BETHLEHEM STEEL COMPANY
Office of
Industrial Health Engineering

October 2, 1962

D. D. Strohmeier:

re: Dust Conditions and Control,
Pipe Covering Shop, Quincy Yard

Herewith are six (6) copies of Dr. Anderson's report of September 26, 1962, same subject.

Your attention is invited to the conclusions and recommendations on pages 4 and 5. It is important that recommendations 3 and 4 be carried out and that a study then be made of the dust conditions in the shop before any further money is invested in exhaust systems having larger capacity or more effective collectors. In the meantime, it is imperative that recommendations 2 and 5 be followed.

A. D. Brandt

ADB:ws
cc: R. K. Branscom
F. R. Barnako
M. P. Charnock, M.D.
V. F. Moravec

sc: D. M. Anderson
J. W. Miller
D. R. Lavalette

Safety Everywhere All the Time

INTRA-OFFICE CORRESPONDENCE

BETHLEHEM STEEL

Bethlehem, Pa.

September 26, 1962

FILE REF.

FROM D. M. Anderson, Industrial Health Engineer

TO A. D. Brandt, Manager of Industrial Health Engineering

SUBJECT DUST CONDITIONS AND CONTROL, PIPE COVERING SHOP, QUINCY YARD

I. Introduction

Dust concentrations due to various shop activities were measured at subject location by D. R. Lavalette, J. W. Miller and D. M. Anderson on 8/30 and 8/31/62. Both breathing zone and general air samples (27 total) were taken and subsequently evaluated following the U. S. Public Health Service procedures. In addition, the performance of the two existing industrial ventilation systems at subject shop was evaluated from the standpoint of hood airflow and dust collector effluent concentrations.

II. Dust Concentrations

A. Sampling Results

Tables 1 and 2 summarize the results of this limited sampling program. Average breathing-zone dust concentrations (Table 2) varied from 2.2 mppcf* during prefabrication and sewing to 18.7 mppcf during band saw cutting. General shop concentrations averaged 2.0 mppcf. It should be pointed out that these averages are subject to revision based upon further sampling which is planned for the near future. The fiber content (fibers greater than 10 microns in length) varied with the material handled, but in all cases averaged less than 2.2% by count.

B. Interpretation of Results

Threshold limits have been established for mineral dusts for use as guides in the control of health hazards and represent conditions under which it is believed that workers may be repeatedly exposed, day after day, without adverse effect. The latest value for asbestos-containing dust which has been established by the American Conference of Governmental Industrial Hygienists (ACGIH) is 5 mppcf (total dust count). This figure is based upon a study in the asbestos textile industry where worker exposures were fairly constant. It has doubtful reliability when applied to pipe covering operations (see reference listed in Table 1) where dust exposure is highly variable and weighted-average concentrations very difficult to determine. Another factor which complicates the interpretation of dust concentration data is the fiber content of the suspended dust. Although it is known that, contrary to most mineral dusts, it is the large (i.e. long) fibers which tend to produce asbestosis, this fact is ignored in the present

* - mppcf - millions of particles per cubic foot of air

threshold limit which is based on total dust count. The fiber content of the airborne dust sampled in the textile industry study was as high as 26% for some operations as compared to 1 or 2% in the present study. Therefore dust from the Quincy shop operations studied is less hazardous than that upon which the threshold limit was based.

In view of the above considerations the threshold limit of 5 mppcf should be considered only as a guide for control purposes, i.e., a benchmark to shoot for when evaluating control procedures.

C. Discussion of Results

Comparison of the threshold limit with the listed average dust concentrations of Table 2 shows that several operations produce objectionably high dust concentrations, viz., grinding-routing, band saw cutting, packing-handling and sweeping. However, comparison of average dust concentrations for these operations with those measured elsewhere (see Table 2) indicates lower concentrations at the Quincy shop than what might be expected. This is undoubtedly due to the dust control provided by the existing industrial ventilation systems as well as to a lower work rate than was the case in the other surveys. Despite these encouraging findings, dust control at subject shop cannot be considered good. It can be improved by more efficient operation of the local exhaust system and by the compulsory use of respiratory protective equipment (see "Recommendations").

Table 2 also shows that one area of work, which is a potentially serious dust-producing operation, has yet to be studied, i.e., installation of pipe covering and other insulation on board ship. This is to be studied in the near future (see "Recommendations").

III. Performance of Industrial Exhaust Systems

A. Hood Performance

Table 3 presents the field data obtained relative to the performance of the two exhaust systems at the Quincy shop. System #1 consists of hoods at the grinder-router table and the spindle sander ducted to a size 10 Aerotec "Integral" Dust Collector. The effluent from this collector is discharged above the building roof line vertically downward by means of a U-bend. System #2 consists of 5 hoods (2 at the 3½' band saw and 3 at the table-band saw) ducted to a size 60 Aerotec collector. The effluent from this collector is discharged beside the size 10 Aerotec stack. Hood volumes, as shown in Table 3, were determined by the hood throat suction method. Total airflow for system #1 was 180 cfm, and 1,260 cfm for system #2. These systems are rated at 300 cfm and 1,800 cfm, respectively. Not only are these systems operating at lower than possible capacity but the relative distribution of air flow per hood is poor.

Table 4 lists the suggested redesign criteria for these two systems which should give optimum dust control with the existing equipment. The volumes shown are the minimum recommended by the ACGIH and have been shown, by experience, to provide adequate dust control. The basic changes in the two systems are the elimination of hood 4C, the connection of hood 1 to system #2 (instead of system #1) and the resizing of connecting ductwork. Hood 4C, which is a "Rube Goldberg" attachment to the table-band saw, will not be necessary if flow through hood 4B is maintained as shown. Hood 1 requires either (a.) the full capacity of system #1 or (b.) connection to a different system. Method (b.) was chosen since the grinder-router produces the greatest amount of dust (see below) of all ventilated equipment therefore requiring a large dust storage hopper in the collector, as exists in system #2. (System #2 at rated flow is more than adequate to handle this added hood when air flow is distributed properly, as shown.) The ductwork resizing, together with a better design of the entry to the size 60 Aerotec (i.e., better layout of branch duct entries) will ensure proper hood air flow distribution. After the system is redesigned, as above, the correct air flows will be assured if the hood entry losses are as given in Table 4.

B. Collector Performance

Table 3C shows the observed and rated pressure loss characteristics of each system. System #1 is operating at only 60% of rated capacity. This is due to a collector pressure loss of six times normal (12.1 vs. 2.0 ins. water). Similarly, system #2 is operating at only 70% of rated capacity due to a collector pressure loss of about twice normal (5.9 vs. 2.8 ins. water). The cause of this inefficient operation is plugged collector tubes (by visual inspection). These small diameter tubes are the primary dust collection elements of the equipment and easily become plugged when the dust hoppers are not cleaned out frequently enough. The units can be returned to and maintained at proper operating conditions by thorough tube cleaning followed by an enforced program of proper clean-out frequency. The bins should never be allowed to become more than about 1/2 to 3/4 full.

Table 3D presents the results of limited stack (point-of-discharge) sampling under conditions of essentially maximum dust loading to the collectors. It was impossible to obtain collector inlet loadings either at the hoods or at the collector because of limitations in hood openings and equipment arrangement. No attempt was made to sample at isokinetic conditions and, therefore, the loadings shown should be considered as order-of-magnitude only. Despite this limitation, the effluent concentrations are obviously extremely high for system #1 and higher than desirable for system #2. It was observed that the effluent from these two stacks settled rapidly within the boundaries of the Quincy yard. Some mechanical equipment in nearby shops, as well as parked automobiles in the vicinity have reportedly been affected adversely due to the discharge from these stacks. In addition, the effluent from these collectors, at times, reenters the pipe covering shop adding to the existing dust concentrations.

The cause of the poor performance of the two collectors, especially the size 10 Aerotec, is the same as that which causes the poor hood performance, i.e., collector tube plugging. When the collectors are thoroughly cleaned and properly maintained and when the exhaust systems are redesigned, as outlined above, the effluent concentrations should drop to less objectionable levels. In addition to the improvement which should be effected by hood and collector modifications, the stacks from each system should be modified to a vertical upward orientation and covered with a weather cap. The existing height (5'-6' above roof level) is adequate since extension of the height might lead to an out-plant problem by increasing the stack fallout trajectory. It may be necessary to change to a more efficient dust collection system but the above procedure should be followed first. Basically inertial collectors, as now installed, should be adequate for this problem.

IV. Conclusions

1. Objectionably high breathing zone dust concentrations are produced in the shop during grinding-routing, band saw cutting, packing-handling and sweeping.

2. Further studies of both in-shop and on-ship dust conditions are warranted.

3. The in-shop conditions are due, in part, to poor performance of the two existing industrial exhaust systems which is caused by poor design and operation of the systems.

4. A serious dust fall problem also exists near the shop due to the poor performance of these systems.

5. Redesign and better operation of the systems will reduce both in-shop and outdoor dust problems.

V. Recommendations

1. Further studies of dust exposures in the pipe covering shop and during insulation installation on shipboard should be made as soon as practicable in order to more fully evaluate the potential health hazards of all operations connected with asbestos pipe covering fabrication and installation at Quincy.

2. Bureau of Mines approved dust respirators should be used by all men who are engaged in grinding, routing, saw cutting, packing, handling and sweeping and proper supervisory surveillance should be maintained to see that these respirators are worn properly and consistently during the above operations.

3. The two exhaust systems should be redesigned and reconditioned as follows:

   a. Hoods should be relocated and ductwork resized as shown in Table 4. (Special attention should be given to the design of the ductwork entry to the size 60 Aerotec unit.)

   b. The dust collector tubes and ductwork should be thoroughly cleaned and the fans and motors checked and reconditioned if necessary.

   c. The existing stack sections should be replaced with 5'-6' vertical sections and provided with weather caps.

   d. The systems should then be balanced to give the proper air flows using the hood entry losses listed in Table 4.

4. A rigidly enforced program of daily cleanout of both dust collectors should be instituted.

5. The use of a portable industrial vacuum cleaner should be substituted for manual sweeping.

6. Dust conditions should be re-evaluated after recommendations 3, 4 and 5 are in effect.

The Office of Industrial Health Engineering has made arrangements to assist in following-out recommendations 1 and 6.

D. M. Anderson

D. M. Anderson

DMA:ws

Table 1. - Airborne Dust Concentrations, Pipe Covering Shop, Quincy Yard

Sample Number	Date	Conditions During Sampling	Dust Concentration mppcf*	Percent Fibers (> 10μ)
A. Routing and Grinding Operations				
YQu-3146	8/30/62	Breathing zone of worker at ventilated grinder-router table continuously routing Kaylo (calcium silicate) sectional insulation. Worker wore respirator. Ductwork leaking dust into area.	6.3	1.1
YQu-3155	8/30/62	Breathing zone of worker helping grinder-router operator (unpacking, packing, etc.) during routing of Kaylo insulation (as above). Worker wore respirator. Simultaneous with YQu-3146.	9.8	0.9
YQu-3169	8/31/62	Same as YQu-3146 on next day. Worker wore respirator. Ductwork repaired.	3.5	0.4
B. Band Saw Cutting Operations				
YQu-3150	8/30/62	Breathing zone of worker cutting Kaylo insulation on 3½' vertical band saw ventilated at top and bottom of run. Worker wore respirator.	34	0.5
YQu-3152	8/30/62	Similar to YQu-3150. Worker did not wear respirator.	14.4	0.6
YQu-3157	8/30/62	Breathing zone of worker cutting Tri-calite (complex silicates) slabs on table-band saw ventilated at top and bottom of run. Worker wore respirator. Bottom hood ineffective.	37	1.6
YQu-3164	8/30/62	Breathing zone of worker assisting operator of table-band saw during operations similar to YQu-3157. Worker did not wear respirator.	5.3	3.3
YQu-3170	8/31/62	Approximate breathing zone of worker during operations similar to YQu-3150 on next day. Worker did not wear respirator.	2.6	0.4

* mppcf - millions of particles per cubic foot of air

Table 1. - Airborne Dust Concentrations, Pipe Covering Shop, Quincy Yard (Cont'd)

Sample Number	Date	Conditions During Sampling	Dust Concentration mppcf*	Percent Fibers (> 10μ)
C. Prefabrication and Sewing Operations				
YQu-3148	8/30/62	General air in south end of shop representative of exposure of one sewer and 2 form-makers working with amosite insulation and asbestos cloth covering. No respirators worn. Average general shop activity.	1.6	1.4
YQu-3156	8/30/62	Breathing zone of worker prefabricating and cementing valve covers using trowel and calcium silicate-asbestos cement. Respirator not worn.	5.4	0.0
YQu-3165	8/30/62	Similar to YQu-3156. Respirator not worn.	0.96	0.0
YQu-3171	8/31/62	Repeat of YQu-3148 on next day. General shop activity about average.	0.94	0.0
D. Miscellaneous Operations				
YQu-3151	8/30/62	Breathing zone of worker unpacking Kaylo sectional insulation. No other dust producing activity in shop. Worker wore respirator.	10.0	1.0
YQu-3158	8/30/62	Breathing zone of worker boxing Tricalite slabs. Table-band saw nearby operated 10% of sample time. Worker wore respirator.	16.6	1.8
YQu-3153	8/30/62	Breathing zone of worker sweeping floor on east side of shop. Floor wetted down lightly beforehand. (Three other sweepers).	37	1.0
YQu-3154	8/30/62	General air of entire shop during and after sweeping. Sweeping one-third of sample time.	13.3	0.7
YQu-3168	8/30/62	Similar to YQu-3153 (different sweeper). Worker wore respirator.	6.4	1.2
YQu-3149	8/30/62	Breathing zone of worker cleaning out hopper of Aerotec (size 10) dust collector and then sweeping up. No respirator worn.	59	0.3

Table 1. - Airborne Dust Concentrations, Pipe Covering Shop, Quincy Yard (Cont'd)

Sample Number	Date	Conditions During Sampling	Dust Concentration mppcf*	Percent Fibers (> 10μ)
D. Miscellaneous Operations (Cont'd)				
YQu-3167	8/30/62	Breathing zone of worker cutting fiberglass sheeting with portable table saw. Good general ventilation.	2.6	3.8
E. General Shop Air				
YQu-3147	8/30/62	General air of entire shop during average activity. Fair general ventilation.	2.5	0.5
YQu-3159	8/30/62	General air of entire shop during lunch period. Fair general ventilation.	2.3	0.0
YQu-3166	8/30/62	General of entire shop during period of little dust production (assembly operations only). Fair general ventilation.	0.14	0.0
YQu-3172	8/31/62	General air of shop area in vicinity of routing and sawing areas. Average activity. (Some dust from Aerotec effluent reenters shop.)	3.1	0.0

Table 2. - Average Dust Concentrations and Comparison with Other Studies

A. Average Concentrations

Operation	No. Samples	Dust Concentration-mppcf Measured Range	Dust Concentration-mppcf Measured Average	Dust Concentration-mppcf Reported Elsewhere* Range	Dust Concentration-mppcf Reported Elsewhere* Average
Grinding-Routing	3	3.5 - 9.8	6.5	9.4 - 100+	50+
Band Saw Cutting	5	2.6 - 37	18.7	11.0 - 100+	42+
Prefabrication-Sewing	4	0.9 - 5.4	2.2	2.1 - 12.3	6.2
Packing-Handling	2	10.0 - 16.6	13.1	- - -	- -
Sweeping	3	6.4 - 37	15.6	- - -	- -
General Shop	4	0.1 - 3.1	2.0	0.0 - 24.6	8.2
Aboard Ship	-	---	-	8.0 - 250	82

B. Average Fiber Content

Dust Source	No. Samples	Percent Fibers (>10μ) Range	Percent Fibers (>10μ) Average
Kaylo insulation (calcium silicate)	12	0.3 - 2.0	1.0
Tricalite insulation(complex silicates)	3	1.6 - 3.3	2.2
General	11	0.0 - 1.4	0.4

* See Fleischer, W.E., Viles, F.J., Gade, R.L. and Drinker, P., "A Health Survey of Pipe Covering Operations in Constructing Naval Vessels", J. Ind. Hyg. and Toxicol., 28, 9 (1946).

Table 3. - Performance of Industrial Ventilation Systems, Pipe Covering Shop, Quincy Yard

A. Hood Performance - System #1

Hood	Location	Entry Loss (h_e) ins. water	Entry Coef. (Ce) estimated	Duct Diam. ins.	Air Flow cfm	Comments
1	grinder-router table	0.2	0.59	4.5	120	after cleaning out dust collector (duct to spindle sander closed)
1	" " "	0.1	0.59	4.5	80	duct to sander open
2	spindle sander	0.1	0.55	3.0	100	" " " "
Total					180	(max. flow)

B. Hood Performance - System #2

Hood	Location	Entry Loss (h_e) ins. water	Entry Coef. (Ce) estimated	Duct Diam. ins.	Air Flow cfm	Comments
3A	3½' band saw - top	0.8	0.55	3.0	100	all system dampers open
3B	" " " - bottom	2.7	0.55	6.0	710	" " " "
4A	table-bandsaw - top	1.4	0.55	3.0	130	" " " "
4B	" " " - bottom	2.9	0.55	3.0	180	" " " "
4C	" " " - added	1.8	0.55	3.0	140	" " " "
Total					1,260	(max. flow)

C. Collector Performance - Pressure Loss

System	Collector	Rated Capacity* cfm	Inlet SP (measured) ins. water	Actual Flow (measured) cfm	Avail. SP** ins. water	Collector ΔP ins. water (meas.)	Collector ΔP ins. water (rated)
#1	Aerotec - size 10	300	0.2	180	12.3	12.1	2.0
#2	Aerotec - size 60	1,800	5.1	1,260	11.0	5.9	2.8

* - At rated 5.0 ins. water SP @ inlet
** - Available for system ΔP and collector ΔP (rated)

Table 3. - Performance of Industrial Ventilation Systems, Pipe Covering Shop, Quincy Yard (Cont'd)

D. - Collector Performance - Effluent Concentrations

System	Collector	Effluent Concentrations by count-bppcf***	Effluent Concentrations by wt.-grs/cu.ft.****	Comments
#1	Aerotec -size 10	14.0	16.3	Dust from cont. op. of router
"	" " "	76.0	38.5	" " " " " "
#2	Aerotec - size 60	1.2	0.4	" " " " " 3½' band saw
"	" " "	1.8	1.2	" " " " " " " "

*** - bppcf - billions of particles per cubic foot of air
****- grs./cu.ft. - grains per cubic foot of air

Table 4. - Recommended Exhaust Volumes for Existing Ventilation Systems.

A. - System #1 (Aerotec-size 10) (300 cfm capacity)

Hood*	Location	Minimum flow required cfm	Replace with duct diam. ins.	Correct Entry Loss (h_e) ins. water
2	Spindle sander	300	4.5	1.2
Total		300		

B. - System #2 (Aerotec-size 60) (1,800 cfm capacity)

Hood*	Location	Minimum flow required cfm	Replace with duct diam. ins.	Correct Entry Loss (h_e) ins. water
1	grinder-router table	350	4.5	1.1
3A	3½' band saw - top	350	4.5	1.2
3B	" " " - bottom	350	4.5	1.2
4A	table-band saw - top	350	4.5	1.2
4B	" " " - bottom	350	4.5	1.2
4C	remove			
Total		1,750		

* same designation as Table 3.