

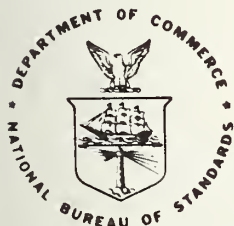
NBSIR 77-1384

Interactive Computer Program for the Determination of Sound Power

Thomas W. Bartel

Institute for Basic Standards
National Bureau of Standards
Washington, D.C. 20234

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U.S. DEPARTMENT OF COMMERCE

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U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, *Secretary*

Dr. Sidney Harman, *Under Secretary*

Jordan J. Baruch, *Assistant Secretary for Science and Technology*

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Acting Director*



ABSTRACT

A description of the computer program used to measure the sound power output of a sound source in a reverberation room is presented. The program controls the operation of a real-time analyzer and a microphone multiplexer. The sound power is computed according to ANSI S1.21. The program is written in FORTRAN V and requires approximately 37,000 eight-bit bytes of core memory. Flow charts, source listings, and sample printouts are included.



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I. INTRODUCTION

This report describes the computer program used to measure the sound power output of a sound source in a reverberation room according to the American National Standard Methods for the Determination of Sound Power Levels of Small Sources in Reverberation Rooms, S1.21-1972. The program is written to control the instrumentation system used for the NBS reverberation room. It could, however, be suitable for use in any laboratory with a similar instrumentation system.

II. INSTRUMENTATION

The program assumes that two elements of the instrumentation system are under computer control. These elements are a real-time analyzer and a microphone multiplexer. The real-time analyzer filters the input signal through 30 contiguous 1/3-octave band-pass filter channels, samples each channel simultaneously for an integration period, determines the rms level for each channel, and transmits the results to the computer. For the NBS system, the time required to transmit the levels in all the 1/3-octave bands to the computer is approximately 1 ms. The real-time analyzer integration time, under computer control, is entered by the operator from a CRT terminal.

The computer controls the channel selection of a microphone multiplexer. In the NBS system, the multiplexer has 16 channels, of which 12 are used with the 12-microphone array installed in the reverberation room.

III. PROGRAM SEQUENCE

The execution of the sound power measurement is summarized in the abbreviated flowchart given in Appendix A. At the beginning of the program, the table of reverberation times for the room are entered. The operator has the option of entering the data from the CRT terminal keyboard or from the disc file output of program REVERB.

The microphone array calibrations are then acquired. These are necessary in order to convert the real-time analyzer data from voltage levels, in dB re 1 mV to sound pressure levels, in dB re 20 μ Pa. The calibrations for each channel, in the form of corrections to be added to the RTA data, may be determined in advance and entered from the CRT terminal keyboard, or they may be measured at this point in the program by relating the real-time analyzer output to a reference signal, such as an acoustic calibrator.

The frequency response corrections for the microphones are then entered from either a disc file or from the CRT keyboard. These corrections may include the frequency response characteristics of the microphones and the responses of the 1/3-octave frequency channels of the real-time analyzer, relative to the 1000 Hz band.

The atmospheric pressure, temperature and humidity (which the program computes from the wet and dry bulb temperatures), the vane speed and the integration time are now entered. The ambient noise is then measured, if desired, followed by a sound pressure level measurement at each microphone with the sound source operating.

The sound power levels are computed and printed out. The operator has the option of either proceeding immediately with another measurement using the same reverberation time data and the same system gain settings, or terminating the program.

IV. COMPUTATIONS

The following quantities are computed:

1. Sound pressure level in the kth 1/3-octave band at microphone j.

$$L_{jk} = X_{jk} - A_k + B_j$$

where X_{jk} is the reading in the k th 1/3-octave band at microphone j , A_k is the frequency response correction for the k th 1/3-octave band for both the microphone* and analyzer, and B_j is the level correction at 1000 Hz for microphone j .

The X_{jk} are printed in the columns labeled MIC 1 to MIC 12 in Printout 1 of Appendix B. The A_k are printed in the column labeled FREQUENCY RESPONSE CORRECTION. The B_j are printed in the column labeled CORRECTION TO RTA DATA. The L_{jk} are printed in the columns labeled MIC 1 to MIC 12 in Printout 2 of Appendix B.

The uncertainty in the sound pressure levels is dependent upon the sampling characteristics of the real-time analyzer, which, in the NBS system, has a resolution of 0.25 dB. The levels are printed to the nearest 0.01 dB in order to aid in tracing the computations performed on the data, rather than to represent the uncertainty of the data.

2. Standard deviation of L_{jk} (according to ANSI S1.21).

$$\sigma_k = \left[(N_m - 1)^{-1} \sum_{j=1}^{N_m} (L_{jk} - \langle L_k \rangle)^2 \right]^{1/2}$$

where N_m is the number of microphones,

$$\langle L_k \rangle = \frac{1}{N_m} \sum_{j=1}^{N_m} L_{jk}$$

*The program can be modified to permit the input of a separate frequency response for each microphone channel to allow for differences among the microphone cartridges used in the array. As presently written it is assumed that all the microphones have the same frequency response corrections.

The σ_k are printed in the column labeled STD. DEV. in Printout 4 of Appendix B.

3. Mean sound pressure level in the kth 1/3-octave band.

$$\bar{L}_k = 10 \log_{10} \left[\frac{1}{N_m} \sum_{j=1}^{N_m} 10^{(L_{jk}/10)} \right]$$

The \bar{L}_k are printed in the column labeled SOUND PRESSURE in Printout 4 of Appendix B.

4. Sound power level in the kth 1/3-octave band.

$$P_k = \bar{L}_k - 10 \log_{10} (T_k/T_0) + 10 \log_{10} (V/V_0) \\ + 10 \log_{10} (1 + S\lambda_k/8V) - 10 \log_{10} (B/1000) - 14$$

where T_k is reverberation time in the kth 1/3-octave band in seconds, T_0 is 1 s, V is the volume of the room in cubic meters, V_0 is 1 m³, λ_k is the wavelength in meters at the center frequency of the kth 1/3-octave band, S is the total surface area of the room in square meters, and B is the barometric pressure in mbars.

The P_k are printed in the column labeled 1/3 OCTAVE BAND SOUND POWER in Printout 4 of Appendix B.

V. SOFTWARE DETAILS

The programming language used is the Interdata FORTRAN V Level 1 Software System.* It is a superset of ANSI Standard X3.9-1966 FORTRAN and should be compatible or nearly compatible with the FORTRAN V used on other computer systems. Users of this program on other systems should check the compatibility of FORMAT statements using the A Format and INTEGER* 2 statements which define the storage size of integers to be two 8-bit bytes.

The program for measuring sound power consists of a main program, SPOWER, written in FORTRAN V, several FORTRAN subroutines, and several assembly language subroutines written for use on an Interdata Model 70 minicomputer. These elements are listed in Table 1. The corresponding flow charts, sample printouts, and listings are given in Appendices B and C.

In the NBS system, the complete task occupies 37,066 eight-bit bytes of memory.

The flow charts, given in the appendices, conform to the American National Standard Flowchart Symbols and Their Usage in Information Processing, X3.5-1970. In these flow charts, the small numbers enclosed in parentheses refer to FORTRAN statement labels in the program listings.

*The commercial computer products utilized are identified in order to adequately describe the program elements discussed in this report. In no case does such identification imply recommendation or endorsement by the National Bureau of Standards, nor does it imply that these products are necessarily the best available for the purpose.

In the program listings, the first three statements of every program or subprogram are control statements used to insert the program name, in the form of a binary label, into the compiled object code.

VI. INPUT/OUTPUT LOGICAL UNITS

The following logical units are used for input/output operations:

- LU1 - File containing a table of the reverberation time. This file is generated by the program REVERB.
- LU2 - Output file for storing the computed sound power levels. This file is rewound at the start of the program and the results of each sound power measurement are successively stored on it.
- LU3 - Hard copy printout device. Should be assigned to a 132-character line printer. During execution of the program, the operator may choose the printout device logical unit to obtain either a hard copy printout or a view of the results on the CRT terminal.
- LU4 - File containing frequency response corrections of the microphones. These corrections consist of a set of 30 numbers, one per band, representing the difference in total system sensitivity between each band and band 30 (1000 Hz). The microphone frequency response and the differences in gain between the real-time analyzer's multi-filter channels are to be incorporated in these corrections.
- LU5 - Operator communication device. Should be assigned to a CRT terminal. Through this device the operator controls the course of the measurement, making decisions that are called for and entering certain measurement parameters. These parameters include:
 1. The reverberation times, if not read from a disc file.
 2. The microphone calibration data, if not obtained during the measurement with a reference signal.

3. The frequency response corrections, if not read from a disc file.
4. The temperature, relative humidity, and atmospheric pressure.
5. The real-time analyzer integration time.

Transmission of data to and from the real-time analyzer and the microphone multiplexer is not handled through logical units, but through separate subroutines written in the computer's assembly language. These subroutines are included in Table 1.

TABLE 1. SOUND POWER PROGRAM ELEMENTS

PROGRAM NAME	TYPE OF PROGRAM	FUNCTION	SUBROUTINES CALLED
SPOWER	FORTRAN Program	Performs measurements and computations to determine sound power levels.	HUMID, SPLCAL, SAMPLE, BAND, MEANLG, MEANAR, SUBMUX, MUX, RTA, DELAY
SPLCAL	FORTRAN Subroutine	Relates real-time analyzer data to a reference signal of known amplitude.	SAMPLE, BAND, MEANLG, RTA
MEANLG	FORTRAN Subroutine	Computes logarithmic mean of a number of samples.	None
MEANAR	FORTRAN Subroutine	Computes arithmetic mean and standard deviation of a number of samples.	None
HUMID*	FORTRAN Subroutine	Computes relative humidity from wet and dry bulb temperatures. Also computes speed of sound.	None
SAMPLE*	FORTRAN Subroutine	Takes a specified number of real-time analyzer samples and checks for signal levels that exceed its maximum input level.	RTA
BAND*	FORTRAN Subroutine	Converts one band of real-time analyzer samples from fixed-point to floating-point numbers.	None
SUBMUX*	FORTRAN Subroutine	Steps the microphone multiplexer to a given microphone channel.	MUX

*Details of these routines are given in T. Bartel, "Interactive Computer Program for the Determination of Reverberation time," NBSIR 77-1383, National Bureau of Standards, Washington, D.C. 20234, December 1977.

TABLE 1. (Continued)

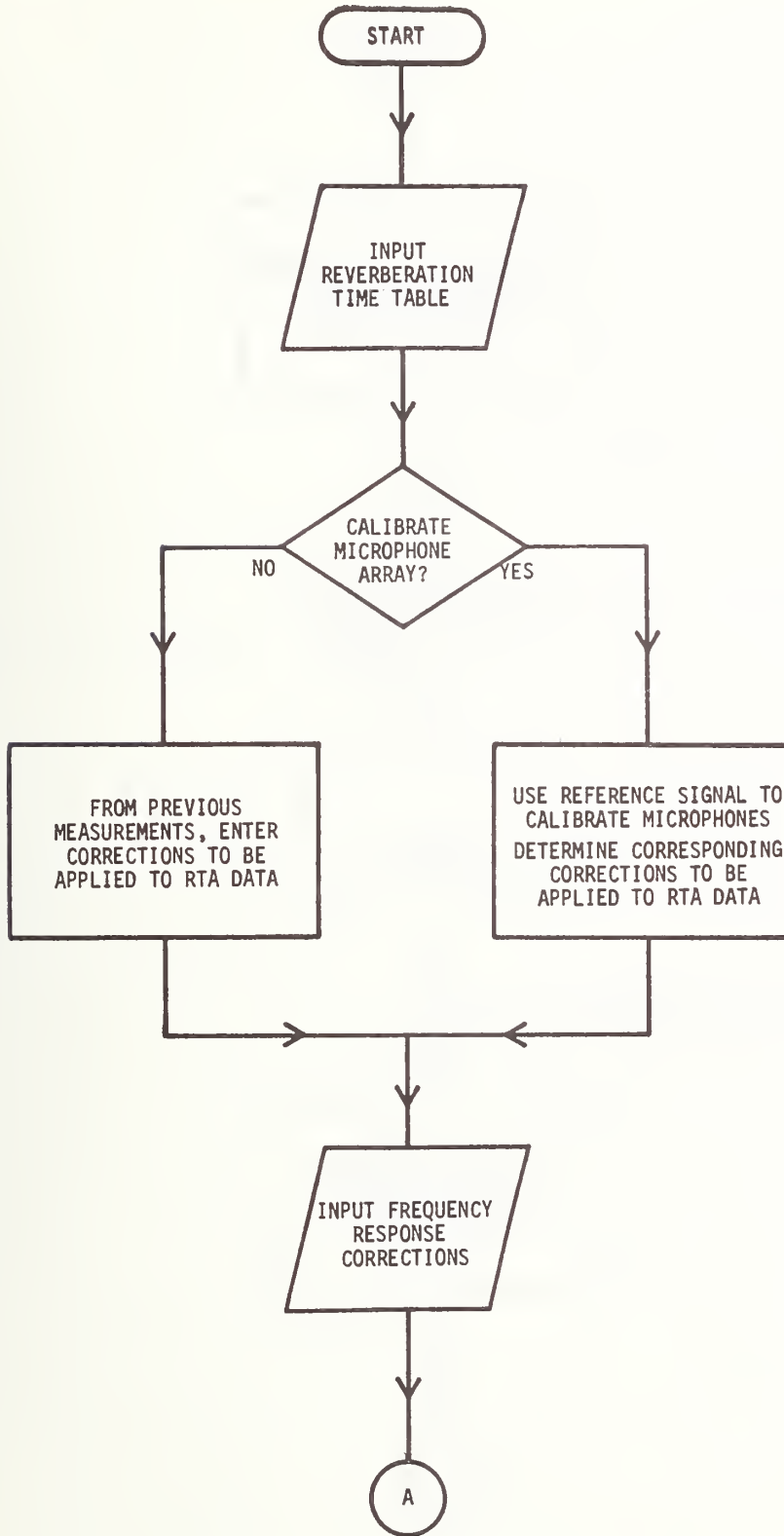
PROGRAM NAME	TYPE OF PROGRAM	FUNCTION	SUBROUTINES CALLED
MUX*	Assembly Language Subroutine, FORTRAN Callable	Steps and reads multiplexer	None
RTA*	Assembly Language Subroutine, FORTRAN Callable	Controls and reads real-time analyzer.	None
DELAY*	Assembly Language Subroutine, FORTRAN Callable	Provides a delay of 0 to 32.767 s in approximate 1-ms increments.	None

*Details of these routines are given in T. Bartel, "Interactive Computer Program for the Determination of Reverberation Time," NBSIR 77-1383, National Bureau of Standards, Washington, D.C. 20234, December 1977.

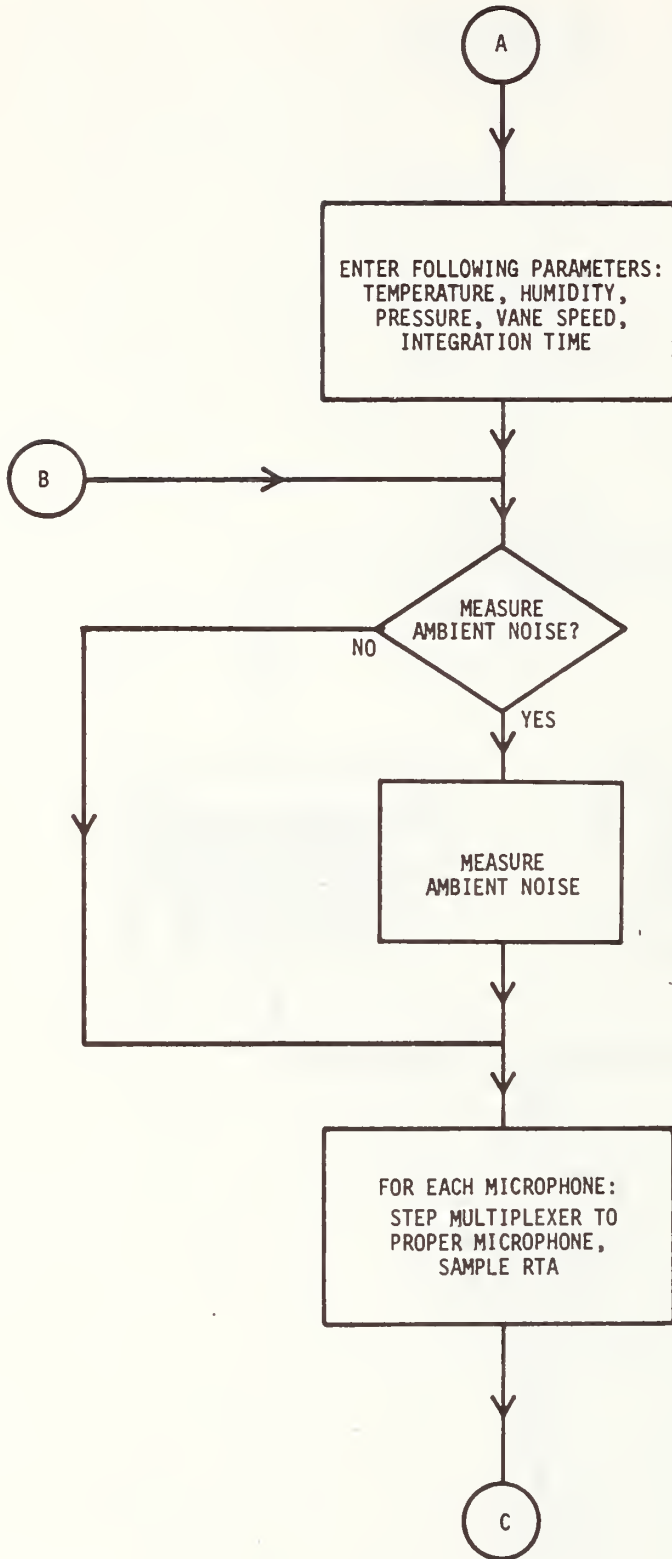
APPENDIX A

Abbreviated Flow Chart of Sound Power Program

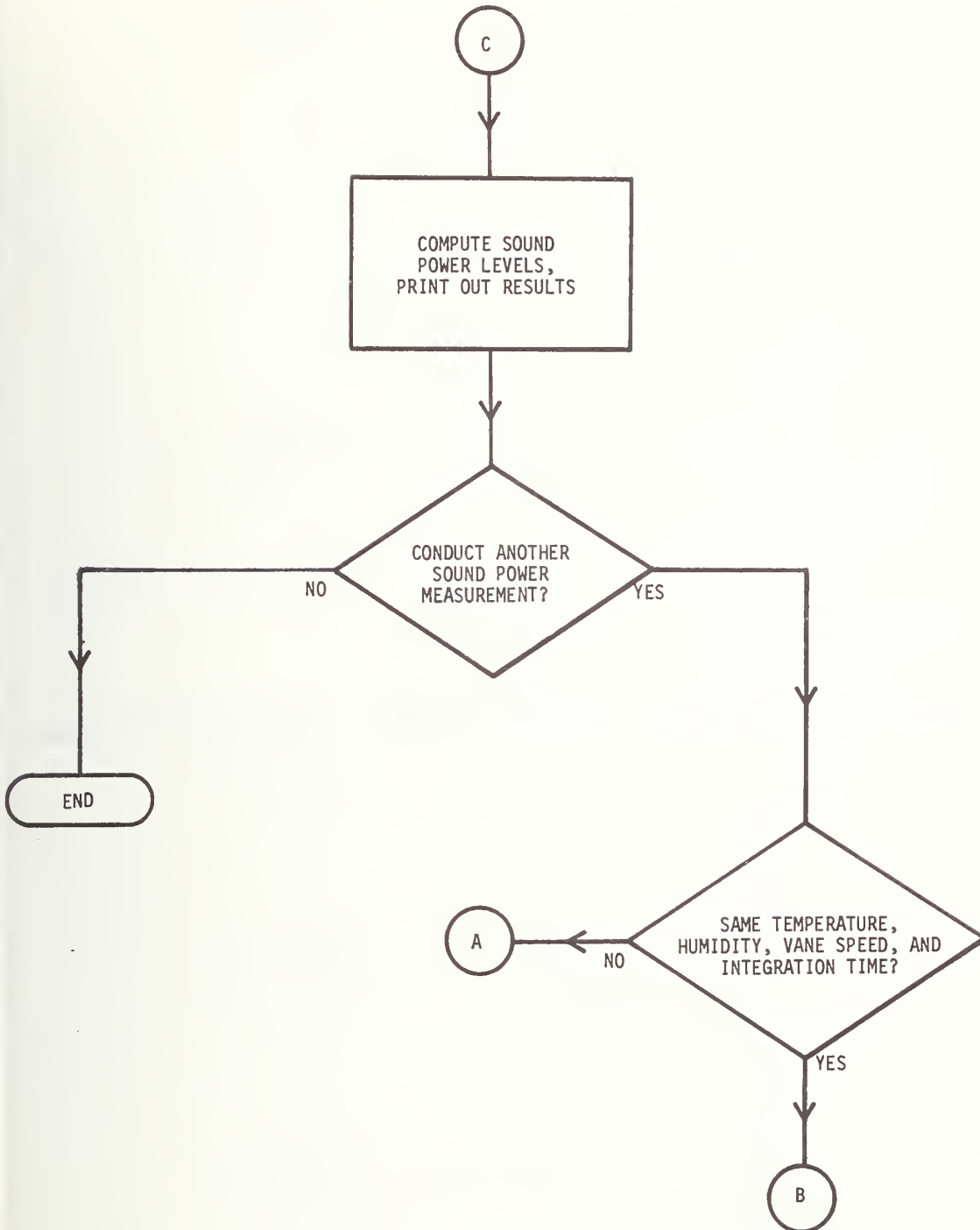
ABBREVIATED FLOW CHART: SPOWER



ABBREVIATED SPOWER-2



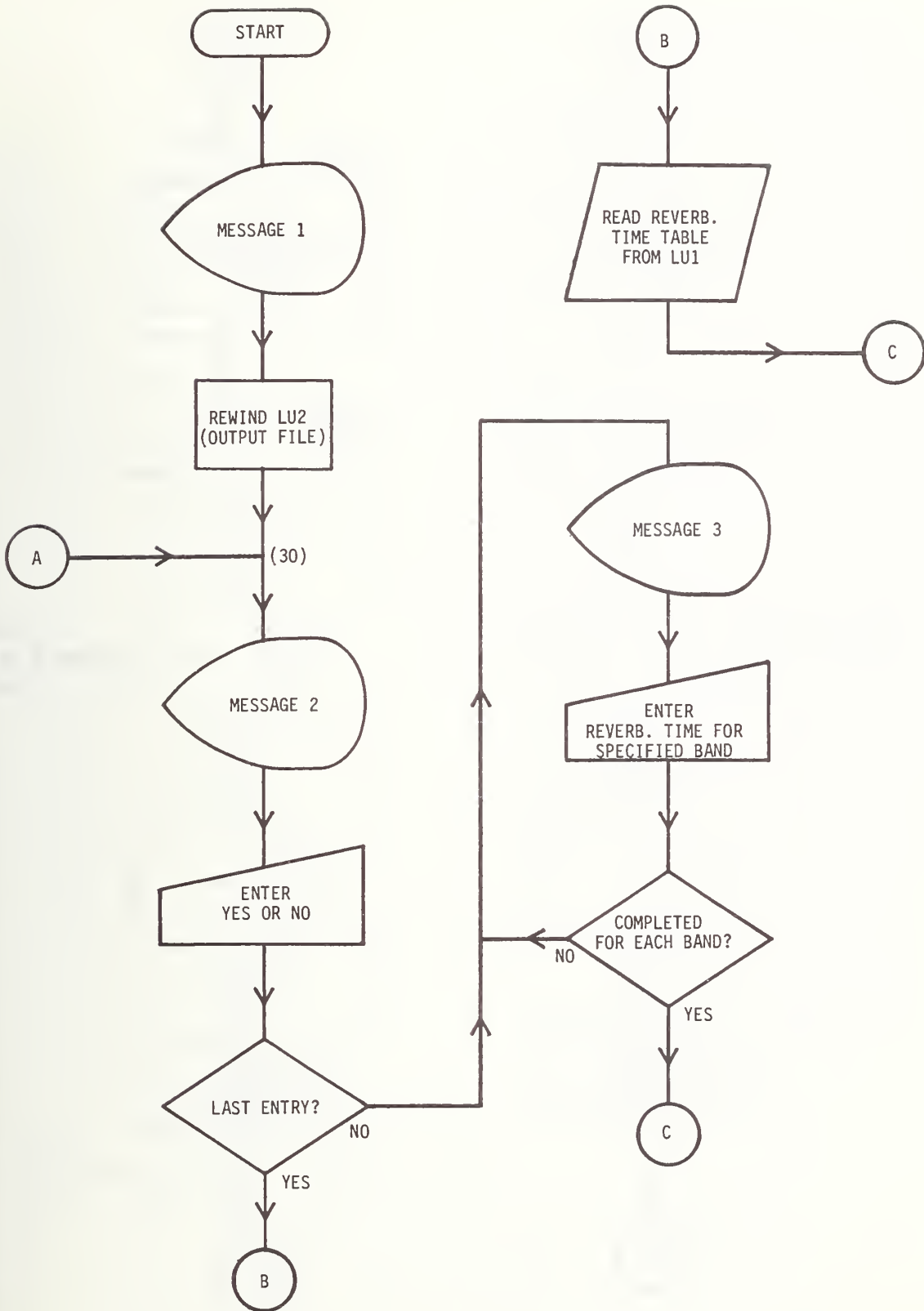
ABBREVIATED SPOWER-3

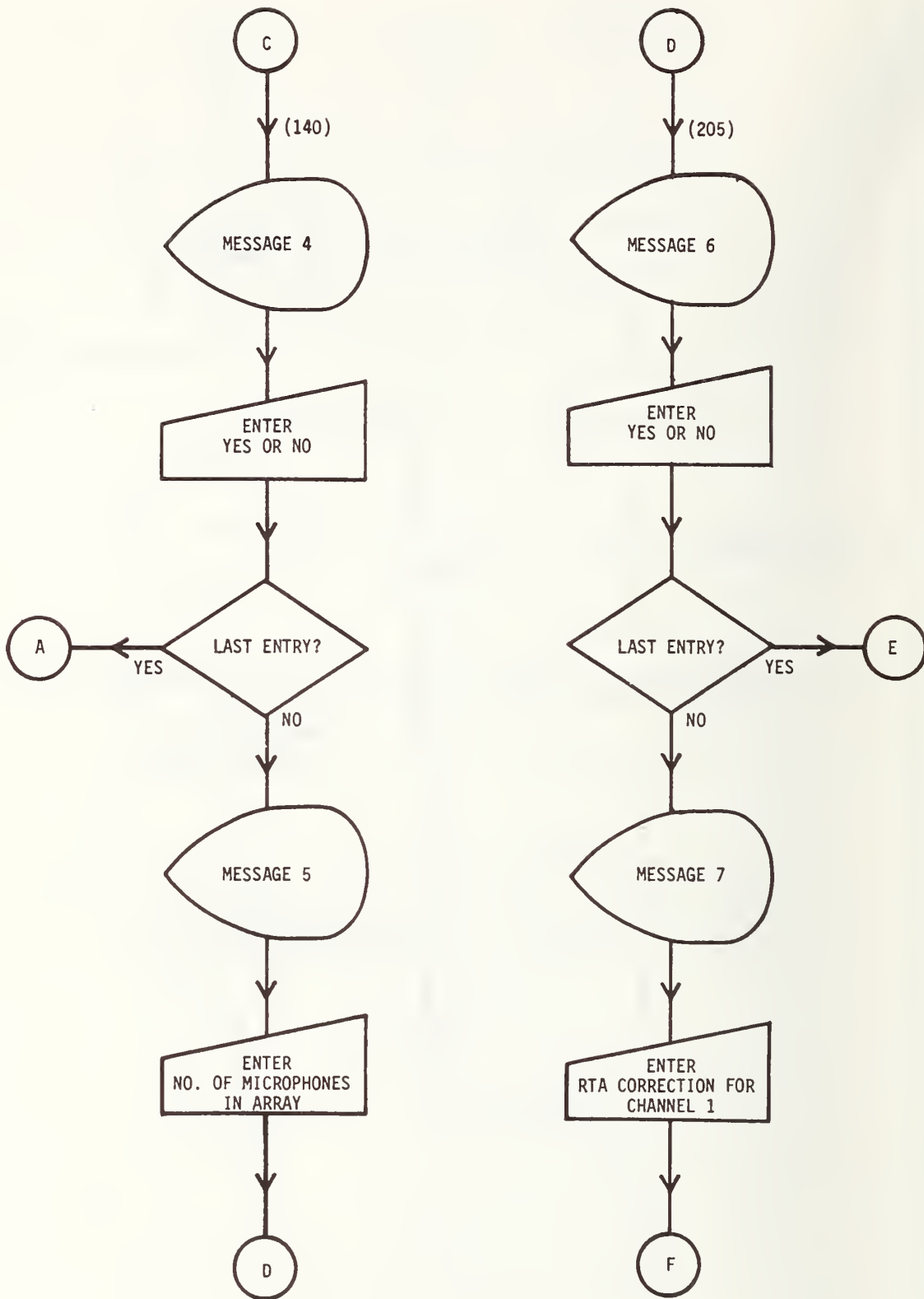


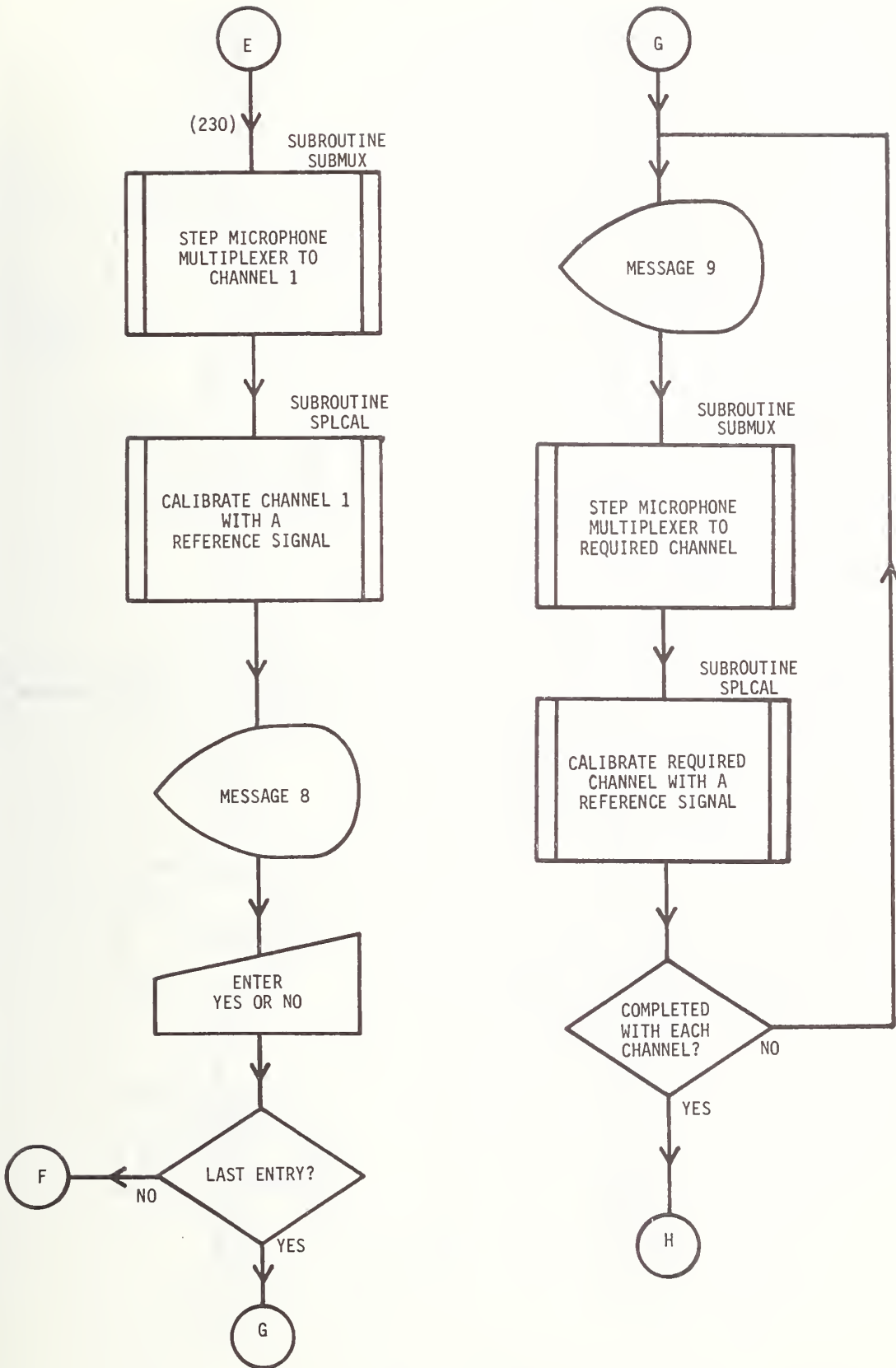
APPENDIX B

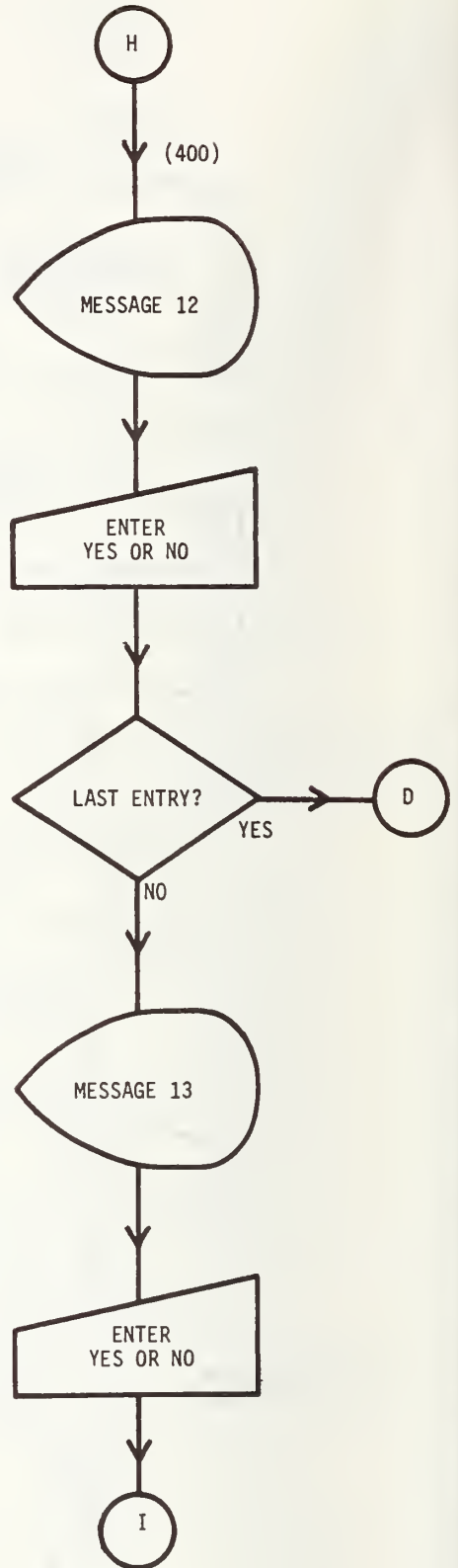
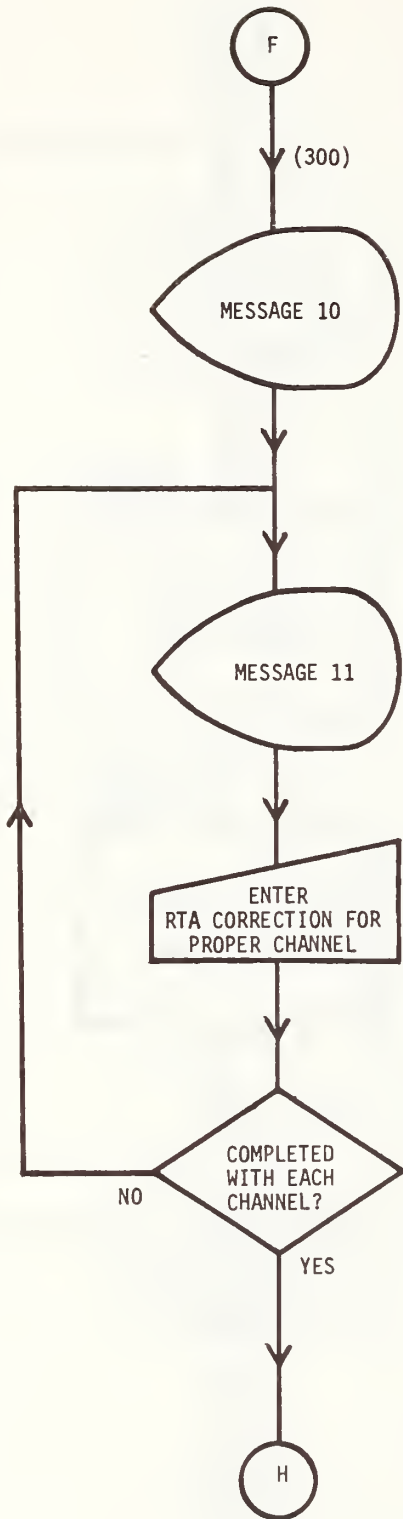
Program SPOWER Flow Chart, Terminal Messages, Printouts and Listings

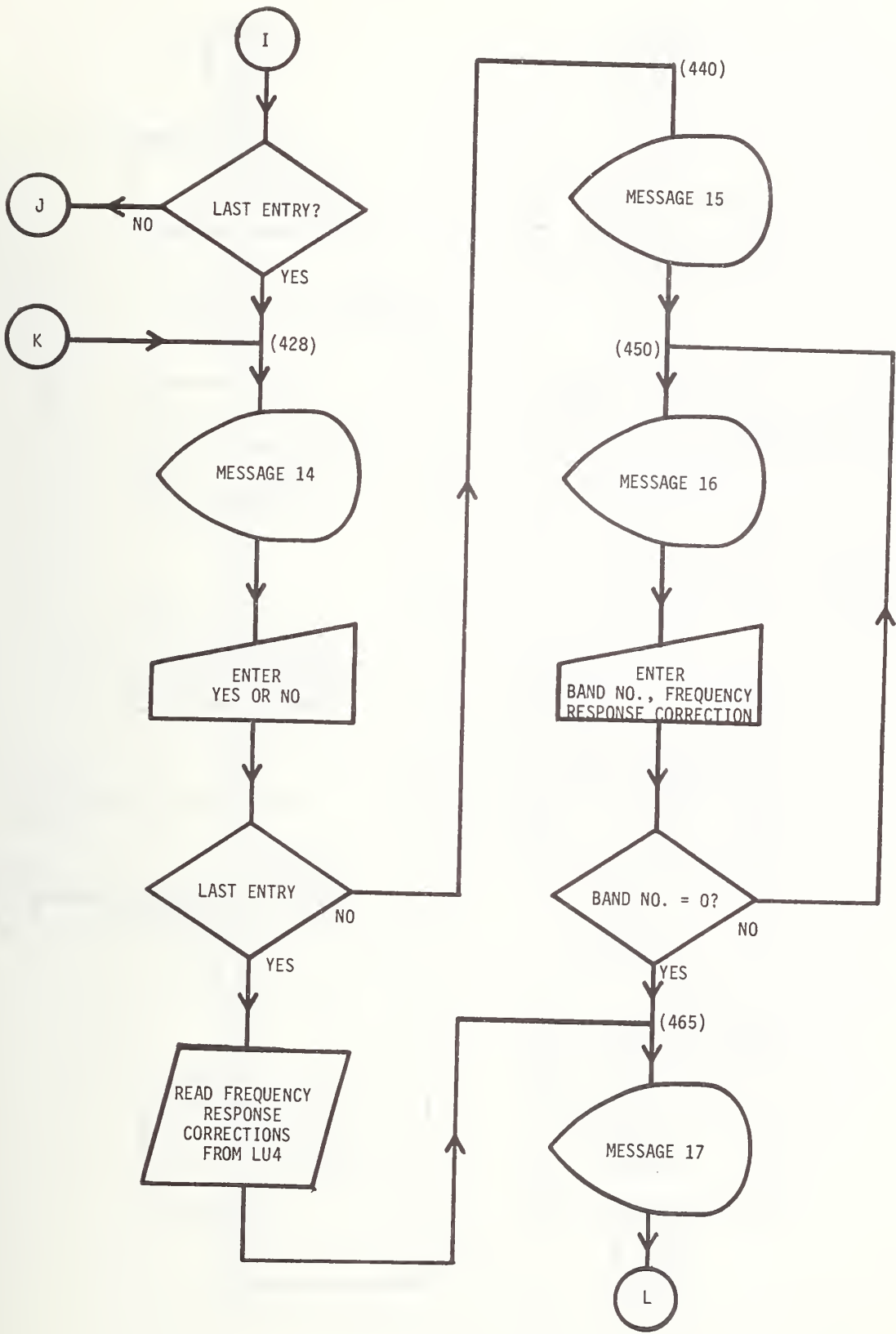
FLOW CHART: SPOWER

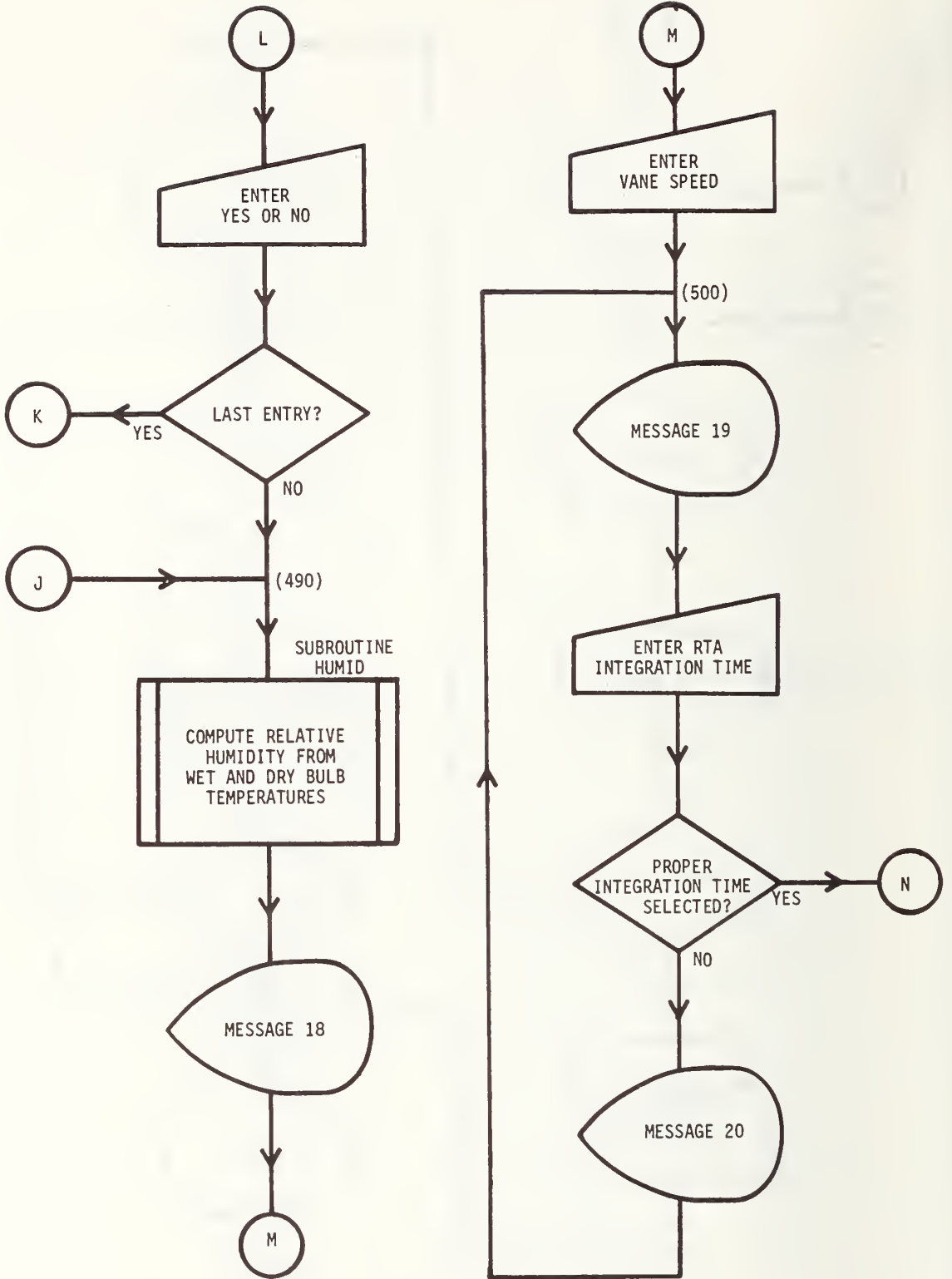


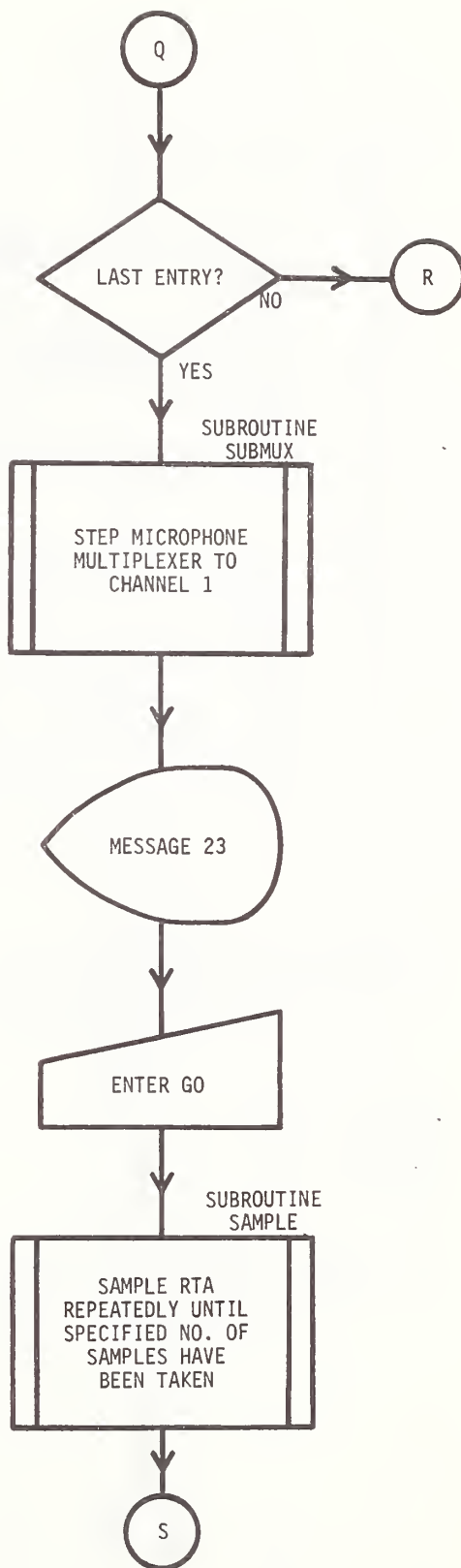
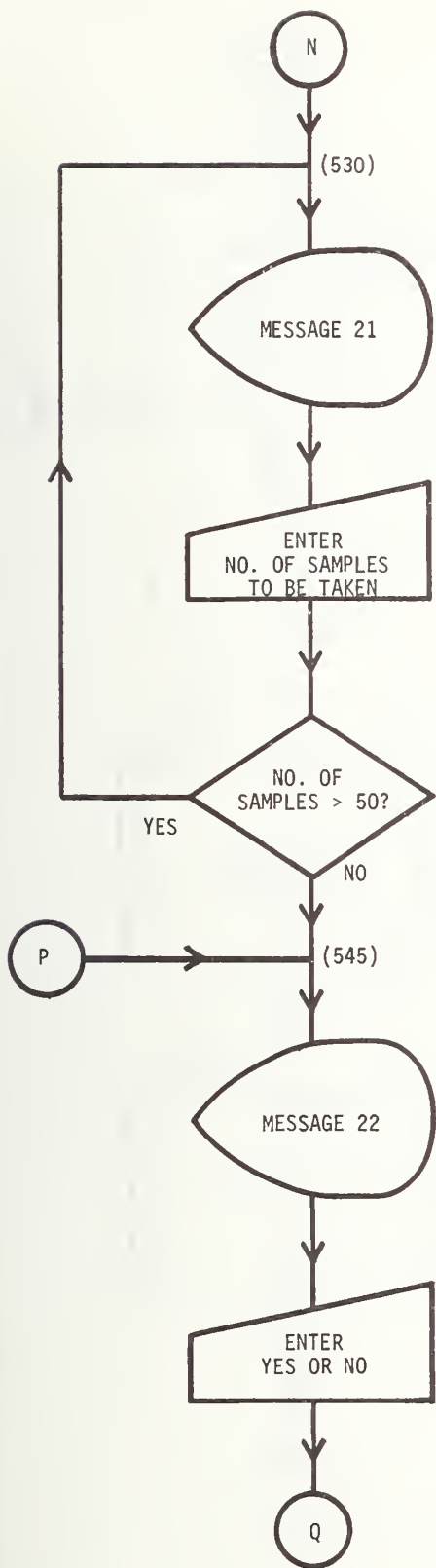


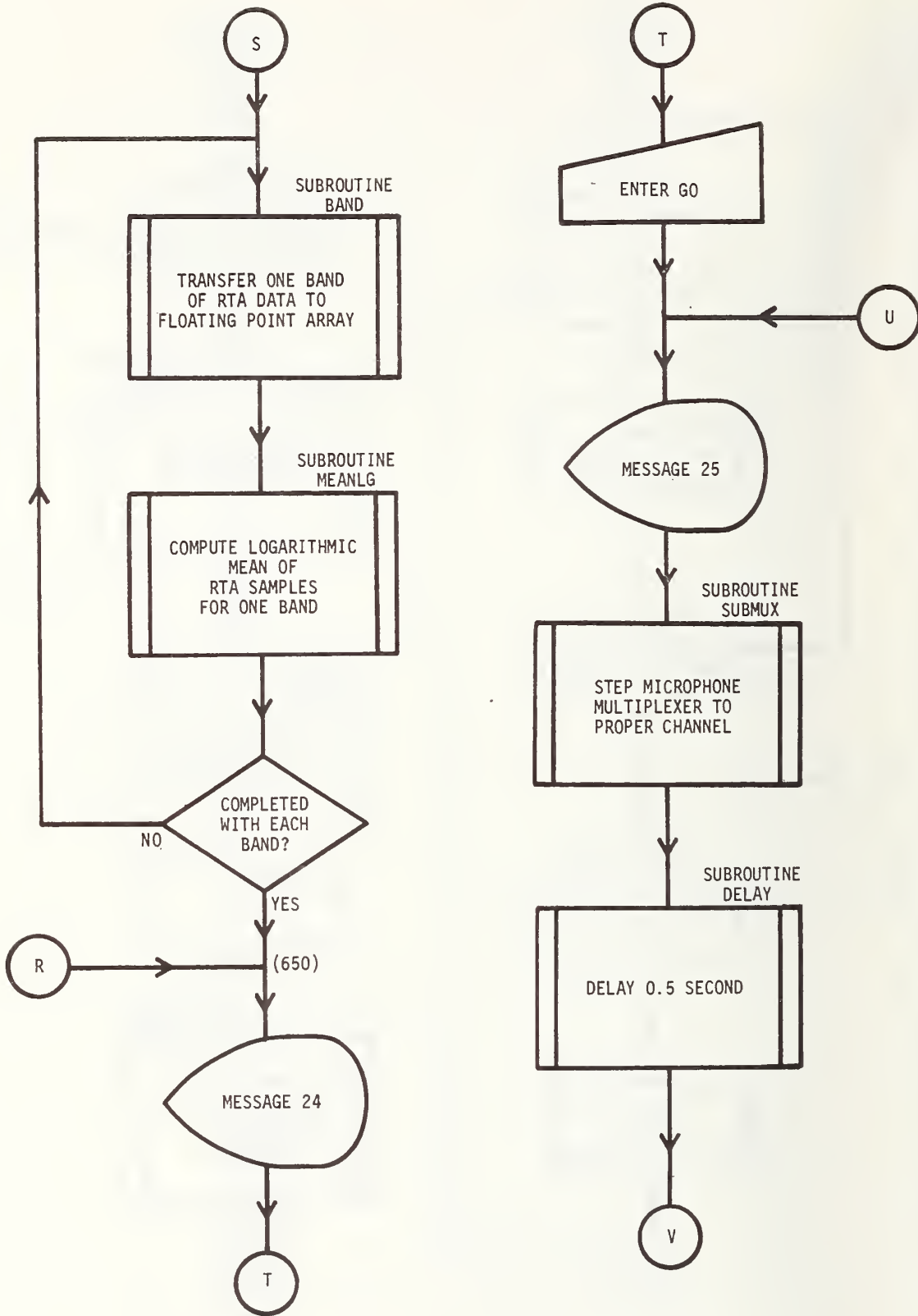


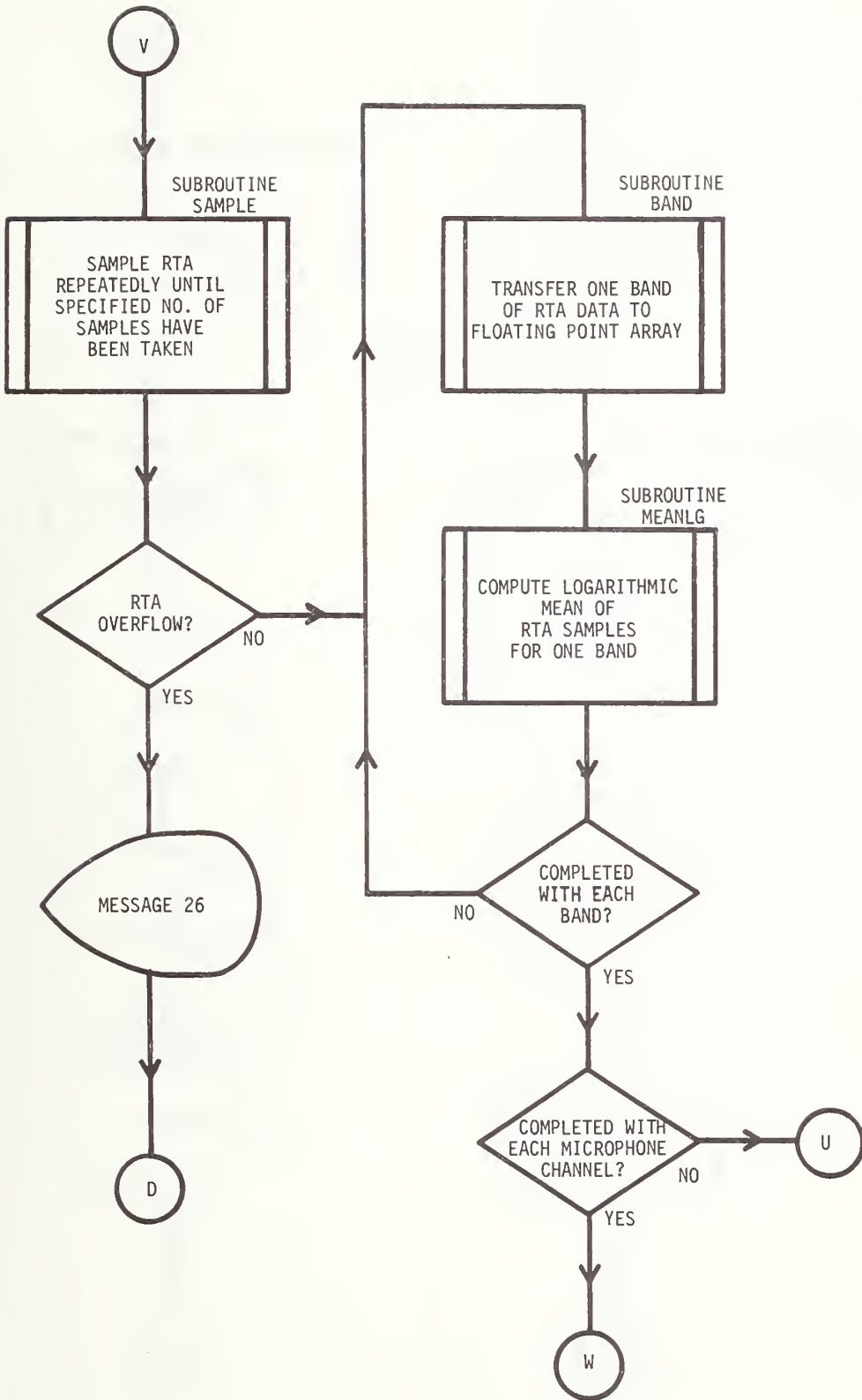


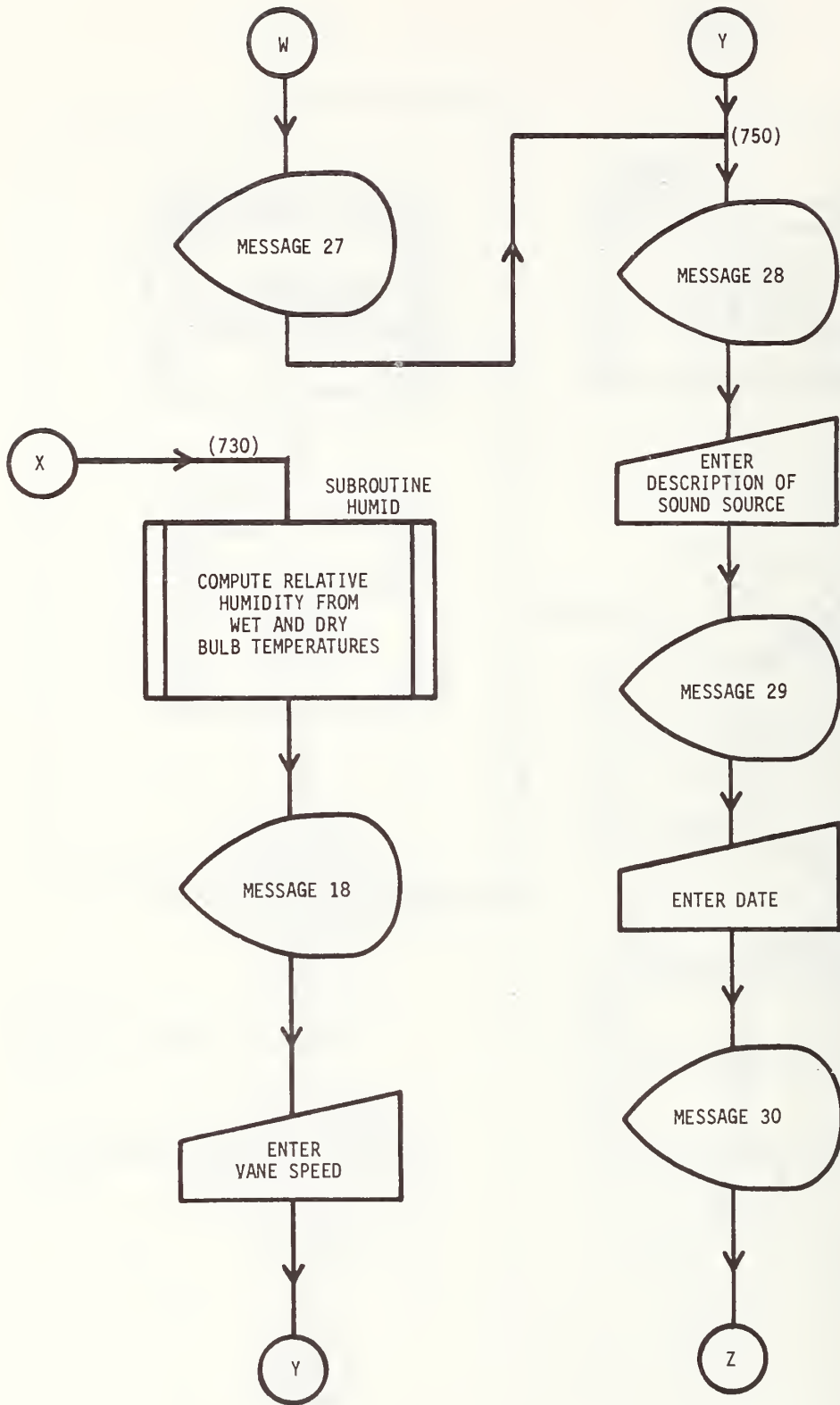


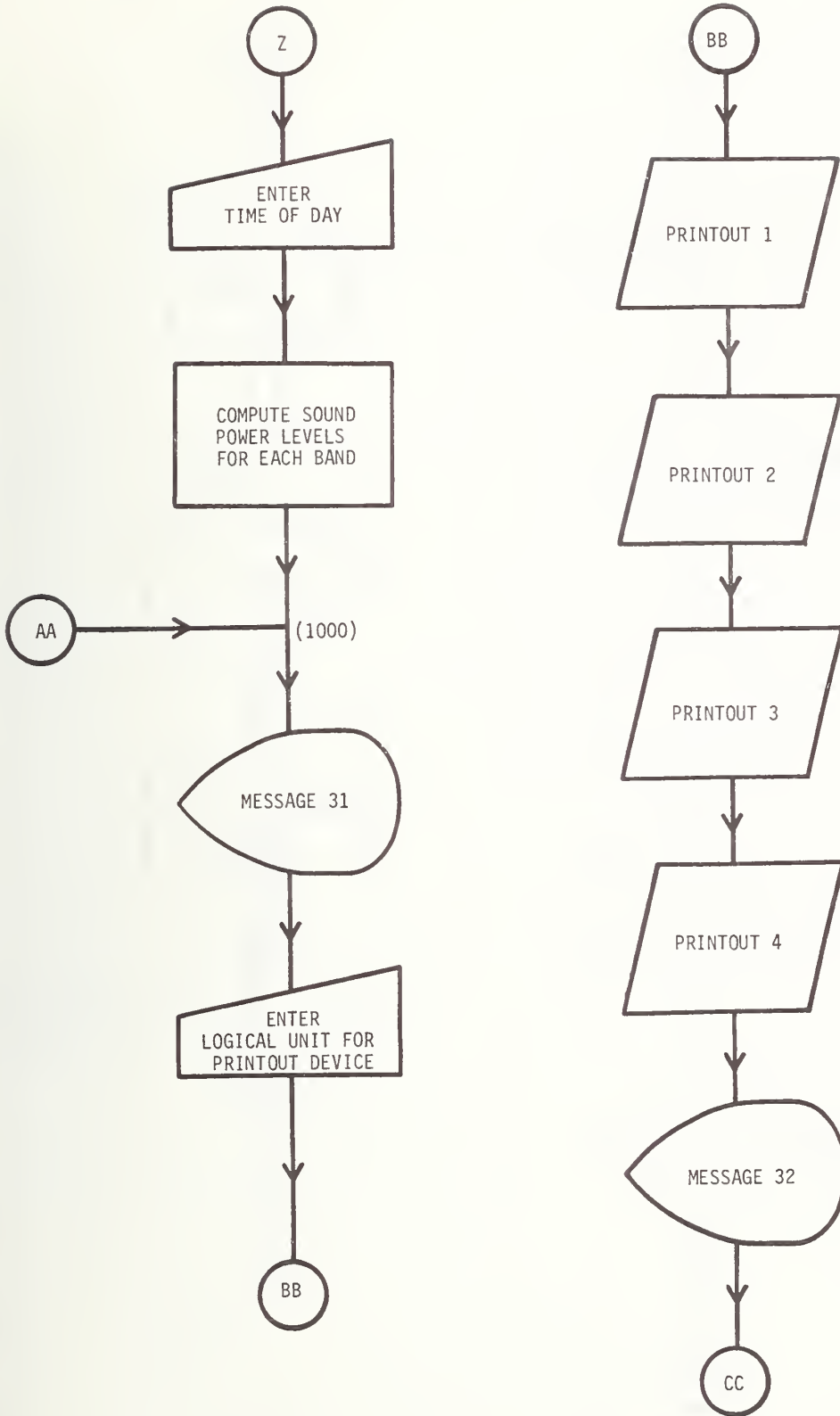


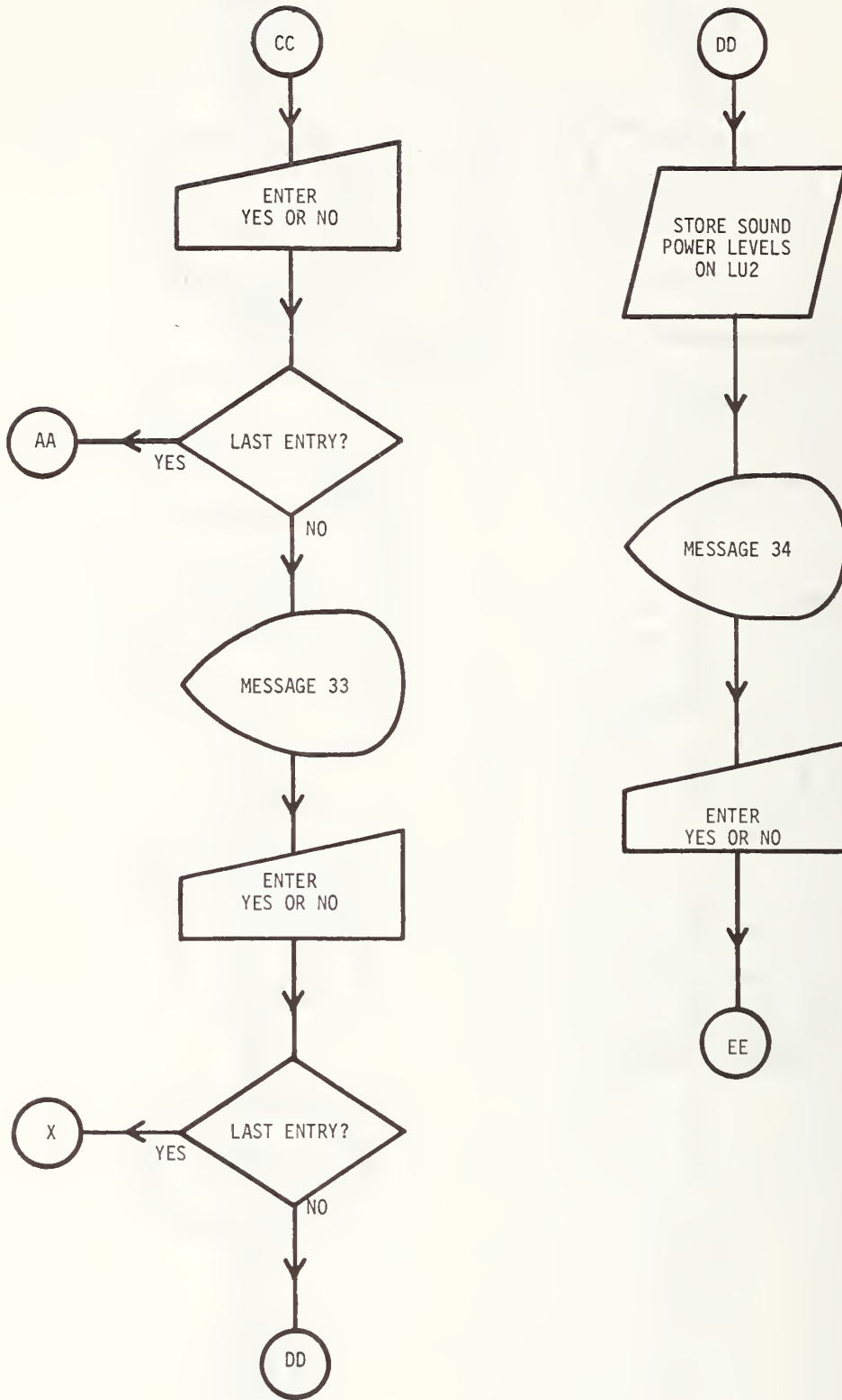


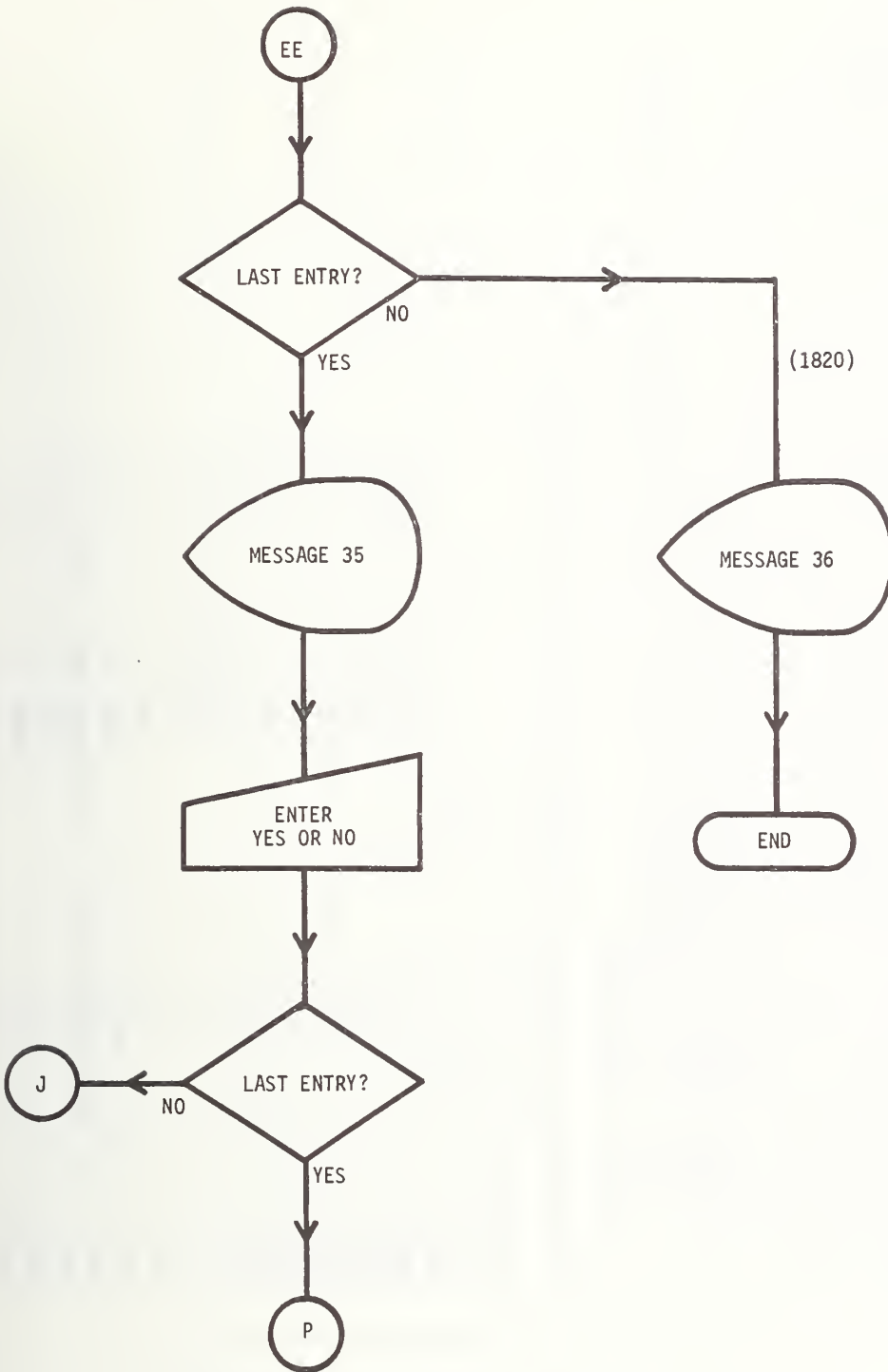












CRT TERMINAL MESSAGES: PROGRAM SPOWER

MESSAGE NO.	FORMAT NO.	MESSAGE																																																																																										
1	10	<p>THIS PROGRAM RUNS AND ANALYZES ONE SOUND POWER MEASUREMENT RE S1.21 WITH 1 SOURCE LOCATION AND UP TO 12 MICROPHONE POSITIONS</p> <p>THE FOLLOWING LOGICAL UNIT ASSIGNMENTS ARE REQUIRED:</p> <p>LU1 -- INPUT FILE CONTAINING REVERBERATION TIME DATA LU2 -- OUTPUT FILE FOR STORING SOUND POWER DATA LU3 -- HIGH SPEED PRINTER LU4 -- INPUT FILE CONTAINING FREQUENCY RESPONSE CORRECTIONS LU5 -- CRT TERMINAL</p>																																																																																										
2	40	DO YOU WANT TO INPUT THE REVERBERATION TIMES FROM THE DISC?																																																																																										
3	110	ENTER REVERBERATION TIME FOR BAND XX (XX.XX)																																																																																										
4	150 & 170	<table border="0"> <tr> <td>BAND 14</td> <td>--</td> <td>T = 22.11</td> <td>BAND 29</td> <td>--</td> <td>T = 5.91</td> </tr> <tr> <td>BAND 15</td> <td>--</td> <td>T = 17.82</td> <td>BAND 30</td> <td>--</td> <td>T = 5.94</td> </tr> <tr> <td>BAND 16</td> <td>--</td> <td>T = 14.85</td> <td>BAND 31</td> <td>--</td> <td>T = 5.92</td> </tr> <tr> <td>BAND 17</td> <td>--</td> <td>T = 9.51</td> <td>BAND 32</td> <td>--</td> <td>T = 5.66</td> </tr> <tr> <td>BAND 18</td> <td>--</td> <td>T = 4.14</td> <td>BAND 33</td> <td>--</td> <td>T = 5.19</td> </tr> <tr> <td>BAND 19</td> <td>--</td> <td>T = 4.57</td> <td>BAND 34</td> <td>--</td> <td>T = 4.63</td> </tr> <tr> <td>BAND 20</td> <td>--</td> <td>T = 3.02</td> <td>BAND 35</td> <td>--</td> <td>T = 4.01</td> </tr> <tr> <td>BAND 21</td> <td>--</td> <td>T = 3.71</td> <td>BAND 36</td> <td>--</td> <td>T = 3.34</td> </tr> <tr> <td>BAND 22</td> <td>--</td> <td>T = 4.51</td> <td>BAND 37</td> <td>--</td> <td>T = 2.70</td> </tr> <tr> <td>BAND 23</td> <td>--</td> <td>T = 5.19</td> <td>BAND 38</td> <td>--</td> <td>T = 2.12</td> </tr> <tr> <td>BAND 24</td> <td>--</td> <td>T = 6.31</td> <td>BAND 39</td> <td>--</td> <td>T = 1.58</td> </tr> <tr> <td>BAND 25</td> <td>--</td> <td>T = 6.80</td> <td>BAND 40</td> <td>--</td> <td>T = 1.16</td> </tr> <tr> <td>BAND 26</td> <td>--</td> <td>T = 6.97</td> <td>BAND 41</td> <td>--</td> <td>T = 0.84</td> </tr> <tr> <td>BAND 27</td> <td>--</td> <td>T = 6.76</td> <td>BAND 42</td> <td>--</td> <td>T = 0.61</td> </tr> <tr> <td>BAND 28</td> <td>--</td> <td>T = 6.18</td> <td>BAND 43</td> <td>--</td> <td>T = 0.00</td> </tr> </table>	BAND 14	--	T = 22.11	BAND 29	--	T = 5.91	BAND 15	--	T = 17.82	BAND 30	--	T = 5.94	BAND 16	--	T = 14.85	BAND 31	--	T = 5.92	BAND 17	--	T = 9.51	BAND 32	--	T = 5.66	BAND 18	--	T = 4.14	BAND 33	--	T = 5.19	BAND 19	--	T = 4.57	BAND 34	--	T = 4.63	BAND 20	--	T = 3.02	BAND 35	--	T = 4.01	BAND 21	--	T = 3.71	BAND 36	--	T = 3.34	BAND 22	--	T = 4.51	BAND 37	--	T = 2.70	BAND 23	--	T = 5.19	BAND 38	--	T = 2.12	BAND 24	--	T = 6.31	BAND 39	--	T = 1.58	BAND 25	--	T = 6.80	BAND 40	--	T = 1.16	BAND 26	--	T = 6.97	BAND 41	--	T = 0.84	BAND 27	--	T = 6.76	BAND 42	--	T = 0.61	BAND 28	--	T = 6.18	BAND 43	--	T = 0.00
BAND 14	--	T = 22.11	BAND 29	--	T = 5.91																																																																																							
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BAND 28	--	T = 6.18	BAND 43	--	T = 0.00																																																																																							

DO YOU WANT TO RE-ENTER THESE DATA?

CRT TERMINAL MESSAGES: PROGRAM SPOWER (page 2)

MESSAGE NO.	FORMAT NO.	MESSAGE
5	190	ENTER NO. OF MICROPHONES IN MICROPHONE ARRAY (2 DIGITS) ENSURE THAT THE MULTIPLEXER DIGISWITCH IS SET TO 12
6	210	DO YOU WANT TO CALIBRATE MICROPHONE CHANNEL NO. 1 WITH A REFERENCE SIGNAL?
7	220	ENTER THE CORRECTION TO BE ADDED TO THE RTA DATA TO GET SOUND PRESSURE LEVELS FOR CHANNEL 1 (XX.XX)
8	250	DO YOU WANT TO CALIBRATE CHANNELS 2 THROUGH 12 IN THE SAME MANNER?
9	260	MICROPHONE CHANNEL XX
10	310	THE CALIBRATIONS FOR CHANNELS 2 THROUGH 12 RELATIVE TO CHANNEL 1 MUST BE ENTERED (CALIBRATION FOR X = RESPONSE OF X - RESPONSE OF 1)
11	320	ENTER CALIBRATION FOR CHANNEL 2 (+ OR - XX.XX)

CRT TERMINAL MESSAGES: PROGRAM SPOWER (page 3)

MESSAGE NO.	FORMAT NO.	MESSAGE																																							
12	405, 410, & 170	<p>MICROPHONE CALIBRATION DATA</p> <table border="1"> <thead> <tr> <th>MICROPHONE CHANNEL NUMBER</th> <th>CORRECTION TO RTA DATA</th> <th>CALIBRATION RELATIVE TO CHANNEL 1</th> </tr> </thead> <tbody> <tr><td>1</td><td>35.85</td><td>0.00</td></tr> <tr><td>2</td><td>35.92</td><td>-0.07</td></tr> <tr><td>3</td><td>37.42</td><td>-1.57</td></tr> <tr><td>4</td><td>35.98</td><td>-0.13</td></tr> <tr><td>5</td><td>34.65</td><td>1.20</td></tr> <tr><td>6</td><td>36.42</td><td>-0.57</td></tr> <tr><td>7</td><td>35.97</td><td>-0.12</td></tr> <tr><td>8</td><td>36.60</td><td>-0.75</td></tr> <tr><td>9</td><td>35.02</td><td>0.83</td></tr> <tr><td>10</td><td>35.20</td><td>0.65</td></tr> <tr><td>11</td><td>35.70</td><td>0.15</td></tr> <tr><td>12</td><td>34.97</td><td>0.88</td></tr> </tbody> </table>	MICROPHONE CHANNEL NUMBER	CORRECTION TO RTA DATA	CALIBRATION RELATIVE TO CHANNEL 1	1	35.85	0.00	2	35.92	-0.07	3	37.42	-1.57	4	35.98	-0.13	5	34.65	1.20	6	36.42	-0.57	7	35.97	-0.12	8	36.60	-0.75	9	35.02	0.83	10	35.20	0.65	11	35.70	0.15	12	34.97	0.88
MICROPHONE CHANNEL NUMBER	CORRECTION TO RTA DATA	CALIBRATION RELATIVE TO CHANNEL 1																																							
1	35.85	0.00																																							
2	35.92	-0.07																																							
3	37.42	-1.57																																							
4	35.98	-0.13																																							
5	34.65	1.20																																							
6	36.42	-0.57																																							
7	35.97	-0.12																																							
8	36.60	-0.75																																							
9	35.02	0.83																																							
10	35.20	0.65																																							
11	35.70	0.15																																							
12	34.97	0.88																																							
13	425	DO YOU WANT TO RE-ENTER THESE DATA?																																							
14	430	DO YOU WANT TO CORRECT FOR THE FREQUENCY RESPONSE OF THE RTA MULTIFILTER AND/OR MICROPHONE?																																							
15	445	DO YOU WANT TO INPUT THE FREQUENCY RESPONSE CORRECTIONS FROM THE DISC?																																							
16	455	FREQ. RESPONSE CORRECTION(BAND X) = RESPONSE(BAND X) - RESPONSE(BAND 30) ENTER BAND NO., CORRECTION (XX,YY.YY) (ENTER 00,0. IF NO FURTHER CORRECTION ARE DESIRED)																																							

CRT TERMINAL MESSAGES: PROGRAM SPOWER (page 4)

MESSAGE NO.	FORMAT NO.	MESSAGE
17	470 & 170	BAND 14: CORRECTION = 0.11 BAND 29: CORRECTION = -0.64 BAND 15: CORRECTION = -0.39 BAND 30: CORRECTION = 0.00 BAND 16: CORRECTION = -0.21 BAND 31: CORRECTION = -0.13 BAND 17: CORRECTION = -0.13 BAND 32: CORRECTION = -0.08 BAND 18: CORRECTION = -0.21 BAND 33: CORRECTION = -0.06 BAND 19: CORRECTION = -0.27 BAND 34: CORRECTION = -0.07 BAND 20: CORRECTION = -0.00 BAND 35: CORRECTION = -0.01 BAND 21: CORRECTION = 0.11 BAND 36: CORRECTION = 0.08 BAND 22: CORRECTION = 0.02 BAND 37: CORRECTION = 0.24 BAND 23: CORRECTION = 0.09 BAND 38: CORRECTION = 0.42 BAND 24: CORRECTION = -0.25 BAND 39: CORRECTION = 0.58 BAND 25: CORRECTION = -0.22 BAND 40: CORRECTION = 1.07 BAND 26: CORRECTION = -0.23 BAND 41: CORRECTION = 1.42 BAND 27: CORRECTION = -0.19 BAND 42: CORRECTION = 0.92 BAND 28: CORRECTION = -0.10 BAND 43: CORRECTION = -0.24
18	740	DO YOU WANT TO RE-ENTER THESE DATA?
19	510	ENTER VANE SPEED IN REV/MIN (XX.X)
20	520	ENTER THE RTA INTEGRATION TIME IN SECONDS (XX.XX)
21	540	YOU HAVE ENTERED AN IMPROPER INTEGRATION TIME
22	550 & 560	ENTER THE NO. OF CONSECUTIVE SAMPLES TO BE TAKEN (2 DIGITS, MAX=50)
23	570	TOTAL INTEGRATION TIME: 30 SAMPLES X 1.00 SECONDS = 30.00 SECONDS DO YOU WANT TO CONDUCT A NOISE MEASUREMENT? ENTER "GO" TO START NOISE MEASUREMENT

CRT TERMINAL MESSAGES: PROGRAM SPOWER (page 5)

MESSAGE NO.	FORMAT NO.	MESSAGE
24	660	ENTER "GO" TO START SOUND POWER MEASUREMENT
25	680	MICROPHONE 1
26	690	THE SYSTEM GAIN MUST BE RE-ADJUSTED
27	720	SOUND POWER MEASUREMENT IS FINISHED
28	800	IDENTIFY SOUND SOURCE (LIMIT: 1 LINE)
29	820	ENTER DATE
30	840	ENTER TIME OF DAY
31	1002	ENTER LOGICAL UNIT FOR DESIRED PRINTOUT DEVICE
32	1700	DO YOU WANT ANOTHER PRINT OF THESE RESULTS?
33	1710	DO YOU WANT TO CORRECT ANY TYPING MISTAKES IN THE PRINTOUT?
34	1800	DO YOU WANT TO CONDUCT ANOTHER SOUND POWER MEASUREMENT USING THE SAME REVERBERATION TIME DATA AND THE SAME SYSTEM GAIN SETTINGS?
35	1810	DO YOU WANT TO USE THE SAME TEMPERATURE, HUMIDITY, VANE SPEED, AND INTEGRATION TIME?
36	1830	END OF JOB

PRINTOUT 1 - PROGRAM SPOWER

BAND NO.	FREQ.	NOISE LEVEL	RTA DATA READOUT												FREQUENCY RESPONSE CORRECTION
			MIC 1	MIC 2	MIC 3	MIC 4	MIC 5	MIC 6	MIC 7	MIC 8	MIC 9	MIC 10	MIC 11	MIC 12	
14	25	6.43	14.89	16.87	17.64	14.15	21.72	18.01	24.23	20.17	21.48	14.12	21.94	25.13	0.11
15	32	5.75	21.41	18.09	22.68	17.71	21.68	21.74	20.97	14.05	25.41	14.42	26.97	26.37	-0.39
16	40	1.99	23.85	26.47	23.82	21.38	27.97	21.81	27.55	7.75	25.35	23.72	25.40	31.27	-0.21
17	50	6.82	27.60	26.84	24.24	26.52	26.66	18.17	26.43	20.50	26.55	27.91	20.90	28.06	-0.13
18	63	4.16	27.72	25.51	27.41	25.07	26.45	25.32	26.41	25.43	28.40	25.33	25.08	28.01	-0.21
19	80	5.61	30.31	34.21	28.47	29.81	33.91	29.45	28.85	27.61	31.63	28.52	28.70	27.83	-0.27
20	100	5.98	31.05	30.86	32.34	32.14	33.60	31.29	32.78	29.72	29.53	31.43	30.55	31.68	-0.00
21	125	4.52	33.06	33.30	31.84	33.26	33.36	33.63	33.15	31.99	32.42	32.96	32.81	33.22	0.11
22	160	0.17	35.11	36.18	32.97	36.05	37.43	34.23	35.41	33.45	35.30	35.20	34.24	35.62	0.02
23	200	0.00	38.49	37.30	36.50	36.84	37.69	36.96	37.51	36.40	36.17	38.01	36.88	37.44	0.09
24	250	0.00	39.33	38.93	37.49	38.16	39.97	38.28	39.40	37.64	38.82	39.26	38.65	39.48	-0.25
25	315	0.00	39.13	38.93	37.24	38.61	40.18	38.46	39.62	38.11	39.13	39.28	38.80	39.39	-0.22
26	400	0.00	39.07	39.01	37.51	38.66	39.73	38.59	39.14	37.56	39.27	39.43	38.60	39.05	-0.23
27	500	0.00	39.27	39.03	37.55	38.74	40.23	38.60	39.44	37.70	39.13	39.21	38.55	39.49	-0.19
28	630	0.00	39.73	39.59	38.56	39.22	40.64	39.18	39.98	38.44	39.63	39.94	39.19	40.11	-0.10
29	800	0.00	41.67	42.05	40.61	41.88	43.12	41.22	42.35	40.71	42.10	42.18	41.44	42.61	-0.64
30	1000	0.00	43.83	44.32	42.64	43.82	45.25	43.29	44.63	42.77	44.14	44.27	43.53	44.61	0.00
31	1250	0.00	44.93	44.95	43.26	44.83	45.84	44.20	45.19	43.62	44.90	45.13	44.34	45.42	-0.13
32	1600	0.00	44.23	44.37	42.63	43.84	45.24	43.42	44.69	42.98	44.23	44.51	43.82	44.80	-0.08
33	2000	0.00	43.45	43.73	42.01	43.36	44.77	42.89	44.17	42.44	43.59	43.94	43.19	44.04	-0.06
34	2500	0.00	41.71	41.70	40.04	41.63	42.76	40.81	42.25	40.53	41.68	41.97	41.20	42.15	-0.07
35	3150	0.00	39.24	39.23	37.60	39.28	40.44	38.51	39.82	38.15	39.26	39.57	38.70	39.81	-0.01
36	4000	0.00	38.68	38.61	37.11	38.65	39.93	37.79	39.36	37.73	38.85	39.10	38.38	39.41	0.08
37	5000	0.00	36.97	37.42	35.68	37.24	38.41	36.40	37.91	36.34	37.41	37.68	36.74	37.85	0.24
38	6300	0.00	35.00	35.30	33.67	35.39	36.45	34.24	35.92	34.31	35.37	35.63	34.65	35.81	0.42
39	8000	0.00	32.32	33.00	31.17	32.80	33.87	31.50	33.51	31.85	32.93	32.97	32.03	33.34	0.58
40	10000	0.00	29.35	30.50	28.77	30.33	31.23	28.46	31.19	29.39	30.50	30.41	29.10	30.75	1.07
41	12500	0.00	25.87	27.41	25.87	26.98	28.41	25.18	28.80	26.83	27.77	27.70	25.85	28.03	1.42
42	16000	0.00	21.13	22.72	21.20	21.43	23.21	19.92	24.85	22.85	23.71	23.52	21.41	23.41	0.92
43	20000	0.00	15.73	16.96	16.49	14.83	17.35	14.40	20.25	18.00	18.75	18.24	16.43	18.33	-0.24

MICROPHONE CALIBRATION DATA

MICROPHONE CHANNEL NUMBER	CORRECTION TO RTA DATA	CALIBRATION RELATIVE TO CHANNEL 1
1	35.85	0.00
2	35.92	-0.07
3	37.42	-1.57
4	35.98	-0.13
5	34.65	1.20
6	36.42	-0.57
7	35.97	-0.12
8	36.60	-0.75
9	35.02	0.83
10	35.20	0.65
11	35.70	0.15
12	34.97	0.88

PRINTOUT 2 - PROGRAM SPOWER

SOUND PRESSURE LEVELS

BAND NO.	FREQ.	NOISE LEVEL	MIC 1	MIC 2	MIC 3	MIC 4	MIC 5	MIC 6	MIC 7	MIC 8	MIC 9	MIC 10	MIC 11	MIC 12
14	35	42.16	50.63	52.68	54.94	50.01	56.25	54.32	60.08	56.65	56.39	49.20	57.53	59.98
15	32	41.98	57.64	54.39	60.49	54.07	56.72	58.54	57.33	51.03	60.81	50.01	63.05	61.73
16	40	38.05	59.90	62.60	61.45	57.57	62.83	58.44	63.72	44.56	60.58	59.13	61.30	66.45
17	50	42.80	63.57	62.88	61.78	62.62	62.44	54.72	62.52	57.23	61.70	63.23	56.73	63.15
18	63	40.22	63.78	61.64	65.04	61.26	61.31	61.95	62.59	62.25	63.63	60.74	61.00	63.19
19	80	41.72	66.42	70.40	66.15	66.06	68.83	66.13	65.08	64.47	64.55	63.99	64.66	63.07
20	100	41.83	66.91	66.78	69.76	68.12	68.25	67.71	68.75	66.32	64.55	66.63	66.25	66.65
21	125	40.25	68.79	69.10	69.15	69.13	67.89	69.93	69.00	68.48	67.33	68.05	68.40	68.08
22	160	36.01	70.95	72.08	70.37	72.02	72.06	70.63	71.36	70.03	70.30	70.38	69.92	70.57
23	200	35.76	74.26	73.13	73.83	72.73	72.25	73.29	73.39	72.92	71.10	73.12	72.49	72.52
24	250	36.10	75.43	75.10	75.16	74.39	74.87	74.95	75.61	74.49	74.08	74.71	74.59	74.70
25	315	36.07	75.20	75.07	74.88	74.81	75.05	75.10	75.80	74.92	74.37	74.70	74.71	74.58
26	400	36.04	75.14	75.15	74.96	74.86	74.60	75.24	75.34	74.38	74.51	74.86	74.52	74.25
27	500	36.04	75.31	75.13	75.16	74.91	75.07	75.21	75.59	74.49	74.34	74.60	74.44	74.65
28	630	35.95	75.68	75.61	76.08	75.30	75.39	75.70	76.05	75.14	74.75	75.24	74.99	75.18
29	800	36.49	78.36	78.62	78.67	78.51	78.41	78.28	78.96	77.95	77.76	78.02	77.79	78.22
30	1000	35.85	79.68	80.23	80.06	79.80	79.90	79.71	80.60	79.37	79.16	79.47	79.23	79.58
31	1250	35.98	80.91	81.00	80.82	80.94	80.62	80.76	81.29	80.36	80.05	80.46	80.18	80.52
32	1600	35.93	80.16	80.37	80.13	79.97	79.97	79.92	80.74	79.66	79.33	79.79	79.60	79.95
33	2000	35.91	79.36	79.71	79.49	79.39	79.48	79.37	80.20	79.10	78.67	79.20	78.95	79.07
34	2500	35.92	77.63	77.70	77.53	77.68	77.48	77.30	78.29	77.20	76.77	77.24	76.97	77.19
35	3150	35.86	75.10	75.16	75.03	75.27	75.09	74.94	75.80	74.75	74.29	74.77	74.40	74.78
36	4000	35.61	74.45	74.65	74.45	74.55	74.50	74.13	75.24	74.25	73.79	74.22	74.00	74.30
37	5000	35.61	72.58	73.10	72.86	72.98	72.82	72.58	73.64	72.70	72.19	72.64	72.20	72.57
38	6300	35.43	70.43	70.80	70.66	70.95	70.68	70.24	71.46	70.49	69.97	70.41	69.93	70.35
39	8000	35.27	67.59	68.33	68.01	68.19	67.94	67.33	68.90	67.87	67.37	67.58	67.15	67.73
40	10000	34.78	64.12	65.34	65.12	65.23	64.81	63.81	66.09	64.92	64.44	64.54	63.72	64.65
41	12500	34.43	60.30	61.91	61.87	61.54	61.64	60.18	63.55	62.01	61.37	61.47	60.12	61.57
42	16000	34.93	56.06	57.72	57.70	56.49	56.94	55.42	59.90	58.53	57.81	57.79	56.19	57.46
43	20000	36.09	51.88	53.12	54.15	51.05	52.24	51.06	56.45	54.83	54.00	53.68	52.37	53.54

PRINTOUT 3 - PROGRAM SPOWER

1/3 OCTAVE BAND SOUND POWER (DB)



BAND NO. FREQ. SOUND POWER

PRINTOUT 4 - PROGRAM SPOWER

SOUND POWER

BAND NO.	FREQ. (HZ)	REVERB TIME (SEC)	STD. DEV. (DB)	SOUND PRESSURE (DB)	1/3 OCTAVE BAND SOUND POWER (DB)	OCTAVE BAND SOUND POWER (DB)
14	25	22.11	3.65	56.17	58.88	
15	32	17.82	4.14	58.70	61.75	67.35
16	40	14.85	5.41	61.64	65.01	
17	50	9.51	3.01	61.77	66.65	
18	63	4.14	1.32	62.56	70.66	76.07
19	80	4.57	2.04	66.50	73.84	
20	100	3.02	1.37	67.42	76.29	
21	125	3.71	0.71	68.66	76.40	81.59
22	160	4.51	0.80	70.96	77.64	
23	200	5.19	0.82	72.97	78.88	
24	250	6.31	0.44	74.86	79.79	84.16
25	315	6.80	0.36	74.95	79.44	
26	400	6.97	0.36	74.83	79.13	
27	500	6.76	0.40	74.93	79.28	84.31
28	630	6.18	0.41	75.45	80.14	
29	800	5.91	0.37	78.31	83.14	
30	1000	5.94	0.42	79.75	84.53	89.24
31	1250	5.92	0.36	80.67	85.43	
32	1600	5.66	0.37	79.97	84.90	
33	2000	5.19	0.39	79.35	84.63	89.08
34	2500	4.63	0.40	77.43	83.20	
35	3150	4.01	0.40	74.97	81.35	
36	4000	3.34	0.37	74.39	81.56	86.03
37	5000	2.70	0.39	72.76	80.84	
38	6300	2.12	0.42	70.55	79.67	
39	8000	1.58	0.49	67.86	78.25	83.10
40	10000	1.16	0.68	64.78	76.51	
41	12500	0.84	0.91	61.53	74.69	
42	16000	0.61	1.21	57.50	72.03	
43	20000		1.59	53.47		

A-WEIGHTED SOUND POWER = 94.42 DB (2.77 MILLIWATTS)
 UNWEIGHTED SOUND POWER = 94.80 DB (3.02 MILLIWATTS)
 A-WEIGHTED SOUND PRESSURE = 88.89 DB
 UNWEIGHTED SOUND PRESSURE = 89.21 DB

VANE SPEED = 7.5 RPM
 NO. OF MICROPHONES = 12
 SAMPLE TIME AT EACH MICROPHONE: 30 SAMPLES X 1.00 SECONDS = 30.00 SECONDS

DRY BULB TEMPERATURE = 21.8 DEG. C (71.2 DEG. F)
 WET BULB TEMPERATURE = 16.7 DEG. C (62.0 DEG. F)
 RELATIVE HUMIDITY = 59.7 %
 BAROMETRIC PRESSURE = 980.8 MILLIBARS (735.7 MM HG)

SOUND SOURCE: B & K TYPE 4204 REFERENCE SOUND SOURCE

DATE: 3/18/77
 TIME: 7:50 A.M.

PROGRAM SPOWER

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1 $ASSM
2 SPOWER PROG SPOWER - PROGRAM TO MEASURE SOUND POWER
3 $FORT
4 C -----
5 C SUBPROGRAMS CALLED: SAMPLE,SPLCAL,DELAY,SUBMUX,MUX,HUMID,BAND,
6 C MEANLG,MEANAR,RTA
7 C -----
8 DIMENSION X(50),RDATA(30,12),SPL(30,12),STD(30),SPLM(30),T60(30),
9 1POWER(30),WEIGHT(30),FLOOR(30),SPLCOR(12),RELCAL(12),ARRAY(12),
10 2SOURCE(18),DATE(5),TIME(5),DATE0(5),TIME0(5),FRCOR(30)
11 INTEGER*2 X0(1560),FREQ(30),B,OVFLOW,FF,FX100,LINE(101),
12 1DOT,STAR,SPACE,LCARET,RCARET
13 DATA DOT,STAR,SPACE,LCARET,RCARET,FF/'X'2E00',X'2A00',X'2000',
14 1X'3C00',X'3E00',X'0C00'/
15 DATA FREQ/25,32,40,50,63,80,100,125,160,200,250,315,400,500,
16 1630,800,1000,1250,1600,2000,2500,3150,4000,5000,6300,8000,
17 210000,12500,16000,20000/
18 DATA WEIGHT/-44.7,-39.4,-34.6,-30.2,-26.2,-22.5,-19.1,-16.1,
19 1-13.4,-10.9,-8.6,-6.6,-4.8,-3.2,-1.9,-.8,0,..6,1..1.2,1.3,
20 21.2,1..5,-.1,-1.1,-2.5,-4.3,-6.6,-9.3/
21 WRITE (5,10)
22 10 FORMAT (X/X/'THIS PROGRAM RUNS AND ANALYZES ONE SOUND POWER
23 1 MEASUREMENT RE S1.21'/'WITH 1 SOURCE LOCATION AND UP TO 12
24 2 MICROPHONE POSITIONS'/'X/X/
25 3'THE FOLLOWING LOGICAL UNIT ASSIGNMENTS ARE REQUIRED:'/'X/
26 45X,'LU1 -- INPUT FILE CONTAINING REVERBERATION TIME DATA'/'
27 55X,'LU2 -- OUTPUT FILE FOR STORING SOUND POWER DATA'/'
28 65X,'LU3 -- HIGH SPEED PRINTER'/'
29 75X,'LU4 -- INPUT FILE CONTAINING FREQUENCY RESPONSE CORRECTIONS'/'
30 85X,'LU5 -- CRT TERMINAL'/'X/X)
31 20 FORMAT (A4)
32 REWIND 2
33 30 WRITE (5,40)
34 40 FORMAT ('DO YOU WANT TO INPUT THE REVERBERATION TIMES FROM
35 1 THE DISC?')
36 READ (5,20) QS
37 IF (QS.EQ.'NO') GO TO 100
38 REWIND 1
39 READ (1,20) C
40 DO 90 I=1,30
41 READ (1,80) J,J,C,T60(I),C,C,J
42 80 FORMAT (I2,X,I5,X,2(F8.4,X),F9.5,X,F6.3,X,I3)
43 90 CONTINUE
44 GO TO 140
45 100 DO 130 I=1,30
46 B=I+13
47 WRITE (5,110) B
48 110 FORMAT ('ENTER REVERBERATION TIME FOR BAND ',I2,4X,'(XX.XX)')
49 READ (5,120) T60(I)
50 120 FORMAT (F10.5)
51 130 CONTINUE
52 140 DO 160 I=1,15
53 B=I+13
54 J=B+15
55 WRITE (5,150) B,T60(I),J,T60(I+15)
56 150 FORMAT ('BAND ',I2,' -- T =',F6.2,15X,'BAND ',I2,' -- T =',F6.2)
57 160 CONTINUE
58 WRITE (5,170)
59 170 FORMAT (X/'DO YOU WANT TO RE-ENTER THESE DATA?')
60 READ (5,20) QS

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SPOWER-2

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61     IF (QS.NE.'NO') GO TO 30
62     DO 180 I=1,30
63     FLOOR(I)=0.
64     DO 180 J=1,12
65     RIATA(I,J)=0.
66     SPL(I,J)=0.
67 180   CONTINUE
68     WRITE (5,190)
69 190   FORMAT ('ENTER NO. OF MICROPHONES IN MICROPHONE ARRAY
70         1 (2 DIGITS)')
71     READ (5,200) NMIC
72 200   FORMAT (I2)
73     RELCAL(1)=0
74 205   WRITE (5,210) NMIC
75 210   FORMAT ('ENSURE THAT THE MULTIPLEXER DIGISWITCH IS SET TO '.12/X/
76         1'DO YOU WANT TO CALIBRATE MICROPHONE CHANNEL NO. 1' /
77         2'WITH A REFERENCE SIGNAL?')
78     READ (5,20) QS
79     IF (QS.NE.'NO') GO TO 230
80     WRITE (5,220)
81 220   FORMAT ('ENTER THE CORRECTION TO BE ADDED TO THE RTA DATA' /
82         1' TO GET SOUND PRESSURE LEVELS FOR CHANNEL 1 (XX.XX)')
83     READ (5,120) SPLCOR(1)
84     GO TO 300
85 230   CALL SUBMUX(1)
86     CALL SPLCAL(SPLCOR(1),50,X,X0,1560)
87     WRITE (5,250) NMIC
88 250   FORMAT ('DO YOU WANT TO CALIBRATE CHANNELS 2 THROUGH '.12,
89         1' IN THE SAME MANNER?')
90     READ (5,20) QS
91     IF (QS.EQ.'NO') GO TO 300
92     DO 270 I=2,NMIC
93     WRITE (5,260) I
94 260   FORMAT ('X'X/'MICROPHONE CHANNEL '.12)
95     CALL SUBMUX(I)
96     CALL SPLCAL(SPLCOR(I),50,X,X0,1560)
97     RELCAL(I)=SPLCOR(1)-SPLCOR(I)
98 270   CONTINUE
99     GO TO 400
100 300   WRITE (5,310) NMIC
101 310   FORMAT ('THE CALIBRATIONS FOR CHANNELS 2 THROUGH '.12,
102         1' RELATIVE TO CHANNEL 1'/' MUST BE ENTERED' /
103         2'(CALIBRATION FOR X = RESPONSE OF X - RESPONSE OF 1)' /X)
104     DO 330 I=2,NMIC
105     WRITE (5,320) I
106 320   FORMAT ('ENTER CALIBRATION FOR CHANNEL '.12,5X,
107         1' (+ OR - XX.XX)')
108     READ (5,120) RELCAL(I)
109     SPLCOR(I)=SPLCOR(1)-RELCAL(I)
110 330   CONTINUE
111 400   WRITE (5,405)
112 405   FORMAT ('X'X/T7.'MICROPHONE CALIBRATION DATA' /X'X' /
113         1'MICROPHONE'.T15.'CORRECTION'.T30.'CALIBRATION' /
114         2T3.'CHANNEL'.T19.'TO'.T30.'RELATIVE TO' /
115         3T3.'NUMBER'.T16.'RTA DATA'.T31.'CHANNEL 1' /X)
116     DO 415 I=1,NMIC
117     WRITE (5,410) I,SPLCOR(I),RELCAL(I)
118 410   FORMAT (T5,12,T16,F7.2,T32,F6.2)
119 415   CONTINUE
120     WRITE (5,170)
```

SPOWER-3

```
121      READ (5,20) QS
122      IF (QS.NE.'NO') GO TO 205
123      DO 420 I=1,30
124      FRCOR(I)=0.
125 420   CONTINUE
126      WRITE (5,425)
127 425   FORMAT ('DO YOU WANT TO CORRECT FOR THE FREQUENCY RESPONSE
128 1 OF THE RTA MULTIFILTER AND/OR MICROPHONE?')
129      READ (5,20) QS
130      IF (QS.EQ.'NO') GO TO 490
131 428   WRITE (5,430)
132 430   FORMAT ('DO YOU WANT TO INPUT THE FREQUENCY RESPONSE
133 1 CORRECTIONS FROM THE DISC?')
134      READ (5,20) QS
135      INDTR=0
136      IF (QS.EQ.'NO') GO TO 440
137      INDTR=1
138      REWIND 4
139      READ (4) FRCOR
140      READ (4) DATED,TIME0
141      GO TO 465
142 440   WRITE (5,445)
143 445   FORMAT ('FREQ. RESPONSE CORRECTION(BAND X) =
144 1 RESPONSE(BAND X) - RESPONSE(BAND 30)'/X)
145 450   WRITE (5,455)
146 455   FORMAT ('ENTER BAND NO., CORRECTION (XX.YY.YY)'/
147 1('ENTER 00.0. IF NO FURTHER CORRECTIONS ARE DESIRED)')
148      READ (5,460) B,I,C
149 460   FORMAT (I2,A1,F10.5)
150      IF (B.EQ.0) GO TO 465
151      FRCOR(B-13)=C
152      GO TO 450
153 465   DO 475 I=1,15
154      B=I+13
155      J=0+15
156      WRITE (5,470) B,FRCOR(I),J,FRCOR(I+15)
157 470   FORMAT (2('BAND ',I2,' : CORRECTION = ',F7.2,9X))
158 475   CONTINUE
159      WRITE (5,170)
160      READ (5,20) QS
161      IF (QS.NE.'NO') GO TO 428
162 490   CALL HUMID(HUMDTY,DTEMPF,DTEMPC,WTEMPF,WTEMPC,
163 1PRESS1,PRESS2,V SOUND)
164      WRITE (5,740)
165      READ (5,120) VANE
166 500   WRITE (5,510)
167 510   FORMAT ('ENTER THE RTA INTEGRATION TIME IN SECONDS (XX.XX)')
168      READ (5,120) T
169      IF ((T.EQ..1).OR.(T.EQ..25).OR.(T.EQ..5).OR.(T.EQ.1.).OR.
170 1(T.EQ.2.).OR.(T.EQ.4.).OR.(T.EQ.8.).OR.(T.EQ.16.).OR:
171 2(T.EQ.32.)) GO TO 525
172      WRITE (5,520)
173 520   FORMAT ('YOU HAVE ENTERED AN IMPROPER INTEGRATION TIME')
174      GO TO 500
175 525   TX100=T*100.
176 530   WRITE (5,540)
177 540   FORMAT ('ENTER THE NO. OF CONSECUTIVE SAMPLES TO BE TAKEN',4X,
178 1('2 DIGITS, MAX=50'))
179      READ (5,200) NSAMP
180      IF (NSAMP.GT.50) GO TO 530
```

SPOWER-4

```
181 545 C=T*NSAMP
182 WRITE (5,550) NSAMP,T,C
183 550 FORMAT (X/'TOTAL INTEGRATION TIME: ',I2,' SAMPLES X ',F5.2,
184 1' SECONDS = ',F6.2,' SECONDS'/X)
185 WRITE (5,560)
186 560 FORMAT ('DO YOU WANT TO CONDUCT A NOISE MEASUREMENT?')
187 READ (5,20) QS
188 IF (QS.EQ.'NO') GO TO 650
189 CALL SUBMUX(1)
190 WRITE (5,570)
191 570 FORMAT ('ENTER "GO" TO START NOISE MEASUREMENT')
192 READ (5,20) QS
193 CALL SAMPLE(0,NSAMP, TX100,OVFLOW,X0,1560)
194 DO 600 I=1,30
195 B=I+13
196 CALL BAND(B,NSAMP,X,X0,1560)
197 CALL MEANLG(NSAMP,X,FLOOR(I),C)
198 600 CONTINUE
199 650 WRITE (5,660)
200 660 FORMAT ('ENTER "GO" TO START SOUND POWER MEASUREMENT')
201 670 READ (5,20) QS
202 DO 710 J=1,NMIC
203 WRITE (5,680) J
204 680 FORMAT ('MICROPHONE ',I2)
205 CALL SUBMUX(J)
206 CALL DELAY(500)
207 CALL SAMPLE(0,NSAMP, TX100,OVFLOW,X0,1560)
208 IF (OVFLOW.EQ.0) GO TO 700
209 WRITE (5,690)
210 690 FORMAT ('THE SYSTEM GAIN MUST BE RE-ADJUSTED')
211 GO TO 205
212 700 DO 710 I=1,30
213 B=I+13
214 CALL BAND(B,NSAMP,X,X0,1560)
215 CALL MEANLG(NSAMP,X,RDATA(I,J),C)
216 710 CONTINUE
217 WRITE (5,720)
218 720 FORMAT (X/X/'SOUND POWER MEASUREMENT IS FINISHED')
219 GO TO 750
220 730 CALL HUMID(HUMDTY,DTEMPF,DTEMPC,WTEMPF,WTEMPC,PRESS1,PRESS2,
221 1V50UND)
222 WRITE (5,740)
223 740 FORMAT ('ENTER VANE SPEED IN REV./MIN (XX.X)')
224 READ (5,120) VANE
225 750 WRITE (5,800)
226 800 FORMAT ('IDENTIFY SOUND SOURCE (LIMIT: 1 LINE)')
227 READ (5,810) (SOURCE(I),I=1,18)
228 810 FORMAT (18A4)
229 WRITE (5,820)
230 820 FORMAT (X/'ENTER DATE')
231 READ (5,830) (DATE(I),I=1,5)
232 830 FORMAT (5A4)
233 WRITE (5,840)
234 840 FORMAT ('ENTER TIME OF DAY')
235 READ (5,830) (TIME(I),I=1,5)
236 VOLUME=424.8
237 AREA=343.73
238 DO 950 I=1,30
239 DO 900 J=1,NMIC
240 SPL(I,J)=RDATA(I,J)+SPLCOR(J)-FRCOR(I)
```


SPOWER-5

```
241      ARRAY(J)=SPL(I,J)
242 900    CONTINUE
243      CALL MEANAR(NMIC,ARRAY,C,STD(I))
244      CALL MEANLG(NMIC,ARRAY,SPLM(I),C)
245      IF (T60(I).EQ.0.) GO TO 950
246      WAVELG=VSOUND/FREQ(I)
247      POWER(I)=SPLM(I)+10*ALOG10(VOLUME*(1+(AREA*WAVELG)/(B*VOLUME))
248      1*1000./((PRESS2*T60(I))))-14
249 950    CONTINUE
250 1000   WRITE (5,1002)
251 1002   FORMAT ('ENTER LOGICAL UNIT FOR DESIRED PRINTOUT DEVICE')
252      READ (5,1005) LU
253 1005   FORMAT (I1)
254      WRITE (LU,1010) (I,I=1,12)
255 1010   FORMAT (X/T62,'RTA DATA READOUT',T121,'FREQUENCY'/
256      1'BAND',T16,'NOISE',T121,'RESPONSE'/
257      2T2,'NO.',T8,'FREQ.',T16,'LEVEL',T24,9('MIC ',I1,3X),
258      33('MIC ',I2,2X),T121,'CORRECTION'/X)
259      DO 1030 I=1,30
260      B=I+13
261      WRITE (LU,1020) B,FREQ(I),FLOOR(I),(RDATA(I,J),J=1,12),
262      1FRCOR(I)
263 1020   FORMAT (T2,I2,T7,I5,T15,F6.2,T23,12(F6.2,2X),T122,F6.2)
264 1030   CONTINUE
265      IF (INDTR.EQ.0) WRITE (LU,1032)
266      IF (LU.EQ.5) GO TO 1034
267      IF (INDTR.EQ.1) WRITE (LU,1033) DATE0,TIME0
268 1032   FORMAT (X/X/X)
269 1033   FORMAT (X/T90,'FREQUENCY RESPONSE MEASURED: ',5A4/
270      1T120,5A4)
271 1034   WRITE (LU,405)
272      DO 1035 I=1,NMIC
273      WRITE (LU,410) I,SPLCOR(I),RELCAL(I)
274 1035   CONTINUE
275      WRITE (LU,1040) FF
276 1040   FORMAT (A1)
277      WRITE (LU,1100)
278 1100   FORMAT (X/X/X/T49,'SOUND PRESSURE LEVELS')
279      WRITE (LU,1105) (I,I=1,12)
280 1105   FORMAT (X/X/X/X/'BAND',T16,'NOISE'/
281      1T2,'NO.',T8,'FREQ.',T16,'LEVEL',T24,9('MIC ',I1,3X),
282      23('MIC ',I2,2X)/X)
283      DO 1110 I=1,30
284      B=I+13
285      C=FLOOR(I)+SPLCOR(I)-FRCOR(I)
286      WRITE (LU,1107) B,FREQ(I),C,(SPL(I,J),J=1,12)
287 1107   FORMAT (T2,I2,T7,I5,T15,F6.2,T23,12(F6.2,2X))
288 1110   CONTINUE
289      WRITE (LU,1040) FF
290      C=0.
291      DO 1150 I=1,30
292      IF (T60(I).EQ.0.) GO TO 1150
293      IF (POWER(I).GT.C) C=POWER(I)
294 1150   CONTINUE
295      NSCALE=10*(INT(C/10.)+1)
296      IF (NSCALE.LT.50) NSCALE=50
297      J=NSCALE-50
298      WRITE (LU,1160) (I,I=J,NSCALE,10)
299 1160   FORMAT (X/X/X/T46,'1/3 OCTAVE BAND SOUND POWER (DB)'/
300      1X/X/X/T14,5(I3,17X),I3/T15,10(' ',9X),',',/X)
```

SPOWER-6

```
301      DO 1220 I=1,30
302      B=I+13
303      DO 1170 J=1,101
304      LINE(J)=SPACE
305 1170  CONTINUE
306      IF (T60(I).NE.0.) GO TO 1175
307      WRITE (LU,1172) B,FREQ(I)
308 1172  FORMAT (I2,T7,I5)
309      GO TO 1220
310 1175  J=INT(2.*POWER(I)+.5)-2*(NSCALE-50)+1
311      IF (J.GE.1) GO TO 1180
312      LINE(I)=LCARET
313      GO TO 1200
314 1180  IF (J.LE.101) GO TO 1190
315      LINE(101)=RCARET
316      GO TO 1200
317 1190  LINE(J)=STAR
318 1200  WRITE (LU,1210) B,FREQ(I),(LINE(J),J=1,101),POWER(I)
319 1210  FORMAT (I2,T7,I5,T15,101A1,T120,F6.2)
320 1220  CONTINUE
321      WRITE (LU,1230) FF
322 1230  FORMAT (X/'BAND',T7,'FREQ.',T121,'SOUND'/
323 1T2,'NO.',T121,'POWER'/A1)
324      WRITE (LU,1400)
325 1400  FORMAT (T23,'SOUND POWER'/X/X/
326 1T41,'1/3 OCTAVE',T54,'OCTAVE'/
327 2T44,'BAND',T54,'BAND'/
328 3'BAND',T16,'REVERB',T25,'STD.',T34,'SOUND',T44,'SOUND',T54,
329 4'SOUND'/
330 5T2,'NO.',T7,'FREQ.',T16,'TIME',T25,'DEV.',T33,'PRESSURE',
331 6T44,'POWER',T54,'POWER'/
332 7T7,'(HZ)',T16,'(SEC)',T25,'(DB)',T34,'(DB)',T44,'(DB)',
333 8T54,'(DB)'/X)
334      DO 1500 I=1,30
335      B=I+13
336      IF (T60(I).NE.0.) GO TO 1420
337      WRITE (LU,1410) B,FREQ(I),STD(I),SPLM(I)
338 1410  FORMAT (T2,I2,T6,I5,T24,F5.2,T33,F6.2)
339      GO TO 1500
340 1420  IF (INT(B/3.+9).EQ.INT(B/3.+1001)) GO TO 1450
341 1430  WRITE (LU,1440) B,FREQ(I),T60(I),STD(I),SPLM(I),POWER(I)
342 1440  FORMAT (T2,I2,T6,I5,T15,F6.2,T24,F5.2,T33,F6.2,T43,F6.2)
343      GO TO 1500
344 1450  IF ((T60(I-1).EQ.0.).OR.(T60(I+1).EQ.0.)) GO TO 1430
345      C=10.*ALOG10(10.**((POWER(I-1)/10.)+10.**((POWER(I)/10.))+
346 110.**((POWER(I+1)/10.)))
347      WRITE (LU,1460)B,FREQ(I),T60(I),STD(I),SPLM(I),POWER(I),C
348 1460  FORMAT (T2,I2,T6,I5,T15,F6.2,T24,F5.2,T33,F6.2,T43,F6.2,
349 1T53,F6.2)
350 1500  CONTINUE
351      X(1)=0.
352      X(2)=0.
353      X(3)=0.
354      X(4)=0.
355      DO 1530 B=14,43
356      I=B-13
357      IF (T60(I).EQ.0.) GO TO 1520
358      X(1)=X(1)+10.**((POWER(I)+WEIGHT(I))/10.)
359      X(2)=X(2)+10.**((POWER(I)/10.))
360 1520  X(3)=X(3)+10.**((SPLM(I)+WEIGHT(I))/10.)
```

SPOWER-7

```

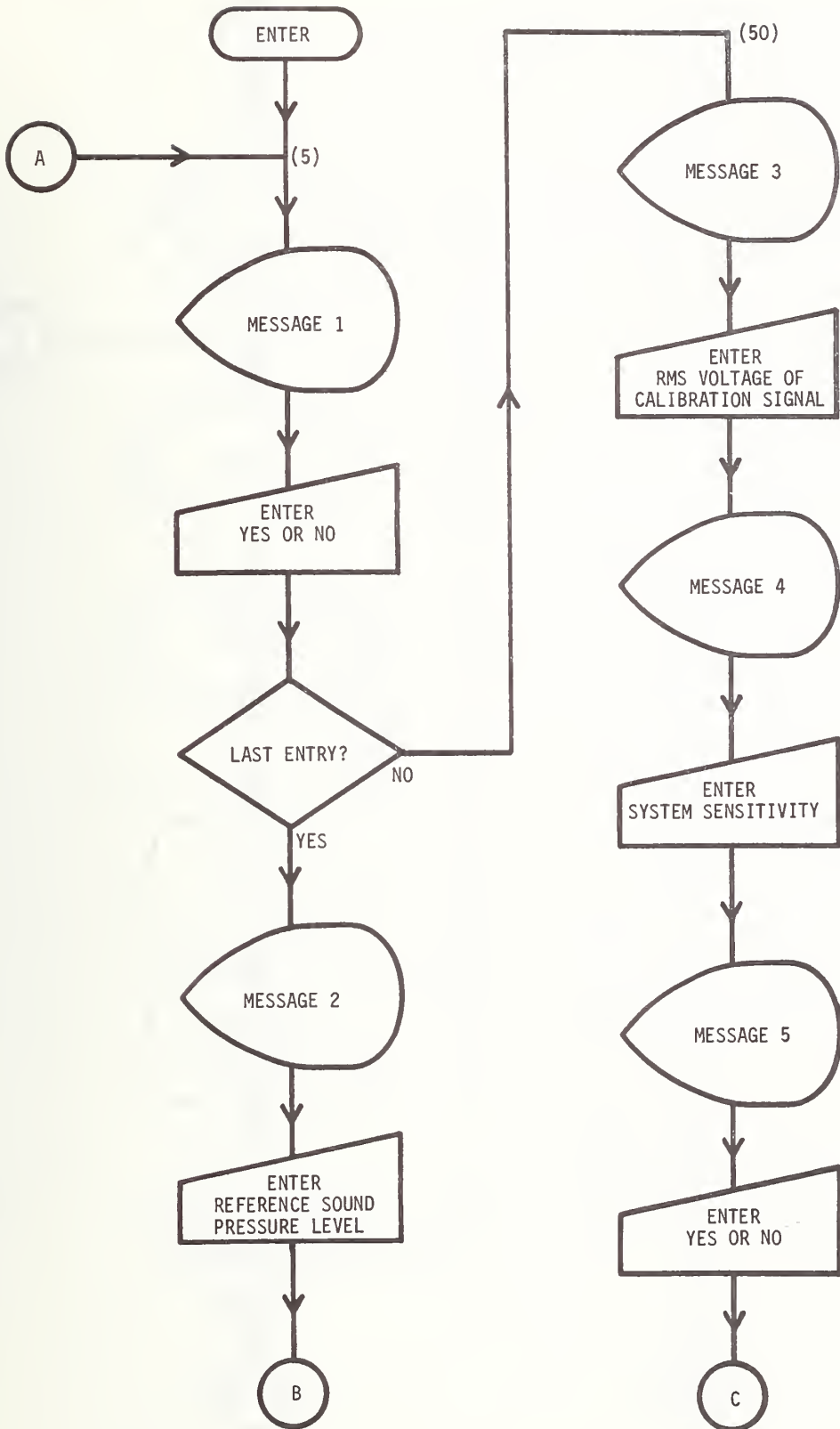
361      X(4)=X(4)+10.**(SPLM(I)/10.)
362 1530  CONTINUE
363      X(5)=10.*ALOG10(X(1))
364      X(6)=X(1)*1.E-9
365      X(7)=10.*ALOG10(X(2))
366      X(8)=X(2)*1.E-9
367      X(9)=10.*ALOG10(X(3))
368      X(10)=10.*ALOG10(X(4))
369      WRITE (LU,1540) (X(I),I=5,10)
370 1540  FORMAT (X/X/'A-WEIGHTED SOUND POWER      = ',F6.2,' DB',
371          14X,'(',F8.2,' MILLIWATTS)'/
372          2'UNWEIGHTED SOUND POWER      = ',F6.2,' DB',4X,'(',F8.2,
373          3' MILLIWATTS)'/
374          4'A-WEIGHTED SOUND PRESSURE = ',F6.2,' DB'/
375          5'UNWEIGHTED SOUND PRESSURE = ',F6.2,' DB'/X)
376      C=T*NSAMP
377      WRITE (LU,1550) VANE.NMIC.NSAMP.T.C. DTEMPC.DTEMPF
378 1550  FORMAT ('VANE SPEED = ',F4.1,' RPM'/
379          1'NO. OF MICROPHONES = ',I2'/
380          2'SAMPLE TIME AT EACH MICROPHONE: ',I2,' SAMPLES X ',F5.2,
381          3' SECONDS = ',F6.2,' SECONDS'/X/
382          4'DRY BULB TEMPERATURE = ',F4.1,' DEG. C',7X,'(',F4.1,' DEG. F)')
383      IF (WTEMPC.EQ.-1000.) GO TO 1570
384      WRITE (LU,1560) WTEMPC,WTEMPF
385 1560  FORMAT ('WET BULB TEMPERATURE = ',F4.1,' DEG. C',7X,'(',F4.1,
386          1' DEG. F)')
387 1570  WRITE (LU,1580) HUMDTY.PRESS2.PRESS1,(SOURCE(I),I=1,18),
388          1(DATE(I),I=1,5),(TIME(I),I=1,3),FF,FF
389 1580  FORMAT ('RELATIVE HUMIDITY      = ',F4.1,' %'/
390          1'BAROMETRIC PRESSURE = ',F6.1,' MILLIBARS ('
391          2F5.1,' MM HG)'/X/
392          2'SOUND SOURCE: ',18A4/X/'DATE: ',5A4/'TIME: ',5A4/A1/A1)
393      WRITE (5,1700)
394 1700  FORMAT ('DO YOU WANT ANOTHER PRINT OF THESE RESULTS?')
395      READ (5,20) QS
396      IF (QS.NE.'NO') GO TO 1000
397      WRITE (5,1710)
398 1710  FORMAT ('DO YOU WANT TO CORRECT ANY TYPING MISTAKES IN THE
399          1 PRINTOUT?')
400      READ (5,20) QS
401      IF (QS.NE.'NO') GO TO 730
402      WRITE (2) POWER
403      WRITE (5,1800)
404 1800  FORMAT ('DO YOU WANT TO CONDUCT ANOTHER SOUND POWER MEASUREMENT'/
405          1'USING THE SAME REVERBERATION TIME DATA AND THE SAME'/
406          2'SYSTEM GAIN SETTINGS?')
407      READ (5,20) QS
408      IF (QS.EQ.'NO') GO TO 1820
409      WRITE (5,1810)
410 1810  FORMAT ('DO YOU WANT TO USE THE SAME TEMPERATURE,HUMIDITY,'/
411          1'VANE SPFED. AND INTEGRATION TIME?')
412      READ (5,20) QS
413      IF (QS.EQ.'NO') GO TO 490
414      GO TO 545
415 1820  WRITE (5,1830)
416 1830  FORMAT (X/X/'END OF JOB')
417      END

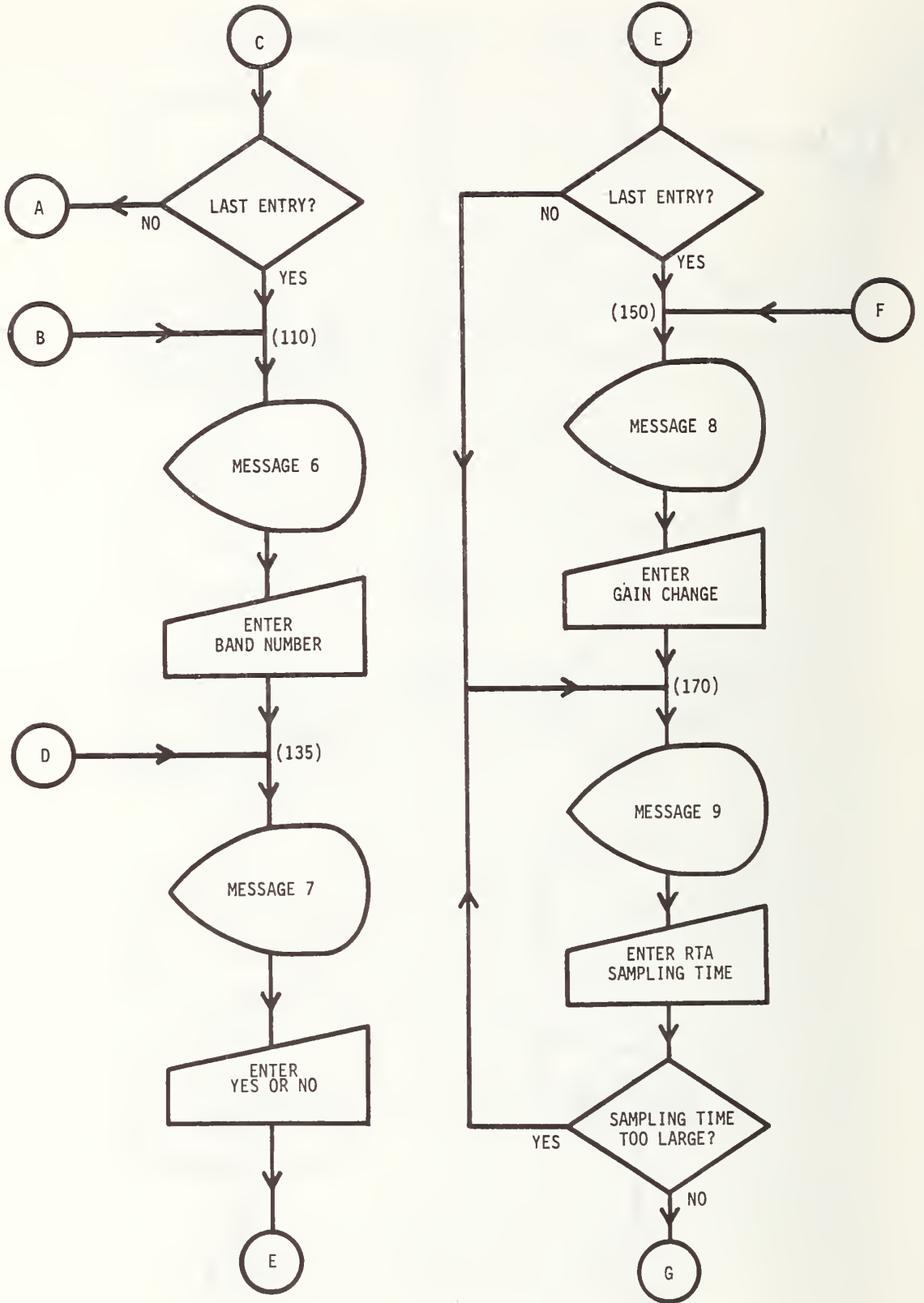
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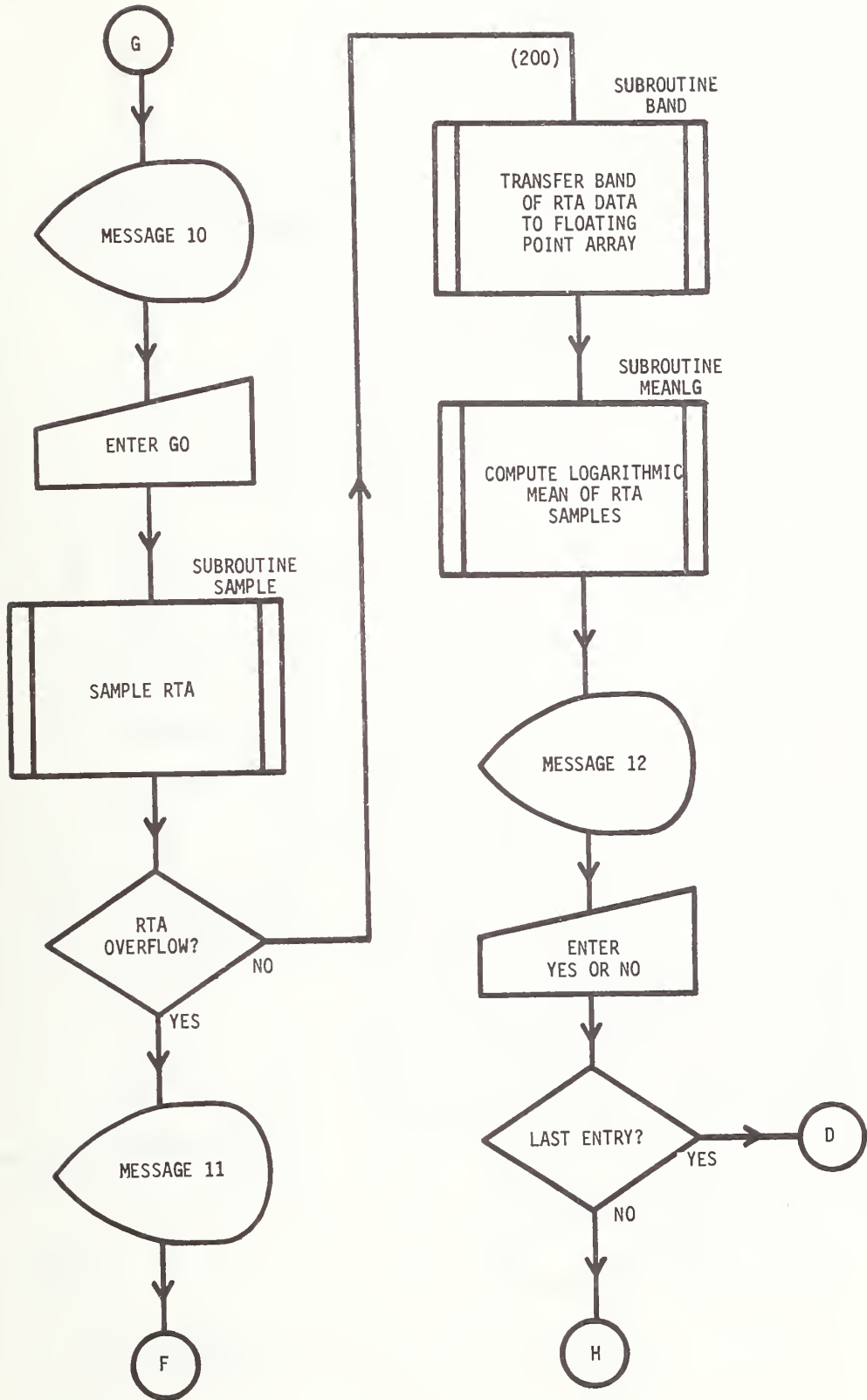
APPENDIX C

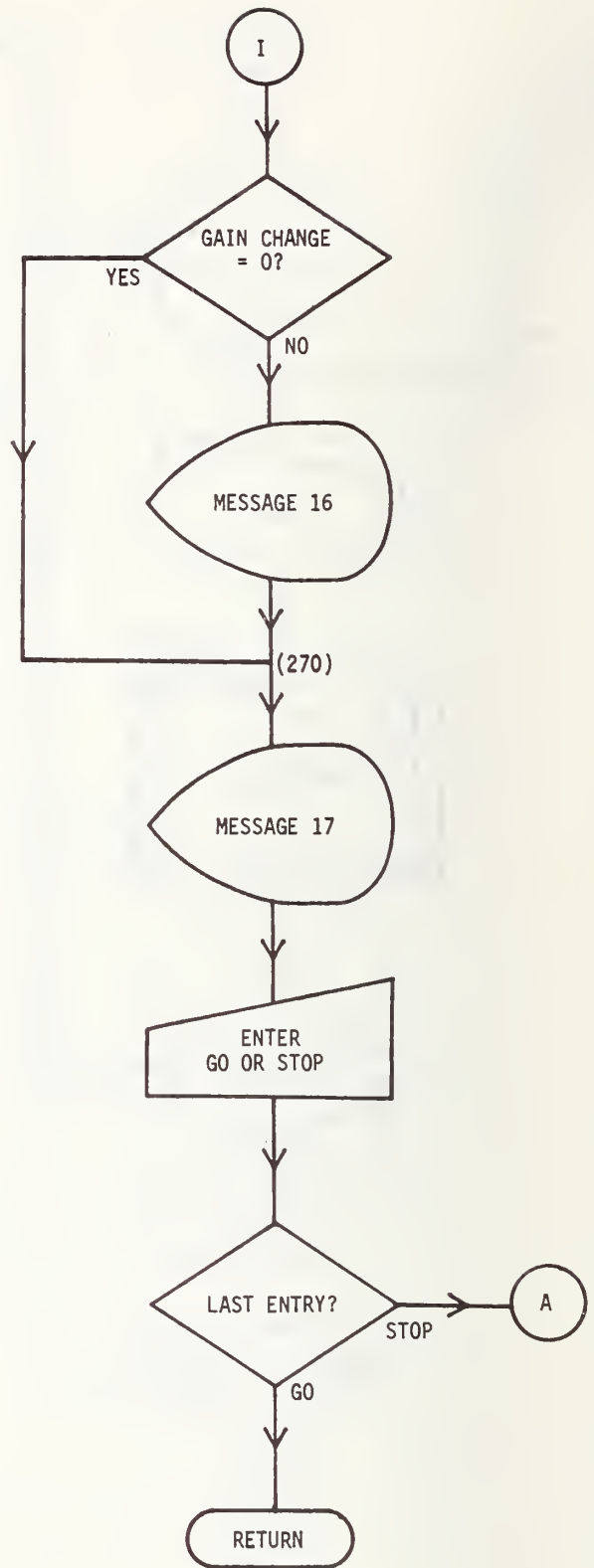
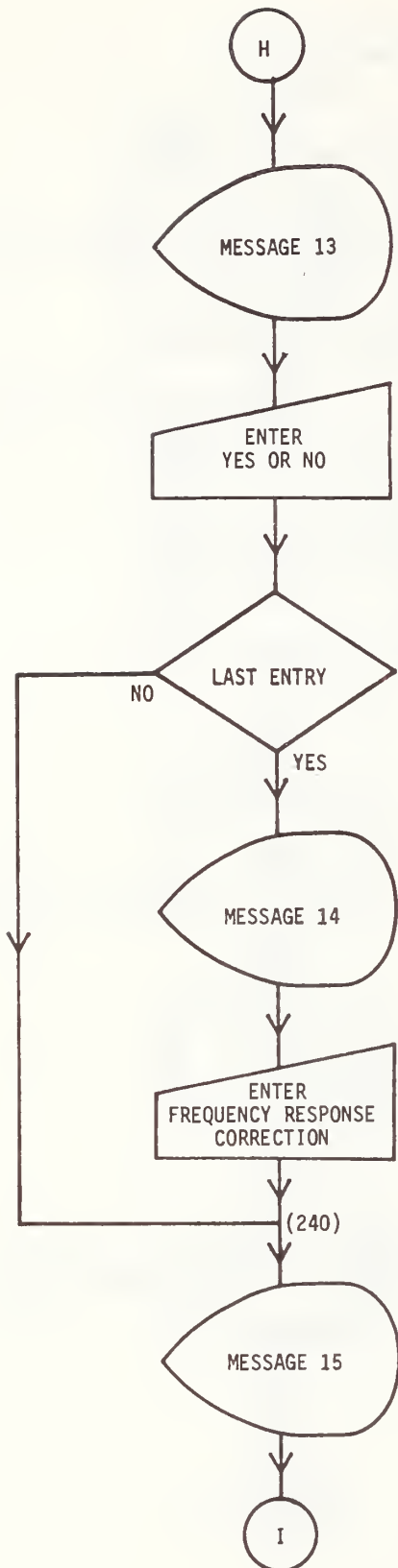
Flow Charts, Terminal Messages and Listings
for Subroutines SPLCAL, MEANLG, and MEANAR

FLOW CHART: SUBROUTINE SPLCAL









CRT TERMINAL MESSAGES: SUBROUTINE SPLCAL

MESSAGE NO.	FORMAT NO.	MESSAGE
1	10	<p>TO RELATE THE RTA DATA TO A KNOWN REFERENCE SIGNAL, TWO CALIBRATION OPTIONS ARE AVAILABLE:</p> <p>OPTION 1: USE AN ACOUSTIC CALIBRATING DEVICE AS A REFERENCE SOUND SOURCE</p> <p>OPTION 2: MEASURE THE RMS VOLTAGE OF A REFERENCE SIGNAL, AND COMPUTE THE SOUND PRESSURE LEVEL FROM THE SYSTEM SENSITIVITY</p> <p>DO YOU WANT TO USE OPTION 1?</p> <p>ENTER THE REFERENCE SOUND PRESSURE LEVEL IN DB (XXX.XX)</p> <p>APPLY CALIBRATION SIGNAL TO SYSTEM, AND MEASURE RMS VOLTAGE OF SIGNAL AT INPUT TO RTA MULTIFILTER</p> <p>ENTER RMS VALUE IN VOLTS (X.XXXXX)</p> <p>ENTER SYSTEM SENSITIVITY IN DB RE 1V/N/SQ. METER (-XX.XX)</p> <p>SOUND PRESSURE LEVEL CORRESPONDING TO CALIBRATION SIGNAL = 113.98 DB RE .00002 N/SQ. METER</p> <p>DO YOU WANT TO CONTINUE?</p>
2	30	<p>ENTER THE BAND NO. CORRESPONDING TO THE FREQ. OF THE CALIBRATION SIGNAL (IF BAND 14 IS USED TO SAMPLE UNFILTERED SIGNAL, ENTER "14")</p>
3	60	
4	80	
5	100	
6	120	

CRT TERMINAL MESSAGES: SUBROUTINE SPLCAL (page 2)

MESSAGE NO.	FORMAT NO.	MESSAGE
7	140	HAVE YOU MADE ANY CHANGE IN THE SYSTEM GAIN TO ACCOMMODATE THE CALIBRATION SIGNAL?
8	160	ENTER TOTAL AMOUNT OF GAIN CHANGE IN DB (MINUS = REDUCTION) (-XX.XXX)
9	175	ENTER TOTAL RTA SAMPLING TIME DESIRED FOR REFERENCE SIGNAL MEASUREMENT (IN SECONDS, 2 DIGITS, MAX = 50)
10	180	ENTER "GO" TO START SAMPLING
11	190	RE-ADJUST SYSTEM GAIN
12	210	AVERAGED RTA READING = 58.15 DB STANDARD DEVIATION = 0.13 DB
13	220	DO YOU WANT TO REPEAT THE RTA SAMPLING?
14	230	DO YOU WANT TO CORRECT FOR FREQUENCY RESPONSE? FROM SYSTEM FREQUENCY RESPONSE CALIBRATION DATA, DETERMINE RESPONSE (CALIBRATION FREQUENCY) - RESPONSE (1000 HZ)
15	250	ENTER THIS DIFFERENCE (-XX.XX) THE CORRECTION TO BE ADDED TO THE RTA READINGS = 35.85 DB REMOVE CALIBRATION SIGNAL
16	260	ADJUST SYSTEM GAIN BY -XX.XX DB (BACK TO ORIGINAL SETTING)
17	280	ENTER "GO" TO CONTINUE, OR "STOP" TO REPEAT CALIBRATION

SUBROUTINE SPLCAL

```
1 $ASSM
2 SPLCAL PROG SPLCAL - SUBROUTINE FOR RELATING RTA DATA TO SPL
3 $FORT
4 C
5 C -----
6 C THIS SUBROUTINE RELATES THE RTA DATA TO A REFERENCE SIGNAL
7 C OF KNOWN AMPLITUDE.
8 C
9 C FORTRAN CALL STATEMENT:
10 C -CALL SPLCAL (SPLCOR,NMAX,X,X0,NX0)
11 C
12 C SPLCOR (REAL) = CORRECTION TO BE ADDED TO SUBSEQUENT RTA DATA
13 C TO GET SPL
14 C NMAX (INT) = MAX. NO. OF RTA SAMPLES ALLOWED BY CALLING PROGRAM
15 C X (REAL) = ARRAY CONTAINING RTA FLOATING POINT DATA FOR 1 BAND
16 C X0 (INT*2) = ARRAY CONTAINING THE FIXED-POINT RTA DATA
17 C NX0 (INT) = NO. OF ELEMENTS IN THE ARRAY X0;
18 C SHOULD BE CHOSEN SO THAT NX0=(30*NSAMP)+60
19 C
20 C OTHER SUBROUTINES CALLED: SAMPLE,BAND,MEANLG
21 C -----
22 C SUBROUTINE SPLCAL(SPLCOR,NMAX,X,X0,NX0)
23 C DIMENSION X(NMAX)
24 C INTEGER*2 X0(NX0),TX100,OVFLOW,BANDNO
25 C REAL MEAN
26 5 WRITE (5,10)
27 10 FORMAT ('TO RELATE THE RTA DATA TO A KNOWN REFERENCE SIGNAL,/'
28 1' TWO CALIBRATION OPTIONS ARE AVAILABLE: '/X/
29 2' OPTION 1: USE AN ACOUSTIC CALIBRATING DEVICE AS A '/'
30 3' REFERENCE SOUND SOURCE' /X/
31 4' OPTION 2: MEASURE THE RMS VOLTAGE OF A REFERENCE SIGNAL, AND '/'
32 5' COMPUTE THE SOUND PRESSURE LEVEL FROM THE '/'
33 6' SYSTEM SENSITIVITY' /X/
34 7' DO YOU WANT TO USE OPTION 1?')
35 20 READ (5,20) GS
36 20 FORMAT (A4)
37 IF (GS.EQ.'NO') GO TO 50
38 30 WRITE (5,30)
39 30 FORMAT ('ENTER THE REFERENCE SOUND PRESSURE LEVEL
40 1 IN DB (XXX.XX)')
41 40 READ (5,40) SPL
42 40 FORMAT (F6.2)
43 GO TO 110
44 50 WRITE (5,60)
45 60 FORMAT ('APPLY CALIBRATION SIGNAL TO SYSTEM, AND MEASURE RMS
46 1 VOLTAGE'/' OF SIGNAL AT INPUT TO RTA MULTIFILTER' /X/
47 2' ENTER RMS VALUE IN VOLTS (X.XXXXX)')
48 70 READ (5,70) VRMS
49 70 FORMAT (F7.5)
50 WRITE (5,80)
51 80 FORMAT ('ENTER SYSTEM SENSITIVITY IN DB RE 1V/N/SQ. METER
52 1 (-XX.XX)')
53 90 READ (5,90) SENS
54 90 FORMAT (F6.2)
55 SPL=20*ALOG10(VRMS/.00002)-SENS
56 100 WRITE (5,100) SPL
57 100 FORMAT ('SOUND PRESSURE LEVEL CORRESPONDING TO CALIBRATION
58 1 SIGNAL'/' = ' .F7.2.' DB RE .00002 N/SQ. METER' /X/
59 2' DO YOU WANT TO CONTINUE?')
60 20 READ (5,20) GS
61 IF (GS.EQ.'NO') GO TO 5
```

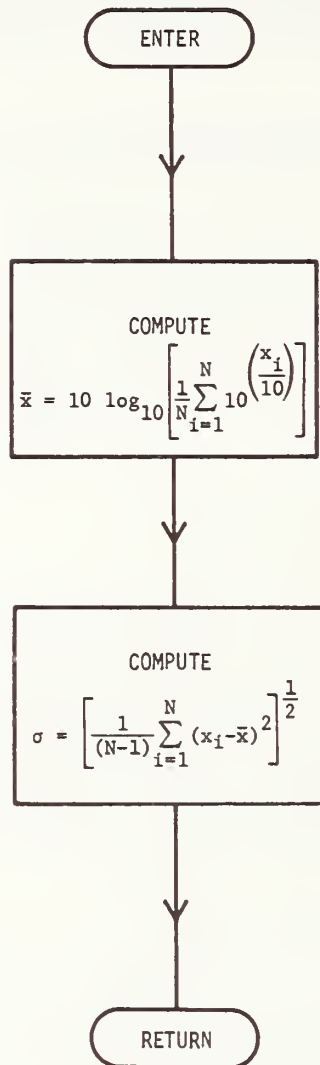
SPLCAL-2

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61 110 WRITE (5,120)
62 120 FORMAT ('ENTER THE BAND NO. CORRESPONDING TO THE FREQ.
63 1 OF THE CALIBRATION SIGNAL' /
64 2 '(IF BAND 14 IS USED TO SAMPLE UNFILTERED SIGNAL, ENTER "14")')
65 READ (5,130) BANDNO
66 130 FORMAT (I2)
67 135 WRITE (5,140)
68 140 FORMAT ('HAVE YOU MADE ANY CHANGE IN THE SYSTEM GAIN TO
69 1 ACCOMMODATE' / 'THE CALIBRATION SIGNAL?')
70 READ (5,20) GS
71 DGAIN=0.
72 IF (GS.EQ.'NO') GO TO 170
73 150 WRITE (5,160)
74 160 FORMAT ('ENTER TOTAL AMOUNT OF GAIN CHANGE IN DB
75 1 (MINUS = REDUCTION)' / '(-XX.XXX)')
76 READ (5,90) DGAIN
77 170 WRITE (5,175) NMAX
78 175 FORMAT ('ENTER TOTAL RTA SAMPLING TIME DESIRED FOR
79 1 REFERENCE SIGNAL MEASUREMENT' /
80 2 '(IN SECONDS, 2 DIGITS, MAX = ',I2,')')
81 READ (5,130) NSAMP
82 IF (NSAMP.GT.NMAX) GO TO 170
83 WRITE (5,180)
84 180 FORMAT ('ENTER "GO" TO START SAMPLING')
85 READ (5,20) GS
86 TX100=100
87 CALL SAMPLE(0,NSAMP,TX100,OVFLOW,X0,NX0)
88 IF (OVFLOW.EQ.0) GO TO 200
89 WRITE (5,190)
90 190 FORMAT ('READJUST SYSTEM GAIN')
91 GO TO 150
92 200 CALL BAND(BANDNO,NSAMP,X,X0,NX0)
93 CALL MEANLG(NSAMP,X,MEAN,STDEV)
94 WRITE (5,210) MEAN,STDEV
95 210 FORMAT ('AVERAGE RTA READING = ',F6.2,' DB' /
96 1 'STANDARD DEVIATION = ',F6.2,' DB' / X /
97 2 'DO YOU WANT TO REPEAT THE RTA SAMPLING?')
98 READ (5,20) GS
99 IF (GS.NE.'NO') GO TO 135
100 FREQOR=0.
101 WRITE (5,220)
102 220 FORMAT ('DO YOU WANT TO CORRECT FOR FREQUENCY RESPONSE?')
103 READ (5,20) GS
104 IF (GS.EQ.'NO') GO TO 240
105 WRITE (5,230)
106 230 FORMAT ('FROM SYSTEM FREQUENCY RESPONSE CALIBRATION DATA,
107 1 DETERMINE' /
108 2 'RESPONSE (CALIBRATION FREQUENCY) - RESPONSE (1000 HZ)' / X /
109 3 'ENTER THIS DIFFERENCE (-XX.XX)')
110 READ (5,90) FREQOR
111 240 SPLCOR=SPL-MEAN+FREQOR+DGAIN
112 WRITE (5,250) SPLCOR
113 250 FORMAT ('THE CORRECTION TO BE ADDED TO THE RTA READINGS = ',
114 1 'F7.2,' DB' / X / 'REMOVE CALIBRATION SIGNAL')
115 IF (DGAIN.EQ.0.) GO TO 270
116 DGAIN=-1.*DGAIN
117 WRITE (5,260) DGAIN
118 260 FORMAT ('ADJUST SYSTEM GAIN BY ',F6.2,' DB (BACK TO
119 1 ORIGINAL SETTING)')
120 270 WRITE (5,280)
```

SPLCAL-3

```
121 200  FORMAT ('ENTER "GO" TO CONTINUE, OR "STOP" TO REPEAT  
122      1 CALIBRATION')  
123      READ (5,20) GS  
124      IF (GS.EQ.'STOP') GO TO 5  
125      RETURN  
126      END
```

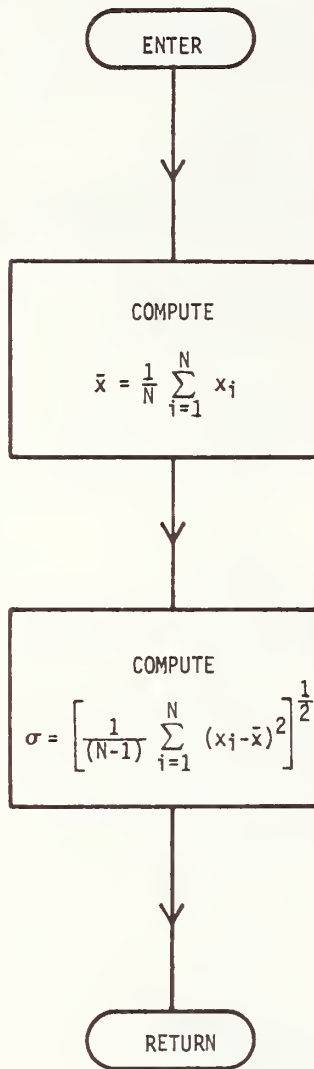
FLOW CHART: SUBROUTINE MEANLG



SUBROUTINE MEANLG

```
1 $ASSM
2 MEANLG PROG MEANLG - SUBROUTINE FOR FINDING LOGARITHMIC MEAN AND STD
3 $FORT
4 C -----
5 C THIS SUBROUTINE COMPUTES THE LOGARITHMIC MEAN AND
6 C STANDARD DEVIATION OF A NUMBER OF SAMPLES
7 C FORTRAN CALL STATEMENT:
8 C -CALL MEANLG (N,X,MEAN,STDEV)
9 C N (INT) = NUMBER OF SAMPLES
10 C X (REAL) = ARRAY OF SAMPLES
11 C MEAN (REAL) = MEAN VALUE OF THE SAMPLES
12 C STDEV (REAL) = STANDARD DEVIATION OF THE SAMPLES
13 C
14 C NO OTHER SUBROUTINES CALLED
15 C -----
16 C SUBROUTINE MEANLG(N,X,MEAN,STDEV)
17 C DIMENSION X(N)
18 C REAL MEAN
19 C C=0.
20 C DO 10 I=1,N
21 C C=C+10.***(X(I)/10.)
22 10 CONTINUE
23 C C=C/N
24 C MEAN=10.*ALOG10(C)
25 C C=0.
26 C DO 20 I=1,N
27 C C=C+(X(I)-MEAN)*(X(I)-MEAN)
28 20 CONTINUE
29 C IF (N.EQ.1) GO TO 30
30 C C=C/(N-1)
31 30 STDEV=SQRT(C)
32 C RETURN
33 C END
```

FLOW CHART: SUBROUTINE MEANAR



SUBROUTINE MEANAR

```
1 $ASSM
2 MEANAR PROG MEANAR - SUBROUTINE FOR FINDING ARITHMETIC MEAN AND STD
3 $FORT
4 C -----
5 C THIS SUBROUTINE COMPUTES THE ARITHMETIC MEAN AND
6 C STANDARD DEVIATION OF A NUMBER OF SAMPLES
7 C FORTRAN CALL STATEMENT:
8 C -CALL MEANAR (N,X,MEAN,STDEV)
9 C N (INT) = NUMBER OF SAMPLES
10 C X (REAL) = ARRAY OF SAMPLES
11 C MEAN (REAL) = MEAN VALUE OF THE SAMPLES
12 C STDEV (REAL) = STANDARD DEVIATION OF THE SAMPLES
13 C
14 C NO OTHER SUBROUTINES CALLED
15 C -----
16 SUBROUTINE MEANAR(N,X,MEAN,STDEV)
17 DIMENSION X(N)
18 REAL MEAN
19 C=0.
20 DO 10 I=1,N
21 C=C+X(I)
22 10 CONTINUE
23 MEAN=C/N
24 C=0.
25 DO 20 I=1,N
26 C=C+(X(I)-MEAN)*(X(I)-MEAN)
27 20 CONTINUE
28 IF (N.EQ.1) GO TO 30
29 C=C/(N-1)
30 30 STDEV=SQRT(C)
31 RETURN
32 END
```



FEDERAL INFORMATION PROCESSING STANDARD SOFTWARE SUMMARY

01. Summary data Yr. Mo. Day 7 7 10 2 8			02. Summary prepared by (Name and Phone) Thomas W. Bartel (301) 921-3783			03. Summary action New Replacament Deletion <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Previous Internal Software ID		
04. Software data Yr. Mo. Day 7 6 1 2 3 0			05. Software title Interactive Program for the Determination of Sound Power			07. Internal Software ID None		
06. Short title SPOWER			08. Software type <input type="checkbox"/> Automated Data System <input checked="" type="checkbox"/> Computer Program <input type="checkbox"/> Subroutine/Module			09. Processing mode <input checked="" type="checkbox"/> Interactive <input type="checkbox"/> Batch <input type="checkbox"/> Combination		
			10. <u>General</u> <input type="checkbox"/> Computer Systems Support/Utility <input checked="" type="checkbox"/> Scientific/Engineering <input type="checkbox"/> Bibliographic/Taxtual			Application area <u>Specific</u> Acoustics; reverberation room measurements		
11. Submitting organization and address Institute for Basic Standards National Bureau of Standards Washington, D.C. 20234					12. Technical contact(s) and phone Thomas W. Bartel (301) 921-3783			
13. Narrative The program is used to measure the acoustic sound power output of a source in a reverberation room according to ANSI S1.21-1972, American National Standard Methods for the Determination of Sound Power Levels of Small Sources in Reverberation Rooms. The computer controls elements of the instrumentation system through a special interface, acquires the digitized sound pressure levels of the reverberant sound field, and computes the sound power levels. Transmission of data to and from the instrumentation system is handled through separate subroutines written in the computer's assembly language.								
14. Keywords Acoustics; computer-controlled instrumentation system; real-time analyzer; reverberation room; sound power.								
15. Computer manuf'r and model Interdata Model 70			16. Computer operating system RTOS			17. Programing language(s) Fortran V, Level 1 Interdata Assembly lang.		18. Number of source program statements 1058
19. Computer memory requirements 37,066 8-bit bytes			20. Tape drives None		21. Disk/Drum units One/2.5 megabyte unit		22. Terminals One	
23. Other operational requirements 132-character line printer real-time analyzer, microphone multiplexer interfaced to computer								
24. Software availability Available <input checked="" type="checkbox"/> Limited <input type="checkbox"/> In-house only <input type="checkbox"/> Paper or mag tape					25. Documentation availability Available <input checked="" type="checkbox"/> Inadequate <input type="checkbox"/> In-house only <input type="checkbox"/> Internal report			
26. FOR SUBMITTING ORGANIZATION USE								

INSTRUCTIONS

01. **Summary Date.** Enter date summary prepared. Use Year, Month, Day format: YYMMDD.
02. **Summary Prepared By.** Enter name and phone number (including area code) of individual who prepared this summary.
03. **Summary Action.** Mark the appropriate box for new summary, replacement summary or deletion of summary. If this software summary is a replacement, enter under "Previous Internal Software ID" the internal software identification as reported in item 07 of the original summary, and enter the new internal software identification in item 07 of this form; complete all other items as for a new summary. If a software summary is to be deleted, enter under "Previous Internal Software ID" the internal software identification as reported in item 07 of the original summary; complete only items 01, 02, 03 and 11 on this form.
04. **Software Date.** Enter date software was completed or last updated. Use Year, Month, Day format: YYMMDD.
05. **Software Title.** Make title as descriptive as possible.
06. **Short Title. (Optional)** Enter commonly used abbreviation or acronym which identifies the software.
07. **Internal Software ID.** Enter a unique identification number or code.
08. **Software Type.** Mark the appropriate box for an Automated Data System (set of computer programs), Computer Program, or Subroutine/Module, whichever best describes the software.
09. **Processing Mode.** Mark the appropriate box for an interactive, Batch, or Combination mode, whichever best describes the software.
10. **Application Area.**
General: Mark the appropriate box which best describes the general area of application from among:

Computer Systems Support/Utility Management/Business Scientific/Engineering	Process Control Bibliographic/Textual Other
---	---

Specific: Specify the sub-area of application; e.g.: "COBOL optimizer" if the general area is "Computer Systems Support/Utility"; "Payroll" if the general area is "Management/Business"; etc. Elaborate here if the general area is "Other."
11. **Submitting Organization and Address.** Identify the organization responsible for the software as completely as possible, to the Branch or Division level, but including Agency, Department (Bureau/Administration), Service, Corporation, Commission, or Council. Fill in complete mailing address, including mail code, street address, city, state, and ZIP code.
12. **Technical Contact(s) and Phone:** Enter person(s) or office(s) to be contacted for technical information on subject matter and/or operational aspects of software. Include telephone area code. Provide organization name and mailing address, if different from that in item 11.
13. **Narrative.** Describe concisely the problem addressed and methods of solution. Include significant factors such as special operating system modifications, security concerns, relationships to other software, input and output media, virtual memory requirements, and unique hardware features. Cite references, if appropriate.
14. **Keywords.** List significant words or phrases which reflect the functions, applications and features of the software. Separate entries with semicolons.
15. **Computer Manufacturer and Model.** Identify mainframe computer(s) on which software is operational.
16. **Computer Operating System.** Enter name, number, and release under which software is operating. Identify enhancements in the Narrative (item 13).
17. **Programming Language(s).** Identify the language(s) in which the software is written, including version; e.g., ANSI COBOL, FORTRAN V, SIMSCRIPT II.5, SLEUTH II.
18. **Number of Source Program Statements.** Include statements in this software, separate macros, called subroutines, etc.
19. **Computer Memory Requirements.** Enter minimum internal memory necessary to execute software, exclusive of memory required for the operating system. Specify words, bytes, characters, etc., and number of bits per unit. Identify virtual memory requirements in the Narrative (item 13).
20. **Tape Drives.** Identify number needed to operate software. Specify, if critical, manufacturer, model, tracks, recording density, etc.
21. **Disk/Drum Units.** Identify number and size (in same units as "Memory"—item 19) needed to operate software. Specify, if critical, manufacturer, model, etc.
22. **Terminals.** Identify number of terminals required. Specify, if critical, type, speed, character set, screen/line size, etc.
23. **Other Operational Requirements.** Identify peripheral devices, support software, or related equipment not indicated above, e.g., optical character devices, facsimile, computer-output microfilm, graphic plotters.
24. **Software Availability.** Mark the appropriate box which best describes the software availability from among: Available to the Public, Limited Availability (e.g.: for government use only), and For In-house Use Only. If the software is "Available", include a mail or phone contact point, as well as the price and form in which the software is available, if possible.
25. **Documentation Availability.** Mark the appropriate box which best describes the documentation availability from among: Available to the Public, Inadequate for Distribution, and For In-house Use Only. If documentation is "Available", include a mail or phone contact point, as well as the price and form in which the documentation is available, if possible. If documentation is presently "Inadequate", show the expected availability date.
26. **For Submitting Organization Use.** This area is provided for the use of the organization submitting this summary. It may contain any information deemed useful for internal operation.

U.S. DEPT. OF COMM BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBSIR 77-1384	2. Gov't Accession No.	3. Recipient's Accession No.
4. TITLE AND SUBTITLE Interactive Computer Program for the Determination of Sound Power		5. Publication Date December 1977	6. Performing Organization Code 200.03
		7. AUTHOR(S) Thomas W. Bartel	
9. PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234		10. Project/Task/Work Unit No. 2003116	11. Contract/Grant No.
		12. Sponsoring Organization Name and Complete Address (Street, City, State, ZIP) Same	
15. SUPPLEMENTARY NOTES			
16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.) A description of the computer program used to measure the sound power output of a sound source in a reverberation room is presented. The program controls the operation of a real-time analyzer and a microphone multiplexer. The sound power is computed according to ANSI S1.21. The program is written in FORTRAN V and requires approximately 37,000 eight-bit bytes of core memory. Flow charts, source listings, and sample printouts are included.			
17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons) Automated data acquisition; computer; reverberation room, software; sound power.			
18. AVAILABILITY <input checked="" type="checkbox"/> Unlimited <input type="checkbox"/> For Official Distribution. Do Not Release to NTIS <input type="checkbox"/> Order From Sup. of Doc., U.S. Government Printing Office Washington, D.C. 20402, SD Cat. No. C13 <input checked="" type="checkbox"/> Order From National Technical Information Service (NTIS) Springfield, Virginia 22151		19. SECURITY CLASS (THIS REPORT) UNCLASSIFIED	21. NO. OF PAGES 63
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