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REPORT

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WYLE RESEARCH REPORT

WCR 75-16

RAILROAD NOISE ANALYSIS

Prepared For

A. Konheim
U.S. Environmental Protection Agency
Office of Noise Abatement and Control
Crystal Mall, Building #2
Washington, D.C. 20460

Prepared By

R. Brown

Wyle Research
128 Maryland Street
El Segundo, California 90245

November 25, 1975

REPORT

1.0 INTRODUCTION

A group of 11 tapes (furnished by EPA) of recorded railroad noise was analyzed to determine the effect of varying the following analysis parameters.

- time constant
- sampling rate
- starting time interval
- data sample
- weighting network

The following report contains descriptions of the analyses performed and tables of the results. Detailed printouts of each statistical distribution can be supplied if desired.

It must be emphasized that the statistical values computed and listed in this report are not necessary the exact values for the sites measured. Differences in frequency response between the field recorder and the analysis recorder were not accounted for, and, in some cases, a field calibration record was not available. However, the accuracy of comparisons between values listed in individual tables using different analysis methods is very good.

2.0 ANALYSIS EQUIPMENT

All but a small quantity of the data were played back on a Nagra IV-SJ tape recorder at twice the original recording speed. The two-track playback recorder was compatible with the recorders used for data acquisition but differences in high frequency response could not be accounted for. Specific analyses were also performed with the data played back at the original recording speed using the Nagra and also an Ampex AG500 reproducer. Frequency weighting of the data played back at twice the speed was provided by a B&K model 123 Spectrum Shaper, and this A-weighted data was then processed through a B&K 3347 Real-Time Analyzer (RTA) interfaced to a DEC PDP-8 computer. Appropriate adjustments of the instrumentation controls and the computer program provided the variations required for the various analyses. A list of the pertinent specifications of the RTA is shown in Table 1.

Table 1

Specifications of the Real Time Analyzer Variables

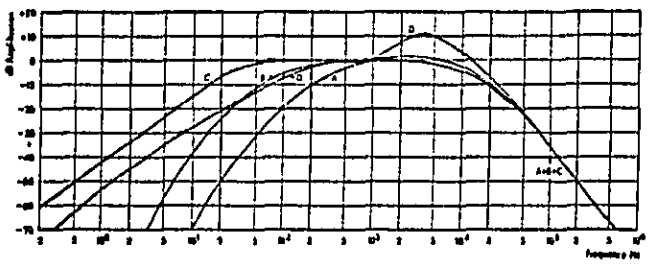
Weighting Networks

(see figure below)

A, B, and C – to IEC 179 – 1965

D – to proposal for measurement of jet engine noise

Linear – 22.4 Hz to 22.4 kHz



Time Constants*

Sine – 70 msec. (rise curve 35 msec.), to approximate IEC 179 and DIN 45633 "Impulse" response.

Fast Random – 240 msec., to IEC 179 "RMS Fast".

Slow Random – 1.5 sec., to IEC 179 "RMS Slow".

*Since most of the tapes were played back at twice the original recording speed, when the Sine time constant on the RTA was selected, the resulting "real time" constant was 140 msec.

3.0 DATA RESULTS

Table 2 lists the tapes analyzed and the instrumentation settings used. These data are listed for reference purposes to assure reproducibility of results if additional analysis is required. The following sections contain a discussion of each analysis performed and the tabulated data are contained in the appendices.

3.1 Time Constant Analysis

One section of a yard tape and two passby events on a right-of-way were analyzed using the three different time constants (i.e., 70 msec to 1.5 sec). The only significant differences occurred in computations of the L_1 and $L_{0.1}$ values. All other values increased or decreased by insignificant amounts when comparing values obtained using different time constants. The analysis of the yard tape was also performed at a very slow sampling rate with the difference occurring only in relation to the tape starting time and not to the variation in time constant.

3.2 Sampling Rate Analysis

When the data analysis first began, it was necessary to play the tape back once for each sampling rate. A 20-minute sample of Tape Y-5 #9 was analyzed at seven different sampling rates from 50 samples per second (SPS) to 0.016 SPS (one sample every 63 seconds). Figure 1 is a plot of the variations found in the statistical levels for this analysis. It was later shown that the variations at low sampling rates (less than 0.5 SPS) are extremely sensitive to small changes in the tape starting time (see Section 3.5) and are completely unpredictable.

Table 2

Control Settings for Railroad Noise Data Reduction Equipment

Tape Number	Channel Reduced	Attenuation Setting (NAGRA)	Input Section Attenuator (RTA)	Gain Control (RTA)	Digital Reference Adjust (RTA)	Resultant Noise Window, dB	Tape Recording Speed, ips	Comments
Y-4 #9	2	+20	0.1 V	3.0	10	40-90	7-1/2	
Y-4 #17	2	+10	0.1 V	3.1	0	30-80	7-1/2	Calibration tone not at immediate beginning of tape.
Y-5 #4	2	+20	0.1 V	6.0	10	40-90	7-1/2	No calibration tone on tape; Y-5 #9 calibration used.
Y-5 #9	2	+20	0.1 V	6.0	10	40-90	7-1/2	
Y-13 #8	2	+30	0.1 V	2.8	20	50-100	7-1/2	
Y-13 #9	2	+30	0.1 V	2.8	20	50-100	7-1/2	Calibration tone at end of tape; ≈44 minute sample.
Y-14 #4	1	0	30 mV	1.0	40	60-110	7-1/2	Channel 2 overdriven and distorted.
Y-14 #9	1	0	30 mV	1.0	40	60-110	7-1/2	Channel 2 overdriven and distorted.
Bloomfield #2	1	0	0.1 V	8.2	20	50-100	3-3/4	80 minute sample.
Bloomfield #4	1	0	30 mV	1.0	30	50-100	3-3/4	80 minute sample.
R-7 #12	2	+30	30 mV	2.5	30	50-100	7-1/2	43 minutes of data; 3 events marked on tape: 1) Not Used. 2) Longest 3) Reduced First

(Nagra IV-SJ Recorder #47 Used)

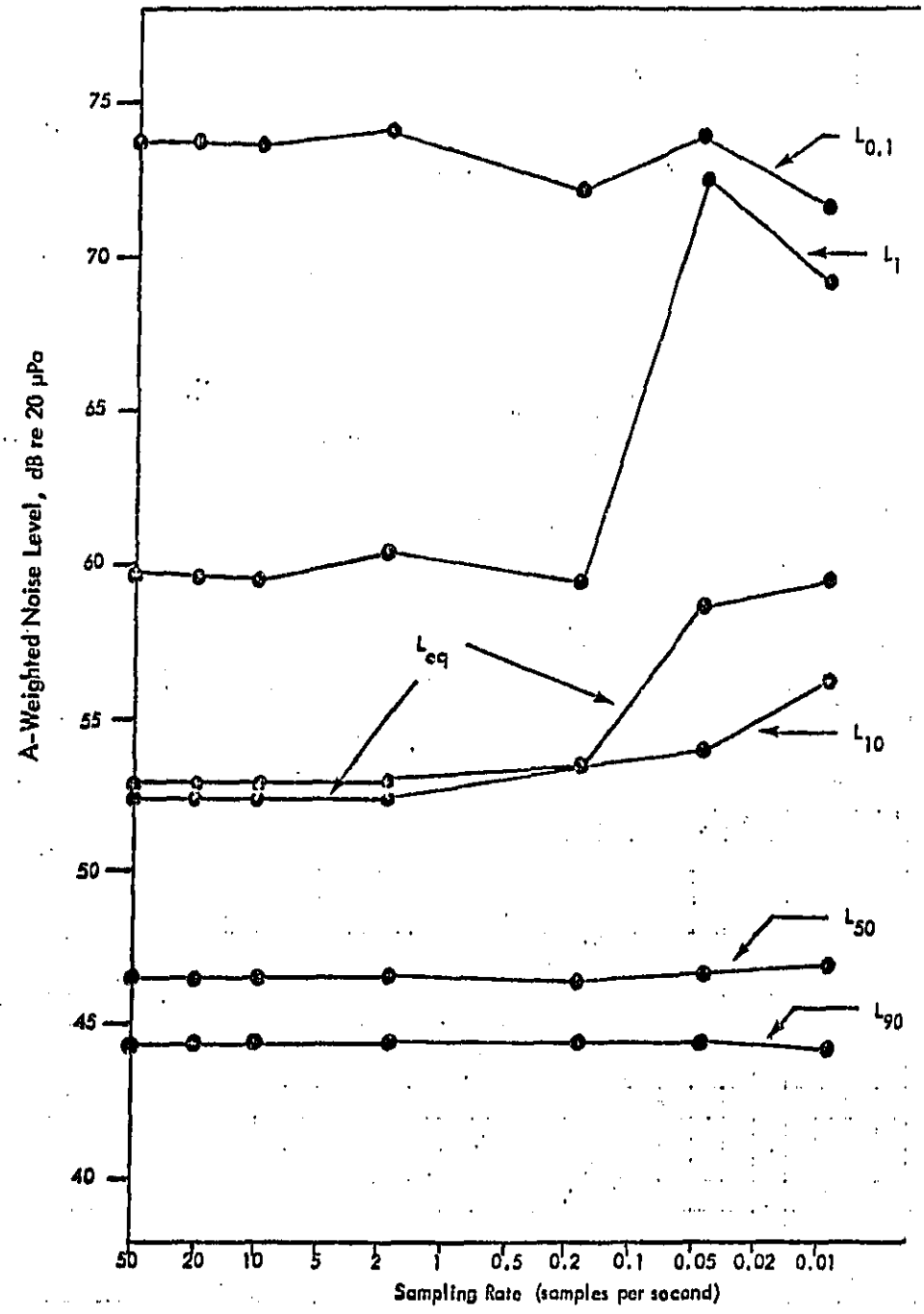


Figure 1. Variations of Statistical Levels With Sampling Rate. (Tape Y-5 #9 - 20 min. sample, individual runs)

All tapes were then analyzed at a sampling rate of 20 SPS and 0.05 SPS and selected tapes were run with a sampling rate of 1 SPS. In Appendix B, the data for these individual runs are marked with an asterisk.

The computer program was later modified to allow five sets of statistical levels to be stored during a single tape run. We were thus able to analyze the data at five different rates (all multiples of the fastest rate) simultaneously, using precisely the same starting time. The fastest rate of 10 SPS was chosen with each slower rate differing by a factor of five. All tapes were thus analyzed at rates of 10, 2, 0.4, 0.08, and 0.016 SPS with a single playback of each tape. Comparisons of the statistical level values from each of these runs yield the most accurate results, whereas comparisons between the individual runs should only be made with realization of possible small errors present due to lack of reproducibility between subsequent runs.

3.3 Cumulative Interval Analysis

The program involved an analysis of all tapes with cumulative printouts of the statistical levels every five minutes at several different sampling rates. As a result of the significant sensitivity due to variations in starting time, it was decided to perform the cumulative interval analysis only at a fast sampling rate (e.g., 20 SPS). The starting time analysis showed that large variations in the statistical levels occur with very small changes in tape starting time when slow sampling rates are employed. Thus, it was felt that the present data should be examined in detail before additional analyses are performed.

All tapes were analyzed at a sampling rate of 20 SPS and after each 5-minute interval, a printout of the statistical levels for the total accumulated time was produced. The tables in Appendix C contain the results of these analyses. The column labeled "number of samples" indicates the quantity of individual data samples included in each computation.

3.4 Starting Time Analysis

Appendix D contains an early analysis of two tapes, examining the effect of large delays in the tape starting time. As expected, the variations in statistical levels depend primarily on the long-term noise level fluctuations. The 20-minute segment of Tape Y-5 #9 was also analyzed at a sampling rate of 0.05 SPS with and without a delay of 10 seconds in starting time. This resulted in very large differences in the L_1 and L_{eq} due to this small change in starting time.

3.5 Starting Time Analysis/Sampling Rate Change

The 20-minute segment of Tape Y-5 #9 was run four times to determine the effect of very small changes in the tape starting time. Each run was analyzed at five different sampling rates – 20, 4, 0.8, 0.16, and 0.032 SPS. The starting time of each run was delayed by 1 second from the previous run. The first significant changes in the statistical levels are apparent at sampling rates of 0.8 SPS and at slower rates. At the low sampling rates, the variations are quite large and illustrate the major fluctuations which would occur due to the starting time changes if the sampling rate is low. This analysis illustrated the need for additional examination of the results before the cumulative interval analysis was performed at low sampling rates.

3.6 Weighting Network Analysis

Three samples of data, a 45-minute yard tape and two train passbys were analyzed with different frequency weighting applied. Appendix F shows the results of these analyses. The data results were obtained by playing the tapes at original

speed using the frequency weighting of a B&K 2204 sound level meter. The results have the approximate variations as expected. Taking the A-weighted statistical levels as a reference, the average difference (Avg) between A-weighted level and other weightings, and the standard deviation (S.D.) of the difference is as follows:

Tape		A – D	A – C	A – Linear
Y-5 #9	Avg, dB	7.7	15.1	16.6
	S.D., dB	1.3	3.8	2.7
R-7 #12	Avg, dB	6.0	6.7	-
(1.2 min)	S.D., dB	0.8	3.8	-
R-7 #12	Avg, dB	6.4	10.0	-
(2.5 min)	S.D., dB	0.3	0.4	-

4.0 CONCLUSIONS

A few unexpected results were obtained during this analysis. The most important result was the large random variations which resulted from very small changes in the tape starting time. This result is illustrated in the tabulated data of Appendix E where large differences in $L_{0.1}$ begin to occur at a sampling rate of 0.8 SPS and L_1 begins to be affected at a sampling rate of 0.16 SPS. These large variations begin at faster sampling rates than originally expected.

The data tabulated in Appendix E was also rearranged and tabulated in Appendix B to illustrate the changes in L-levels for various sampling rates with identical starting times. It is interesting to note the random fluctuations (positive and negative) in the L-levels at the lowest sampling rates. It was assumed earlier that the L-levels would only decrease from the true value determined at a fast sampling rate, but positive changes in level are also possible. The only L-level which appears to be unaffected by changes in sampling rate is the L_{90}.

Due to the fluctuating nature of the L-level changes at slow sampling rates, the cumulative interval analysis was performed only at the fastest rate. It may be desirable to examine the current results in detail and perform an analysis of this parameter at a future time.

One analysis which resulted in virtually no change in L-levels was the variations due to changes in time constant (data in Appendix A).

These conclusions are based upon a cursory evaluation of the detailed data reduction for the specific data supplied and should not be utilized for final judgments regarding analysis methods on all types of community noise data or on other railroad noise data. Nevertheless, based only on the results of this limited evaluation, one

could tentatively recommend the following for analysis of railroad noise levels.

- Time Constant – Use of "fast random" is preferred.
- Sample Rate – For accurate measurement of statistical levels up to L_{10}, sampling rates equal or faster than 2 SPS appear adequate. For accurate measurement of statistical levels up to $L_{0.1}$, sampling rates equal to or faster than 10 SPS appear to be required.
- Starting Time – For sampling rates equal to or slower than 0.8 SPS, statistical levels of a 20 minute sample were sensitive to changes in starting time of 1 sec. Further study is needed to fully evaluate the tradeoff between sample length, sampling rate, and starting time.
- Weighting Network – A- or D-weighted levels seem to show the most consistent statistical levels. C- or Linear-weighted levels vary, relative to A levels considerably more at various statistical levels. A-weighting is recommended for train noises until such time as subjective data are available to confirm a more accurate prediction of annoyance for train noises.

ANALYSIS CATEGORY

A

(Time Constant Analysis)

Time Constant Analysis

Sampling Rate 20 Samples/Second Weighting A

Tape #	Sample Length	Time Constant	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y-549	20min	70 msec	23876	42.6	44.8	50.7	57.6	71.5	50.6
"	"	240msec	23886	42.7	44.8	50.7	57.8	71.8	50.6
"	".	1.5sec	23882	43.0	45.0	51.0	61.0	70.3	50.6
R-7#12	1.2 min	70 msec	1387	62.3	80.0	84.3	87.9	89.0	81.5
"	"	240msec	1386	62.2	79.7	84.1	87.6	88.9	81.3
"	"	1.5sec	1389	61.8	80.1	84.0	87.5	89.0	81.4
R-7#12	2.5min	70msec	3022	68.3	72.2	78.9	86.5	87.9	76.6
"	"	240msec	3025	68.3	72.2	78.5	86.4	87.0	76.6
"	"	1.5sec	3022	68.4	72.4	78.8	86.5	87.9	76.7

Time Constant Analysis

Sampling Rate .05 Samples/Second Weighting A

Tape #	Sample Length	Time Constant	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y-S#9	20 min	70 msec	63	43.1	44.8	51.2	54.4	54.9	47.5
"	"	240 msec	63	42.7	44.5	50.5	54.1	54.9	47.3
"	"	1.5 sec	63	42.9	44.7	51.1	54.7	54.9	47.7

ANALYSIS CATEGORY

B

(Sampling Rate Analysis)

Sampling Rate Analysis

Tape Number Y-4 #9 Time Constant 140 ms Tape Duration 45 min. Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	53336	41.4	43.2	47.8	60.0	80.0	53.6
	10 sps	26902	42.3	44.0	48.4	61.1	80.2	56.9
	2 sps	5380	42.3	44.0	45.5	59.4	79.4	56.1
*	1 sps	2692	41.4	43.2	47.7	62.1	79.8	56.6
	0.4 sps	1075	42.3	44.0	48.4	58.7	79.9	57.0
	0.0Psps	215	42.4	44.1	48.7	69.9	75.9	56.3
*	0.05 sps	142	41.2	42.9	47.3	53.6	55.8	45.4
	0.016 sps	43	42.2	44.1	49.0	65.1	—	56.2

* Individual Runs

Sampling Rate Analysis

Tape Number Y-H #17 Time Constant 140 ms Tape Duration 45 min Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	53729	47.3	49.4	55.1	65.7	73.5	55.0
	10 sps	26772	47.6	49.6	55.4	65.9	73.6	55.3
	2 sps	5353	47.6	49.6	55.5	65.9	73.4	55.2
	0.4 sps	1069	47.6	49.6	55.4	65.5	71.9	55.3
	0.08 sps	213	47.5	49.6	55.5	65.9	77.1	57.4
*	0.05 sps	129	47.3	49.4	56.0	64.5	69.1	54.5
	0.016 sps	41	(48.6)	49.6	55.2	64.9	—	54.7

* Individual Runs

Sampling Rate Analysis

Tape Number Y-S #4 Time Constant 140 ms Tape Duration 45 min. Weighting H

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	52494	41.7	44.6	52.3	62.0	70.1	51.4
	10 sps	26473	42.4	45.3	52.7	62.1	70.5	51.8
	2 sps	5294	42.5	45.3	52.7	61.9	70.5	51.8
*	1 sps	2661	41.6	44.7	52.3	62.6	70.1	51.6
	0.4 sps	1058	42.5	45.3	52.7	61.2	70.9	52.0
	0.05 sps	211	42.4	45.4	52.5	60.0	70.7	52.7
*	0.05 sps	141	41.6	45.0	51.0	60.6	69.5	50.3
	0.016 sps	41	42.3	42.3	51.9	62.2	—	52.3

* Individual Runs

Sampling Rate Analysis

Tape Number Y-5 #9 preliminary analysis Time Constant 140 ms Tape Duration 20 min. Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	50	59509	44.3	46.3	52.6	59.8	73.9	52.4
*	20	23579	44.3	46.3	52.6	59.7	73.9	52.4
*	10	11923	44.3	46.3	52.6	59.6	73.8	52.4
*	2.5	2912	44.3	46.3	52.6	60.2	74.0	52.4
*	0.25	292	44.2	46.2	53.2	59.2	72.1	53.2
*	0.05	64	44.2	46.4	53.6	72.7	73.9	58.7
*	0.016	20	44.0	46.4	55.9	69.1	71.7	59.4

* Individual Runs

Sampling Rate Analysis

Tape Number Y-5#9 Time Constant 140 ms Tape Duration 20 min (no delay) Weighting A

Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
20 SPS	23584	44.6	46.6	52.7	59.6	73.8	52.7
4 SPS	4716	44.7	46.6	52.7	60.0	74.1	52.6
0.8 SPS	943	44.7	46.6	52.7	59.8	69.1	51.3
0.16 SPS	188	44.7	46.6	53.0	64.1	68.5	51.9
0.032 SPS	37	44.6	46.7	53.4	61.3	—	52.1

Sampling Rate Analysis

Tape Number V-5 #9 Time Constant 140 ms Tape Duration 20 min (one sec. delay) Weighting A

Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
20 SPS	23572	45.0	46.8	52.7	59.6	73.7	52.7
4 SPS	4714	45.0	46.8	52.7	59.8	73.3	52.6
0.8 SPS	942	45.0	46.8	52.8	59.6	72.2	52.6
0.16 SPS	188	45.1	46.8	52.4	58.6	70.7	52.6
0.032 SPS	37	45.3	46.8	51.3	65.3	—	57.0

Sampling Rate Analysis

Tape Number Y-5 #9 Time Constant 140 ms Tape Duration 20 min Weighting A
2 sec. delay

Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
20 SPS	23552	45.2	46.9	52.7	59.6	73.7	52.7
4 SPS	4710	45.2	46.9	52.6	59.4	73.1	52.7
0.8 SPS	942	45.2	46.9	52.9	59.5	74.1	53.0
0.16 SPS	188	45.1	46.9	53.3	58.2	60.7	50.2
0.032 SPS	37	44.9	46.9	52.6	60.6	—	51.2

Sampling Rate Analysis

Tape Number Y-5#9 Time Constant 140 ms Tape Duration 20 min. Weighting A
3 sec. delay

Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
20 SPS	23537	45.2	46.9	52.7	59.6	73.8	52.7
4 SPS	4706	45.2	46.9	52.7	60.0	74.1	52.6
0.8 SPS	941	45.2	47.0	52.7	60.3	76.1	53.2
0.16 SPS	188	45.2	47.0	52.5	57.4	—	49.8
0.032 SPS	37	45.2	47.1	52.3	55.3	—	49.1

Sampling Rate Analysis

Tape Number Y-5#19 Time Constant 140 ms Tape Duration 45 min Weighting A.

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	53458	44.6	46.7	50.7	57.0	70.2	50.7
	10 sps	26856	45.2	47.1	50.9	57.2	70.3	51.1
	2 sps	5370	45.2	47.1	51.0	57.0	70.2	51.7
	0.4 sps	1074	45.2	47.1	51.0	57.6	69.9	50.5
	0.08 sps	213	45.2	47.1	51.1	57.4	55.9	49.2
*	0.05 sps	143	44.6	46.8	51.6	66.4	73.9	55.6
	0.016 sps	41	45.3	47.3	51.3	56.2	—	49.2

* Individual Runs

Sampling Rate Analysis

Tape Number Y-13 #8 Time Constant 140 ms Tape Duration 45 min. Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	.20 sps	53276	54.4	59.2	63.3	69.6	87.2	62.7
	10 sps	27040	55.0	59.4	63.4	69.5	86.2	63.9
	2 sps.	5407	55.0	59.4	63.4	69.3	85.4	64.2
	0.4 sps	1051	55.0	59.3	63.4	69.4	88.0	64.9
	0.05 sps	215	55.0	59.5	62.8	68.2	—	60.8
*	0.05 sps	143	54.7	59.2	63.0	66.5	67.0	60.6
	0.016 sps	43	54.8	59.0	62.8	67.7	—	61.0

* Individual Runs

Sampling Rate Analysis

Tape Number V-13 #9 Time Constant 140 ms Tape Duration ≈ 45 min Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	50353	60.1	62.8	69.4	88.6	97.8	76.5
	10 sps	25082	60.1	62.7	69.7	89.2	97.5	76.2
	2 sps	5015	60.1	62.7	68.9	88.5	98.0	76.3
	0.4 sps	1003	60.1	62.7	68.8	87.5	98.0	76.4
	0.08 sps	200	60.1	62.7	69.7	93.0	98.4	79.3
*	0.05 sps	133	59.4	62.0	69.2	93.3	98.3	73.5
	0.016 sps	40	60.1	62.5	69.0	91.0	—	83.1

* Individual Runs

Sampling Rate Analysis

Tape Number X-14 #4 Time Constant 140 ms Tape Duration 45 min Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	52953	64.1	65.3	75.8	94.6	100.4	81.0
	10 sps	27025	61.7	62.9	78.9	94.9	100.7	81.6
	2 sps	5405	61.7	62.9	78.9	94.8	100.9	81.7
	0.4 sps	1081	61.4	62.8	78.7	95.3	100.9	82.1
	0.08 sps	215	60.1	57.5	74.5	93.8	95.8	79.3
*	0.05 sps	143	62.1	63.3	79.7	93.6	99.5	81.6
	0.016 sps	43	(59.5)	62.2	78.1	86.5	—	76.4

* Individual Runs

Sampling Rate Analysis

Tape Number Y-14 #9 Time Constant 140 ms Tape Duration 45 min Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	53559	63.3	64.3	70.4	86.5	94.9	74.7
	10 sps	26832	61.2	62.4	70.5	86.9	95.5	74.9
	2 sps	5365	61.2	62.4	70.6	86.7	94.6	74.8
	0.45 sps	1072	61.2	62.4	71.3	86.8	92.5	74.0
	0.08 sps	213	61.1	62.4	69.4	87.4	92.8	74.2
*	0.05 sps	142	60.8	60.6	70.3	90.2	92.7	75.9
	0.016 sps	41	61.1	62.3	71.4	77.9	—	69.0

* Individual Runs

Sampling Rate Analysis

Tape Number Resamples #2 Time Constant 140 ms Tape Duration 80 min Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	95495	55.6	56.9	64.4	81.6	81.0	68.6
	10 sps	47845	53.4	55.0	64.1	81.8	89.1	68.5
	2 sps	9569	53.4	55.0	64.1	81.8	89.3	68.5
	0.4 sps	1912	53.4	55.0	63.8	81.9	89.4	68.4
	0.2 sps	381	53.4	55.0	64.3	80.5	87.7	66.1
*	0.05 sps	255	56.2	57.7	66.7	76.9	83.7	69.3
	0.016 sps	76	(50.9)	55.0	61.2	76.7	—	60.4

* Individual Runs

Sampling Rate Analysis

Tape Number BLOOMFIELD #4 Time Constant 140 ms Tape Duration 80 min Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	94524	55.2	56.2	58.7	76.2	89.1	66.4
	10 sps	47922	52.5	53.4	58.0	76.2	89.0	66.2
	2 sps	9583	52.5	53.4	58.0	76.1	89.8	66.1
	0.4 sps	1916	(47.4)	24.1	58.0	75.8	89.1	66.3
	0.08 sps	383	(47.9)	25.8	58.0	76.3	85.9	65.5
*	0.05 sps	254	54.2	56.0	61.8	77.5	79.7	64.2
	0.016 sps	76	(46.8)	20.7	58.4	77.9	—	68.9

* Individual Runs

Sampling Rate Analysis

Tape Number R-7 #12 Time Constant 140 ms Tape Duration 43 min Weighting A

	Sampling Rate	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
*	20 sps	49137	60.6	72.7	81.0	88.4	92.2	78.7
	10 sps	24255	60.4	72.8	81.1	88.5	92.2	78.7
	2 sps	4851	60.4	72.9	81.1	88.5	92.2	78.8
	0.4 sps	976	60.3	72.9	81.2	88.7	92.0	78.8
	0.05 sps	194	59.8	73.5	81.6	88.5	91.8	78.7
*	0.05 sps	131	59.8	72.0	81.7	88.4	84.8	78.5
	0.016 sps	39	59.4	73.0	81.2	89.0	—	78.7

* Individual Runs

ANALYSIS CATEGORY

C

(Cumulative Interval Analysis)

Cumulative Interval Analysis

Tape No. Y-4 #9 Sample Duration 45 min

Sampling Rate 20 Samples/Second Analysis Time Constant 140ms

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	5803	41.4	42.7	45.0	77.3	82.2	59.7
2	10	11746	41.3	42.8	45.0	77.3	82.2	59.6
3	15	17656	41.3	42.8	44.9	75.3	81.6	57.5
4	20	23577	41.3	42.8	44.5	73.4	81.6	56.6
5	25	29575	41.4	43.2	45.4	71.4	81.0	55.8
6	30	35418	41.4	43.1	47.7	69.5	80.6	55.1
7	35	41443	41.4	43.1	47.2	66.7	80.3	54.5
8	40	47379	41.4	43.2	47.5	63.7	80.2	54.0
9	45	53336	41.4	43.2	47.8	60.0	80.0	53.6

Cumulative Interval Analysis

Tape No. X-4 #17 Sample Duration 45 min M.C.T.

Sampling Rate 20 Samples/Second Analysis Time Constant 140 msec.

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	5791	47.8	49.3	51.9	57.0	61.4	50.8
2	10	11704	47.7	49.2	51.5	58.4	70.7	52.0
3	15	17635	48.0	50.1	57.1	61.4	77.0	56.6
4	20	23543	47.9	49.9	56.4	65.5	75.6	56.1
5	25	29459	47.9	49.8	55.8	66.0	74.7	55.7
6	30	35377	47.7	49.6	55.6	65.8	74.4	55.5
7	35	41593	47.6	49.5	55.5	65.6	73.7	55.2
8	40	47504	47.5	49.4	55.0	65.2	73.6	54.9
9	45	53429	47.3	49.4	55.1	65.7	73.5	55.0

Cumulative Interval Analysis

Tape No. Y-5 #4 Sample Duration 45 min.

Sampling Rate 20 Samples/Second Analysis Time Constant 140 ms

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	5311	44.5	47.7	51.7	55.9	58.1	49.5
2	10	11716	42.8	47.2	52.3	57.4	60.0	49.7
3	15	17657	42.3	45.8	52.6	59.5	62.0	49.8
4	20	23593	42.0	44.7	51.7	58.1	61.7	49.0
5	25	29534	41.8	44.2	51.2	57.7	61.4	48.8
6	30	35425	42.0	44.9	52.2	59.8	67.1	50.2
7	35	42161	42.0	44.8	51.8	57.2	66.9	49.9
8	40	48029	41.6	44.6	52.5	62.7	70.2	51.6
9	45	52494	41.7	44.6	52.3	62.6	70.1	51.4

Cumulative Interval Analysis

Tape No. Y-S #9 Sample Duration 45 min

Sampling Rate 20 Samples/Second Analysis Time Constant 140 ms

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	6064	46.7	50.9	55.7	68.0	76.8	56.7
2	10	11996	45.0	47.8	54.3	63.4	76.0	54.5
3	15	17901	44.5	46.8	53.5	62.2	74.6	53.4
4	20	23812	44.3	46.3	52.5	57.7	73.8	52.4
5	25	29701	44.3	46.2	51.8	58.8	73.0	51.9
6	30	35637	44.4	46.3	51.5	57.8	71.8	51.4
7	35	41578	44.5	46.5	51.2	57.6	71.2	51.2
8	40	47517	44.6	46.5	50.9	57.2	70.7	50.9
9	45	53458	44.6	46.7	50.7	57.0	70.2	50.7

Cumulative Interval Analysis

Tape No. Y-13 #8 Sample Duration 45 min. A-weighted

Sampling Rate 20 Samples/Second Analysis Time Constant 140 msec

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	5995	60.3	61.5	63.1	67.7	76.6	63.9
2	10	11992	60.1	61.4	64.9	68.9	76.1	63.2
3	15	17829	60.1	61.4	65.1	68.7	76.0	63.2
4	20	23740	60.0	61.5	66.3	72.0	76.1	63.4
5	25	29151	58.3	61.1	65.0	70.5	77.8	63.3
6	30	35548	55.3	60.7	64.5	71.0	78.6	64.1
7	35	41465	55.7	60.3	63.9	70.4	78.2	63.5
8	40	47317	54.5	59.9	63.6	69.9	78.1	63.0
9	45	53276	54.4	59.2	63.0	69.6	77.3	62.9

Cumulative Interval Analysis

Tape No. Y13#9 Sample Duration 44 min.

Sampling Rate 20 Samples/Second Analysis Time Constant 140 msec

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	5804	58.7	62.3	68.0	85.3	92.0	72.4
2	10	11716	59.3	63.7	67.8	83.7	90.8	70.5
3	15	17646	59.8	63.0	65.2	85.0	92.0	72.3
4	20	23535	60.0	62.8	70.0	91.1	95.3	77.6
5	25	29455	60.2	63.1	71.2	92.2	98.3	77.3
6	30	35378	60.3	63.2	71.1	90.8	illegible	77.5
7	35	41295	60.3	63.2	69.9	illegible	illegible	illegible
8	40	47217	60.2	63.0	69.4	89.1	97.9	76.7
9	44	50353	60.1	62.8	69.4	illegible	97.8	illegible

Cumulative Interval Analysis

Tape No. Y-1414 Sample Duration 45 min.

Sampling Rate 20 Samples/Second Analysis Time Constant 1/2 sec

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	5795	63.5	64.3	67.2	77.5	79.6	69.2
2	10	13353	63.5	64.3	66.1	76.6	78.9	67.0
3	15	17493	63.6	64.3	65.9	76.5	78.7	66.5
4	20	23417	63.7	64.4	67.4	85.9	95.4	74.1
5	25	29343	63.7	64.6	70.7	92.1	100.1	78.5
6	30	35260	64.0	64.7	75.1	94.5	100.6	83.9
7	35	41174	64.0	65.3	77.2	94.6	100.4	81.3
8	40	47012	64.0	65.4	77.5	94.8	100.2	81.5
9	45	52953	64.1	65.3	78.8	94.6	100.4	81.4

Cumulative Interval Analysis

Channel 1 Tape No. X-1449 Sample Duration 45 mins A-weighted

Sampling Rate 20 Samples/Second Analysis Time Constant 125 msec

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	5855	64.1	66.0	76.4	86.0	92.1	74.7
2	10	12021	63.5	65.0	79.2	90.5	97.6	77.1
3	15	17968	63.5	64.8	78.6	90.8	97.4	78.1
4	20	24203	63.5	64.8	78.6	90.2	96.7	77.5
5	25	30134	63.5	64.6	76.3	87.2	96.0	76.6
6	30	35876	63.5	64.5	74.5	88.3	95.6	75.9
7	35	41775	63.4	64.5	73.2	87.7	96.1	75.6
8	40	47685	63.4	64.4	71.6	87.1	95.2	75.1
9	45	53559	63.3	64.3	70.4	86.5	94.9	74.7

Channel 1 Cumulative Interval Analysis

A-wtd

Tape No. Bloomfield #2 Sample Duration 80 min.

Sampling Rate 20 Samples/Second Analysis Time Constant 140 msec

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	5923	54.9	55.4	57.2	86.4	90.0	71.3
2	10	11763	55.1	56.2	58.7	83.7	89.4	69.5
3	15	17674	55.2	56.3	58.0	77.2	88.1	68.9
4	20	23612	55.2	56.4	59.5	72.7	88.2	68.9
5	25	29517	55.3	56.5	59.9	81.1	89.2	69.9
6	30	35646	55.3	56.6	60.0	77.9	89.1	69.0
7	35	41568	55.3	56.5	60.1	76.2	88.3	69.4
8	40	47491	55.3	56.5	61.2	75.6	88.7	69.9
9	45	53489	55.4	56.6	64.7	82.8	89.1	69.0
10	50	60215	55.8	56.8	63.8	81.9	89.0	69.6
11	55	64214	55.6	56.7	64.3	81.4	88.7	68.3
12	60	71741	55.6	56.8	64.4	82.2	89.0	69.7
13	65	77656	55.7	56.9	64.6	81.6	88.3	68.5
14	70	83566	55.7	56.9	64.7	81.0	88.1	68.4
15	75	89569	55.7	56.9	64.3	81.5	88.5	69.1
16	80	95495	55.6	56.9	64.4	81.6	88.3	68.4

Cumulative Interval Analysis

Tape No. Bloomfield #4 Sample Duration 80 min.

Sampling Rate 20 Samples/Second Analysis Time Constant 140 msec

Printout #	Cumulative Duration	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
1	5 min.	5789	55.5	56.4	59.6	64.3	66.2	58.1
2	10	11716	55.4	56.2	59.7	63.2	65.8	57.5
3	15	17634	55.4	56.4	70.3	86.4	91.4	72.1
4	20	23561	55.4	56.4	71.1	84.9	91.1	71.2
5	25	29471	55.3	56.3	64.6	83.2	90.9	67.3
6	30	35397	55.2	56.3	62.5	82.1	90.8	64.3
7	35	41318	55.2	56.3	63.0	80.0	90.	67.3
8	40	47045	55.2	56.3	61.3	78.4	90.5	64.6
9	45	53024	55.2	56.3	61.5	77.6	90.3	63.2
10	50	58952	55.2	56.2	60.5	77.6	90.2	62.8
11	55	64858	55.2	56.2	60.4	76.7	90.1	62.6
12	60	70821	55.2	56.2	59.9	76.4	89.7	62.6
13	65	76750	55.2	56.2	59.5	76.1	89.1	62.2
14	70	82678	55.2	56.2	59.2	75.9	89.5	62.4
15	75	88511	55.2	56.2	59.1	76.2	89.3	62.5
16	80	94534	55.2	56.2	59.	76.2	89.1	62.

ANALYSIS CATEGORY

D

(Starting Time Analysis)

Starting Time Analysis

Sampling Rate 20 Samples/Second Weighting A Time Constant 140 ms

Tape #	Analyzed Segment	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y-4 #17	Complete 45 min.	53424	47.3	49.4	55.1	65.7	73.5	55.0
Y-4 #17	Last 35 min.	41322	47.2	49.4	54.0	65.9	73.9	55.6
Y-5 #9	Complete 45 min.	53458	44.6	46.7	50.7	57.0	70.2	50.7
Y-5 #9	Last 35 min.	41397	44.7	46.6	49.3	54.2	64.5	48.5

Starting Time Analysis

Sampling Rate .05 Samples/Second Weighting A Time Constant 140 ms

Tape #	Analyzed Segment	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y-5#9	First 20 min.	63	44.6	47.0	53.7	68.5	—	56.3
Y-5#9	First 20 min. Delayed 10 seconds	63	44.9	46.6	52.7	57.9	—	50.8
Y-5#9	First 22 min. Analyzed for Sampling Rate	69	44.2	46.6	55.9	69.1	71.7	59.4

ANALYSIS CATEGORY

E

(Starting Time Analysis/Sampling Rate Change)

Starting Time Analysis/Sampling Rate Change

Sampling Rate 20 Samples/Second Weighting A Time Constant 140 ms

Tape #	Analyzed Segment	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y-5 #9	20 min. - No Delay	23584	44.6	46.6	52.7	59.6	73.8	52.7
Y-5 #9	20 min - 1 sec. Delay	23552	45.0	46.5	52.7	59.6	73.7	52.7
Y-5 #9	20 min - 2 sec. Delay	23552	45.2	46.9	52.7	59.6	73.7	52.7
Y-5 #9	20 min - 3 sec. Delay	23537	45.2	46.9	52.7	59.6	73.8	52.7

Starting Time Analysis/Sampling Rate Change

Sampling Rate 4 Samples/Second Weighting A Time Constant 140 ms

Tape #	Analyzed Segment	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y5-#9	20 min. - No DELAY	4716	44.7	46.6	52.7	60.0	74.1	52.6
Y-5 #9	20 MIN. - 1 SEC. DELAY	4714	45.0	46.8	52.7	59.8	73.3	52.6
Y-5 #9	20 min. - 2 SEC. DELAY	4710	45.2	46.9	52.6	59.4	73.1	52.6
Y-5 #9	20 min - 3 SEC DELAY	4706	45.2	46.9	52.7	60.0	74.1	52.6

Starting Time Analysis/Sampling Rate Change

Sampling Rate 0.8 Samples/Second Weighting A Time Constant 140 ms

Tape #	Analyzed Segment	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y-5 #9	20 min. - NO DELAY	943	44.7	46.6	52.7	59.8	69.1	51.3
Y-5 #9	20 min - 1 SEC. DELAY	942	45.0	46.8	52.8	59.6	72.3	52.6
Y-5 #9	20 min. - 2 SEC. DELAY	942	45.2	46.9	52.9	59.5	74.1	53.0
Y-5 #9	20 MIN. - 3 SEC. DELAY	941	45.2	47.0	52.7	60.3	76.1	53.2

E-4

Starting Time Analysis/Sampling Rate Change

Sampling Rate 0.16 Samples/Second Weighting A Time Constant 140 ms

Tape #	Analyzed Segment	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y-5 #9	20 min. - No Delay	188	44.7	46.6	53.0	64.1	68.5	51.9
Y-5 #9	20 min. - 1 sec. Delay	188	45.1	46.8	52.4	58.6	70.7	52.6
Y-5 #9	20 min. - 2 sec. Delay	188	45.1	46.9	53.3	58.2	60.7	50.2
Y-5 #9	20 min. - 1 sec. Delay	188	45.2	47.0	52.5	57.4	—	49.8

Starting Time Analysis/Sampling Rate Change

Sampling Rate 0.032 Samples/Second Weighting A Time Constant 1/40 ms

Tape #	Analyzed Segment	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y-5 #9	20 MIN. - NO DELAY	37	44.6	46.7	53.4	61.3	—	52.1
Y-5 #9	20 MIN. - 1 SEC. DELAY	37	45.3	46.8	51.3	65.3	—	57.0
Y-5 #9	20 MIN. - 2 SEC DELAY	37	44.9	46.9	52.6	60.6	—	51.2
Y-5 #9	20 MIN. - 3 SEC. DELAY	37	45.2	47.1	53.3	55.3	—	49.1

ANALYSIS CATEGORY

F

(Weighting Network Analysis)

Weighting Network Analysis

Sampling Rate 20 Samples/Second Analysis Time Constant 70 msec

Tape #	Sample Length	Weighting Network	Number of Samples	L_{90}	L_{50}	L_{10}	L_1	$L_{.1}$	L_{eq}
Y-5 #9	45 min.	A	53849	44.0	45.7	50.0	55.6	68.7	49.5
		C	53859	57.4	60.8	66.4	74.5	77.3	65.1
		D	53846	51.5	53.3	59.3	64.2	74.3	56.9
		Linear	53817	59.7	62.2	69.1	74.9	80.7	66.4
R-7 #12	1.2 min.	A	1387	62.3	80.0	84.4	87.9	89.0	81.5
		C	1388	76.5	86.1	89.9	91.9	93.0	87.2
		D	1388	69.8	85.2	89.9	94.0	95.0	87.1
R-7 #12	2.5 min.	A	3022	68.3	72.2	78.8	86.5	87.9	76.6
		C	3025	78.4	82.5	88.0	96.8	98.0	86.8
		D	3025	75.2	78.6	85.3	92.5	93.9	83.0