ENVIRONMENTAL NOISE ASSESSMENT FOR
PERC SYNTHANE PLANT

MASTER

By

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ABSTRACT

Environmental noise data were obtained at eleven selected sites around the Pittsburgh Energy Research Center's SYNTHANE plant at Bruceton, Pennsylvania. The data revealed that noise emission from the plant has a significant impact upon an area as far as about a mile to the east of the plant. It is recommended that additional data be obtained when the plant is operating at its design capacity.

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INTRODUCTION

The SYNTHANE plant under consideration here is a pilot plant engineered and operated by the C-E Lummus Company for the U. S. Department of Energy. The plant utilizes the SYNTHANE (SYNthetic meTHANE) process developed by the Pittsburgh Energy Research Center of the Department of Energy and has a design capacity to convert 72 tons of coal per day into 1.2 million cubic feet of pipe line quality fuel gas.

The key steps of the process consist of:

- Coal Preparation
- Coal Pressurization
- Gasification and Char Removal
- Gas Cleanup
- Shift Conversion
- Acid Gas Removal
- Methanation
- Compression of Carbon Dioxide
- Sulfur Removal

The concern here is strictly in regard to the noise emission from the plant rather than with respect to any of its operating characteristics. The principal noise producers in the plant can be divided into the following categories:

Mechanical: grinders, pulverizers, gears, conveyors

Flow Devices: fans, blowers, compressors, valves

Combustion: furnaces, flares, heaters

Electromechanical: generators, motors, transformers, circuit breakers

Augmenting the operating noises are noises produced by maintenance operations

and those resulting from truck movements.

The pilot plant is located in South Park Township, adjacent to the Bruceton Research Station of the U. S. Bureau of Mines which has been in the area for many years. A substantial portion of South Park Township is occupied by a county park which is its namesake. Aside from a number of retail businesses in the area, the South Park Township is predominantly residential in nature. This area is generally very quiet as there are no major highways through the township. The closest highway in the vicinity is State Route 51 which runs through Jefferson Borough and is about 2½ miles east of the SYNTHANE plant. There are, however, three operating rail lines through the area - namely, Pittsburgh and West Virginia, Baltimore and Ohio, and the Montour railroad.

The operation of the plant has drawn complaints from its immediate neighbors concerning the noise emission from the plant. Some complaints came from as far as a mile away in an area east of the plant. This is probably due to the fact that the plant is situated in a valley which opens out to the east. Residents in other directions are probably somewhat protected by the ridge that partially surrounds the plant. To avoid generating adverse publicity, local residents were not interviewed regarding the exact nature of their complaints. From the author's discussion with plant engineers, it appears that complaints were mostly directed against the gas flare, the popping of the valves, the operation of the vacuum truck, and in general, noisy night-time operations.

The immediate purpose of this study is to assess the magnitude of the noise impact upon the neighboring communities. This information can be used to formulate appropriate noise abatement measures or procedures. The long range objective is to gain some understanding of the noise problem that

will be associated with commercial development of the SYNTHANE process.

NOISE MONITORING

In order to assess the noise impact on a given area, it is necessary to determine (1) the noise level existing in the area prior to the introduction of the noise source under consideration into the area, and (2) the noise level when the source under consideration is in operation. The former noise level is referred to as the baseline level, while the latter, as the impacted level. Since, in the present case, baseline data is not available, and the plant cannot be completely silenced to permit the collection of such data, an alternative approach must be employed. The approach is to use "surrogate" sites instead of the actual sites. To be acceptable, the surrogate sites must have an acoustical ambience comparable to that of the actual sites but are not impacted by the noise source under consideration. To this end, a total of eleven monitoring sites have been chosen in this study. These selected sites are categorized as follows:

1. Sites 1 through 3 located along the boundary of the plant.
2. Sites 4 through 8 located at points where complaints have originated from.
3. Sites 9 through 11 located in the general South Park area, but sufficiently far removed from any particular noisy operation or any major roadway.

A full description of the sites is given in Table 1.

Since it is to be expected that the noise at a given site will exhibit much temporal fluctuation, only continuous monitoring will portray the entire event. Such an extensive monitoring program is ruled out for the present study. Budgetary limitations required that only 8 hour samples be taken at the impacted sites, while 24 hour samples be taken to determine the baseline data. Actual monitoring is further limited to five minute samples

Table 1 - Description of monitoring sites.

Site No.	location	Description	Approx. dist. to plant
1	South Park Township	At plant bndry near guard house	-
2	South Park Township	At plant bndry near barn	-
3	South Park Township	At plant bndry near storage tank	-
4	South Park Township	Off drive to Cherokee Stable	10 yds
5	Jefferson Borough	Intersection of Arch and Wood Streets	1/2 mile
6	South Park Township	Off Wallace Drive half way btwn plant & Cochran Mill Rd.	200 yds
7	Jefferson Borough	On Schneider's farm off Gill Hall Road	1 mile
8	Jefferson Borough	Near intersection of Stilley Rd and Dale Street	1-1/4 miles
9	South Park Township	On parking lot near intersection of Corrigan Drive & Brownsville Rd.	1-1/2 miles
10	South Park Township	Near intersection of Snowden Rd and Sunny Drive	2 miles
11	Jefferson Borough	Lithuanian Country Club ballfield off Coal Valley Road	2-1/2 miles

for each sampling hour. To be useful, the sample data must yield acceptable estimates for the statistics of the noises under consideration. The statistics that are of the most interest here are the equivalent sound levels, L_{eq} , and specified percentile sound levels such as the L_{10} and L_{90} levels. For a given sampling scheme, the probable error is determined by the temporal characteristics of the noise. For relatively steady noises, such as those near the SYNTHANE plant, the error is expected to be small, but for general environmental noises, the error would be greater. This problem has not been adequately addressed to in the literature. Using five minute samples, the error, according to one study, (Ref. 1) can be as large as 4.5 dB for L_{eq} , 5 dB for L_{10} , and 2.5 dB for L_{90} for noises which are dominated by intermittent traffic and community activities. For the purpose of this study, these errors should be considered acceptable, as decisions involving environmental noises commonly have a resolution of only 5 dB.

DATA COLLECTION AND ANALYSIS

Under the constraints of available instrumentation and with the intention of limiting field manpower and instrumentation requirements, the author opted for a two-step approach for acquiring the needed data. The first step is the field recording of the noise and the second step is the laboratory analysis of the recorded data. The link between the field and laboratory phases of the work is provided by the signal recorded at the beginning of each tape.

The field recording system consisted of a sound level meter, a battery powered tape recorder, and an acoustic signal generator for providing the necessary reference signal. A windscreen was used over the input microphone to eliminate wind generated noise. Recordings were not made whenever the

wind speed exceeded 15 miles per hour. The frequency response of the sound level meter was set in the A-weighting mode as this practice will tend to reduce chances of either overloading the sound level meter, or saturating the magnetic tape. The sound level meter also served as a calibrated attenuator for the tape recorder. On playback, the signal from the tape recording was fed through a calibrated attenuator into a level recorder. The signal coming out of the level recorder was then sorted by a distribution analyzer into various level intervals. A 5 dB interval was chosen for this study.

The tape recorder has a dynamic range of about 45 decibel. The use of the intermediary attenuators during the recording as well as the playback stage greatly expanded the range of levels that can be handled by the system. As a matter of fact, by appropriately adjusting the input level at the start of a recording session, overloading was never observed. The period of measurement spanned the better parts of September and October. The days during which recordings were made are shown in Table 2. The purpose of this tabulation is to enable any future correlation of the noise data with the plant operation log and other pertinent environmental data.

PRESENTATION OF DATA

The hourly sound level distributions are exhibited in Tables 3 through 13. From these data, the equivalent sound levels, L_{dn} were computed and shown collectively in Table 14. The L_{dn} levels were obtained by averaging the daytime and night-time sound intensities over a 24 hour period with the night-time intensity augmented by a factor of 10. Details of the computation are included in the Appendix. For Sites 1 through 8 only, L_d was measured and L_n is assumed to equal L_d , since the plant operation noise is expected

Table 2: Days on which data were obtained

Hour	Site designation										
	1	2	3	4	5	6	7	8	9	10	11
0000	-	-	-	-	-	-	-	-	10/1	10/14	10/10
0100	-	-	-	-	-	-	-	-	10/14	10/14	10/10
0200	-	-	-	-	-	-	-	-	10/14	10/14	10/10
0300	-	-	-	-	-	-	-	-	10/14	10/14	10/10
0400	-	-	-	-	-	-	-	-	10/14	10/14	10/10
0500	-	-	-	-	-	-	-	-	10/14	10/14	10/10
0600	-	-	-	-	-	-	-	-	10/26	10/26	10/21
0700	-	-	-	-	-	-	-	-	10/26	10/26	10/21
0800	-	-	-	10/26	-	-	-	-	10/26	10/26	10/21
0900	9/14	9/14	9/14	10/11	10/11	10/26	10/11	10/11	9/21	9/21	9/21
1000	9/14	9/14	9/14	10/05	-	10/11	10/11	10/11	9/21	9/21	9/21
1100	9/14	9/14	9/14	10/05	10/11	10/11	10/11	-	9/21	9/21	9/21
1200	9/14	9/14	9/14	-	10/11	-	10/11	10/11	9/21	9/21	9/21
1300	9/19	9/19	9/19	-	10/11	-	10/11	10/11	9/23	9/21	9/21
1400	9/19	9/19	9/19	10/05	10/05	10/11	10/11	10/11	9/20	9/20	9/20
1500	9/19	9/19	9/19	10/05	10/05	10/11	10/11	10/11	9/20	9/23	9/23
1600	9/19	9/19	9/19	10/05	10/05	10/06	10/06	10/06	9/23	9/23	10/07
1700	-	-	-	10/05	10/05	10/06	10/06	10/06	9/23	9/23	10/07
1800	-	-	-	-	-	-	-	-	10/04	10/04	10/07
1900	-	-	-	-	-	-	-	-	10/04	10/04	10/07
2000	-	-	-	-	-	-	-	-	10/04	10/04	10/14
2100	-	-	-	-	-	-	-	-	10/13	10/13	10/14
2200	-	-	-	-	-	-	-	-	10/13	10/13	10/14
2300	-	-	-	-	-	-	-	-	10/13	10/13	10/14
2400	-	-	-	-	-	-	-	-	10/13	10/13	10/14

for Site No. 1

vel, dBA

[illegible]

1997

[illegible]

Sound level, dBA

[illegible]

for Site-No. 4

[illegible]

und level distributi

[illegible]

15

[illegible]

for Site No. 7

[illegible]

Table 10: Sample hourly sound level distribution
for Site No. 8

[illegible]

Table 11: Sample hourly sound level distribution
for Site No. 9

Hour	25	30	35	40	45	50	55	60	65	70	75	80
0000												
0100	0.00	6.27	28.26	31.00	23.14	10.83	0.50	0.00				
0200	1.23	64.80	23.20	6.14	4.40	0.23	0.00					
0300	0.07	80.86	7.47	6.37	2.90	2.13	0.17	0.00				
0400	18.10	73.27	4.83	1.33	1.27	1.20	0.00					
0500	0.63	84.57	11.33	1.74	0.73	0.90	0.00					
0600	0.00	0.00	61.17	23.90	8.60	3.73	2.40	0.20				
0700		0.00	59.33	26.27	6.47	6.06	1.87	0.00				
0800			0.00	19.80	20.70	31.17	20.66	6.84	0.00			
0900			0.00	13.67	30.53	39.00	12.63	3.47	0.70	0.00		
1000		0.00	0.47	34.20	42.83	19.07	2.20	1.23	0.00			
1100		0.00	2.13	31.44	25.53	18.10	13.90	7.40	1.50	0.00		
1200		0.00	11.63	34.44	31.30	14.60	3.56	3.07	1.40	0.00		
1300		0.00	1.30	24.50	44.33	20.24	3.23	4.73	1.67	0.00		
1400		0.00	0.00	1.67	20.80	4.00	16.36	37.40	19.20	0.57	0.00	
1500			0.00	22.93	49.97	18.47	4.14	2.00	1.06	1.54	0.03	
1600			0.00	6.73	35.24	35.00	12.20	6.30	4.40	0.13	0.00	
1700			0.00	10.87	35.83	36.40	13.33	3.07	0.50	0.00		
1800			0.00	8.63	31.40	28.80	17.40	9.40	4.34	0.03	0.00	
1900			0.00	8.97	31.76	35.04	11.83	3.00	3.17	6.23	0.00	
2000		0.00	14.10	24.10	28.07	6.87	0.00					
2100		0.00	0.30	10.40	19.20	30.27	25.60	9.50	3.50	1.16	0.07	
2200		0.00	11.57	25.30	23.23	10.37	6.10	0.00				
2300		0.00	0.43	29.30	28.00	21.84	17.26	2.67	0.50	0.00		
2400	0.00	30.50	23.43	9.40	21.14	12.33	2.50	0.70	0.00			

hourly
Site No

Hour	25	30	35	40	45	50	55	60	65	70	75	80
0000												
0100		0.00	19.70	79.50	0.80	0.00						
0200			0.00	1.50	75.50	15.80	5.90	1.30	0.00			
0300			0.00	1.30	78.00	18.30	2.40	0.00				
0400			0.00	8.30	85.20	6.50	0.00					
0500			0.00	0.10	66.10	17.70	12.40	3.70				
0600			18.70	77.80	3.40	0.10	0.00					
0700				0.70	40.00	43.70	12.90	1.70	1.00	0.00		
0800				3.40	35.60	51.00	8.80	1.10	0.10	0.00		
0900				0.00	0.10	26.70	41.50	18.10	9.70	3.80	0.10	0.00
1000				0.00	47.13	32.20	10.94	5.60	2.16	1.54	0.43	0.00
1100			0.00	4.40	59.40	16.80	11.17	7.66	0.57	0.00		
1200				0.00	40.90	45.17	9.16	3.54	1.10	0.13	0.00	
1300			0.00	31.83	41.80	12.57	11.87	1.93	0.00			
1400			0.00	0.23	46.04	37.13	15.03	1.57	0.00			
1500			0.00	0.87	64.26	22.60	8.17	3.03	1.05	0.02	0.00	
1600				0.00	38.80	25.20	24.33	8.34	2.20	1.13	0.00	
1700				0.00	42.33	30.67	20.43	6.34	0.23	0.00		
1800				0.00	23.60	45.70	21.60	8.40	0.70	0.00		
1900				0.00	13.00	43.40	26.20	12.30	3.40	1.70	0.00	
2000			0.00	4.20	65.40	20.00	9.00	1.40	0.00			
2100				0.00	50.20	39.40	7.40	3.00	0.00			
2200				0.00	51.50	38.70	8.40	1.20	0.20	0.00		
2300			0.00	0.80	72.80	22.30	2.40	0.80	0.70	0.20	0.00	
2400				0.00	66.30	26.70	5.60	1.40	0.00			

Table 14: Day and night equivalent sound levels at the monitoring sites

Site No.	L_d	L_n^*	L_{dn}
1	61.9	(61.9)	68.3
2	62.0	(62.0)	68.4
3	67.7	(67.7)	74.1
4	62.1	(62.1)	66.5
5	62.5	(62.5)	68.9
6	55.5	(55.5)	61.9
7	48.8	(48.8)	55.2
8	56.6	(56.6)	63.0
9	57.3	46.8	57.1
10	57.6	51.3	59.4
11	51.7	45.9	53.8

* Note: Numbers in parentheses are assumed to be identical to the respective day-time levels.

to stay essentially constant throughout an entire day. For Sites 9 through 11, the tabulated L_n levels reflect the actual measured values.

DISCUSSIONS

1. The baseline L_{dn} levels were found to range from a low of 54 to a high of 59 dBA. The main source of noise is surface transportation, although small aircraft flyover noises were often heard during the recording sessions. For the purpose of further discussion the baseline L_{dn} level shall be taken to be 55 dBA which is near the low end of the measured range.
2. The noise levels at Sites 4 through 8 are mostly higher than those found at farther away sites. The only exception is the data obtained at Site 7 located on a farm off Gill Hall Road near a DOE monitoring station. Although at this site the plant was in full view, the noise from the plant was barely audible. The low level found at this site is due to the relatively greater distance from roadways. There is no question that traffic is an important component of the noise at Sites 6 and 8, thus the L_{dn} levels indicated at those sites tend to be an over estimation of the actual noise levels, as the traffic noise should die down considerably during the night-time hours.
3. The rather high level of noise at Site 5 was found to be mostly due to a commercial sand blasting operation on a nearby property. Assuming that the sand blasting activity will not continue into night-time hours the given L_{dn} level at Site 5 is likely to be higher than the actual level. An evaluation of the measured

noise levels in terms of existing state and federal regulations or recommendations (2) are shown in Table 15.

4. The impact on the surrounding neighborhood of the plant can be determined in either of two ways. One way is to use the measured L_{dn} levels at the impacted sites, the other is to use the difference between the impacted level and the baseline level for the area. The former procedure was used by the Environmental Protection Agency (3) and the latter was adopted by the International Standards Organization (4). Using the EPA procedure, 5 dB should be added to the measured levels to account for the "suburban" nature of the area. For calculating the impact according to the ISO procedure, baseline level of 55 dBA was assumed. The results for Sites 4 through 8 are shown in Table 16. These correlations reveal that widespread complaints against the noise emitted from the pilot plant could come from an area as far as about a mile to the east of the plant.
5. The data reported thus far reflect really only the noise emitted by the plant in a "stand-by" mode, as throughout the project period the plant was not able to achieve sustained production operation as projected. Additional information should be collected when the design capacity is achieved, since the increase in the level of noise emission could be significant.
6. As a consequence of this study, a student research project was initiated and is currently in progress at the Graduate School of Public Health, the University of Pittsburgh. The intent of

that project is to determine the reliability that can be ascribed to various sampling durations over a 24 hour period. The conclusion reached there will aid in the interpretation of data reported herein.

Table 15: Rating the measured noise levels according to existing regulations or recommendations for residential uses

Site	States				Federal	
	Colorado	Illinois	New Jersey	Oregon	EPA	HUD
1 Day	Ex	Ex	Ex	Ex	Ex	DA
1 Night	Ex	Ex	Ex	Ex		
2 Day	Ex	Ex	Ex	Ex	Ex	DA
2 Night	Ex	Ex	Ex	Ex		
3 Day	Ex	Ex	Ex	Ex	Ex	DN
3 Night	Ex	Ex	Ex	Ex		
4 Day	Ex	Ac	Ex	Ex	Ex	DA
4 Night	Ex	Ex	Ex	Ex		
5 Day	Ex	Ex	Ac	Ex	Ex	DA
5 Night	Ex	Ex	Ex	Ex		
6 Day	Ex	Ac	Ac	Ac	Ex	DA
6 Night	Ex	Ex	Ex	Ex		
7 Day	Ac	Ac	Ac	Ac	Ac	DA
7 Night	Ac	Ac	Ac	Ac		
8 Day	Ex	Ex	Ac	Ac	Ex	DA
8 Night	Ex	Ex	Ex	Ex		
9 Day	Ex	Ac	Ac	Ac	Ex	DA
9 Night	Ac	Ac	Ac	Ac		
10 Day	Ex	Ac	Ac	Ac	Ex	DA
10 Night	Ex	Ac	Ex	Ac		
11 Day	Ac	Ac	Ac	Ac	Ac	DA
11 Night	Ac	Ac	Ac	Ac		

Legend: Ac = Acceptable
 Ex = Excessive
 DA = Discretionary - normally Acceptable
 DN = Discretionary - normally Unacceptable

Table 16: Characterizing the impact at Sites 4 through 8

	Site No.				
	4	5	6	7	8
Normalized L _{dn} , dBA	71.5	73.9	66.9	61.2	68.0
EPA category	Threats of legal action	Threats of legal action	Widespread complaints	Widespread complaints	Widespread complaints
L _{dn} - 55	11.5	13.9	6.9	0.2	8.0
ISO category	Widespread complaints	Widespread complaints	Sporadic complaints	No observ- able reaction	Sporadic complaints

REFERENCES

1. K. Eldred, Community Noise, EPA, NTID 300.3 (1971).
2. T. Yen, Noise Emission Considerations for Coal Conversion Processes. Report prepared for the Oak Ridge Associated Universities (1977).
3. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA 550/9 - 74 - 004 (1974).
4. Assessment of Noise with Respect to Community Response, International Organization for Standardization, 150/R 1966-1971.

Appendix - The Calculation of Equivalent Sound Levels

To calculate L_d or L_n values from the data exhibited in Tables 3 through 13, it is convenient to replace the integrals that are commonly used to define such levels with summations over discrete contributions from each designated level range. The appropriate formula is:

$$L_{eq} = 10 \log \frac{1}{100n} \sum_{i=1}^n (10^{L_i/10}) P_i$$

where L_i is the center level in each level range. For example 52.5 is taken as the center level in the range of 50 to 55 dB level range, etc. P_i is the percent of time over the entire sampling period that the sound level fell within the corresponding level range, and n is the total number of sampling hours in a given period.

Once the L_d and L_n levels are obtained for a given site, the resultant L_{dn} level is given by the formula

$$L_{dn} = 10 \log \frac{1}{24} ((15)10^{L_d/10} + (9)10^{(L_n+10)/10})$$