2. One zinc plant equipped with reduction furnaces, retort drying ovens, and other operations compatible with zinc plants.

3. One sulfuric acid plant.

Other heavy industries in the nearby area, which interested the investigators, included: two steel companies and one by-product plant in Monessen; a steel and by-product plant in Clairton; a glass company in Charleroi; and a [illegible] company and a railroad in Elrama.

A study of the plant processes and analyses of the raw materials used in those industries led the investigators to analyze the atmosphere for the following constituents:

Total particulate matter	Acid gases	Carbon monoxide
Lead	Hydrogen	Oxygen
Cadmium	Arsine	Oxides of nitrogen
Zinc	Arsenic	Stibine
Iron	Sulfur dioxide	Manganese
Chloride	Total sulfur	Iron carbonyl
Fluoride	Carbon dioxide	

The investigators concluded that:

> It seems reasonable to state that while no *single* substance was responsible for the October, 1948, episode, the syndrome could have been produced by a combination or summation of the action of two or more of the contaminants. Sulfur dioxide and its oxidation products, together with particulate matter, are considered significant contaminants. However, the significance of the other irritants as important adjuvants to the biological effects cannot be finally estimated on the basis of present knowledge.
>
> Information available on the toxicological effects of mixed irritant gases is meager and data on possible enhanced action due to adsorption of gases on particulate matter is limited. Further, available toxicological information pertains mainly to adults in relatively good health. Hence, the lack of fundamental data on the physiologic effects of a mixture of gases and particulate matter, over a period of time, is a severe handicap in evaluating the effects of atmospheric pollutants on persons of all ages and in various stages of health.

Although sufficient data were not available to determine the exact causative agent, sufficient environmental data were available to make ten recommendations which, if fulfilled, would prevent a recurrence of the disaster.

Poza Rica. The third much-publicized incident occurred in Poza Rica, Mexico,[4] on November 24, 1950, with a record of 22 persons dead and 320 people hospitalized.

A review of the history of the incident shows that the sulfur-removal unit (Girbotol unit) began operation on November 21, 1950. A few days after the unit was in operation trouble developed, when the amine solution overflowed, partly plugging the gas lines to the pilot lights of the flares. However, the unit appeared normal under the reduced rate of flow.

On November 24, 1950, at approximately 2:00 A.M., efforts were made to increase the rate of flow of gas to the plant's rated capacity of 60 billion cubic feet per day. The desired rate of flow was reached at approximately 2:30 A.M. At approximately 4:00 A.M. difficulty was encountered, and the gas flow began bypassing through the unit, with the probable result that unburned hydrogen sulfide escaped into the atmosphere.

[4] L. C. McCabe and G. D. Clayton, Air pollution by hydrogen sulfide in Poza Rica, Mexico, *Arch. Ind. Hyg. and Occupational Medicine*, 6, 199–213 (1952).

The available meteorological data indicate a pronounced low-altitude temperature inversion, a high concentration of haze and nuclei, and a very slight wind movement prevailing.

The epidemiological study indicated that the time of onset of the incident was about 4:50 A.M., and the acute phase was ended about 5:10 A.M. The victims were affected in a geographical area in direct proximity to the effluent stack of the Girbotol unit. During this short period, the acute exposure to the atmospheric pollution caused the death of 22 people and the hospitalization of 320.

The onset, the symptoms and signs, as well as the pathological findings, are consistent with hydrogen sulfide poisoning, and there were no findings that conflicted with this diagnosis. Therefore, it is to be concluded that the hydrogen sulfide that caused this morbidity and mortality came from the effluent stack of the Girbotol unit.

London. During the period December 5–8, 1952, the fourth and worst air-pollution disaster occurred. When these deaths were being recorded, the London area experienced periods of smog, culminating in one of much intensity. The onset was accompanied by meteorological factors of low temperature inversion and almost complete absence of wind or air movement. No radio or balloon-sonde ascents were made within the fog belt. Ascents at Cardington, 50 miles north of London, where visibility did not fall below 1,000 yards during the period, show a continuous inversion from ground level up to heights between 500 and 1,000 feet. Reports from aircraft landing at London Airport after the fog had cleared temporarily place the height of the inversion at 200 to 300 feet, with a haze layer extending to 2,000 feet.

This is the first air-pollution disaster where air sampling was conducted before, during, and after the episode. The data collected showed the particulate matter (obtained by sampling with filter paper and reporting the degree of color in milligrams of total weight per cubic meter of air) ranged from 0.30 to 1.8 mg. per cubic meter of air, with an average of 0.50 for the two-week period preceding the disaster. On the days when deaths were occurring, the values increased to a maximum of 4.46 mg. per cubic meter of air, a ninefold increase over the previous average.

Sulfur dioxide ranged from 0.09 to 0.33 p.p.m. with an average of 0.15, for the two-week period preceding the disaster. During the period when deaths were occurring the SO_2 values increased to a maximum of 1.33 p.p.m., which was also a ninefold increase over the average of the preceding days.

During the weeks ending December 13 and December 20, 1952, at least 3,000 more deaths occurred than would be expected. Although the increase was present