RECEIVED BY DTIC SEP 18 1968

ARH-SA-19

DATE _____

COPY NO.

8-14-68

A

Atlantic Richfield Hanford Company

RICHLAND, WASHINGTON

TITL AND AUTHR

AN ON-LINE COMPUTER AND DATA TRANSMISSION NETWORK
SUPPORTING TWO NUCLEAR ANALYTICAL LABORATORIES

W. C. Johnson Jr. and Roy A. R. Kent

D I S T R I B U T I O N

NAME

BUILDING AREA

NAME

BUILDING	AREA
1	100
2	200
3	300
4	400
5	500
6	600
7	700
8	800
9	900
10	1000
11	1100
12	1200
13	1300
14	1400
15	1500
16	1600
17	1700
18	1800
19	1900
20	2000
21	2100
22	2200
23	2300
24	2400
25	2500
26	2600
27	2700
28	2800
29	2900
30	3000
31	3100
32	3200
33	3300
34	3400
35	3500
36	3600
37	3700
38	3800
39	3900
40	4000
41	4100
42	4200
43	4300
44	4400
45	4500
46	4600
47	4700
48	4800
49	4900
50	5000
51	5100
52	5200
53	5300
54	5400
55	5500
56	5600
57	5700
58	5800
59	5900
60	6000
61	6100
62	6200
63	6300
64	6400
65	6500
66	6600
67	6700
68	6800
69	6900
70	7000
71	7100
72	7200
73	7300
74	7400
75	7500
76	7600
77	7700
78	7800
79	7900
80	8000
81	8100
82	8200
83	8300
84	8400
85	8500
86	8600
87	8700
88	8800
89	8900
90	9000
91	9100
92	9200
93	9300
94	9400
95	9500
96	9600
97	9700
98	9800
99	9900
100	10000

CONF-68091P-2

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

ROUTE TO

PAYROLL NO.

LOCATION[illegible]

UNCLASSIFIED

CLASSIFICATION

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.

UNCLASSIFIED

ARH-SA-19

Page 1

AN ON-LINE COMPUTER AND DATA TRANSMISSION NETWORK
SUPPORTING TWO NUCLEAR ANALYTICAL LABORATORIES

By

W. C. Johnson Jr.

Systems Analyst - Management Systems
Financial Planning and Management Systems
Business Management
Atlantic Richfield Hanford Company

and

Roy A. R. Kent

Information System Section
System and Electronics Division
Battelle Memorial Institute
Pacific Northwest Laboratory

August 14, 1968

Atlantic Richfield Hanford Company

Richland, Washington 99352

NOTICE

THIS REPORT WAS PREPARED FOR USE WITHIN ATLANTIC RICHFIELD HANFORD CO. IN THE COURSE OF WORK UNDER ATOMIC ENERGY COMMISSION CONTRACT AT (45-1)-2130, AND ANY VIEWS OR OPINIONS EXPRESSED IN THE REPORT ARE THOSE OF THE AUTHOR ONLY. THIS REPORT IS SUBJECT TO REVISION UPON COLLECTION OF ADDITIONAL DATA.

LEGAL NOTICE

THIS REPORT WAS PREPARED AS AN ACCOUNT OF GOVERNMENT SPONSORED WORK. NEITHER THE UNITED STATES, NOR THE COMMISSION, NOR ANY PERSON ACTING ON BEHALF OF THE COMMISSION:

A. MAKES ANY WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, WITH RESPECT TO THE ACCURACY, COMPLETENESS, OR USEFULNESS OF THE INFORMATION CONTAINED IN THIS REPORT, OR THAT THE USE OF ANY INFORMATION, APPARATUS, METHOD, OR PROCESS DISCLOSED IN THIS REPORT MAY NOT INFRINGE PRIVATELY OWNED RIGHTS; OR

B. ASSUMES ANY LIABILITIES WITH RESPECT TO THE USE OF, OR FOR DAMAGES RESULTING FROM THE USE OF ANY INFORMATION, APPARATUS, METHOD, OR PROCESS DISCLOSED IN THIS REPORT.

AS USED IN THE ABOVE, "PERSON ACTING ON BEHALF OF THE COMMISSION" INCLUDES ANY EMPLOYEE OR CONTRACTOR OF THE COMMISSION, OR EMPLOYEE OF SUCH CONTRACTOR, TO THE EXTENT THAT SUCH EMPLOYEE OR CONTRACTOR OF THE COMMISSION, OR EMPLOYEE OF SUCH CONTRACTOR PREPARES, DISSEMINATES, OR PROVIDES ACCESS TO, ANY INFORMATION PURSUANT TO HIS EMPLOYMENT OR CONTRACT WITH THE COMMISSION, OR HIS EMPLOYMENT WITH SUCH CONTRACTOR.

UNCLASSIFIED

UNCLASSIFIED

ARH-SA-19

Page 2

INTERNAL DISTRIBUTION

1 - M. D. Alford
2 - O. F. Beaulieu
3 - M. H. Campbell
4 - W. C. Cronin
5 - G. L. Gurwell
6 - W. M. Harty
7 - H. H. Hopkins
8 - W. C. Johnson
9 - R. J. Kofoed
10 - C. W. Malody
11 - R. W. McCullugh
12 - L. W. Miller
13 - H. C. Rathvon
14 - R. D. Shimer
15 - O. V. Smiset
16 - P. W. Smith
17 - R. E. Smith
18 - W. G. Smith
19 - R. E. Tomlinson
20 - R. A. Yoder
21 - L. L. Zahn
22-23 - 200 Files

EXTERNAL DISTRIBUTION

Pacific Northwest Laboratory

24 - R. A. R. Kent
25 - R. L. Reynolds

UNCLASSIFIED

UNCLASSIFIED

ARH-SA-19
Page 3

ABSTRACT

AN ON-LINE COMPUTER AND DATA TRANSMISSION NETWORK
SUPPORTING TWO NUCLEAR ANALYTICAL LABORATORIES

An on-line data retrieval and update system is described in supporting the analytical laboratories at ARHCO's Chemical Processing complex in Richland, Washington.

Much of the repetitive-type work that is performed in the laboratories is handled by the computer system which incorporates queueing techniques and interrupt routines for servicing the many terminals.

The computer is located in the analytical laboratory of one nuclear facility and classified lines connect the terminals located within this facility. Non-classified lines connect the computer to terminals in two other nuclear facilities which are geographically located 1.5 and 5.5 miles away, respectively.

UNCLASSIFIED

Introduction

In operating chemical separations plants that process radiated nuclear reactor fuel elements, a primary consideration is the quality and timeliness of data available to first-line supervisors and process control engineers. Many of their decisions are made on data from instrument readings and laboratory analyses results or combinations thereof. The value of data within this context diminishes with time, and consequently, must be transmitted quickly and presented accurately.

The initial application for this computer system mechanizes the calculations and the storage and transmission of data that can be classified as clerical, repetitive-type work now encountered in the laboratories. To accomplish these objectives, an on-line IBM 1800 computer and data transmission network was installed.

Essentially there are four basic types of input to the computer; i.e., sample requests, data entry for calculations, updating, and requests for specific information. The computer, having processed the information, produces output such as the following to the user or users.

- Analytical determination cards.
- A serial number listing for each sample point and required analysis.
- Immediate analytical results.
- Update information.
- Miscellaneous reports.
- Data punched on cards for further processing.

The system concept integrates the computer into the laboratory and processing functions emphasizing a minimum of change in existing methods and work routines. Particular attention has been given to methods supplying data to the computer. For instance, a large portion of the input data is entered into the computer by means of programmed keyboards, which are analogous in appearance and operation to that of a desk calculator.

Equipment

A schematic diagram of the system configuration is shown in the Appendix (Figure 4). Terminal 1A, on the unclassified line, is located approximately 5.5 miles from the computer.

Hardware

- 1 - 1801 IBM Computer with a core capacity of 8,192 words consisting of sixteen binary bits and a memory cycle time of four micro-seconds.
- 4 - 1092-1093 Programmed Keyboards
- 2 - 1052 Printer Keyboards
- 1 - 1816 Console Printer Keyboard
- 1 - 1442 Card Reader and Punch
- 5 - 1053 Printers
- 5 - 1051 Control Units
- 1 - 2310 Disk Storage

Software Parameters

Input

Input to the computer will come from the following sources:

- 1092-1093 Programmed Keyboards
- 1052 Printer Keyboards
- 1816 Console Typewriter Keyboard
- 1801 Console Switches
- 1442 Card Reader

The 1092-1093 Programmed Keyboards are used to enter data in most cases. The operation is simple, positive; the input can be visually edited and checked prior to transmission, and record length is fixed by the physical device.

Keymats are overlayed on the programmed keyboards and are used for defining field information as well as describing each particular key. The bottom edge of the keymat is used for code identification, and acts as a sensing device to generate the code that identifies each individual keymat. A maximum number of forty-eight keymats can be utilized on each 1092-1093 unit.

The 1052 Printer Keyboards are used for special applications where it becomes necessary to introduce alphameric data. Also this device can be used for communications between the terminals if this capability is needed for future applications.

The 1816 Console Printer Keyboard is used to communicate to the processor controller through a program in memory which interprets the incoming characters and controls the keyboard accordingly.

The 1442 Card Reader function is for program introduction, disc maintenance for all parameter information introduced on a routine basis and all other repetitive information that requires a major shift in core programs.

Output

Output from the computer will come from the following sources:

- 1053 Printers
- 1052 Printers
- 1816 Printer
- 1442 Card Punch

The 1053 Printers in both laboratory sample receiving stations will be used solely for generation of analytical determination cards and will contain a special form at all times (see Appendix - Figure 3). The 1053 Printers at the other three locations will handle all output for those terminals.

The 1052 Printers will handle all output, other than analytical cards, at both laboratory sample receiving stations. Typical output will represent small reports, error messages, and analytical results.

The 1816 Console Printer is used mainly for system monitoring; i.e., special error messages, error statements not required by the users, and to report system conditions that indicate unfavorable operation.

The 1442 Card Punch is used to develop information when it is needed for further machine processing or for punching data on cards that can be used in existing programs on larger computers, such as the Univac 1108.

Discussion

The process cycle flow for lines 1 and 2 is represented in the Appendix (Figure 1 and Figure 2, respectively). A typical routine program and sequence of events for line 1 would be the following: The dispatcher, having been informed as to the particular processing information that is

needed (1), generates the routine analytical determination cards required by pressing the respective key or keys on his 1092-1093 keyboard (2). A visual edit is made at this time prior to sending the information to the computer by scanning the keyboard buttons which are lighted after being pressed. If satisfactory, the information is sent to the computer where system action occurs (3). Analytical determination cards with the pertinent data required for analysis are then printed out in the laboratory (4) on the 1053 printer which contains a preprinted form (see Appendix - Figure 3). After the cards are printed, the dispatcher receives a listing (5) of the samples to be taken with their respective serial numbers and analyses.

By telephone, the dispatcher requests the process operators (6) to take the samples that are necessary to perform the required analyses. The samples are then delivered to the laboratory.

After the analysis is performed on the sample, the analytical data are entered (7) via the 1092-1093 Keyboard in the laboratory using the appropriate keymat. The basic calculation equations are maintained on disc in a file. When variable data are entered, the required calculation is performed by the computer and the result is automatically printed on the 1052 printer in the laboratory with a limit control message (8). After verification by the analyst, the results are sent to the dispatcher (9) and received on his 1053 Printer (10).

All completed results are stored in a file on disk. This file is then utilized for recall of analytical data for summary reports, to obtain data to be punched on cards for other programs (11), or used to generate additional analyses or reruns on existing serial numbers.

Analytical Card Generation

In operating a multi-product chemical separations plant, many types of samples must be taken throughout the process for various reasons; i.e., process control, product recovery, waste loss information, material balance reports, nuclear accountability, etc. The immediate application for this system provides for generation of analytical determination cards to support these criteria.

These samples fall into three general classifications:

Routine Samples - Samples required in monitoring the various streams throughout the continuous process flow cycle.

Batch Samples - Samples used to characterize the feed, waste or product material.

Start-up Samples - Samples required for control until process equilibrium is established. Usually fluctuates on a time basis such as once per hour, every two hours, etc.

Additionally, different types of analysis requests may be made as required for process control.

Additional Analysis - Used for requesting additional analyses on existing samples.

Rerun - Used for requesting that a specific analysis be run again to confirm the original result.

New Sample Analysis - Used for requesting that a special sample be taken for a specific analysis.

1800 Program Scheduling

Control processes may be classified under three basic headings:

- o Program or event sequence.
- o Time dependence.
- o Interrupt initiation.

In practice, a process may be a combination of all three categories, but is usually weighted more heavily towards one. Rarely does a process lend itself to only one. By combining queueing with priority techniques, the system becomes flexible for any control system's requirements. In the 1800 system an interrupt facility provides an automatic branch in the normal program based upon external conditions. These interrupt conditions are assigned to priority levels as required. Up to twenty-four levels of priority interrupts are available with a maximum of 384 interrupts.

There are two important operating characteristics of the interrupt system.

1. When more than one request line is connected to any priority level, it is necessary by programming means to identify the individual request(s) causing the priority level to be energized.
2. The first request that is recognized on a given priority level prevents future requests on that or lower priority levels from interrupting until the completion of servicing the first interrupt is signaled.

Utilizing the IBM 1050 Data Communications System in this application requires a control system that is able to immediately recognize certain events when they occur. When an interrupt occurs, the normal sequence of events is discontinued until some action is taken. If a second and

more critical interrupt occurs while the first one is being serviced, the situation becomes more complicated. The more critical interrupt, having a higher priority, will be serviced after the first one has been suspended. Such a chain of interrupts may continue through several iterations, as shown in Figure 1.

Each interrupt in turn must complete its required action before the system can return to normal.

Figure 1 - Multi-Level Processing

1st Interrupt Level

2nd Interrupt Level

3rd Interrupt Level

Mainline Level

System Flow

A general description of the system flow is represented in the Appendix (Figure 5).

Function of the Elements in System Flow

I/O Data Tables

Two data tables will be kept in INSKEL COMMON to hold data prior to inputting or outputting to terminals. INSKEL COMMON is one of the principal means by which core loads and subroutines within the 1800 system can communicate with one another.

Line Control

Polls terminals.

Checks terminal software indicators.

Checks data tables for data.

Calls the main line core load programs by the time sharing "Call Queue" routine which is used to place a core load entry in the core load queue table. The core load queue table is a list of names of main line core loads, including priorities, that have been placed in line for future execution.

Uses timer interrupt to poll the terminals every Δt milliseconds.

Checks the line status indicators and transfers control appropriately.

Is an in-core program.

Allows completion of a positive request from one terminal on a line before servicing another request on that line.

Provides equal priority to all lines and terminals--first come, first-served basis.

Input Editing

Each keymat has an input editing routine.

Calls INED (Input Editor) which calls other input editing routines.

Combines data and sets the data into the correct INSKEL COMMON variable name locations.

Chains to the job or error message routine.

Indexes the line status indicator.

Job

Job includes the various types of actions or functions performed by the computer; i.e., calculations, set-up for card generation, updating, punching data on cards, and output of reports.

Calls the OUTPT program with a CALL SPECL routine. The CALL SPECL routine suspends execution of the current mainline core load and transfers control to program sequence control, saves the terminated program on the disk, then executes the next program.

Chains to the OUTDA program.

Indexes the line status indicator.

Output

Determines where data can be sent (which terminal or terminals).

Labels the parameters essential for polling and sends these parameters to disk.

Converts the data from job to an acceptable output form for the terminals. Sets up records to be written to disk and adds the idle characters needed.

Writes the converted records to disk.

Is called as a SPECL from job.

OUTDA

Is called by the job area and line control.

Reads data from the disk into the data tables.

Indexes the line status indicators.

Exits via CALL VIAQ routine which executes the highest priority core load in the queue table. If the table is empty, the process is considered to be in an idle condition.

Error Message Recovery

Accepts error messages from either line control or the input editor.

Transfers control to job, and calls OUTPT which in turn sets up the error message to be printed out.

Recovery Routine

Provides the routine for regenerating the system from disk.

Makes the necessary corrections on disk before recovery begins.

Always returns to line control.

Reports

In general, the available reports can be classified in two categories; those required for process control and those required for management information. Information needed for these reports can be obtained when specifically requested.

The reports are relatively small in size, however, mainly due to the limitations of the 1050 system printers which generate approximately seven lines per minute. In contrast, this can be compared to high speed printers that generate from 300 to 1500 lines per minute. Presently there are five types of reports.

<u>Type</u>	<u>Description</u>
I	All complete analyses for one sample point and a specific analysis starting from a specified serial number to date.
II	All incomplete analyses starting from a specified serial number to date.
III	All complete analyses for a specific serial number.
IV	All incomplete analyses for a specific serial number.
V	All complete analyses starting from a specific serial number to date.

An example for a Type I report is shown in the Appendix (Figure 6).

FIGURE 1
Purex Plant

FIGURE 2
B-Plant - 222-S

SERIAL NO.	SAMPLE POINT	BATCH	DATE	TIME	RESULT UNITS	PRIOR- ITY
1000-01	Q-6	5	7-17-68	0830	cpm/gal	1
DETERM.	METHOD	RUN TYPE	SAMP. STATUS	CARRIER	COST CENTER	
Np	PuA-6b	Normal		PR	7	
NO. OF DILUTIONS	RERUNS	SAMPLE SIZE				
6/2		100-10-100				
NOTE: INPUT VARIABLES MUST BE ENTERED IN ASCENDING ORDER						REMARKS
X-1	cpm	X-2	%	GROSS; TIME; CORR; NET;		
X-3		X-4				
X-5		X-6				
X-7		X-8				
RESULTS						
DATE	TIME	ANALYST	APPROVED			

FIGURE 3
Analytical Determination Card

FIGURE 4
Computer Configuration and Data Transmission Network

FIGURE 5
System Flow

<u>Sample Point</u>	<u>Serial Number</u>	<u>Date</u>	<u>Time</u>	<u>Analysis</u>	<u>Result</u>	<u>Units</u>	<u>Out of Limits</u>	
H-2	1922-01	04-15-68	0830	HNO ₃	1.33	LBS/GAL		
H-2	1973-01	04-15-68	1645	HNO ₃	1.36			
H-2	2015-01	04-16-68	0030	HNO ₃	1.37			
H-2	2059-01	04-16-68	0845	HNO ₃	1.42			
H-2	2107-01	04-16-68	1655	HNO ₃	1.43			
H-2	2120-01	04-16-68	1820	HNO ₃			HNO ₃	X.XX
H-2	2126-01	04-16-68	1945	HNO ₃			HNO ₃	X.XX
H-2	2134-01	04-16-68	2230	HNO ₃			HNO ₃	X.XX
H-2	2152-01	04-17-68	0015	HNO ₃	1.50			
H-2	2173-01	04-17-68	0130	HNO ₃	1.21			
H-2	2183-01	04-18-68	0230	HNO ₃	1.25			
H-2	2194-01	04-18-68	0330	HNO ₃	1.26			
H-2	2206-01	04-18-68	0430	HNO ₃	1.27			
H-2	2224-01	04-18-68	0835	HNO ₃	1.29			

Figure 6

ANALYTICAL RESULT REPORT