156	000124	STARMS
6	161	000062	000073	000113	000105	000075	000087	000100	000134	STARMS
7	161	000212	000312	000351	000223	000177	000194	000220	000281	STARMS
8	161	000285	000281	000290	000303	000361	000448	000727	001152	STARMS
9	161	001052	000833	000815	000927	001091	001566	002141	001811	STARMS
10	161	001545	001439	001185	001081	000999	000912	000484	000298	STARMS
11	161	000400	000842	001041	000765	000557	000631	001245	001084	STARMS
12	161	000408	000276	000286	000199	000146	000127	000100	000080	STARMS
13	161	000059	000064	000064	000060	000058	000057	000063	000078	STARMS
14	161	000081	000098	000164	000252	000412	000415	000473	000446	STARMS
15	161	000404	000231	000158	000124	000087	000046	000038		STARMS
	162F1U				0 436 5	196107	0106	6		STARMS
1	162	3585-	000029	000055	000146	000213	000226	000154	000179	STARMS
2	162	000181	000091	000049	000031	000033	000029	000028	000028	STARMS
3	162	000033	000040	000062	000094	000090	000068	000050	000055	STARMS
4	162	000081	000067	000056	000062	000112	000204	000288	000219	STARMS
5	162	000176	000162	000159	000136	000099	000098	000097	000091	STARMS
6	162	000099	000108	000095	000070	000081	000112	000176	000341	STARMS
7	162	000490	000621	000969	001059	000832	000603	000161	000142	STARMS
8	162	000174	000137	000154	000253	000237	000166	000120	000121	STARMS
9	162	000143	000140	000156	000185	000213	000206	000216	000205	STARMS
10	162	000199	000177	000188	000207	000256	000206	000166	000217	STARMS
11	162	000314	000352	000417	000675	001018	001579	001446	000868	STARMS
12	162	000431	000435	000735	001057	001190	000797	000567	000348	STARMS
13	162	000257	000245	000222	000195	000150	000112	000069	55 -	STARMS
14	162	000050	000087	000197	000258	000268	000224	000163	000075	STARMS
15	162	000056	000046	000036						STARMS
	163F1U				0 436 5	96537	0106	6		STARMS
1	163	3595-	000069	000125	000144	000240	000252	000097	000074	STARMS
2	163	000078	000097	000148	000237	000295	000408	000521	000795	STARMS
3	163	000879	000793	000634	000419	000393	000407	000512	000617	STARMS
4	163	000702	000704	000602	000378	000261	000223	000213	000208	STARMS
5	163	000347	000300	000175	000126	000073	000048	000040	000036	STARMS
6	163	000031	000036	000043	000083	000092	000105	000188	000226	STARMS
7	163	000109	000097	000084	000100	000112	000114	000111	000134	STARMS
8	163	000258	000316	000306	000202	000191	000175	000236	000281	STARMS
9	163	000312	000365	000412	000376	000354	000433	000646	000930	STARMS
10	163	000730	000476	000362	000358	000342	000430	000769	001844	STARMS
11	163	002549	001984	000647	000517	000394	000500	001188	001419	STARMS
12	163	000807	000292	000182	000130	000114	000097	000093	000089	STARMS
13	163	000091	000096	000082	000079	000080	000082	000088	000061	STARMS
14	163	000134	000207	000388	000410	000206	000106	000081	000054	STARMS
15	163	000050								STARMS

17.0 APPENDIX C: OUTPUT LISTING FROM URDAT RUN

The following example run was made using the programs and data sets provided in the attached diskettes.

APPENDIX C: URDAT RUN

DATA ANALYSIS OF PRIMARY U-ASSAY FILE "6AMDATA", DATE: JAN 88
 ID: URDAT RUN ON TEST FILE "6AMDAT"
 NO INTERMEDIATE FILE OUTPUT REQUESTED. RUN BY:PDV

PAGE 1

```

*****
COLLAR : NORTH EAST : PIT :DPTH:BOT:SMPL:          PRPRTY : AREA : HOLE
ELEV. : COORD. COORD.:DEPTH:SMPL:OXD:CODE:          CODE  : NO.  : (SAMPLE)
7000.5: 5000 5000:150.0:121:100:20:          URDAT : AAA  : TEST 1
  
```

U308 CHEMICAL OR CORRECTED EQUIV. RADIOMETRIC ASSAYS.

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308
51.0	1.00	.050	70.0	5.00	.150**	87.0	3.00	.040	105.0	4.00	.300**	115.0	2.00	.030
53.0	2.00	.020	74.0	4.00	.020	89.0	2.00	.090	107.0	2.00	.060	117.0	2.00	.020
56.0	3.00	.060	78.0	4.00	.050	91.0	2.00	.200**	109.0	2.00	.040	119.0	2.00	.040
60.0	4.00	.020	82.0	4.00	.090	96.0	5.00	.100*	111.0	2.00	.100*	121.0	2.00	.010
65.0	5.00	.100*	84.0	2.00	.300**	101.0	5.00	.350**	113.0	2.00	.400**			

```

*****
COLLAR : NORTH EAST : PIT :DPTH:BOT:SMPL:          PRPRTY : AREA : HOLE
ELEV. : COORD. COORD.:DEPTH:SMPL:OXD:CODE:          CODE  : NO.  : (SAMPLE)
7000.5: 5000 5000:150.0:100:20:          URDAT : AAA  : TEST 1
  
```

NO ASSAYS OR DEPTH RECORDED, ASSUME HOLE (SAMPLE) IS BARREN.

```

*****
COLLAR : NORTH EAST : PIT :DPTH:BOT:SMPL:          PRPRTY : AREA : HOLE
ELEV. : COORD. COORD.:DEPTH:SMPL:OXD:CODE:          CODE  : NO.  : (SAMPLE)
11000.5: 6000 5000:150.0:466:100:V1:          VDATA : VVV  : TEST 2
  
```

U308 EQUIV. RADIOMETRIC (UNCORR. FOR DISEQUIL.) AND V205 ASSAYS.

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	GRADE V205	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	GRADE V205	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	GRADE V205	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	GRADE V205
401.0	1.00	.050	1.050	414.0	2.00	.020	2.000	435.5	2.00	.020	.020	451.0	2.00	.500*	1.000
403.0	2.00	.020	1.020	424.0	10.00	.010	.050	437.5	2.00	.010	2.000	453.0	2.00	.020	.100
408.0	5.00	.040	2.000	424.5	.50	.200**	1.000	447.5	10.00	.010	.200	455.0	2.00	.550*	2.000
410.0	2.00	.100*	5.550	429.5	5.00	.040	4.000	448.0	.50	.250**	5.000	465.0	10.00	.010	.200
412.0	2.00	.150*	.500	433.5	4.00	.500*	5.550	449.0	1.00	.020	.100	465.5	.50	.020	.200

```

*****
COLLAR : NORTH EAST : PIT :DPTH:BOT:SMPL:          PRPRTY : AREA : HOLE
ELEV. : COORD. COORD.:DEPTH:SMPL:OXD:CODE:          CODE  : NO.  : (SAMPLE)
7000.0: 5055 6055:150.0:300:100:611:          URDAT : AAA  : TEST 2
  
```

U308 EQUIV. RADIOMETRIC ASSAYS, UNCORRECTED FOR DISEQUILIBRIUM.

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308
134.0	4.00	.050	170.0	15.00	.250**	209.0	9.00	.020	240.0	4.00	.030
136.5	2.50	.000	175.0	5.00	1.040**	220.0	11.00	.090			
141.5	5.00	.020	180.0	5.00	.820*	226.0	6.00	.480**			
145.0	3.50	.000	185.0	5.00	.070	230.0	4.00	.060			
155.0	10.00	.110*	200.0	15.00	.000	236.0	6.00	.120*			

APPENDIX C: URDAT RUN

```

#####
COLLAR : NORTH EAST : PIT :DPTH:BOT:SMPL:H2O : K-FACTOR: DEAD :CRIT: H2O: AIR:CPS/INCH:LOG- :FULL :PRPRTY : AREA : HOLE
ELEV. : COORD. COORD. :DEPTH:SMPL:OXD:CODE:DPTH: (LAST) : TIME :FACT:CORR:CORR: (LAST) :TYPE :SCALE: CODE NO. (SAMPLE)
7293.0: 7930 9376: :5189:100: F1U: 230: .00000330: 3.0: NO :1.28:1.00: :AC : (14) : URDAT : BBB : TEST 3
#####
  
```

GAMMA LOG INTERPRETED VALUES; DATA: UNCORRECTED CPS. DATE LOGGED: 0/0

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308
1591.5	.50	.004	1596.5	.50	.022	1601.5	.50	.002	1606.5	.50	.005	1621.5	.50	.001
1592.0	.50	.000	1597.0	.50	.035	1602.0	.50	.008	1607.0	.50	.003	1624.0	.50	.009
1592.5	.50	.032	1597.5	.50	.174	1602.5	.50	.005	1607.5	.50	.000	1624.5	.50	.027
1593.0	.50	.008	1598.0	.50	.296	1603.0	.50	.005	1608.0	.50	.013	1625.0	.50	.008
1593.5	.50	.000	1598.5	.50	.106	1603.5	.50	.003	1608.5	.50	.059	1625.5	.50	.005
1594.0	.50	.041	1599.0	.50	.137	1604.0	.50	.005	1609.0	.50	.009	1626.0	.50	.006
1594.5	.50	.035	1599.5	.50	.130	1604.5	.50	.006	1609.5	.50	.000	1626.5	.50	.008
1595.0	.50	.029	1600.0	.50	.049	1605.0	.50	.006	1610.0	.50	.005	1627.0	.50	.002
1595.5	.50	.008	1600.5	.50	.081	1605.5	.50	.011	1610.5	.50	.000			
1596.0	.50	.016	1601.0	.50	.035	1606.0	.50	.007	1623.0	12.50	.000			

```

#####
COLLAR : NORTH EAST : PIT :DPTH:BOT:SMPL:H2O : K-FACTOR: DEAD :CRIT: H2O: AIR:CPS/INCH:LOG- :FULL :PRPRTY : AREA : HOLE
ELEV. : COORD. COORD. :DEPTH:SMPL:OXD:CODE:DPTH: (LAST) : TIME :FACT:CORR:CORR: (LAST) :TYPE :SCALE: CODE NO. (SAMPLE)
7211.0: 7780 9198: :5185:100: F1U: 329: .00000330: 3.0: NO :1.28:1.00: :A3 : (14) : URDAT : BBB : TEST 4
#####
  
```

GAMMA LOG INTERPRETED VALUES; DATA: UNCORRECTED CPS. DATE LOGGED: 0/0

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308
1583.5	.50	.006	1592.0	.50	.125	1600.5	.50	.017	1609.0	.50	.005	1617.5	.50	1.464
1584.0	.50	.004	1592.5	.50	.926	1601.0	.50	.032	1609.5	.50	.006	1618.0	.50	1.779
1584.5	.50	.007	1593.0	.50	.465	1601.5	.50	.029	1610.0	.50	.004	1618.5	.50	2.222
1585.0	.50	.006	1593.5	.50	.671	1602.0	.50	.030	1610.5	.50	.012	1619.0	.50	.626
1585.5	.50	.021	1594.0	.50	.508	1602.5	.50	.056	1611.0	.50	.002	1619.5	.50	.256
1586.0	.50	.024	1594.5	.50	.012	1603.0	.50	.364	1611.5	.50	.014	1620.0	.50	1.524
1586.5	.50	.041	1595.0	.50	.068	1603.5	.50	1.882	1612.0	.50	.032	1620.5	.50	1.432
1587.0	.50	.110	1595.5	.50	.101	1604.0	.50	2.931	1612.5	.50	.115	1621.0	.50	.000
1587.5	.50	.089	1596.0	.50	.094	1604.5	.50	3.477	1613.0	.50	.966	1621.5	.50	.128
1588.0	.50	.000	1596.5	.50	.224	1605.0	.50	3.407	1613.5	.50	.522	1622.0	.50	.053
1588.5	.50	.020	1597.0	.50	.424	1605.5	.50	3.747	1614.0	.50	.933	1622.5	.50	.097
1589.0	.50	.008	1597.5	.50	.363	1606.0	.50	1.579	1614.5	.50	.563	1623.0	.50	.000
1589.5	.50	.029	1598.0	.50	.381	1606.5	.50	.433	1615.0	.50	.833	1623.5	.50	.033
1590.0	.50	.019	1598.5	.50	.250	1607.0	.50	.054	1615.5	.50	1.556	1624.0	.50	.000
1590.5	.50	.012	1599.0	.50	.086	1607.5	.50	.000	1616.0	.50	1.065	1624.5	.50	.009
1591.0	.50	.013	1599.5	.50	.035	1608.0	.50	.009	1616.5	.50	1.294			
1591.5	.50	.032	1600.0	.50	.058	1608.5	.50	.011	1617.0	.50	1.404			

APPENDIX C: URDAT RUN

```

*****
COLLAR , NORTH EAST , PIT , DPTH:BOT:SMPL:H2O , F-FACTOR, DEAD ,CRIT, H2O, AIR:OPS/INCH LOG- ,FULL ,PRPRTY , AREA , HOLE
ELEV. , COORD. ,COORD. ,DEPTH:SMPL:DXD:CODE:DPTH, (LAST) , TIME (FACT:CORR:CORR) (LAST) ,TYPE ,SCALE , CODE , NO. , (SAMPLE)
720.0, 7930 9376, 5189,100, A11, 239,00000330, 3.0, NO 11.281, 96, ,A1, , UPDAT , CCC , TEST 5
    
```

 GAMMA LOG INTERPRETED VALUES: DATA: INCHES DEFL. (RECTL). DATE LOGGED: 0/0

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308
1591.5	.50	.004	1596.5	.50	.022	1601.5	.50	.002	1606.5	.50	.005	1622.5	.50	.001
1592.0	.50	.000	1597.0	.50	.025	1602.0	.50	.008	1607.0	.50	.003	1624.0	.50	.009
1592.5	.50	.032	1597.5	.50	.174	1602.5	.50	.005	1607.5	.50	.000	1624.5	.50	.027
1593.0	.50	.008	1598.0	.50	.298	1603.0	.50	.005	1608.0	.50	.010	1625.0	.50	.008
1593.5	.50	.000	1598.5	.50	.106	1603.5	.50	.002	1608.5	.50	.055	1625.5	.50	.005
1594.0	.50	.041	1599.0	.50	.171	1604.0	.50	.005	1609.0	.50	.009	1626.0	.50	.108
1594.5	.50	.035	1599.5	.50	.139	1604.5	.50	.006	1609.5	.50	.000	1626.5	.50	.008
1595.0	.50	.029	1600.0	.50	.049	1605.0	.50	.006	1610.0	.50	.005	1627.0	.50	.002
1595.5	.50	.008	1600.5	.50	.081	1605.5	.50	.011	1610.5	.50	.000			
1596.0	.50	.016	1601.0	.50	.025	1606.0	.50	.007	1611.0	.50	.000			

```

*****
COLLAR , NORTH EAST , PIT , DPTH:BOT:SMPL:H2O , F-FACTOR, DEAD ,CRIT, H2O, AIR:OPS/INCH LOG- ,FULL ,PRPRTY , AREA , HOLE
ELEV. , COORD. ,COORD. ,DEPTH:SMPL:DXD:CODE:DPTH, (LAST) , TIME (FACT:CORR:CORR) (LAST) ,TYPE ,SCALE , CODE , NO. , (SAMPLE)
7211.0, 789 9198, 5185,100, A21, 229,00000330, 3.0, NO 11.281, 100, ,A2, , UPDAT , CCC , TEST 6
    
```

 GAMMA LOG INTERPRETED VALUES: DATA: INCHES DEFL. (RECTL). DATE LOGGED: 0/0

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308
1583.5	.50	.008	1592.0	.50	.125	1600.5	.50	.017	1609.0	.50	.005	1617.5	.50	1.479
1584.0	.50	.004	1592.5	.50	.926	1601.0	.50	.032	1609.5	.50	.008	1618.0	.50	1.368
1584.5	.50	.007	1593.0	.50	.465	1601.5	.50	.029	1610.0	.50	.004	1618.5	.50	2.221
1585.0	.50	.006	1593.5	.50	.671	1602.0	.50	.001	1610.5	.50	.012	1619.0	.50	.627
1585.5	.50	.021	1594.0	.50	.508	1602.5	.50	.056	1611.0	.50	.002	1619.5	.50	.256
1586.0	.50	.024	1594.5	.50	.012	1603.0	.50	.365	1611.5	.50	.014	1620.0	.50	1.524
1586.5	.50	.041	1595.0	.50	.068	1603.5	.50	1.877	1612.0	.50	.032	1620.5	.50	1.402
1587.0	.50	.110	1595.5	.50	.101	1604.0	.50	2.949	1612.5	.50	.115	1621.0	.50	.000
1587.5	.50	.089	1596.0	.50	.094	1604.5	.50	3.451	1613.0	.50	.066	1621.5	.50	.128
1588.0	.50	.010	1596.5	.50	.224	1605.0	.50	3.423	1613.5	.50	.522	1622.0	.50	.053
1588.5	.50	.020	1597.0	.50	.424	1605.5	.50	3.730	1614.0	.50	.933	1622.5	.50	.097
1589.0	.50	.008	1597.5	.50	.363	1606.0	.50	1.575	1614.5	.50	.563	1623.0	.50	.000
1589.5	.50	.029	1598.0	.50	.381	1606.5	.50	.436	1615.0	.50	.833	1623.5	.50	.033
1590.0	.50	.019	1598.5	.50	.250	1607.0	.50	.054	1615.5	.50	1.558	1624.0	.50	.000
1590.5	.50	.012	1599.0	.50	.086	1607.5	.50	.000	1616.0	.50	1.060	1624.5	.50	.009
1591.0	.50	.017	1599.5	.50	.025	1608.0	.50	.009	1616.5	.50	1.296			
1591.5	.50	.058	1600.0	.50	.058	1608.5	.50	.011	1617.0	.50	1.399			

APPENDIX C: URDAT RUN

```

#####
COLLAR : NORTH EAST : PIT : DPTH:BOT:SMPL:H2O : K-FACTOR: DEAD :CRIT: H2O: AIR:CPS/INCH:LOG- :FULL :PRPRTY : AREA : HOLE
ELEV. : CGORD. :COORD.:DEPTH:SMPL:DXD:CODE:DPTH: (LAST) : TIME :FACT:CORR:CORR: (LAST) :TYPE :SCALE : CODE : NO. : (SAMPLE)
7203.0: 7930 9376: :5189:100: F11: 230: .00000330: 3.0: NO :1.28: .94: :X3 : (IN) : URDAT :BBB : TEST 7
#####
    
```

GAMMA LOG INTERPRETED VALUES; DATA: INCHES DEFL.(RECTL). DATE LOGGED: 0/0

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308
1591.5	.50	.004	1596.5	.50	.022	1601.5	.50	.002	1606.5	.50	.005	1623.5	.50	.001
1592.0	.50	.000	1597.0	.50	.035	1602.0	.50	.008	1607.0	.50	.003	1624.0	.50	.009
1592.5	.50	.032	1597.5	.50	.174	1602.5	.50	.005	1607.5	.50	.000	1624.5	.50	.027
1593.0	.50	.008	1598.0	.50	.296	1603.0	.50	.005	1608.0	.50	.013	1625.0	.50	.008
1593.5	.50	.000	1598.5	.50	.106	1603.5	.50	.003	1608.5	.50	.059	1625.5	.50	.005
1594.0	.50	.041	1599.0	.50	.137	1604.0	.50	.005	1609.0	.50	.009	1626.0	.50	.006
1594.5	.50	.035	1599.5	.50	.130	1604.5	.50	.006	1609.5	.50	.000	1626.5	.50	.008
1595.0	.50	.029	1600.0	.50	.049	1605.0	.50	.006	1610.0	.50	.005	1627.0	.50	.002
1595.5	.50	.008	1600.5	.50	.081	1605.5	.50	.011	1610.5	.50	.003			
1596.0	.50	.016	1601.0	.50	.035	1606.0	.50	.007	1623.0	12.50	.000			

LITHOLOGIC UNIT CODE: JM12 JM13 JM14 JM15 JM16 JM17 JM18 JM19 JM20 JM21 JM22
 DEPTH TO TOP OF UNIT: 50. 100. 150. 1000. 1150. 1200. 1250. 1500. 1600. 1650. 1700.

```

#####
COLLAR : NORTH EAST : PIT : DPTH:BOT:SMPL:H2O : K-FACTOR: DEAD :CRIT: H2O: AIR:CPS/INCH:LOG- :FULL :PRPRTY : AREA : HOLE
ELEV. : CGORD. :COORD.:DEPTH:SMPL:DXD:CODE:DPTH: (LAST) : TIME :FACT:CORR:CORR: (LAST) :TYPE :SCALE : CODE : NO. : (SAMPLE)
7211.0: 7780 9198: :5185:100: F11: 329: .00000330: 3.0: NO :1.28: .94: :X4 : (IN) : URDAT :BBB : TEST 9
#####
    
```

NO ASSAYS RECORDED; ASSUME HOLE (SAMPLE) IS BARREN TO DEPTH SAMPLED.
 LITHOLOGIC UNIT CODE: JM12 JM13 JM14 JM15 JM16 JM17 JM18 JM19 JM20 JM21 JM22
 DEPTH TO TOP OF UNIT: 50. 100. 150. 1000. 1150. 1200. 1250. 1300. 1350. 1400. 1450.

```

#####
COLLAR : NORTH EAST : PIT : DPTH:BOT:SMPL:H2O : K-FACTOR: DEAD :CRIT: H2O: AIR:CPS/INCH:LOG- :FULL :PRPRTY : AREA : HOLE
ELEV. : CGORD. :COORD.:DEPTH:SMPL:DXD:CODE:DPTH: (LAST) : TIME :FACT:CORR:CORR: (LAST) :TYPE :SCALE : CODE : NO. : (SAMPLE)
7211.0: 7780 9198: :5185:100: F10: 329: .00000330: 3.0: NO :1.28: .94: :X4 : (IN) : URDAT :BBB : TEST 10
#####
    
```

GAMMA LOG INTERPRETED VALUES; DATA: PREVIOUSLY INTRPRTD. DATE LOGGED: 0/0

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308
1581.5	.50	.004	1586.5	.50	.022	1591.5	.50	.002	1596.5	.50	.005	1613.5	.50	.001
1582.0	.50	.000	1587.0	.50	.035	1592.0	.50	.008	1597.0	.50	.003	1614.0	.50	.009
1582.5	.50	.032	1587.5	.50	.174	1592.5	.50	.007	1597.5	.50	.000	1614.5	.50	.027
1583.0	.50	.008	1588.0	.50	.296	1593.0	.50	.005	1598.0	.50	.013	1615.0	.50	.008
1583.5	.50	.000	1588.5	.50	.106	1593.5	.50	.003	1598.5	.50	.059	1615.5	.50	.005
1584.0	.50	.041	1589.0	.50	.137	1594.0	.50	.005	1599.0	.50	.009	1616.0	.50	.006
1584.5	.50	.035	1589.5	.50	.130	1594.5	.50	.006	1599.5	.50	.000	1616.5	.50	.008
1585.0	.50	.029	1590.0	.50	.049	1595.0	.50	.006	1600.0	.50	.005	1617.0	.50	.002
1585.5	.50	.008	1590.5	.50	.081	1595.5	.50	.011	1600.5	.50	.003			
1586.0	.50	.016	1591.0	.50	.035	1596.0	.50	.007	1613.0	12.50	.000			

LITHOLOGIC UNIT CODE: JM12 JM13 JM14 JM15 JM16
 DEPTH TO TOP OF UNIT: 50. 100. 150. 1000. 2000.

APPENDIX C: URDAT RUN

```

*****
COLLAR : NORTH EAST : PIT : DPTH:BOT:SMPL:H2D : K-FACTOR: DEAD :CRIT: H2D: AIR:CPS/INCH:LOG- :FULL : PRPRTY : AREA : HOLE
ELEV. : COORD. COORD. :DEPTH:SMPL:OXD:CODE:DPTH: (LAST) : TIME :FACT:CORR:CORR: (LAST) :TYPE :SCALE: CODE : NO. : (SAMPLE)
7211.0: 7780 9198: 15185:100: F20: 329: .00000330: 3.0: NO :1.28: .94: :X4 : : :URDAT : BBB : TEST11
*****
  
```

GAMMA LOG INTERPRETED VALUES; DATA: PREVIOUSLY INTRPRTD. DATE LOGGED: 6/12

BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308	BOT DPTH (FT.)	THK. (FT.)	GRADE U308
1583.5	.50	.022	1586.0	.50	1.000*	1588.5	.50	.001
1584.0	.50	.120*	1586.5	.50	.878*	1589.0	.50	.000
1584.5	.50	.311**	1587.0	.50	.555*	1589.5	.50	.022
1585.0	.50	.500*	1587.5	.50	.119*			
1585.5	.50	.880*	1588.0	.50	.060			

ALL DATA FILES FOR RUN HAVE BEEN PROCESSED.

DATA ANALYSIS OF PRIMARY U-ASSAY FILE "GAMDAT4", DATE: JAN 88
 ID: URDAT RUN ON TEST FILE "GAMDAT".
 NO INTERMEDIATE FILE OUTPUT REQUESTED. RUN BY:PDV

PAGE 1

*** SUMMARY OF HOLE STATISTICS ***

TOTAL NUMBER OF HOLES PROCESSED FOR RUN/BLOCK = 12;

OF THESE:

- 0 10 HAD SAMPLE ASSAY DATA.
- 0 2 HAD NO ASSAYS REPORTED ("BARREN").

"PEAK-GRADE-ST" SUMMARY; HOLES WITH SAMPLES, AT OR ABOVE THE INDICATED CUTOFF GRADE, TOTALING, AT LEAST, EITHER 4 FEET OR THE INDICATED ST.

CUTOFF GRADE = .10 %U308, MIN. ST = .40; # HOLES = 4

CUTOFF GRADE = .30 %U308, MIN. ST = 1.20; # HOLES = 1

CUTOFF GRADE = .40 %U308, MIN. ST = 1.60; # HOLES = 1

CUTOFF GRADE = .50 %U308, MIN. ST = 2.00; # HOLES = 4

SAMPLES AT INDICATED "PEAK" GRADE ARE NOT NECESSARILY CONTIGUOUS;
 IF SAMPLES EDITED, PEAK GRADE VALUES APPLY ONLY TO SELECTED SAMPLES.

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