27
2-24-81
JLB
24 copy to NTIS

ornl

**OAK
RIDGE
NATIONAL
LABORATORY**

**UNION
CARBIDE**

**OPERATED BY
UNION CARBIDE CORPORATION
FOR THE UNITED STATES
DEPARTMENT OF ENERGY**

2
R-2225

ORNL/TM-7488

MASTER

**SORA: Computer Storage or
Retrieval of Radionuclide
Analyses Data**

D. D. Huff

ENVIRONMENTAL SCIENCES DIVISION
Publication No. 1578

REPRODUCTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
NTIS price codes—Printed Copy: A03; Microfiche A01

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Contract No. W-7405-eng-26

SORA: COMPUTER STORAGE OR RETRIEVAL OF
RADIONUCLIDE ANALYSES DATA

D. D. Huff

ENVIRONMENTAL SCIENCES DIVISION
Publication No. 1578

Nuclear Waste Programs
(Activity No. AR05 15 15 0; ONL-WL09)

Date Published: February 1981

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
DEPARTMENT OF ENERGY

REPRODUCTION OF THIS DOCUMENT IS UNLIMITED *eb*

**THIS PAGE
WAS INTENTIONALLY
LEFT BLANK**

ACKNOWLEDGMENTS

The genesis of the computer program presented in this report began with D. S. Ward, formerly of the Environmental Sciences Division. Mr. Ward deserves credit for initiating the gathering of existing data and developing the first version of the SORA program, together with a summary of the early results.

The initial data were produced through the efforts of many researchers and technical support staff, most notably J. O. Duguid, O. M. Sealand, and D. S. Ward, of the Environmental Sciences Division.

**THIS PAGE
WAS INTENTIONALLY
LEFT BLANK**

ABSTRACT

HUFF, D. D. 1981. SORA: Computer storage or retrieval of radionuclide analyses data. ORNL/TM-7488. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 32 pp.

The need for information on the fate and transport of radionuclides placed in shallow-land disposal sites emphasizes the necessity for an orderly, objective means for storing and retrieving results of radiochemical analyses of samples collected on or near such locations. A computer program (SORA) was developed to aid in organizing such results and to ensure their availability for computer processing. The program documentation provides a format that specifies how results from radiochemical analyses of environmental samples may be recorded. It is also a guide to the listing of results generated by the program.

**THIS PAGE
WAS INTENTIONALLY
LEFT BLANK**

TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT	v
LIST OF TABLES	ix
LIST OF FIGURES	ix
INTRODUCTION	1
PROGRAM DOCUMENTATION	2
Program Scope	2
Input	2
Specification of Units for Output	7
Site Description	7
Description of Variables	8
Location Coordinates and Site Information	9
Observation Data	10
Input Example	13
Output	16
PROGRAM APPLICATIONS	16
FUTURE WORK	17
REFERENCES	18
APPENDIX - Listing of SORA Program	19

**THIS PAGE
WAS INTENTIONALLY
LEFT BLANK**

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Sample types and associated identification codes	11
2	Analytical laboratory identification codes	12

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	A listing of the complete punched-card input for the example described in the text	3
2	A listing of the output generated by the SORA program for a descriptive example	4-6

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

X

INTRODUCTION

The continuing need for reliable information on the fate and transport of radionuclides placed in shallow-land disposal sites demands an orderly, objective means for storing and retrieving results of radiochemical analyses of samples collected on or near such locations. One aspect of the need is simply documentation of the organized set of data associated with shallow-land disposal sites in a hard copy for future reference. Another reason for providing such documentation is compliance with quality assurance (Q/A) mandates.

Overriding the simple considerations of documenting and preserving information gathered, however, is the need to make the data available in a format that will facilitate its future use in sophisticated analyses of disposal-site behavior. For example, efforts have been underway for some time to quantify the relative importance of various hydrologic processes in the transport of radionuclides from shallow-land disposal sites. Many of the efforts relied upon use of digital computer models to characterize transport processes. A key component of such work is access to reliable computer-formatted data bases for evaluating model performance and providing insight into transport mechanisms.

The objectives of this report are to document a computer program (SORA) that organizes results from radionuclide analyses and ensures their availability for data base management systems, and to present an example of results collected by the Environmental Sciences Division in ORNL waste disposal areas.

PROGRAM DOCUMENTATION

Program Scope

The program documented in this report is limited in scope to serving as a guide for objective specifications for storing results of radionuclide analyses and generating a printed copy of those results in a standardized format. In other words, the program serves to dictate how radiochemical-analysis results from solid waste storage area (SWSA) samples are to be organized into computer format, and then to generate an organized hard copy of the available results. The program documentation is broken into two parts: input requirements and explanation of the program output. In addition, a complete listing of the program is given in the appendix to this report.

Input

The program was written in a general form to allow input for any particular situation of interest. Input consists of five components: specification of units for the output report, a description of the general location under consideration, a description of the variables included in the data, an explicit definition of individual site coordinates, and results of radiochemical analyses for each specific location and sampling date. In the following descriptions, the card-input formats are explicitly documented, and an example is provided in Figs. 1 and 2.

CARD

```

1 3 1
2 SWSA 3 GROUNDWATER SAMPLING PROGRAM DATA:
3 SWSA 3 INPUT CONCENTRATIONS IN WATER GIVEN IN PC1/ML
4 SWSA 3 INPUT DEPTH TO WATER IS GIVEN IN METERS
5 SWSA 3
6 SR-90 H-3 CO-60 CS-137 GROSS A
7 SB-125 IR-95 RA-226 EU-154 CE-144
8 1-131 RU-106 TH-228 WAT-LEV
9 033 21629.5 26428.1
10 033 COORDINATES REFERENCE: MAP BY PETREE FOR D. WEBSTER-NO NUMBER-FEB 1980
11 033 CASING ELEVATION 840.0 GROUND ELEVATION
12 033
13 3 780712 2.65 W033
14 1 781007 0.14 0.05 0.18 0.01 W033 A 9086338
15 1 790115 0.01 C033 A11458827
16 3 790126 1.79 W033
17 4
18 039 21670.6 26009.7
19 039 COORDINATES REFERENCE: MAP BY PETREE FOR D. WEBSTER-NO NUMBER-FEB 1980
20 039 CASING ELEVATION 849.7 GROUND ELEVATION
21 039
22 3 780712 6.47 W039
23 1 781007 0.05 0.01 0.08 0.004 W039 A 9086339
24 1 790115 0.01 C039 A11458828
25 1 790115 0.004 W039 A11458828
26 1 790115 0.004 C039 A12399824
27 3 790126 5.73 W039
28 4
29 0315 21726.0 25697.7
30 0315 COORDINATES REFERENCE: MAP BY PETREE FOR D. WEBSTER-NO NUMBER-FEB 1980
31 0315 CASING ELEVATION 849.2 GROUND ELEVATION
32 0315
33 3 780712 8.85 W0315
34 1 781007 1.02 0.004 0.03 0.01 W0315 A 9086340
35 1 790115 0.63 C0315 A11458829
36 3 790126 7.07 W0315
37 4
38 0316 21871.1 25668.2
39 0316 COORDINATES REFERENCE: MAP BY PETREE FOR D. WEBSTER-NO NUMBER-FEB 1980
40 0316 CASING ELEVATION 841.8 GROUND ELEVATION
41 0316
42 3 780712 9.07 W0316
43 1 781007 0.21 0.003 0.01 0.01 W0316 A 9086341
44 1 790115 0.14 C0316 A11458830
45 3 790126 8.24 W0316
46 4
47 0320 22012.5 25820.8
48 0320 COORDINATES REFERENCE: MAP BY PETREE FOR D. WEBSTER-NO NUMBER-FEB 1980
49 0320 CASING ELEVATION 837.6 GROUND ELEVATION
50 0320
51 3 780712 6.83 W0320
52 1 781007 -0.004 0.003 0.008 -0.004 W0320 A 9086342
53 1 790115 0.004 C0320 A11458831
54 2 790115 0.004 ***** DELIBERATE ERROR ON THIS CARD *****
55 3 790126 6.71 W0320
56 4

```

Fig. 1. A listing of the complete punched-card input for the example described in the text.

```

*****
*                                     *
*               SORA                 *
*                                     *
*****

```

COMPUTER STORAGE/RETRIEVAL OF WHITE OAK CREEK
WATERSHED RADIONUCLIDE ANALYSES

SWSA 3 GROUNDWATER SAMPLING PROGRAM DATA:
SWSA 3 INPUT CONCENTRATIONS IN WATER GIVEN IN PCI/ML
SWSA 3 INPUT DEPTH TO WATER IS GIVEN IN METERS
SWSA 3

AREA : 3 ORNL COORDINATE: NORTH 21629.5
LOCATION: 3 EAST 26428.1

U33 COORDINATES REFERENCE: MAP BY PETREE FOR D. WEBSTER-NO NUMBER-FEB 1980
C33 CASING ELEVATION 840.0 GROUND ELEVATION
U33
THE CONCENTRATION UNITS ARE: BECQUERELS PER ML OR GRAM
THE DEPTH TO WATER IS MEASURED IN: METERS

DATE	SR-90	H-3	CO-60	CS-137	GROSS A	IDNT	LAB	ANAL REPT	ANAL LOG
10/ 7/78	18.65	0.0000	6.660	23.98	1.332	W033	A	908	6338
1/15/79	1.332	0.0000	0.0000	0.0000	0.0000	C033	A	1145	8827

DATE	I-131	RU-106	TH-229	WAT-LEV		IDNT	LAB	ANAL REPT	ANAL LOG
7/12/78	0.0000	0.0000	0.0000	2.650	0.0000	W033			
1/26/79	0.0000	0.0000	0.0000	1.790	0.0000	W033			

AREA : 3 ORNL COORDINATE: NORTH 21670.6
LOCATION: 9 EAST 26709.7

O39 COORDINATES REFERENCE: MAP BY PETREE FOR D. WEBSTER-NO NUMBER-FEB 1980
C39 CASING ELEVATION 849.7 GROUND ELEVATION
O39
THE CONCENTRATION UNITS ARE: BECQUERELS PER ML OR GRAM
THE DEPTH TO WATER IS MEASURED IN: METERS

DATE	SR-90	H-3	CO-60	CS-137	GROSS A	IDNT	LAB	ANAL REPT	ANAL LOG
10/ 7/78	6.660	0.0000	1.332	10.66	0.5328	W039	A	908	6339
1/15/79	1.332	0.0000	0.0000	0.0000	0.0000	C039	A	1145	8828
1/15/79	0.5328	0.0000	0.0000	0.0000	0.0000	W039	A	1145	8828
1/15/79	0.5328	0.0000	0.0000	0.0000	0.0000	C039	A	1239	9824

DATE	I-131	RU-106	TH-228	WAT-LEV		IDNT	LAB	ANAL REPT	ANAL LOG
7/12/78	0.0000	0.0000	0.0000	6.470	0.0000	W039			
1/26/79	0.0000	0.0000	0.0000	5.730	0.0000	W039			

Fig. 2. A listing of the output generated by the SORA program for a descriptive example.

AREA : 3 ORNL COORDINATE: NORTH 21726.0
LOCATION: 15 EAST 25697.7

0315 COORDINATES REFERENCE: MAP BY PETREE FOR D.WFSTER-NO NUMBER-FEB 1980
0315 CASING ELEVATION 849.2 GROUND ELEVATION .
0315
THE CONCENTRATION UNITS ARE: BECQUERELS PER ML OR GRAM
THE DEPTH TO WATER IS MEASURED IN: METERS

DATE	SR-90	H-3	CO-60	CS-137	GROSS A	IDNT	LAB	ANAL REPT	ANAL LOG
10/ 7/78	143.9	0.0000	0.5328	3.996	1.332	W0315	A	908	6340
1/15/79	83.92	0.0000	0.7000	0.0000	0.0000	C0315	A	1145	8829

DATE	I-131	RU-106	TH-228	WAT-LEV		IDNT	LAB	ANAL REPT	ANAL LOG
7/12/78	0.0000	0.0000	0.0000	8.850	0.0000	W0315			
1/26/79	0.0000	0.0000	0.0000	7.070	0.0000	W0315			

AREA : 3 ORNL COORDINATE: NORTH 21871.1
LOCATION: 16 EAST 25668.2

0316 COORDINATES REFERENCE: MAP BY PETREE FOR D.WFSTER-NO NUMBER-FEB 1980
0316 CASING ELEVATION 841.8 GROUND ELEVATION .
0316
THE CONCENTRATION UNITS ARE: BECQUERELS PER ML OR GRAM
THE DEPTH TO WATER IS MEASURED IN: METERS

DATE	SR-90	H-3	CO-60	CS-137	GROSS A	IDNT	LAB	ANAL REPT	ANAL LOG
10/ 7/78	27.97	0.0000	0.3996	1.332	1.332	W0316	A	908	6341
1/15/79	18.65	0.0000	0.0000	0.0000	0.0000	C0316	A	1145	8830

DATE	I-131	RU-106	TH-228	WAT-LEV		IDNT	LAB	ANAL REPT	ANAL LOG
7/12/78	0.0000	0.0000	0.0000	9.070	0.0000	W0316			
1/26/79	0.0000	0.0000	0.0000	8.240	0.0000	W0316			

Fig. 2. (continued)

AREA : 3 ORNL COORDINATE: NORTH 22012.5
 LOCATION: 20 EAST 25820.8

0320 COORDINATES REFERENCE: MAP BY PETREE FOR D.WEBSTER-NO NUMBER-FEB 1980
 0320 CASING ELEVATION 837.6 GROUND ELEVATION

0320
 THE CONCENTRATION UNITS ARE: BECQUERELS PER ML OR GRAM
 THE DEPTH TO WATER IS MEASURED IN: METERS

DATE	SR-90	H-3	CO-60	CS-137	GROSS A	IDNT	LAB	ANAL REPT	ANAL LOG
10/ 7/78	-0.5328	0.0000	0.3996	1.066	-0.5328	W0320	A	908	6342
1/15/79	0.5328	0.0000	0.0000	0.0000	0.0000	C0320	A	1145	8831

DATE	1-131	RU-106	TH-228	WAT-LEV		IDNT	LAB	ANAL REPT	ANAL LOG
7/12/78	0.0000	0.0000	0.0000	6.830	0.0000	W0320			
1/26/79	0.0000	0.0000	0.0000	6.710	0.0000	W0320			

 THE FOLLOWING DATA HAD UNACCEPTABLE CHARACTERS IN NUMERIC FIELDS

2 79C115 C.004 ***** DELIBERATE ERROR ON THIS CARD *****

Fig. 2. (continued)

Specification of Units for Output

In the past few years, there have been several different units of measurement for radioactivity [e.g., disintegrations per minute (dpm), picoCuries (pCi), Becquerels (Bq)] and depth to groundwater (meters, feet) in common use. As a result, data management requires a provision for the option of specifying the measurement units used for SORA input and output. The description given here indicates the codes associated with measurement units for both radioactivity and depth to groundwater. The format used to specify units for the printed output report is:

<u>Card</u>	<u>Col</u>	<u>Name and meaning of variables</u>
1	2	IOCU: Code for radiation units in all output - 0 or blank: pCi 1 : pCi 2 : dpm 3 : Bq
	4	IODU: Code for length units in output - 0 or blank: meters (m) 1 : meters (m) 2 : feet (ft)

Site Description

There are four cards used for this input. The data are read as alphanumeric, and there are no specific requirements for columns to be used.

<u>Card</u>	<u>Col</u>	<u>Name and meaning of variables</u>
2	1-80	TITL1: A descriptive heading for the site under consideration.
3	1-80	TITL2: Continuation of the descriptive heading.

<u>Card</u>	<u>Col</u>	<u>Name and meaning of variables</u>
4	1-80	COMNT1: Comments that will be printed as part of the heading.
5	1-80	COMNT2: Comments that will be printed as part of the heading. The cards may be left blank if so desired, but must be included.

The site description cards are only used once for a given computer run. Once the site is described, a multiple number of site coordinates and observation data may be included.

Description of Variables

The descriptive titles of the variables contained in the data set are included in this section of the input. There is space for up to 15 different variable names, which are contained on three input cards.

<u>Card</u>	<u>Col</u>	<u>Name and meaning of variables</u>
6	11-18	HEADN: Up to 8-character description of the first radionuclide included in the data set for this location (e.g., ⁹⁰ Sr).
	21-28	HEADN: Up to 8-character description of the second radionuclide in the data set.
	31-38	HEADN: Third radionuclide in the data set.
	41-48	HEADN: Fourth radionuclide in the data set.
	51-58	HEADN: Fifth radionuclide in the data set.
7	11-18	HEADN: Sixth radionuclide in the data set.
	21-28	HEADN: Seventh radionuclide in the data set.

<u>Card</u>	<u>Col</u>	<u>Name and meaning of variables</u>
	31-38	HEADN: Eighth radionuclide in the data set.
	41-48	HEADN: Ninth radionuclide in the data set.
	51-58	HEADN: Tenth radionuclide in the data set.
8	11-18	HEADN: Eleventh radionuclide in the data set.
	21-28	HEADN: Twelfth radionuclide in the data set.
	31-38	HEADN: Thirteenth radionuclide in the data set.
	41-48	HEADN: Water-level measurement in the data identification.
	51-58	HEADN: Fifteenth variable in the data set.

Note: Cards 6-8 must be included even if they are partially or completely blank. For example, if only five radionuclides have been assayed, only the first card will have information on it.

Location Coordinates and Site Information

For each specific location, an identifier and a set of coordinates provide explicit identification of the field location that was sampled. The grid coordinates are a part of the ORNL grid system and may be referenced to the base map for the White Oak Creek watershed (Farrow 1980). Supplemental information describing past history or reference maps for the location may be included as comments to be printed with data for each specific site.

The site location is specified by a combination of an area identification code, which is referenced to a base map and a site identifier. For the solid waste storage areas (SWSA), the area code is the same as the historic solid waste storage area number at ORNL. Thus, SWSA 4 has an area code of 04. The site identifier may be any combination of numbers and letters that are commonly used to denote a sampling site. For wells, we use the well number that was assigned when the well was installed. An example of a mixed (numeric and character) site identifier would be a well in the vicinity of an intermediate-level trench, such as WT7-5 (Duguid 1975), or one of the wells in the flood plain below SWSA-4, where the local north/south and east/west coordinates are truncated to integer values.

<u>Card</u>	<u>Col</u>	<u>Name and meaning of variables</u>
9	1-2	AC: Area code (e.g., 04 for SWSA-4).
	3-10	ID: Abbreviated site identification (e.g., WT7-5; Note: ID should be left-justified).
	11-20	X: ORNL grid coordinate (NORTH).
	21-30	Y: ORNL grid coordinate (EAST).
10-12	1-80	TITL3: Comments that will be printed as part of the site location information; may include alternate names and other grid system coordinates.

Observation Data

The values associated with each variable in the data set are included in this part of the input. Each card contains a number that associates it with one of the three sets of five variables (see

Description of Variables). It also contains the information on measurement of units, sampling date, results of radiochemical analyses, the type of sample, the site area code and common identifier, an identification of the laboratory that performed the analyses, and the analytical chemistry report and log numbers, which assure positive cross-referencing with analytical laboratory records.

The sample types and associated codes are given in Table 1 below:

Table 1. Sample types and associated identification codes

Sample type	Single sample code	Composite sample code
Stream sediment	M	A
Lake sediment	H	K
Stream water	S	B
Well water	W	C
Seep water	E	P
Lake water	L	R
Soil	F	D
Vegetation	V	T
Rock	G	X
Interstitial water	I	F
Quality assurance	Q	J
Other	O	

The current listing of analytical laboratory identification codes are given in Table 2.

Table 2. Analytical laboratory identification codes

Division	Person in charge	Identification code
Analytical chemistry	Scott	A
Analytical chemistry	Parker	B
Environmental sciences	Larson (Cerenkov)	C

It should be apparent that both the sample type and analytical laboratory code lists may require expansion in the future. These lists will be maintained with the data cards as a part of the low-level waste management program data library.

<u>Card</u>	<u>Col</u>	<u>Input description</u>
13-N	2	NCD: Integer 1, 2, or 3 corresponding to: 1 - first five radionuclides (listed on card 6) 2 - second five radionuclides (card 7) 3 - third five radionuclides (card 8).
	3	NCU: Code for radioactivity units (see Card 1).
	4	NDU: Code for length units (see Card 1).
5-6		DATE: Year of sample collection.
7-8		Month of sample collection.
9-10		Day of sample collection.

<u>Card</u>	<u>Col</u>	<u>Input description</u>
	11-20	C: Concentration of radionuclides number 1 (for first, second, or third sets of five).
	21-30	C: Radionuclide number 2.
	31-40	C: Radionuclide number 3.
	41-50	C: Radionuclide number 4.
	51-60	C: Radionuclide number 5.
	61	STYP: Type of sample collected and analyzed (see Table 1).
	62-63	AC: Area code for site location.
	64-71	CNAM: Common name for the site, left-adjusted in the field. This should be identical to the 8-character identifier used on card 9.
	72	Analytical laboratory identification code (see Table 2).
	73-76	IAC(1): Analytical chemistry report number (final 4 digits), right-adjusted.
	77-80	IAC(2): Analytical chemistry log number (final 4 digits), right-adjusted.
N+1	2	NCD: Use the integer 4 to indicate completion of input for this specific location.
N+2	see Sections 3-4	For any additional locations where data are available, cards 8 to (N+1) are repeated.

Input Example

The following example is drawn from data collected at five specific locations within SWSA 3 at ORNL. The actual card images used are given in Fig. 1. They are numbered sequentially to aid the discussion and should be used in conjunction with the preceding input descriptions.

The first portion of the input describes general attributes of the output and the site. The first card (see Specification of Units for Output) specifies Becquerel (the value 3 in column 2) and meters (the value 1 in column 4) as output units (see Specification of Units for Output). The next four cards (see Site Description) provide a general description of the site, and include comments about the units used for measurement. The next three cards (see Description of Variables) provide a listing of the variables presented on the data cards. The sixth card is associated with data cards where the computer program variable NCD is 1, the seventh card goes with data cards where NCD is 2, and the eighth card goes with data where NCD is 3. Together, these first eight cards complete the general description for the output units and subsequent data. The remaining cards are repeated for each specific sampling location within the general area.

The first example for Location Coordinates and Site Information is made up of cards 9 through 12. Card 9 includes the area identifier (03) and the specific sampling site identification. Most wells are designated by a number, such as 3, which is used here. The ORNL grid coordinates are given as a key factor in exact site location. Thus, card 9 indicates that well number 3 in SWSA 3 is located at ORNL coordinates N21629.5 by E26428.1. The subsequent three cards are available for supplemental information. In the example, the area code and sample site identifier were included as the first few columns on each card. In addition, information about the reference map and the physical characteristics of the site were provided.

The final data for a site (see Observation Data) are included in cards 13 through 17. For example, card 13 has NCD equal to 3, NCU and NDU blank, and the fourth variable entered as data. Thus, this refers to water level and represents a measured distance of 2.65 m from the measuring point to water on July 12, 1978. The sample identification code indicates the sample type is well water at well number 3 in SWSA 3. Card 14 contains results for ^{90}Sr , ^{60}Co , ^{137}Cs , and gross alpha analyses in picoCuries per milliliter. The sample was analyzed by Laboratory A (Table 2) and has report number 908 and log number 6338. Card 17 indicates the end of input for well 3 in SWSA 3.

Data for additional sites in SWSA 3 are shown in the remaining portion of the example. Several points are illustrated in these example cards. For instance, line 24 shows ^{90}Sr input for a composite sample collected in January 1979. Although the day of sample collection is shown as the 15th, this is merely for convenience in dealing with an extended sampling period. The mid-point of the month is used for all composite samples listed here. It is recommended that the mid-point of the period over which the composite is collected be used as the date given for future composite samples. Line 25 is an example of a replicate analysis included for quality assurance purposes. It has the same report and log numbers as the data on line 24, except it has a Q for sample type, thus indicating a quality assurance sample.

The final site in the example contains two points of interest. The minus sign before a number indicates the result was less than or equal to the value shown. Two examples appear on line 52. On line 54, a

deliberate error was introduced to illustrate the limited error-handling facility of the program. When characters appear where numeric input is expected, a read error will occur. Rather than allow the summarization program to be aborted at this point, it was more useful to save the images of offensive cards and list them as the final part of the output for the site. This can be useful in screening cards as they are introduced into the data base.

Output

The SORA program translates the input data in the example to the output shown in Fig. 2. Note that only those groupings of analyses that contain assayed results are printed for a given location. The occurrence of zero or missing values is shown by 0.0000 in the output. For values less than or equal to the reported result, a negative sign is placed in front of the value. It should also be noted that units for both radioactivity concentration and depth to groundwater are given in the heading for each site. In this example, concentrations are given as Becquerel per milliliter (or Bq/q) and depth to water is given in meters.

PROGRAM APPLICATIONS

The SORA program is compatible with all ORNL computers. For the example presented here, the MODCOMP CLASSIC computer, which is operated by the Environmental Sciences Division, was used to produce the results shown. Instructions for using the SORA program with any of the ORNL computers are available from the author on request. It should be

re-emphasized here that executing the SORA program is a worthwhile means of ensuring that the data are in correct format. It serves as an important screening device to eliminate errors and facilitate subsequent use of the data set.

FUTURE WORK

It is anticipated that the cards used by the SORA program will provide the basis for input to the SYSTEM 1022 data base management system currently in use by the Waste Management Project within the Environmental Sciences Division. Thus, the rather simple process of satisfying the SORA program requirements also lays the foundation for building a comprehensive interactive computer data base. In addition, it is planned that the output from the SORA program will be archived on microfiche at periodic intervals to assure permanent records of analytical results while minimizing card storage requirements.

REFERENCES

- Duguid, J. O. 1976. Annual progress report of burial ground studies at Oak Ridge National Laboratory: Period ending September 30, 1975. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 54 pp.
- Farrow, N. D. 1980. White Oak Creek watershed topographic map and related materials. ORNL/TM-7289. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Listing of SORA program

[illegible]

APPENDIX (continued)

```

C      PROGRAMMING NOTES:
C
C      THE VARIABLES IN AND IO ARE SET IN A DATA STATEMENT. FOR
C      NORMAL USE THEY ARE 5 AND 6 RESPECTIVELY, BUT CAN BE CHANGED
C      FOR INTERACTIVE USE ON THE PDP-10.
C
C      THE COMMENTS THAT ARE INPUT VIA COMNT1 AND COMNT2 SHOULD
C      INDICATE THE MEASUREMENT UNITS FOR RADIONUCLIDE ANALYSES AND
C      WATER LEVEL.
C
C      WHEN DATA FOR MULTIPLE SITES ARE INCLUDED, THE LAST CARD FOR EACH
C      SITE SHOULD BE FOLLOWED BY A CARD WITH THE NUMBER 4 PUNCHED IN
C      COLUMN 3.
C
C      IN ORDER TO ACCOMMODATE DATA CARDS PREPARED FOR EARLIER VERSIONS
C      OF THE SORA PROGRAM, A BLANK OR ZERO VALUE FOR NCD IS ASSUMED = 1.
C      THIS MAY CAUSE CONFUSION IF THE INPUT CARDS ARE NOT IN THE CORRECT
C      SEQUENCE. TO ALERT THE USER TO SUCH PROBLEMS, THE PROGRAM WILL
C      PRINT A WARNING TO THE OUTPUT DEVICE, INCLUDED IN SITE DATA, THEN
C      ATTEMPT TO RECOVER BY READING ADDITIONAL CARDS.
C      IF BOTH NCD AND DATE(1) ARE BLANK OR ZERO (E.G., A BLANK CARD),
C      THEN IT IS ASSUMED THAT INPUT VALUES FOR A SITE ARE COMPLETE.
C
C      PROGRAM AUTHOR:
C
C      THIS VERSION OF THE SORA PROGRAM WAS WRITTEN BY
C
C      D.D. HUFF
C      ENV SCI DIV - ORNL
C      DECEMBER, 1979
C
C-----
C      INTEGER DATE,HEADN,TITL1,TITL2,COMNT1,COMNT2
C      DIMENSION TITL1(20),TITL2(20),DATE(3,3,50),HEADN(3,10),COMNT1(20
C      +),COMNT2(20),ID(2),C(3,5,50),IDNT(3,50,5),IORS(3)
C      DIMENSION IDAT(3),CT(5),IDTMP(3),IACT(2),IAC(3,50,2),LAH(5)
C      DIMENSION IERC(20),ICHARE(20,10),ILR(3,50)
C      DIMENSION LARC(3,3),LARD(2,2),CCONV(3),DCONV(2)
C      DATA LARC/'PICG','DPY','RECQ','CUR',' ','UERE','IES ',
C      + ' ','LS ' /
C      DATA LARD/'METE','FEET','RS ',' ' /
C      DATA CCONV/1.00,2.22,133.20/
C      DATA DCONV/1.00,3.2808/
C      DATA ISPEC/1/
C      DATA IN,IO,IE/5,6,6 /
C      DATA LAH/'IDNT','ANAL','REPT',' LOG',' LAR' /
C      WRITE(10,7055)
C      WRITE(10,111)
C      READ(IN,4) JGCU,100U
C      INPUT THE DESIRED OUTPUT UNITS FOR CONCENTRATION AND DEPTH TO WATER
C----- READ TITLE
C      READ(IN,1)(TITL1(I),I=1,20),(TITL2(I),I=1,20)
C      WRITE(10,3)(TITL1(I),I=1,20),(TITL2(I),I=1,20)
C----- READ ADDITIONAL COMMENTS
C      READ(IN,1)(COMNT1(I),I=1,20),(COMNT2(I),I=1,20)
C      WRITE(10,3) COMNT1,COMNT2
C----- READ HEADINGS
C      DO 90 M=1,3
C      90 READ(IN,2)(HEADN(M,I),I=1,10)
C----- READ LOCATION IDENTIFICATION AND COORDINATES
C      1000 CONTINUE
C      IERF=C
C      READ(IN,10,ERR=7000,END=700) ICODE,ID(1),ID(2),X,Y
C      READ(IN,1) (COMNT1(I),I=1,20),(COMNT2(I),I=1,20),(TITL1(I),I=1,
C      + 20)
C      WRITE(10,119)
C      WRITE(10,112)
C      WRITE(10,100) ICODE,X,ID,Y
C      WRITE(10,3) COMNT1,COMNT2,TITL1
C-----

```

APPENDIX (continued)

```

C----- READ OBSERVATION DATA FOR A SPECIFIED LOCATION
C-----
      DO 30 I=1,3
30      IOBS(I)=1
22      CONTINUE
      READ(IN,20,ERR=7500,END=700) NCDT,NCU,NDU,IDAT,CT,IDTMP,ILAB,IAC
      ICU=NCU
      IDU=NDU
      IF(ICU.LT.1) ICU=1
      IF(IDU.LT.1) IDU=1
      NCD = NCDT
      IF (NCD.EQ.0) NCD=1
      IF ((NCD.GE.1).AND.(NCD.LE.4)) GO TO 40
      WRITE(IE,41)
      WRITE(IE,20) NCDT,IDAT,CT,IDTMP,ILAB,IAC
41      FORMAT(' ERROR ON INPUT; RECORD THAT FOLLOWS WAS SKIPPED:')
      GO TO 22

C
C----- TEST FOR END OF INPUT FOR A SITE, THEN IF NCD=4, OUTPUT RESULTS
C
40      IF((NCDT.EQ.4).OR.((IDAT(1).EQ.0).AND.(NCDT.EQ.0))) GO TO 21
      IOT = IORS(NCD)
      DO 46 LL=1,5
      GO TO (42,43,44,45,45),LL
42      ILB(NCD,IOT)=ILAB
43      IAC(NCD,IOT,LL) = IACT(LL)
44      DATE(LL,NCD,IOT) = IDAT(LL)
      IDNT(NCD,IOT,LL) = IDTMP(LL)
45      C(NCD,LL,IOT) = CT(LL)*CCONV(IOCUC)/CCONV(ICU)
      IF((LL.EQ.4).AND.(NCD.EQ.3)) C(NCD,LL,IOT)=CT(LL)*
      > DCONV(IOCUD)/DCONV(IDU)
46      CONTINUE
      IOBS(NCD) = IOT + 1
      GO TO 22

C
C
C
7500      CONTINUE
      BACKSPACE IN
      READ(IN,1) (IERC(I),I=1,20)
      IERF=IERF+1
      DO 7501 IEF=1,20
7501      ICHARE(IEF,IERF)=IERC(IEF)
      GO TO 22

C
C-----
C
C
21      CONTINUE
C----- INPUT AT A SITE IS NOW COMPLETE
C
      WRITE(10,120) (LABC(IOCUC,J),J=1,3)
      WRITE(10,121) (LABD(IOCUD,J),J=1,2)
      DO 60 M=1,3
      IF(IOBS(M).EQ.1) GO TO 65
      NOB=IOBS(M)-1
      WRITE(10,102) (HEADN(M,I),I=1,10),LAB(1),LAB(5),LAB(2),LAB(3),
      + LAB(2),LAB(4)
      DO 35 K=1,NOB
35      WRITE(10,105) DATE(2,M,K),DATE(3,M,K),DATE(1,M,K),(C(M,J,K),J=1,
      + 5),(IDNT(M,K,N),N=1,3),ILB(M,K),(IAC(M,K,LJ),LJ=1,2)
      WRITE(10,106)
60      CONTINUE
      IF(IEF.EQ.0) GO TO 1000
C

```

APPENDIX (continued)

```

C      THIS OUTPUTS MISPUNCHED CARDS AS THE LAST PART OF THE DATA FOR THE
C      SITE---AND ALERTS THE USER TO THE POSSIBLE PROBLEM
C
      WRITE(10,7502)
7502  FORMAT(/1X,108('*'))//10X,'THE FOLLOWING DATA HAD UNACCEPTABLE',
      *  ' CHARACTERS IN NUMERIC FIELDS'//)
      DO 7503 JK=1,IERF
      WRITE(10,3) (ICHARE(J,JK),J=1,20)
      WRITE(10,7504)
7504  FORMAT(1X,108('*'))
7503  CONTINUE
      GO TO 1000
7000  WRITE(10,10) ID,X,Y
      WRITE(10,7001)
7001  FORMAT(' ERROR EXIT TAKEN')
700  CONTINUE
      WRITE(6,7005)
      STOP
C
L----- FORMATS FOLLOW
C
1      FORMAT(2CA4)
2      FORMAT(1CX,5(2A4,2X))
3      FORMAT(15X,2CA4)
4      FORMAT(12I2)
10     FORMAT(12,2A4,2F10.0)
20     FORMAT(12,2I1,3I2,5G10.3,2A4,A3,A1,2A4)
100    FORMAT(5X,'AREA  ' :',12,6X,'ORNL COORDINATE:  NORTH ',
      *  'R.1,1,5X,'LOCATION: ',2A4,17X,'EAST  ',F8.1//)
102    FORMAT(// ' DATE',6X,5(2A4,4X),1X,A4,5X,A4,2X,A4,1X,A4,2X,A4,
      *  1X,A4,1X,'-----',2X,
      *  5(10(' '),2X),10(' '),2X,'---  ',9(' '),2X,9(' '))
105    FORMAT(1X,2(12,' '),12,5(2X,G10.4),2X,2A4,A3,2X,A1,5X,A4,7X,
      *  A4)
106    FORMAT(1X,8(' '),2X,5(10(' '),2X),10(' '),2X,'---  ',
      *  9(' '),2X,9(' '))
111    FORMAT(/1X,108('*'))/47X,1X('*'),/47X,'*',16X,'*',/
      *  47X,'*      SOHA      ',/47X,'*',16X,'*',/
      *  47X,1X('*'),///,32X,
      *  'COMPUTER STORAGE/RETRIEVAL OF WHITE OAK CREEK'/
      *  37X,'WATERSHED RADIONUCLIDE ANALYSES'//1X,108('*'))//)
112    FORMAT(///1X,108('*'))//)
119    FORMAT(1H1)
120    FORMAT(15X,'THE CONCENTRATION UNITS ARE:',3X,3A4,1X,'PER ML',
      *  ' OR GRAM')
121    FORMAT(15X,'THE DEPTH TO WATER IS MEASURED IN:',3X,2A4)
7005  FORMAT(1H1)
      END
ASS LO TY

```

INTERNAL DISTRIBUTION

1-2.	S. I. Auerbach	21.	I. M. Munro
3.	R. O. Chester	22.	O. M. Sealand
4.	N. H. Cutshall	23.	B. P. Spalding
5.	N. D. Farrow	24.	T. Tamura
6.	T. Grizzard	25.	J. E. Vath
7.	C. S. Haase	26.	N. D. Vaughan
8-12.	D. D. Huff	27.	G. T. Yeh
13.	J. R. Jones	28-29.	Central Research Library
14.	I. L. Larsen	30-39.	ESD Library
15.	C. A. Little	40.	Laboratory Records Dept.
16-17.	R. S. Lowrie	41.	Laboratory Records, ORNL-RC
18.	R. J. Luxmoore	42.	ORNL Y-12 Technical Library
19.	B. F. Maskewitz	43.	ORNL Patent Section
20.	M. S. Moran		

EXTERNAL DISTRIBUTION

- 44. E. L. Albenesius, Savannah River Laboratory, Aiken, SC 29801
- 45. L. Andrews, Chem Nuclear, P.O. Box 1866, Bellevue, WA 98009
- 46. T. Bergstrom, University of Michigan, Ann Arbor, MI 48109
- 47. L. Bradley, 2726 Country Club Drive, Olympia, WA 98502
- 48. R. L. Brodzinski, Battelle Northwest, 329 Bldg., 300 Area, Richland, WA 99352
- 49. R. Broseus, National Institute of Health, 9000 Rockville Pike, Bethesda, MD 20205
- 50. H. Brown, National Governors Association, 444 North Capital, Washington, DC 20555
- 51. P. Colombo, Brookhaven National Laboratory, Bldg. 830, Upton, NY 11973
- 52. William J. Coppoc, Texaco, Inc., P.O. Box 509, Beacon, NY 12508
- 53. P. Costello, Office of the Governor, Statehouse, Boise, ID 83702
- 54. T. Deboer, Empire State Plaza, Albany, NY 12223
- 55. J. L. Deichman, Rockwell Hanford Operation, 2750 E. Bldg., 200 E. Area, P.O. Box 800, Richland, WA 99352
- 56. J. L. Dieckhoner, Division of Waste Products, Office of Waste Management, Department of Energy, Washington, DC 20545
- 57. W. Dornseife, Pennsylvania Bureau of Radiation Protection, P.O. Box 2063, Harrisburg, PA 17120
- 58. J. O. Duguid, Battelle Project Management Division, 505 King Ave., Columbus, OH 43201
- 59. L. Franks, Bureau of Consumer Health Protection, 505 King Street, Carson City, NV 89701
- 60. E. Fray, EG&G Idaho, P.O. Box 1625, Idaho Falls, ID 83401
- 61. G. Frieling, Wisconsin Electric Power Co., Milwaukee, WI 53201
- 62. R. H. Galbraith, 322 N. Lauderdale, Memphis, TN 38101
- 63. Robert M. Garrels, Department of Marine, University of South Florida, 830 S. First Street, St. Petersburg, FL 33701

64. P. J. Gillis, Stone & Webster, P.O. Box 2325, Boston,
MA 02107
65. E. Held, Office of Nuclear Regulatory Research, Mail Stop
1130-SS, Washington, DC 20555
66. D. Jacobs, Evaluation Research Corporation, Oak Ridge, TN 37830
67. J. L. Johnson, Los Alamos Scientific Laboratory, P.O. Box 1663,
Los Alamos, NM 87545
- 68-72. M. L. Krupinski, EG&G Idaho, P.O. Box 1625, Idaho Falls,
ID 83401
- 73-78. D. E. Large, Oak Ridge Operations, Department of Energy, Oak
Ridge, TN 37830
79. W. W. Larson, 81 Highland Circle, Wayland, MA 01788
80. D. Lavine, Deadhill Road, Durham, CT 06422
81. J. A. Lenhard, Oak Ridge Operations, Department of Energy, Oak
Ridge, TN 37830
82. G. B. Levin, EG&G Idaho, P.O. Box 1625, Idaho Falls, ID 83401
83. R. A. Lewis, EV-34, GTN, U.S. Department of Energy, Washington,
DC 20545
84. T. McLaughlin, EPA, 401 M Street, SW, Washington, DC 20460
85. G. L. Meyer, EPA, 401 M Street, SW, Washington, DC 20460
86. G. Oertel, Director, Division of Waste Products, Office of Waste
Management, Department of Energy, Washington, DC 20545
87. W. S. Osburn, Jr., Division of Ecological Research, Office of
Health and Environmental Research, Department of Energy,
Washington, DC 20545
88. J. Peel, Idaho Operations, Department of Energy, 550 Second
Street, Idaho Falls, ID 83401
89. R. W. Peterson, ONWI, Battelle Columbus Laboratory, 505 King
Ave., Columbus, OH 43201
90. S. J. Phillips, Pacific Northwest Laboratory, Richland,
WA 99352
91. R. Pope, Sandia Laboratories, P.O. Box 5800, Albuquerque,
NM 87185
92. P. Psomas, Division of Waste Management, NRC, Washington,
DC 20555
93. R. Rawl, Department of Transportation, Washington, DC 20460
94. Paul G. Risser, Department of Botany and Microbiology,
University of Oklahoma, Norman, OK 73019
95. J. R. Robertson, USGS, National Center MS 410, Reston,
VA 22092
96. E. M. Romney, UCLA, 900 Veteran Ave., Los Angeles, CA 90024
97. H. Shealey, Bureau of Radiological Health, 2600 Bull Street,
Columbia, SC 29201
98. G. R. Shepherd, Department of Energy, Rm 4G-052, MS 4G-085,
Forestal Building, Washington, DC 20545
99. D. Smith, Division of Waste Management, NRC, Washington,
DC 20555
100. J. G. Steger, Los Alamos Scientific Laboratory, P.O. Box 1663,
Los Alamos, NM 87545

101. Richard H. Waring Department of Forest Science, Oregon State University, Corvallis, OR 97331
102. J. Watson, University of North Carolina, Chapel Hill, NC 27514
103. R. L. Watters, Office of Health and Environmental Research, Department of Energy, Washington, DC 20545
104. J. B. Whitsett, Idaho Operations, Department of Energy, 550 Second Street, Idaho Falls, ID 83401
105. T. Wolff, Environmental Improvement Division, P.O. Box 968, Santa Fe, NM 97503
106. R. W. Wood, Office of Health and Environmental Research, Bldg. GTN, Germantown, MD 20767
107. G. Yuan, Natural Resources Defense Council, 25 Kearney, San Francisco, CA 94108
- 108-134. Technical Information Center, Department of Energy, Oak Ridge, TN 37830