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SUPPLEMENTAL REPORT ON OFFICIAL INVESTIGATION OF THE
DISASTER OF OCTOBER 30 & 31, 1948 IN DONORA AND
VICINITY OF THE BOROUGH COUNCIL OF DONORA

AUTHORIZATION

This supplemental report was made pursuant to the authorization of Borough of Donora Council, in a unanimous resolution passed November 1, 1948, to investigate the cause of the disaster of the previous weekend.

There has been some question of the previous report of Nov. 29, 1948 about the use of the words "OFFICIAL REPORT". This question was a quibble because The U. S. Steel Corporation for financial reasons did not want the real cause of the catastrophe known. The resolution was passed. I had to report. Therefore it was official to the Borough Council.

THE DISASTER

Donora is a town of 13,000 people. There are a large number of people in the valley outside of the Borough limits. More than three-quarters of these people were affected by the chemicals in the fog that persisted in the last few days of October 1948. In the town of Webster directly across the river nearly every one who does not work for the U. S. Steel Corporation said that they were effected. It is my opinion that every one in the valley and adjoining hollows were effected to varying degrees.

There was little unusual about this fog. Whenever similar fogs existed for several days in the Vicinity of Donora the Death rate increased. In towns in many parts of the nation with open hearth furnaces that use Fluorspar this is a common occurrence.

CAUSE

Donora, Washington County, Pennsylvania, is situated in the narrow valley of the Monongahela River on a horseshoe bend about 25 miles south of Pittsburgh. The river valley is very narrow at this point, the flood plain is about 500 feet wide on the Donora side and 200 feet on the Webster side. At this point from the flood plains, the sides of the valley rise very steeply at about 300 to some 400 feet above the river. At the South end of the river flows from the West, flowing toward the North of the town and then again to the West, nearly encircling the town. A fog or cloud bank across the top of the hills can make a pocket where may be very little movement of air. The fog was over the valley for four days. Thus the gaseous waste products of the several plants and railroads were effectively held in the valley. As the wind moved very slowly, the concentrations of the noxious products increased. It took nearly forty hours for the concentration to

become severe enough to kill the residents. 17 died in Danzha and 3 in Wafister, and others in surrounding territory including Inupiat.

Deer being saturated with soot from the many fires that did not combust completely, the fog blanket also contained toxic quantities of one or more gases. The toxic gases present were:

1. Sulfur dioxide
2. Carbon monoxide
3. Carbon dioxide
4. Hydrofluoric acid.

Although it has not yet been shown that numbers 1, 2 and 3 were present in quantities sufficient to kill, Hydrofluoric Acid was there in quantities sufficient to give symptoms in humans of chronic and acute fluorine intoxication.

Also present in the soot well quantities of:

1. Silicon 5%
2. Iron 3%
3. Aluminum 3%
4. Carbon

minor quantities of zinc, calcium and traces of:

1. Copper 0.0X (Low)
2. Lead 0.X
3. Nickel 0.00X
4. Tin 0.0X
5. Bismuth 0.00X
6. Manganese 0.X
7. Magnesium 0.X
8. Silver 0.00X
9. Cadmium 0.0X
10. Chromium 0.00X
11. Boron 0.00X
12. Molybdenum 0.00X
13. Vanadium 0.00X
14. Titanium 0.X
15. Zirconium 0.0X
16. Cobalt 0.00X
17. Strontium 0.0X
18. Barium 0.0X

Selenium was present to the extent of less than 1 part per million.

SULFUR DIOXIDE

In all cases of serious damage from Sulfur dioxide, the quantities allowed to escape are higher than the amount of Sulfur

roasted for Sulfuric acid manufacture. There is little reason to believe that Sulfuric acid manufacture was so inefficient that toxic quantities escaped. Moreover, the pattern of damage to vegetation was not that of Sulfur dioxide. Although corn is one of the plants least affected by Sulfur dioxide, corn was severely damaged. The symptoms of the affected humans do not fit Sulfur dioxide poisoning. Since no evidence of a catalyst to convert Sulfur dioxide to Sulfur by other investigators. Very few reports have been received concerning the characteristic SO₂ smell.

There is evidence that carbon of the soot, iron oxide, and ultra-violet light act as catalysts. We have found that the precipitated smog did contain sulfuric acid as well as Hydrofluoric acid.

The open hearths, combustion of coal, as well as the sulfuric acid plant make SO₂ that escapes into the atmosphere. The concentration of SO₂ from the open hearth is small. The total of these gases added to the general pollution reaches irritating proportions.

Hydrofluoric acid which is a decomposition product of the reaction of sand and fluorspar is present in small altho still toxic and irritating quantities. The reaction of the Hydrofluoric acid with the water vapor like the reaction of the sulfur trioxide with water in the air tend to settle toward the ground.

Sulfuric and sulfurous acid products of the decomposition of the sulfur in fuels cause considerable destruction to property and no doubt to Health. They are not as serious as Hydrofluoric acid. The American Steel & Wire Company makes galvanized wire, by adding a zinc coating to steel wire. Tests have been made by committees of the American Society of Testing Materials for many years showing how such wire stands up in various locations.

	<u>CORROSION IN YEARS</u>			
	<u>INITIAL</u>	<u>20%</u>	<u>37%</u>	<u>100%</u>
Pittsburgh	1.75	1.8		2.5
State College	7.75	8.5	8.75	
Sandy Hook	3.5	3.75		4.6
Lafayette	7.25	7.6		9.0
Bridgport, Conn.	3.5	3.85		4.85
Ithaca	8.0	8.75	9.25	
Ames, Iowa	8.25		9.5	

From this table and many others in the reports to ASTM it shows that Pittsburgh is the most corrosive in the U. S. A. Conditions at Donora and Webster are actually worse because the vegetation is more seriously damaged. Other cities have high corrosion rates varying between the two extremes. Unnecessary corrosion of property and injury to health cost every one extra money. This can be prevented.

Dr. H. V. Churchill, V. P. & Director of Research of the Aluminum Co. of America has been interested in the amount of fluorine in vegetation. As a result of law suits against his company and plants that they operated that the research department under Churchill's direction has made many analysis of vegetation along the Allegheny River. This site was chosen because their main labs are located at New Kensington. Churchill published his results in Industrial & Engineering Chemistry, Analytical Edition Jan. 1948. Churchill reports considerable Fluorine in the vegetation. The quantity increased as the season progressed.

Credit was given to the large quantities of coal combusted in the Pittsburgh District source. Coal does not contribute as much fluorine containing gases as Steel Industry. As the fluorspar used in the open hearth, the electric furnace and the zinc refining collectively is much more than the large chemical industry. The following is from the Bureau of Mines on Fluorspar consumption in tons.

	1940	1945	1946	1947	1948
Steel Industry	110,000	197,916	160,735	209,395	200,000
Hydrofluoric Mfg.		109,315	83,901	100,363	100,000

The quantity in coal is not equal to these figures. Considering the Pittsburgh District is the worlds largest steel producing center with Donora & Monessen as a part there is more from this source than many others. There is a minimum of 4 lbs. of fluorspar used for each ton of steel. The use in zinc production is far greater per ton than in steel.

The zinc furnaces are not arranged so as to collect the Fluorine containing gases. They go off at a level well below the valley's top. They leave the mill at about 60 ft. above the ground. The pictures of the mill show that more smoke came from the furnaces below the stacks than from the stacks. These gases have been analyzed and found to contain sufficient fluorine to kill small animals in 8 hours and probably humans in 8 hours. This should have been known by the mill management as they should have noticed that they killed the vegetation years ago. When the gases given off by the zinc mill became so bad that the superintendent could not live in the house where the superintendent formerly lived, the company did or should have had the gases analyzed. The presence of fluorine should have made the company correct its ways. When the mill superintendent could not live in his fine house he should have applied the golden rule and realized that the neighbors also did not thrive under the fumes. The mill should have realized that if vegetation were killed the fumes were injuring the health.

CARBON DIOXIDE

The quantity of Carbon dioxide present was not sufficient to cause suffocation. The concentration may have been sufficient

to have contributed. The symptoms were, however, not those of carbon dioxide suffocation. Moreover, the blood examinations did not indicate carbon dioxide. However, the Sulfur dioxide, Carbon monoxide, and Carbon dioxide could have contributed in a minor way to the catastrophe.

The toxic effects of these three gases were enhanced by the concentrations of each other, HF, soot uncombusted fuel gases and other imparities. We doubt if the amount of CO₂ itself was sufficient to kill.

ZINC & CADMIUM

In the Nov. 29, 1948 report we stated that zinc and cadmium could not have carried all over town. Subsequent investigation has shown that zinc oxide might have reached 0.3% of the solid matter of the smog in the north end of town.

Cadmium selenide was less than 1 p.p.m. of the solid matter of the smog. Cadmium salts were higher. Cadmium Selenide is very toxic to the human respiratory system. HF was 1000 or more times as concentrated. They did suspend in the fog but not in toxic quantities.

SMOKE

Smoke is generally an unnecessary nuisance. Smoke is the sign of inefficiency. It is poorly combusted particles of fuel. The fuel value that goes into the air as particles of carbon, tars, and gases may be as much as 50% of the heating value of coal.

There are ways of measuring the amount of CO₂ in the stack. It should be 14%. Several companies sell the CO₂ indicators & recorders. There, also, are smoke density indicators which will give a signal whenever the density is greater than pre-determined. The relay can start a blower or other equipment to control the smoke. The relay also operates an alarm that warns the boiler operator to adjust his drafts to get better fuel combustions.

Methods of correcting inefficient fuel combustion have been well known to other communities for years. Some of the companies operating in the Donora Valley have been practicing it elsewhere. There have been numerous times that I have #5 smoking locomotives in the valley. The number of non-smoking locomotives is in the small minority, they are inconspicuous along side of the black smokers.

There are other cities which have corrected such filth menaces by passing the proper laws.

SCOT

Altho soot did not cause the trouble subsequent investi-

The larger the installation for combusting fuel oil or coal, the less excuse there is for smoke to be emitted. It used to be that a smoking chimney was a sign of a busy industry. Now it is a sign of a wasteful plant, inefficiently operated and probably losing money.

The large railroads are offenders in the smoke problem at the round-house in switching and on the busy track. The executives in charge of the motive equipment say that there is no need of smoking locomotives. Executives admit that when a locomotive is smoking, that their fireman on that particular locomotive is not doing his job correctly. Therefore in a number of cities, the large railroads, which could have prevented such enactment of ordinances for the control of air pollution, have generally cooperated in the preparation of such ordinances, as they expect to save money by the better operation of their locomotives.

The research departments of some of the larger railroads and the locomotive manufacturers have been doing considerable investigating of ways and means of preventing smoke from being emitted from the locomotive. A properly fired locomotive will not smoke even when the throttle is suddenly opened, causing a strong draft to go through the fire-bed.

There are a number of grades of bituminous coal on the market in the United States. There appears at various times to be a tight market on the high volatile coals, as they are useful in gas making. Therefore highly volatile research coal should not be used as a primary fuel in a grate. If it is deemed economical to use such high volatile bituminous coals as compared to low and medium volatile bituminous coals, the high volatile bituminous coal should be pre-treated. Pre-treating does not need to cost money. The products derived from the pre-treating of high volatile bituminous coal are in great demand in the chemical market. These materials, which are driven off in the pre-treating are:

1. Aromatic solvents, including benzol.
2. Tar acids, such as phenol.
3. Gases. The gas can be used for operating the process, and some can be sold. Fine, which are normally not desired in the combustion of coal, will be agglomerated in such processes.

The yield of two thousand lbs. (2,000 lbs.) of high volatile coal by such processes would yield 1,500 to 1,800 lbs. of coke as well as 10,000 cu. ft. of gas and many lbs. of chemicals. The heat value out of the remaining coke will be approximately the same in our methods of combustion as poorly burned coal so that people can afford to pay more for the coke than they do for the coal, while the operating expense and profit will come out of the gas and chemical products. We are now wasting 20% to 50% of our coal, which would allow for a 20% increase in the price of the coke.

directed by the industrialists that nothing very concrete was done except to scare one or more of the offenders. The same type of disaster is happening on a smaller scale in a number of large industrial cities of the United States, including Cleveland. Cleveland has some of the same contributors as Donora. The Open Hearth furnaces are much more active in the Cuyahoga Valley than at Donora. Both in the Monacaohela Valley and at Donora the coke works are inefficient. This should not be allowed. The management should be interested in saving the money. It is now being laid down on the houses of Donora and Webster and other places where the operator cannot sell his product.

For a long time there has been a popular idea that smoke does not injure health. This we shall have to differ with because smoke frequently has absorbed acids in the air, such as hydrofluoric and sulphuric. Such acids, when absorbed with the carbon into the lungs and onto the membrane of the respiratory system, certainly affect one's health. Also this same soot, with acid gases absorbed, causes the hydrolysis or breakdown of cotton or other cellulosic materials. It has been reported to us that many a time clothes put on the line to dry will have soot marks, and where these soot marks are, the cloth will disintegrate. It has been reliably reported that the average adult breathes about 30 cu. inches of air in each inhalation. This amounts to around 2,000 gallons of air every 24 hours, or around 30 lbs. in weight, which is 3 to 8 times the amount of food and water consumed by the individual. This carbon deposits on the lung, the acid will be transferred from the soot to the mucous membrane, causing irritation. It has been reliably reported by investigators, such as H. B. Mellor, former chief of Pittsburgh's Bureau of Smoke Regulation, that, "More persons are devitalized, and poisoned by impurities obtained in smoke polluted air than by noxious ingredients in food and water." This is what you are breathing.

Smoke contains several things which make it visible, - namely, carbon and organic materials which are classified as tar. We have found that the soot in Donora does contain tar and sulphates as well as many metallurgical dusts, and it is the hydrocarbons in the tar which investigators say are one of the causes of respiratory cancer. Better combustion would eliminate this serious hazard. The soot adjoining the Donora Valley ranges up to a thousand tons per mile per year. The greater the distance from the Donora Valley, the more this drops off until it gets in the neighborhood of 200 tons per mile per year. These figures were much higher several years ago before the Smoke Ordinance was installed. It shows that improvement can be made and we feel that a still greater improvement can be continued.

Although we see the black soot, there are many other things which wash out into the atmosphere with the soot, and should be treated as seriously. Sulfur, for instance, is dissipated into the air along with the exhaust products from the combustion of coal. Fly ash is a particularly disagreeable material. Also there are a number of plants which are just as serious as the smoking chimneys located in the valley.

Fluorine gases in atmosphere as industrial waste blamed for death and chronic poisoning of Donora and Webster, Pa., inhabitants . . . Rohm and Haas begins operations in Houston . . . Merck aid obtained in setting up penicillin plant in U. S. zone, Germany

CIRCUMSTANTIAL and actual proof has been found of acute fluorine poisoning by the smog in the Monongahela River Valley to persons who already had chronic fluorine intoxication, states the official report of investigations of the cause of the deaths of 17 people in Donora, Pa., and of 3 in Webster during the last weekend in October. Most of the well-known symptoms of acute fluorine poisoning were found by members of the medical profession who examined victims of the smog, Philip Sadtler, consultant, discovered.

The fog bank across the tops of the valley walls surrounding the towns for four days had permitted little movement of air and allowed the gaseous waste products of several plants and the railroads to accumulate. Besides being saturated with soot, the fog blanket also contained sulfur dioxide, carbon monoxide, and hydrofluoric acid. It has not yet been shown that the first three were present in quantities sufficient to kill. Numerous factors, however, indicated fluorine poisoning, Mr. Sadtler states. Fluorine-containing substances are used in several plants in the vicinity. Analysis of blood of deceased and hospitalized victims showed 12 to 25 times the normal quantity of fluorine. Corn crops, very sensitive to fluorine, were severely damaged and all of the vegetation north of the town was killed. One of the primary symptoms of acute fluorine poisoning in human beings, dyspnea (distressed breathing similar to attacks of asthma) has been found in hundreds of cases. Although those who were affected were of all ages, those who died had displayed symptoms similar to those of chronic fluorine poisoning much earlier. Conspicuous evidence of such chronic

poisoning in young persons in the vicinity is the high incidence of mottled tooth enamel and dental caries. Moreover, many effects of secondary fluorine poisoning are to be seen in herbivorous animals in the region. Lastly, inanimate objects show evidence of attack by acid gases.

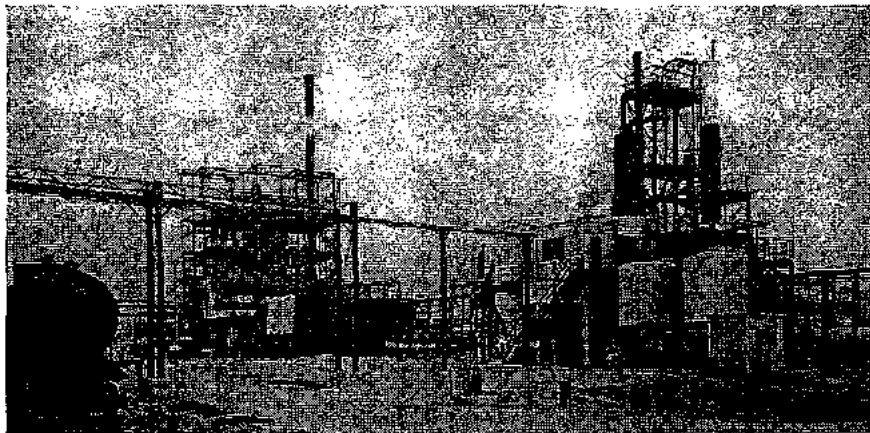
Recommendations for improvements call for completion of the study in order to single out the plants, materials, and processes causing the trouble. Changes should be made in suspect processes to prevent emission of fluorine-containing fumes, and improvements in combustion are needed. Cottrell precipitators to collect dust and scrubbers to absorb the acid gases are also essential, Mr. Sadtler concludes.

Rohm and Haas' Houston Plant in Operation

The fourth and newest plant of the Rohm and Haas Co., on which construction began early in 1947 (C&EN, page 3362, Dec. 25, 1946), is now in operation. Situated on a 500-acre tract on the Ship Channel, about 15 miles from Houston, Tex., the plant is the first one in the country to be built for the large-scale production of hydrogen cyanide by direct synthesis.

Most hydrogen cyanide has been made in the past by acid decomposition of sodium or calcium cyanides. The direct method used at the new plant is that of catalytically reacting ammonia with methane. In order to obtain high-purity methane for this reaction, the new plant has in operation the second one of Union Oil Co.'s new hypersorption units to be installed in this country, the other being at Dow's

Rohm and Haas' new Houston plant. Hydrogen cyanide unit appears in left background and one of the intermediate processing units, in the right foreground



... methane, which, plant. This unit concentrates the methane in natural gas (about 90%) to almost 100%.

The hydrogen cyanide is reacted with cracked refinery gases to produce ethyl acrylonitrile or with acetone to produce acetone cyanohydrin. The company hopes to manufacture methyl methacrylate from acetone cyanohydrin some time in the future, but at present the acrylonitrile products are being shipped to the Rohm and Haas plants to be used in the manufacture of methyl methacrylate plastics and other materials.

Process engineering for the new plant was done by the Rohm and Haas engineering staff and construction, by the J. P. Wheeler Corp.

Penicillin to Be Produced in U. S. Zone with Merck Aid

Merck & Co., Inc., Rahway, N. J., at the request of the U. S. Military Government for Germany, has agreed to assist in the installation of a penicillin plant in the U. S. zone. An agreement has been reached between Merck & Co., the Joint Export-Import Agency, a United States-United Kingdom organization controlling all economic activities in Bizonia, Farbwerke Höchst, a pharmaceutical plant in the U. S. zone. This plant will be operated by a trustee under general supervision of allied authorities.

Merck will provide plans, assistance, and competent personnel to advise on plant construction and initial operation, but will have no corporate or financial interest in the plant or its operation except to receive royalties as called for in the agreement. Excluded in the agreement are royalties on penicillin sold to or produced for the accounts of the U. S. or U. K. military governments used for occupation forces.

This agreement is similar to previous ones reached by Merck and the Glaxo Laboratories, Ltd., and Rhone-Poulenc to produce penicillin at plants at Greenford, England, and Paris, France, respectively.

Du Pont Plans Texas Nylon Intermediates Plant

The purchase of one tract and the exercise of an option on another, a total of 1,700 acres in all, in the Guadalupe River valley, near Victoria, Tex., for a projected chemical plant has been announced by E. I. du Pont de Nemours & Co. Victoria is 120 miles southwest of Houston and 72 miles northwest of Corpus Christi. The ammonia department of the company has concluded preliminary engineering studies of the site with a view toward building there a third plant to make chemical intermediates for nylon. These intermediates would be supplied to other Du Pont plants at Seaford, Del., Martinsville, Va., Chattanooga, Tenn., and Parkersburg, W. Va., for