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PART II

ENVIRONMENTAL PROTECTION AGENCY

NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

Asbestos, Beryllium, and Mercury

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Title 40—Protection of Environment

CHAPTER I—ENVIRONMENTAL PROTECTION AGENCY

SUBCHAPTER C—AIR PROGRAMS

PART 61—NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

Asbestos, Beryllium, and Mercury

On March 31, 1971 (36 FR 5931), pursuant to section 112 of the Clean Air Act, as amended, the Administrator published an initial list of three hazardous air pollutants which, in his judgment may cause, or contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness. The pollutants were asbestos, beryllium, and mercury. On December 7, 1971 (36 FR 23239), the Administrator proposed standards for these pollutants.

Interested persons participated in the rulemaking by giving testimony at public hearings and by sending comments to EPA. Public hearings were held in New York City on January 18, 1972, and in Los Angeles on February 15 and 16, 1972. A third hearing, scheduled to be held in Kansas City, on February 1, 1972, was canceled because of a lack of requests to participate. Sixty-eight persons gave testimony at the public hearings, and 56 persons sent comments to EPA. Represented were industries, universities, governmental agencies—Federal, State, and local, and environmental groups. Copies of the public hearing records are available at all EPA Regional Offices and at the Division of Stationary Source Enforcement, room 3220, 401 M Street SW., Washington, D.C. 20460, where copies of the comments received are also available.

The bases for the Administrator's determinations that asbestos, beryllium, and mercury are hazardous, the derivations of the standards now adopted, the Environmental Protection Agency's responses to the significant comments received, and the principal revisions to the proposed standards are summarized below. A more detailed statement is available on request from the Emission Standards and Engineering Division, Environmental Protection Agency, Research Triangle Park, N.C. 27711, Attention: Mr. Don Goodwin. In addition, the Administrator is issuing information on control techniques for asbestos, beryllium, and mercury as directed by section 112(b)(2) of the act. Copies of these documents may be obtained free of charge from EPA Regional Offices.

Asbestos

Asbestos is a hazardous air pollutant within the meaning of section 112. Many persons exposed to asbestos dust developed asbestosis when the dust concentration was high or the duration of exposure was long (1–7). A large number of studies have shown that there is an association between occupational exposure to asbestos and a higher-than-expected incidence of bronchial cancer (8–30). Asbestos also has been identified as a causal factor in the development of mesotheliomas, cancers of the membranes lining the chest and abdomen (36–47). There are reports of mesotheliomas associated with nonoccupational exposures in the neighborhood of asbestos sources (34, 42, 47, 48). An outstanding feature has been the long period, commonly over 30 years, between the first exposure to asbestos and the appearance of a tumor (49, 50). There is evidence which indicates that mesotheliomas occur after much less exposure to asbestos dust than the exposure associated with asbestosis (51, 52).

It is not practicable, at this time, to establish allowable numerical concentrations or mass emission limits for asbestos. Satisfactory means of measuring ambient asbestos concentrations have only recently been developed, and satisfactory means of measuring asbestos emissions are still unavailable. Even if satisfactory means of measuring asbestos emissions did exist, the previous unavailability of a satisfactory means of measuring ambient levels of asbestos makes it impossible to estimate even roughly the quantitative relationship between asbestos-caused illness and the doses which caused those illnesses. This is a major problem, since some asbestos caused illnesses have a 30-year latency period.

EPA considered the possibility of banning production, processing, and use of asbestos or banning all emissions of asbestos into the atmosphere, but rejected these approaches. The problem of measuring asbestos emissions would make the latter approach impossible to enforce. Either approach would result in the prohibition of many activities which are extremely important; moreover, the available evidence relating to the health hazards of asbestos does not suggest that such prohibition is necessary to protect public health. For example, demolition of any building containing asbestos fireproofing or insulating materials would have to be prohibited as would the use of materials containing even trace amounts of asbestos which could escape into the atmosphere.

Finally, the available evidence suggests a gradient of effects from direct occupational, to indirect occupational exposure, to families of workers exposed to asbestos and persons in the neighborhood of asbestos sources—in all of which situations asbestos concentrations are undoubtedly high by comparison with most community air. This suggests that there are levels of asbestos exposure that will not be associated with any detectable risk, although these levels are not known (53).

It is probable that the effects of asbestos inhalation are cumulative; that is, low-level and or intermittent exposure to asbestos over a long time may be equally as important in the etiology of asbestotic disease as high level and/or continuous exposure over a shorter period. On the other hand, the available evidence does not indicate that levels of asbestos in most community air cause asbestotic disease. Taking both these considerations into account, the Administrator has determined that, in order to provide an ample margin of safety to protect the public health from asbestos, it is necessary to control emissions from major man-made sources of asbestos emissions into the atmosphere, but that it is not necessary to prohibit all emissions.

In this determination, the Administrator has relied on the National Academy of Sciences' report on asbestos (53), which concludes: "Asbestos is too important in our technology and economy for its essential use to be stopped. But, because of the known serious effects of uncontrolled inhalation of asbestos minerals in industry and uncertainty as to the shape and character of the dose-response curve in man, it would be highly imprudent to permit additional contamination of the public environment with asbestos. Continued use at minimal risk to the public requires that the major sources of man-made asbestose emission into the atmosphere be defined and controlled."

The means of control used are limitations on visible emissions with an option in some cases to use designated control equipment, requirements that certain procedures be followed, and prohibitions on the use of certain materials or of certain operations. These means of control are required because of the impossibility at this time of prescribing and enforcing allowable numerical concentrations or mass emission limitations known to provide an ample margin of safety. The alternative of no control of the sources subject to this standard was rejected because of the significant health hazard of unregulated emissions of asbestos into the atmosphere from the designated major sources.

It is the Administrator's judgment that the asbestos sources subject to this standard are the major sources of asbestos emissions. In the absence of quantitative emission data, the Administrator's judgment was based on an national inventory of sources and emissions of asbestos (54) and other reports (53, 55). The asbestos emissions and emission factors presented in the national inventory were based on information obtained from production and reprocessing companies. This information included production figures, estimates of control equipment efficiency and material balances; it did not include emission test results. The major sources of asbestos emissions were considered to fall into five categories: (1) Mining and milling; (2) manufacturing; (3) fabrication; (4) demolition; and (5) spraying. In determining which of these major sources should be covered by the standard promulgated herein, the Administrator considered the effect other Federal regulations will have on the emissions from such sources and the proximity of such sources to the public. In addition, the Administrator considered comments on the proposed standard and additional technical data not available before proposal. The following paragraphs explain these considerations and the changes made to the standard between proposal and final promulgation.

The promulgated standard applies to asbestos mills, selected manufacturing operations, the use of spray-on asbestos

References at end of article.

materials, demolition operations, and the surfacing of roadways with asbestos tailings. The Administrator will continue to investigate other existing and new sources of asbestos emission and if any of them are found to be major sources, the standard will be revised to cover them.

As applied to mines, the proposed standard would have limited the emissions from drilling operations and prohibited visible emissions of particulate matter from mine roads surfaced with asbestos tailings. The Bureau of Mines has prescribed health and safety regulations (30 CFR 55.5) for the purpose of protecting life, the promotion of health and safety, and the prevention of accidents in open pit metal and nonmetallic mines. As related to asbestos mines, these regulations prohibit persons working in a mine from being exposed to asbestos concentrations which exceed the threshold limit value adopted by the American Conference of Governmental Industrial Hygienists. The regulations specify that respirators shall not be used to prevent persons from being exposed to asbestos where environmental measures are available. For drilling operations, the regulations require that the holes be collared and drilled wet. The regulations recommend that haulage roads, rock transfer points, crushers, and other points where dust (asbestos) is produced sufficient to cause a health or safety hazard be wetted down as often as necessary unless the dust is controlled adequately by other means. In the judgment of the Administrator, implementation of these regulations will prevent asbestos mines from being a major source which must be covered by the standard promulgated herein. Furthermore, the public is sufficiently removed from the mine work environment that their exposure should be significantly less than that of the workers in the work environment. Accordingly, the promulgated standard does not apply to drilling operations or roadways at mine locations.

For asbestos mills, the proposed standard would have applied to ore dumps, open storage areas for asbestos materials, tailings dumps, ore dryers, air for processing ore, air for exhausting particulate material from work areas, and any milling operation which continuously generates inplant visible emissions. The promulgated standard prohibits visible emissions from any part of the mill, but it does not apply to dumps of asbestos tailings or open storage of asbestos ores. The Bureau of Mines' regulations previously referenced and regulations issued by the Occupational Safety and Health Administration (20 CFR 1910.93a) protect workers from the hazards of air contaminants in the work environment. The Occupational Safety and Health Administration regulations were promulgated on June 7, 1972. The regulations are intended to protect the health of employees from asbestos exposure by means of engineering controls (i.e. isolation, enclosures, and dust collection) rather than by personal protective equipment. It is the judgment of the Administrator that measures taken to comply with the Bureau of Mines and Occupational Safety and Health Administration regulations to protect the health of persons who work in proximity to dumps and open storage areas will prevent the dumps and storage areas from being major sources of asbestos emissions.

The proposed standard would have applied to buildings, structures, or facilities within which any fabricating or manufacturing operation is carried on which involves the use of asbestos materials. Comments received on the proposed standard indicated that the requirements for fabricating and manufacturing operations were confusing. Much of the confusion was created by the use of terms such as "any," "continuously," and "forced gas streams." The promulgated standard is more definitive as to applicability of the provisions. The promulgated standard prohibits visible emissions from the nine manufacturing operations which, in the judgment of the Administrator, are major sources of asbestos. The promulgated standard does not cover fabrication operations. Of all fabrication operations, only those operations at new construction sites are considered to be major sources of asbestos emissions. The Occupational Safety and Health Administration regulations specify that all hand- or power-operated tools (i.e. saws, scorers, abrasive wheels, and drills) which produce asbestos dust be provided with dust collection systems. In the judgment of the Administrator, implementation of these regulations will prevent fabrication operations from being a major source which must be covered by the standard promulgated herein.

The proposed standard would have prohibited visible emissions of asbestos particulate material from the repair or demolition of any building or structure other than a single-family dwelling. Comments indicated that the no visible emission requirement would prohibit repair or demolition in many situations, since it would be impracticable, if not impossible, to do such work without creating visible emissions. Accordingly, the promulgated standard specifies certain work practices which must be followed when demolishing certain buildings or structures. The standard covers institutional, industrial, and commercial buildings or structures, including apartment houses having more than four dwelling units, which contain friable asbestos material. This coverage is based on the National Academy of Sciences' report (53) which states, "In general, single-family residential structures contain only small amounts of asbestos insulation. Demolition of industrial and commercial buildings that have been fireproofed with asbestos-containing materials will prove to be an emission source in the future, requiring control measures." Apartment houses with four dwelling units or less are considered to be equivalent to single-family residential structures. The standard requires that the Administrator be notified at least 20 days prior to the commencement of demolition.

The proposed standard would have limited emissions from a number of sources by stipulating that such emissions could not exceed the amounts which would be emitted from the source if the source were equipped with a fabric filter, or, in some cases, a wet-collection air-cleaning device. This would have required a standardized emission-measuring technique, which is not currently available. The promulgated standard prohibits visible emissions which contain asbestos and provides the option of using specified air-cleaning methods. The existence of particulate asbestos material in a gas stream vented to the atmosphere can be determined by collecting a sample on a filter and analyzing it by microscopy techniques. The proposed standard stated that the air-cleaning requirement would not be met if a number of listed faults, e.g., broken bags, leaking gases, threadbare bags, existed and it required that collection hoppers on some baghouses be emptied without generating visible emissions. Comments received suggested that this negative approach tended to make the quality of air-cleaning operations dependent upon the ability of EPA to anticipate and to include in the standard all the factors which would constitute improper methods. Since the intent was, and is, to require high quality air-cleaning operations, the promulgated standard requires proper installation, use, operation, and maintenance without precisely defining the means to be used.

The proposed standard would have prohibited the spraying of any material containing asbestos on any portion of a building or structure, prohibited the spraying of any material containing asbestos in an area directly open to the atmosphere, and limited emissions from all other spraying of any material containing asbestos to the amount which would be emitted if specified air-cleaning equipment were used. Comments received pointed out that this standard would: (1) Prohibit the use of materials containing only the trace amounts of asbestos which occur in numerous natural substances, (2) prohibit the use of materials to which very small quantities of asbestos are added in order to enhance their effectiveness, and (3) prohibit the use of materials in which the asbestos is strongly bound and which would not generate particulate asbestos emissions. The promulgated standard applies to those uses of spray-on asbestos materials which could generate major emissions of particulate asbestos material. For those spray-on materials used to insulate or fireproof buildings, structures, pipes, and conduits, the standard limits the asbestos content to no more than 1 percent. Materials currently used contain from 10- to 80-percent asbestos. The intent of the 1-percent limit is to ban the use of materials which contain significant quantities of asbestos, but to allow the use of materials which would: (1) Contain trace amounts of asbestos which occur in numerous natural substances, and (2) include very small quantities of asbestos (less than 1 percent) added to enhance the material's effectiveness. Although a

standardized reference method has not been developed to quantitatively determine the content of asbestos in a material, there are acceptable methods available, based on electron microscopy, which independent laboratories have developed. Determining the asbestos content of a material with these methods costs approximately $300, and the results are accurate within plus or minus 50 percent; these limits on accuracy were taken into account in establishing the 1-percent limitation.

The proposed standard would have prohibited the surfacing of any roadway with asbestos tailings. The promulgated standard applies to all roadways except those on ore deposits; these roadways are temporary, and control measures taken to comply with the Bureau of Mines regulations prevent them from being a major source which must be covered by the standard promulgated herein. At this time, the application of asbestos tailings to public roadways is not widely practiced, but because of the close proximity of roads to the public, a ban on using asbestos tailings on roadways is included in the promulgated standard to avoid a future problem and stop the practice where it is followed. The term "surfacing" is defined to include the deposit of asbestos tailings on roadways covered with snow or ice; therefore, this practice is prohibited.

Consideration was given to including provisions in the standard requiring proper disposal of the asbestos material generated during demolition and collected in control devices used to comply with the requirements of this standard. It was decided that this was not necessary because the Occupational Safety and Health Administration regulations (29 CFR 1910.93a(h)) include housekeeping and waste disposal requirements. These regulations require that any asbestos waste, consigned for disposal, be collected and disposed of in sealed impermeable bags or other closed, impermeable containers.

The potential environmental impact of the promulgated standard was evaluated, and it was concluded that the standard will not cause any adverse effects. The potentially adverse environmental effects of the standard are:

(1) The asbestos-materials which will be collected in control devices and generated during demolition will have to be disposed of or recycled.

(2) Materials, such as mineral wool, ceramic wool, and fiberglass, will be substituted for asbestos presently contained in spray-applied fireproofing and insulating materials.

In some manufacturing operations, a major portion of the asbestos-material collected by fabric filters is either recycled to the process or is marketed for other uses. For example, one asbestos textile mill recycles large quantities of longer-fiber asbestos for process use and sells more than 90 percent of the remaining collected materials to a brake lining manufacturer. Consequently, a significant portion of the increased quantities of "waste" asbestos materials which will result from the implementation of the standard will not require disposal. Where disposal is required, the Occupational Safety and Health Administration regulations (29 CFR 1910.93a(h)) require that any asbestos waste, consigned for disposal, be collected and disposed of in sealed impermeable bags or other closed, impermeable containers. The contamination of ground water supplies with asbestos from landfill disposal is not considered a potential problem.

The substitution of ceramic wool, mineral wool, and fiberglass for asbestos is not now known to be a problem. There is no evidence that these materials cause health effects in the concentrations found in occupational or ambient environments.

Although the standard was not based on economic considerations, EPA is aware of the impact ($5) and considers it to be reasonable. Costs among the various sources covered by the standard are quite variable. Although the standard may adversely affect some individual plants or companies which are marginal operations, it appears that such effects will be minimal and the impact to the asbestos industries as a whole will not be large.

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Beryllium

Beryllium is a hazardous air pollutant within the meaning of section 112. The proven effects of airborne beryllium materials on human health include both acute and chronic lethal inhalation effects (1, 2), as well as skin and conjunctival effects (2). Insufficient data are available to incriminate beryllium as a human carcinogen (1, 2), but the lack of of any mechanism for the total elimination of beryllium body burdens, and the resulting possibly long residence time may enhance the opportunity for cancer induction. The Beryllium Registry now contains over 630 proven cases of beryllium-related disease (3), but since many of these were most likely due to exposure prior to the institution of controls, proper assessment of the period of exposure is not always possible (1, 2); it is known, however, that chronic beryllium disease is associated not only with activities involving extraction processes, but also that 64 registry cases resulted from exposure during machining operations on beryllium materials (3). There are at least 45 cases of nonoccupationallyincurred diseases on file with the registry, of which approximately half have been fatal (3), and retrospective studies of the concentrations of beryllium that resulted in some cases of chronic beryllium disease from nonoccupational exposure have concluded that the lowest concentration which produced disease was greater than 0.01 $\mu g/m^3$ and probably less than 0.10 $\mu g/m^3$ (4).

In 1949, when it became apparent that beryllium was a toxic material, the Atomic Energy Commission adopted a limit for beryllium concentrations in community air (i.e., 0.01 μg of beryllium per cubic meter of air averaged over a 30-day period) (2). Beryllium refining companies holding contracts with the AEC to operate AEC-owned refinery facilities and expand their own refinery capacity to meet AEC's beryllium requirements, were required to observe the community air limit. With the termination of these contracts in the 1961–63 period due to a reduction in AEC requirements for beryllium, the refineries were no longer subject to the AEC community air limit. The AEC's health and safety requirements, however, have continued to apply to all AEC-owned facilities, some of which fabricate and assemble beryllium parts.

In the period since the implementation of the AEC guideline, no reported cases of chronic beryllium disease have occurred as a result of community exposure, and the Committee on Toxicology of the National Academy of Sciences concluded that the AEC guideline limit represents a safe level of exposure (1).

Accordingly, the Administrator has determined that in order to provide an ample margin of safety to protect the public health from beryllium, sources of beryllium dust, fume, or mist emissions into the atmosphere should be controlled to insure that ambient concentrations of beryllium do not exceed 0.01 $\mu g/m^3$—30-day average.

The beryllium standard covers extraction plants, foundries, ceramic manufacturing plants, machine shops (processing beryllium or beryllium alloys containing in excess of 5 percent beryllium) and disposal of beryllium-containing wastes. Most affected beryllium sources are limited to emissions of not more than 10 grams per day. This level was determined through dispersion estimates as the level which would protect against the occurrence of 30-day average ambient concentrations exceeding 0.01 $\mu g/m^3$. The sources covered by the standard are the only known ones that could result in ambient beryllium concentrations in excess of 0.01 $\mu g/m^3$. The assumptions and equations used to make the dispersion estimates are given in the Background Information Report for Asbestos, Beryllium, and Mercury (APTD–0753), published at the time the standards were proposed.

Rocket testing facilities are required to meet the limit of 75 microgram-minutes per cubic meter, accumulated during any period of 2-consecutive weeks. The limit for rocket testing facilities is the same as that developed in 1966 by the Committee on Toxicology of the National Academy of Sciences for protection of off-site personnel from intermittent exposures to soluble beryllium compounds arising from the firing of rocket motors (1).

The proposed standard did not include a provision on open burning of beryllium-containing waste. The promulgated standard includes a ban on open burning of beryllium-containing waste. This change was made because information received after proposal indicated that such sources can cause ambient concentrations of beryllium in excess of 0.01 $\mu g/m^3$ and because it is not possible to control the emissions from open burning. The promulgated standard does allow disposal of beryllium-containing waste in incinerators which are controlled so as not to exceed the 10-gram-per-day limit. The disposal of beryllium-containing explosive waste is included in the standard covering rocket testing.

The proposed standard would have covered all machining operations which use alloys containing any amount of beryllium. Comments were received which claimed that numerous machining operations use alloys containing low concentrations of beryllium and do not exceed the 10-gram-per-day emission limitation. An investigation of these comments revealed that alloys which include beryllium either contain a large amount (greater than 60 percent) or a small amount (less than 5 percent), and that approximately 8,000 machining operations use the low beryllium content alloys. Tests were conducted by the Agency to determine the beryllium emissions from the operations which use the low beryllium content alloys (e.g. stamping, tube drawing, milling, and sawing). The results indicated that even if the emissions were vented to the outside air, which they ordinarily are not, they would be significantly below the 10-gram-per-day emission limitation. After considering these results and the administrative burden if the standard applied to such a large number of sources, the proposed standard was changed to exempt the machining operations which use alloys containing less than 5-percent beryllium.

The proposed standard would have allowed all sources of beryllium to choose between meeting the 10-gram-per-day emission limit and complying by use of ambient monitoring to insure that the 0.01 $\mu g/m^3$ 30-day average is never exceeded. After reconsidering the proposed standard and the difficulty inherent in using ambient air quality data, as opposed to emission data, as a regulatory tool, it was decided to limit the use of ambient data as a means of compliance

References at end of article.

to those sources which have demonstrated over a reasonable past period that they can meet and have met the ambient limitation. Therefore, the standard being promulgated herein allows the ambient option only to existing sources which have 3 years of current ambient air quality data which demonstrate to the Administrator's satisfaction that the 0.01 $\mu g/m^3$ level can be met in the vicinity of the source. A minimum of 3 years of data was judged to be necessary to demonstrate that the ambient guideline of 0.01 $\mu g/m^3$ (30-day average) can be met because of the possibility of monthly, seasonal, and even annual variations in ambient levels caused by variations in meteorology and production. The existing sources which could qualify or this option are four beryllium extraction plants and, possibly, a small number of machine shops. These sources were designed or modified to facilitate compliance with the 0.01 $\mu g/m$ ambient limit.

The potential environmental impact of this standard was evaluated and it was concluded that the standard will not cause any adverse effects. Beryllium is a very expensive material, and most gas streams emitting significant quantities of beryllium are controlled with high efficiency dry collectors, and the collected material is recycled or sold back to the primary producers. Wet collectors are rarely used strictly as an air pollution control device, but more often as an extraction process control device allowing recycle of waste liquids to the process. Absolute filters are often used as final filters and collect small quantities of beryllium from very low concentration gas streams. These filters are usually buried in company owned or segregated dumps or stored in unused mines or buildings. Most of the solid wastes are prepackaged prior to burial to prevent escape of beryllium to the environment.

Although the standard is not based on economic considerations, EPA is aware of the economic impact (5) of the standard. Since most of the sources of beryllium emissions are already controlled and in compliance with the standard, the economic impact will be very small.

References

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2. National Institute for Occupational Safety and Health: Occupational Exposure to Beryllium (Criteria for a Recommended Standard). Washington, U.S. Department of Health, Education, and Welfare (PHS, HSMHA), 1972 (HSM 72-10268).

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4. Eisenbud, M., R. C. Wanta, C. Dustan, L. T. Steadman, W. B. Harris, and B. S. Wolf: Noneoccupational Berylliosis. J. Ind. Hyg. Toxicol., 31, 282-294, 1949.

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Mercury

Mercury is a hazardous air pollutant within the meaning of section 112. Exposure to metallic mercury vapors may cause central nervous system injury, and renal damage (1, 3). Experience with mercury vapor comes almost exclusively from animal experiments and industrial exposures. Animal (rat) data indicate a risk of accumulation in critical systems upon prolonged exposure, with a potential, for example, for selective brain damage (2, 3). Prolonged exposure to about 100 micrograms mercury per cubic meter of air involves a definite risk of mercury intoxication (3).

To determine the ambient air level of mercury that does not impair health, the airborne burden must be considered together with the water- and food-borne burdens. An expert group concluded, based on its analysis of several episodes of mercury poisoning in Japan, that 4 micrograms of methylmercury per kilogram of bodyweight per day would result in the intoxication of a sensitive adult; application of a safety factor of 10 yielded an acceptable exposure of about 30 micrograms per day for a 70-kilogram man, and this level is also believed to provide satisfactory protection against genetic lesions, and poisoning of the fetus and of children (4).

It should be noted that methylmercury is considered to be by far the most hazardous mercury compound, particularly via the ingestion of fish in which it has been concentrated through the food chain. (3, 5). The Environmental Protection Agency, in view of the present limited knowledge as to the effects of inhaled mercury in the general population, and in order to best assure the requisite "ample margin of safety to protect the public health," has concluded that it is prudent to consider exposures to methylmercury (diet) and mercury vapor (air) to be equivalent and additive. It has been estimated that from average diets, over a considerable period, mercury intakes of 10 micrograms per day may be expected (6), so that, in order to restrict total intake to 30 micrograms per day, the average mercury intake from air would have to be limited to 20 micrograms per day. Assuming inhalation of 20 cubic meters of air per day, the air could contain an average daily concentration of no more than 1 microgram of mercury per cubic meter.

The standard promulgated herein regulates the only two sources, mercury ore processing facilities and mercury cell chlor-alkali plants, which have been found to emit mercury in a manner that could cause the ambient concentration to exceed the inhalation effects limits of 1 microgram per cubic meter. The standard limits emissions from these facilities to not more than 2,300 grams per day. The emission limit of 2,300 grams per day was derived from dispersion estimates as the level which would protect against the violation of an average daily ambient concentration of 1 microgram per cubic meter. The assumptions and equations used to make the dispersion estimates are given in the Background Information Report for Asbestos, Beryllium, and Mercury (APTD-0753), published at the time the standards were proposed.

Many mercury cell chlor-alkali plant cell rooms present severe source testing problems due to their design and construction. Such sources may either reconstruct the cell room so that accurate source tests can be made or employ housekeeping and maintenance practices that minimize mercury emissions from the cell room. Source test data and calculations have indicated that when such practices are used, 1,300 grams per day is a reasonable estimate of emissions from the cell room. Therefore, when this option is chosen, an emission of 1,300 grams per day will be assigned to the cell room. This permits emissions of not more than 1,000 grams per day from the hydrogen and end box ventilation streams combined.

Compliance with the standard will be determined by the EPA reference method or EPA-approved substitute methods. Where a chlor-alkali plant chooses the housekeeping and maintenance practices option, determination of compliance of the cell room emission will be based on the use of EPA-approved practices. A list of approved practices may be obtained from EPA on request to regional offices.

The only major change in the mercury standard is the introduction of the above option of assigning an emission number to the cell room provided certain housekeeping and maintenance requirements are met. When this option is chosen, testing is not required for emissions from the cell room. This option is offered because comments, testimony, and EPA source testing experience indicated that most existing cell rooms cannot be accurately tested for mercury emissions. Accurate emission tests are unduly complicated and costly because of the cell room configuration.

Some of the changes suggested in written comments and public hearing testimony were considered by EPA but not made. The most significant one involved the environmental chemistry of mercury, that is, environmental mercury in the atmosphere is transformed to mercuric oxide by the action of ultraviolet radiation, and since mercuric oxide is not as toxic as elemental mercury, the standard should be less stringent. This argument is based on laboratory experiments under controlled conditions with generated radiation. The reaction cited in the testimony occurs when elemental mercury is irradiated with ultraviolet light with a wavelength of 2,537 angstrom (A). Naturally occurring ozone in the upper atmosphere absorbs light in the ultraviolet region below 3,000 A; (7) hence the wavelength of ultraviolet necessary for the reaction is absent in the ambient atmosphere, and the reaction does not proceed at as high a rate as implied by the submitted testimony. Field measurements of both mercury vapors and particulate mercury in ambient air indicate that as much as 96 percent of the mercury de-

References at end of article.

tected was in an elemental vapor form (data collected by EPA at the Federal Building in Moundsville, W. Va.).

The Environmental Protection Agency recognizes that mercury and its compounds constitute a multimedia contapounds constitute a multimedia contamination problem, i.e., strong evidence alter its natural distribution in the environment; that such uses may cause or hasten additional deposits into water or soil over and above those occurring naturally, thereby building up environmental concentrations; and the mercury levels accumulate in the biota, with the result that potentially dangerous residue levels are reached in foods consumed by man and animals.

Current data on the environmental transport of mercury do not permit a clear assessment of the effect of mercury emissions into the atmosphere on the mercury content in the aquatic and terrestrial environments. Results of ongoing research will determine if there is a need for more comprehensive control of mercury emissions into the air. The standard promulgated herein is intended to protect the public health from the effects of inhaled mercury.

The environmental impact of this standard was evaluated and it was concluded that the standard will not cause any adverse effects since the control of mercury emissions to the atmosphere will have only minimal impact on other areas of environmental concern. The simplest control for mercury emissions to the atmosphere is cooling to condense the mercury. This cooling can be indirect or direct. By indirect cooling, the mercury condenses and is retained for recycle or sale. By direct cooling with a water scrubber, the water is usually recirculated after using centrifugal or gravitational separation to remove the mercury. The water cannot be reused indefinitely and eventually requires additional treatment to remove the mercury. In most cases, such treatment facilities are already being utilized to meet water quality standards.

A widely used control device for particulate mercury emissions is the mist eliminator. Residues in these devices are removed by gravity and washing with a recycled liquid. Another control method is chemical scrubbing. In this system, scrubbing liquids are continuously made up while waste materials are usually recycled to the process feed solutions. Recycling of these liquids avoids significant contamination of water with mercury residues.

The use of adsorption beds is a highly efficient control method for removing mercury from gas streams. Two primary types are available: (1) Chemically treated activated carbon beds, and (2) molecular sieves. Most of the mercury collected by activated carbon can be reclaimed by retorting the carbon but this usually destroys the carbon structure and necessitates disposal. Some small amount of residual mercury will remain with the carbon, but it is tightly bound and is not easily transferred into the air or water. Regenerative molecular sieves do not cause a waste disposal problem because the sieves can be regenerated in place without retorting and can be reused many times.

Although the standard was not based on economic considerations, EPA is aware of the impact (8) and considers it to be reasonable. Because mercury is an international commodity, world prices determine the fortunes of the domestic mercury mining industry. Historically, mercury prices fluctuate greatly in response to small changes in demand or supply. Domestic mercury mines are considered high-cost producers in relation to foreign producers. Because the average price has dropped from $404 per flask in 1969 to approximately $320 currently, the number of domestic mercury mines in operation has dropped sharply from 109 in 1969 to six or seven in March 1973. As long as the price of mercury remains below marginal costs of production (generally about $400), the remaining domestic mines will be ill equipped to absorb any cost increases.

The total chlor-alkali industry comprises 68 plants. Approximately 28 are mercury cell plants and account for about 27 percent of the U.S. production of chlorine and caustic.

The future of the chlorine-caustic industry appears healthy. Demand for chlorine is expected to grow at an annual rate of 6 percent projected from 1971. Demand for caustic soda will grow at least at the same rate as chlorine, and perhaps faster. Prices for chlorine and sodium hydroxide have been rising steadily through the sixties into 1971. Based on these trends, the cost of control to comply with the mercury standard will be passed forward to the consumer. Use of these two basic commodities is so diverse that any price increases will be well dispersed through all manufacturing activities.

References

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3. Friberg, L., and J. Vostal (Eds.): Mercury in the Environment—A Toxicological and Epidemiological Appraisal. Prepared by the Karolinska Institute Department of Environmental Hygiene (Stockholm) for the U.S. Environmental Protection Agency (Office of Air Programs). November 1971.

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6. Westöö, G.: Mercury in Foodstuffs—Is There a Great Risk of Poisoning? VAR FODA, 4, 1–6, 1965.

7. Leighton, P. A.: Photochemistry of Air Pollution. Academic Press, 1961.

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General Provisions

The standards promulgated below are applicable to new, modified, and existing sources. Any new or modified source must comply with the standards upon beginning operation. Any existing source must comply with the standards within 90 days after promulgation, unless a waiver of compliance is granted.

After considering the proposed general provisions and the comments received on them, the Administrator made several changes which are included in the standards promulgated below. A new section was added to specifically require new stationary sources to notify the Administrator before beginnning operation. The requirements for source reporting and request for waiver of compliance were combined into one section. The time for submitting the source report was extended from 30 to 90 days to provide sources with more time to complete the information required. Appendix A was added to provide sources a description and format of the information required.

The proposed standards required all sources of mercury and beryllium to test their emissions within 3 months of the effective date and at least once every 3 months thereafter; a provision was included to allow the Administrator to waive the periodic tests for sources in compliance with a standard. The standards promulgated below require the initial test within 90 days of the effective date and include a provision to allow the Administrator to waive this requirement if the source is meeting the standard or has requested a waiver of compliance. Periodic tests are not required unless specifically requested by the Administrator. The Administrator may cancel a waiver of emission tests and may require a test under the authority of section 114 of the Act at any time. Appendix A specifies the information which a source must provide the Administrator when applying for a waiver of initial emission testing.

The standards promulgated below do not require the owner or operator to request a waiver of compliance before a specific date. However, the owner or operator should submit the request within 30 days after the effective date of the regulation to be assured that action will be taken on the waiver application prior to the 90th day after the effective date. Continued operation in excess of a standard after the 90th day without a waiver is a violation of the act.

The Administrator may grant an existing source a waiver, permitting a period of up to 2 years for compliance, provided that steps will be taken during the waiver period to assure that the health of persons will be protected from imminent endangerment and provided that such period is necessary for the installation of controls. To be granted a waiver of compliance, a source must submit a written request to the Administrator and provide certain information to assist the Administrator in making a judgment.

within 60 days after receiving a request, the Administrator will notify the owner or operator of approval or intention to deny the waiver. Any waiver of compliance granted by the Administrator will be in writing and specify conditions the source must meet during the waiver period. If the Administrator intends to deny a request, the owner or operator will be given a specified time to provide additional information or arguments prior to final action on the request. Final action on a request will be in writing by the Administrator, and if denied, will include reasons for denial.

The President may exempt any new, modified, or existing stationary source from compliance with the standards for a period of up to 2 years, provided the technology is not available to implement the standards and the operation of such source is required for reasons of national security. Also, the President may grant exemptions for additional periods of 2 years or less.

The construction of a new source or modification of an existing source covered by these standards cannot begin without approval of the Administrator. To obtain approval, the owner or operator of such sources must apply in writing to the Administrator. Within 60 days, the Administrator will notify the owner or operator of approval or intention to deny approval. If the Administrator intends to deny approval, a specified time will be given to provide additional information or arguments prior to final action on the application. The final action on any application will be in writing by the Administrator, and if denied, will include the reasons for denial.

Although the demolition of buildings or structures containing asbestos material and the spraying of asbestos material will in many cases be modifications of existing stationary sources, the Administrator's approval is not required before beginning such operations. Section 112(c)(1) of the act specifies that no person may construct any new source or modify any existing source "* * * unless the Administrator finds that such source if properly operated will not cause emissions in violation of such standard." The demolition and spraying provisions are expressed in terms of procedures to be followed. Therefore, if the source is properly operated, it will be complying with the standard, and there is no need for the Administrator to make a finding with respect to each new source subject to these provisions.

Each source covered by these standards is required to submit to the Administrator within 90 days after promulgation certain information pertaining to its operation. Changes in the information must be submitted within 30 days after the change, except where the change is considered a modification. Then the requirements for a modified source are applicable.

Three terms are associated with determining compliance by means of source testing: (1) Reference method, (2) equivalent method, and (3) alternative method. Reference methods are the preferred methods of sampling and analyzing used to determine compliance. The reference methods for beryllium and mercury are included in appendix B to this part. An equivalent method is any method of sampling and analyzing which has been demonstrated to the Administrator's satisfaction to have a consistent and quantitatively known relationship to the reference method under specified conditions. An alternative method is any method of sampling and analyzing which does not meet all the criteria for equivalency but which can be used in specific cases to determine compliance. Alternative methods may be approved by the Administrator for source testing; however, in cases where determinations of compliance using an alternative method are disputed, use of the reference method or its equivalent will be required by the Administrator. An approved alternative method for beryllium is included in appendix B hereto.

All emission data provided to or obtained by the Administrator in carrying out these regulations will be available to the public. Records, reports, or information other than trade secrets will be available to the public.

Pursuant to section 112(d)(1) of the act, the Environmental Protection Agency intends to delegate the authority to implement and enforce national emission standards (except with respect to stationary sources owned or operated by the United States) for hazardous air pollutants to any State which submits an adequate procedure to the Administrator. The requisite procedure for requesting such delegation will be issued in the future by the Environmental Protection Agency.

The regulations for the national emission standards for asbestos, beryllium, and mercury are hereby promulgated effective upon promulgation (April 6, 1973).

Dated: March 30, 1973.

ROBERT W. FRI,
Acting Administrator,
Environmental Protection Agency.

A new Part 61 is added to Chapter I, Title 40, Code of Federal Regulations, as follows:

Subpart A—General Provisions

Sec.
61.01 Applicability.
61.02 Definitions.
61.03 Abbreviations.
61.04 Address.
61.05 Prohibited activities.
61.06 Determination of construction or modification.
61.07 Application for approval of construction or modification.
61.08 Approval by Administrator.
61.09 Notification of startup.
61.10 Source reporting and waiver request.
61.11 Waiver of compliance.
61.12 Emission tests and monitoring.
61.13 Waiver of emission tests.
61.14 Source test and analytical methods.
61.15 Availability of information.
61.16 State authority.

Subpart B—National Emission Standard for Asbestos

61.20 Applicability.
61.21 Definitions.
61.22 Emission standard.
61.23 Air cleaning.
61.24 Reporting.

Subpart C—National Emission Standard for Beryllium

61.30 Applicability.
61.31 Definitions.
61.32 Emission standard.
61.33 Stack sampling.
61.34 Air sampling.

Subpart D—National Emission Standard for Beryllium Rocket Motor Firing

61.40 Applicability.
61.41 Definitions.
61.42 Emission standard.
61.43 Emission testing—rocket firing or propellant disposal.
61.44 Stack sampling.

Subpart E—National Emission Standard for Mercury

61.50 Applicability.
61.51 Definitions.
61.52 Emission standard.
61.53 Stack sampling.
Appendix A—Compliance Status Information.
Appendix B—Test Methods.
Method 101—Reference method for determination of particulate and gaseous mercury emissions from stationary sources (air streams).
Method 102—Reference method for determination of particulate and gaseous mercury emissions from stationary sources (hydrogen streams).
Method 103—Beryllium screening method.
Method 104—Reference method for determination of beryllium emissions from stationary sources.

AUTHORITY: 42 U.S.C. 1857c-7.

Subpart A—General Provisions

§ 61.01 *Applicability.*

The provisions of this part apply to the owner or operator of any stationary source for which a standard is prescribed under this part.

§ 61.02 *Definitions.*

As used in this part, all terms not defined herein shall have the meaning given them in the act:

(a) "Act" means the Clean Air Act (42 U.S.C. 1857 et seq.).

(b) "Administrator" means the Administrator of the Environmental Protection Agency or his authorized representative.

(c) "Alternative method" means any method of sampling and analyzing for an air pollutant which does not meet all of the criteria for equivalency but which has been demonstrated to the Administrator's satisfaction to, in specific cases, produce results adequate for his determination of compliance.

(d) "Commenced" means that an owner or operator has undertaken a continuous program of construction or modification or that an owner or operator has entered into a contractual obligation to undertake and complete, within a reasonable time, a continuous program of construction or modification.

(e) "Compliance schedule" means the date or dates by which a source or category of sources is required to comply with the standards of this part and with any steps toward such compliance which are set forth in a waiver of compliance under § 61.11.

(f) "Construction" means fabrication, erection, or installation of a stationary source.

(g) "Effective date" is the date of promulgation in the FEDERAL REGISTER of an applicable standard or other regulation under this part.

(h) "Equivalent method" means any method of sampling and analyzing for an air pollutant which has been demonstrated to the Administrator's satisfaction to have a consistent and quantitatively known relationship to the reference method, under specified conditions.

(i) "Existing source" means any stationary source which is not a new source.

(j) "Modification" means any physical change in, or change in the method of operation of, a stationary source which increases the amount of any hazardous air pollutant emitted by such source or which results in the emission of any hazardous air pollutant not previously emitted, except that:

(1) Routine maintenance, repair, and replacement shall not be considered physical changes, and

(2) The following shall not be considered a change in the method of operation:

(i) An increase in the production rate, if such increase does not exceed the operating design capacity of the stationary source;

(ii) An increase in hours of operation.

(k) "New source" means any stationary source, the construction or modification of which is commenced after the publication in the FEDERAL REGISTER of proposed national emission standards for hazardous air pollutants which will be applicable to such source.

(l) "Owner or operator" means any person who owns, leases, operates, controls, or supervises a stationary source.

(m) "Reference method" means any method of sampling and analyzing for an air pollutant, as described in appendix B to this part.

(n) "Startup" means the setting in operation of a stationary source for any purpose.

(o) "Standard" means a national emission standard for a hazardous air pollutant proposed or promulgated under this part.

(p) "Stationary source" means any building, structure, facility, or installation which emits or may emit any air pollutant which has been designated as hazardous by the Administrator.

§ 61.03 Abbreviations.

The abbreviations used in this part have the following meanings:

°C—Degrees Centigrade.
cfm—Cubic feet per minute.
ft²—Square feet.
ft³—Cubic feet.
°F—Degrees Fahrenheit.
in—Inch.
l—Liter.
ml—Milliliter.
M—Molar.
m³—Cubic meter.
nm—Nanometer.
oz—Ounces.
v/v—Volume per volume.
yd²—Square yards.
w.g.—Water gage.
inHg—Inches of mercury.
inH₂O—Inches of water.
g—Grams.
mg—Milligrams.
N—Normal.
°R—Degree Rankine.
min—Minute
sec—Second.
avg.—Average.
I.D.—Inside diameter.
O.D.—Outside diameter.
μg—Micrograms (10^{-6} gram).
%—Percent.
Hg—Mercury.
Be—Beryllium.

§ 61.04 Address.

All requests, reports, applications, submittals, and other communications to the Administrator pursuant to this part shall be submitted in duplicate and addressed to the appropriate regional office of the Environmental Protection Agency, to the attention of the Director, Enforcement Division. The regional offices are as follows:

Region I (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont), John F. Kennedy Federal Building, Boston, Mass. 02203.

Region II (New York, New Jersey, Puerto Rico, Virgin Islands), Federal Office Building, 26 Federal Plaza (Foley Square), New York, N.Y. 10007.

Region III (Delaware, District of Columbia, Pennsylvania, Maryland, Virginia, West Virginia), Curtis Building, Sixth and Walnut Streets, Philadelphia, Pa. 19106.

Region IV (Alabama, Florida, Georgia, Mississippi, Kentucky, North Carolina, South Carolina, Tennessee), Suite 300, 1421 Peachtree Street, Atlanta, Ga. 30309.

Region V (Illinois, Indiana, Minnesota, Michigan, Ohio, Wisconsin), 1 North Wacker Drive, Chicago, Ill. 60606.

Region VI (Arkansas, Louisiana, New Mexico, Oklahoma, Texas), 1600 Patterson Street, Dallas, Tex. 75201.

Region VII (Iowa, Kansas, Missouri, Nebraska), 1735 Baltimore Street, Kansas City, Mo. 64108.

Region VIII (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming), 916 Lincoln Towers, 1860 Lincoln Street, Denver, Colo. 80203.

Region IX (Arizona, California, Hawaii, Nevada, Guam, American Samoa), 100 California Street, San Francisco, Calif. 94111.

Region X (Washington, Oregon, Idaho, Alaska), 1200 Sixth Avenue, Seattle, Wash. 98101.

§ 61.05 Prohibited activities.

(a) After the effective date of any standard prescribed under this part, no owner or operator shall construct or modify any stationary source subject to such standard without first obtaining written approval of the Administrator in accordance with this subpart, except under an exemption granted by the President under section 112(c)(2) of the act. Sources, the construction or modification of which commenced after the publication date of the standards proposed to be applicable to such source, are subject to this prohibition.

(b) After the effective date of any standard prescribed under this part, no owner or operator shall operate any new source in violation of such standard except under an exemption granted by the President under section 112(c)(2) of the act.

(c) Ninety days after the effective date of any standard prescribed under this part, no owner or operator shall operate any existing stationary source in violation of such standard, except under a waiver granted by the Administrator in accordance with this subpart or under an exemption granted by the President under section 112(c)(2) of the act.

(d) No owner or operator subject to the provisions of this part shall fail to report, revise reports, or report source test results as required under this part.

§ 61.06 Determination of construction or modification.

Upon written application by an owner or operator, the Administrator will make a determination of whether actions taken or intended to be taken by such owner or operator constitute construction or modification or the commencement thereof within the meaning of this part. The Administrator will within 30 days of receipt of sufficient information to evaluate an application, notify the owner or operator of his determination.

§ 61.07 Application for approval of construction or modification.

(a) The owner or operator of any new source to which a standard prescribed under this part is applicable shall, prior to the date on which construction or modification is planned to commence, or within 30 days after the effective date in the case of a new source that already has commenced construction or modification and has not begun operation, submit to the Administrator an application for approval of such construction or modification. A separate application shall be submitted for each stationary source.

(b) Each application shall include:

(1) The name and address of the applicant.

(2) The location or proposed location of the source.

(3) Technical information describing the proposed nature, size, design, operating design capacity, and method of operation of the source, including a description of any equipment to be used for control of emissions. Such technical information shall include calculations of emission estimates in sufficient detail to permit assessment of the validity of such calculations.

§ 61.08 Approval by Administrator.

(a) The Administrator will, within 60 days of receipt of sufficient information to evaluate an application under § 61.07, notify the owner or operator of approval or intention to deny approval of construction or modification.

(b) If the Administrator determines that a stationary source for which an

application pursuant to § 61.07 was submitted will, if properly operated, not cause emissions in violation of a standard, he will approve the construction or modification of such source.

(c) Prior to denying any application for approval of construction or modification pursuant to this section, the Administrator will notify the owner or operator making such application of the Administrator's intention to issue such denial, together with:

(1) Notice of the information and findings on which such intended denial is based, and

(2) Notice of opportunity for such owner or operator to present, within such time limit as the Administrator shall specify, additional information or arguments to the Administrator prior to final action on such application.

(d) A final determination to deny any application for approval will be in writing and will set forth the specific grounds on which such denial is based. Such final determination will be made within 60 days of presentation of additional information or arguments, or 60 days after the final date specified for presentation, if no presentation is made.

(e) Neither the submission of an application for approval nor the Administrator's granting of approval to construct or modify shall:

(1) Relieve an owner or operator of legal responsibility for compliance with any applicable provision of this part or of any other applicable Federal, State, or local requirement, or

(2) Prevent the Administrator from implementing or enforcing this part or taking any other action under the act.

§ 61.09 Notification of startup.

(a) Any owner or operator of a source which has an initial startup after the effective date of a standard prescribed under this part shall furnish the Administrator written notification as follows:

(1) A notification of the anticipated date of initial startup of the source not more than 60 days nor less than 30 days prior to such date.

(2) A notification of the actual date of initial startup of the source within 15 days after such date.

§ 61.10 Source reporting and waiver request.

(a) The owner or operator of any existing source, or any new source to which a standard prescribed under this part is applicable which had an initial startup which preceded the effective date of a standard prescribed under this part shall, within 90 days after the effecure date, provide the following information in writing to the Administrator:

(1) Name and address of the owner or operator.

(2) The location of the source.

(3) The type of hazardous pollutants emitted by the stationary source.

(4) A brief description of the nature, size, design, and method of operation of the stationary source including the operating design capacity of such source. Identify each point of emission for each hazardous pollutant.

(5) The average weight per month of the hazardous materials being processed by the source, over the last 12 months preceding the date of the report.

(6) A description of the existing control equipment for each emission point.

(i) Primary control device(s) for each hazardous pollutant.

(ii) Secondary control device(s) for each hazardous pollutant.

(iii) Estimated control efficiency (percent) for each control device.

(7) A statement by the owner or operator of the source as to whether he can comply with the standards prescribed in this part within 90 days of the effective date.

(b) The owner or operator of an existing source unable to operate in compliance with any standard prescribed under this part may request a waiver of compliance with such standard for a period not exceeding 2 years from the effective date. Any request shall be in writing and shall include the following information:

(1) A description of the controls to be installed to comply with the standard.

(2) A compliance schedule, including the date each step toward compliance will be reached. Such list shall include as a minimum the following dates:

(i) Date by which contracts for emission control systems or process modifications will be awarded, or date by which orders will be issued for the purchase of component parts to accomplish emission control or process modification;

(ii) Date of initiation of onsite construction or installation of emission control equipment or process change;

(iii) Date by which onsite construction or installation of emission control equipment or process modification is to be completed; and

(iv) Date by which final compliance is to be achieved.

(3) A description of interim emission control steps which will be taken during the waiver period.

(c) Changes in the information provided under paragraph (a) of this section shall be provided to the Administrator within 30 days after such change, except that if changes will result from modification of the source, as defined in § 61.02 (j), the provisions of § 61.07 and § 61.08 are applicable.

(d) The format for reporting under this section is included as appendix A of this part. Advice on reporting the status of compliance may be obtained from the Administrator.

§ 61.11 Waiver of compliance.

(a) Based on the information provided in any request under § 61.10, or other information, the Administrator may grant a waiver of compliance with a standard for a period not exceeding 2 years from the effective date of such standard.

(b) Such waiver will be in writing and will:

(1) Identify the stationary source covered.

(2) Specify the termination date of the waiver. The waiver may be terminated at an earlier date if the conditions specified under paragraph (b) (3) of this section are not met.

(3) Specify dates by which steps toward compliance are to be taken; and impose such additional conditions as the Administrator determines to be necessary to assure installation of the necessary controls within the waiver period, and to assure protection of the health of persons during the waiver period.

(c) Prior to denying any request for a waiver pursuant to this section, the Administrator will notify the owner or operator making such request of the Administrator's intention to issue such denial, together with:

(1) Notice of the information and findings on which such intended denial is based, and

(2) Notice of opportunity for such owner or operator to present, within such time limit as the Administrator specifies, additional information or arguments to the Administrator prior to final action on such request.

(d) A final determination to deny any request for a waiver will be in writing and will set forth the specific grounds on which such denial is based. Such final determination will be made within 60 days after presentation of additional information or arguments, or 60 days after the final date specified for such presentation, if no presentation is made.

(e) The granting of a waiver under this section shall not abrogate the Administrator's authority under section 114 of the act.

§ 61.12 Emission tests and monitoring.

(a) Emission tests and monitoring shall be conducted and reported as set forth in this part and appendix B to this part.

(b) The owner or operator of a new source subject to this part, and at the request of the Administrator, the owner or operator of an existing source subject to this part, shall provide or cause to be provided, emission testing facilities as follows:

(1) Sampling ports adequate for test methods applicable to such source.

(2) Safe sampling platform(s).

(3) Safe access to sampling platform(s).

(4) Utilities for sampling and testing equipment.

§ 61.13 Waiver of emission tests.

(a) Emission tests may be waived upon written application to the Administrator if, in his judgment, the source is meeting the standard, or if the source is operating under a waiver of compliance or has requested a waiver of compliance.

(b) If application for waiver of the emission test is made, such application shall accompany the information required by § 61.10. The appropriate form is contained in appendix A to this part.

(c) Approval of any waiver granted pursuant to this section shall not abrogate the Administrator's authority under the act or in any way prohibit the Administrator from later canceling such waiver. Such cancellation will be made only after notice is given to the owner or operator of the source.

§ 61.14 Source test and analytical methods.

(a) Methods 101, 102, and 104 in appendix B to this part shall be used for all source tests required under this part, unless an equivalent method or an alternative method has been approved by the Administrator.

(b) Method 103 in appendix B to this part is hereby approved by the Administrator as an alternative method for sources subject to § 61.32(a) and § 61.42 (b).

(c) The Administrator may, after notice to the owner or operator, withdraw approval of an alternative method granted under paragraph (a) or (b) of this section. Where the test results using an alternative method do not adequately indicate whether a source is in compliance with a standard, the Administrator may require the use of the reference method or its equivalent.

§ 61.15 Availability of information.

(a) Emission data provided to, or otherwise obtained by, the Administrator in accordance with the provisions of this part shall be available to the public.

(b) Any records, reports, or information, other than emission data, provided to, or otherwise obtained by, the Administrator in accordance with the provisions of this part shall be available to the public, except that upon a showing satisfactory to the Administrator by any person that such records, reports, or information, or particular part thereof (other than emission data), if made public, would divulge methods or processes entitled to protection as trade secrets of such person, the Administrator will consider such records, reports, or information, or particular part thereof, confidential in accordance with the purposes of section 1905 of title 18 of the United States Code, except that such records, reports, or information, or particular part thereof, may be disclosed to other officers, employees, or authorized representatives of the United States concerned with carrying out the provisions of the act or when relevant in any proceeding under the act.

§ 61.16 State authority.

(a) The provisions of this part shall not be construed in any manner to preclude any State or political subdivision thereof from:

(1) Adopting and enforcing any emission limiting regulation applicable to a stationary source, provided that such emission limiting regulation is not less stringent than the standards prescribed under this part.

(2) Requiring the owner or operator of a stationary source, other than a stationary source owned or operated by the United States, to obtain permits, licenses, or approvals prior to initiating construction, modification, or operation of such source.

Subpart B—National Emission Standard for Asbestos

§ 61.20 Applicability.

The provisions of this subpart are applicable to those sources specified in § 61.22.

§ 61.21 Definitions.

Terms used in this subpart are defined in the act, in subpart A of this part, or in this section as follows:

(a) "Asbestos" means actinolite, amosite, anthophyllite, chrysotile, crocidolite, tremolite.

(b) "Asbestos material" means asbestos or any material containing asbestos.

(c) "Particulate asbestos material" means finely divided particles of asbestos material.

(d) "Asbestos tailings" means any solid waste product of asbestos mining or milling operations which contains asbestos.

(e) "Outside air" means the air outside buildings and structures.

(f) "Visible emissions" means any emissions which are visually detectable without the aid of instruments and which contain particulate asbestos material.

§ 61.22 Emission standard.

(a) Asbestos mills: There shall be no visible emissions to the outside air from any asbestos mill except as provided in paragraph (f) of this section. Outside storage of asbestos materials is not considered a part of an asbestos mill.

(b) Roadways: The surfacing of roadways with asbestos tailings is prohibited, except for temporary roadways on an area of asbestos ore deposits. The deposition of asbestos tailings on roadways covered with snow or ice is considered "surfacing."

(c) Manufacturing: There shall be no visible emissions to the outside air, except as provided in paragraph (f) of this section, from any building or structure in which the following operations are conducted or directly from any of the following operations if they are conducted outside of buildings or structures.

(1) The manufacture of cloth, cord, wicks, tubing, tape, twine, rope, thread, yarn, roving, lap, or other textile materials.

(2) The manufacture of cement products.

(3) The manufacture of fireproofing and insulating materials.

(4) The manufacture of friction products.

(5) The manufacture of paper, millboard, and felt.

(6) The manufacture of floor tile.

(7) The manufacture of paints, coatings, caulks, adhesives, sealants.

(8) The manufacture of plastics and rubber materials.

(9) The manufacture of chlorine.

(d) Demolition: Any owner or operator of a demolition operation who intends to demolish any institutional, commercial, or industrial building (including apartment buildings having more than four dwelling units), structure, facility, installation, or portion thereof which contains any boiler, pipe, or load-supporting structural member that is insulated or fireproofed with friable asbestos material shall comply with the requirements set forth in this paragraph.

(1) Notice of intention to demolish shall be provided to the Administrator at least 20 days prior to commencement of such demolition or anytime prior to commencement of demolition subject to paragraph (d)(4) of this section.

Such notice shall include the following information:

(i) Name of owner or operator.

(ii) Address of owner or operator.

(iii) Description of the building, structure, facility, or installation to be demolished.

(iv) Address or location of the building, structure, facility or installation.

(v) Scheduled starting and completion dates of demolition.

(vi) Method of demolition to be employed.

(vii) Procedures to be employed to meet the requirements of this paragraph.

(2) The following procedures shall be used to prevent emissions of particulate asbestos material to outside air:

(i) Friable asbestos materials, used to insulate or fireproof any boiler, pipe, or load-supporting structural member, shall be wetted and removed from any building, structure, facility, or installation subject to this paragraph before wrecking of load-supporting structural members is commenced. The friable asbestos debris shall be wetted adequately to insure that such debris remains wet during all stages of demolition and related handling operations.

(ii) No pipe or load-supporting structural member that is covered with friable asbestos insulating or fireproofing material shall be dropped or thrown to the ground from any building, structure, facility, or installation subject to this paragraph, but shall be carefully lowered or taken to ground level.

(iii) No friable asbestos debris shall be dropped or thrown to the ground from any building, structure, facility, or installation subject to this paragraph or from any floor to any floor below. For buildings, structures, facilities, or installations, 50 feet or greater in height, friable asbestos debris shall be transported to the ground via dust-tight chutes or containers.

(3) Sources subject to this paragraph are exempt from the requirements of §§ 61.05(a), 61.07, and 61.09.

(4) Any owner or operator of a demolition operation who intends to demolish a building, structure, facility, or installation to which the provisions of this paragraph would be applicable but which has been declared by proper State or local authority to be structurally unsound and which is in danger of imminent collapse is exempt from the requirements of this paragraph other than the reporting requirements specified by paragraph (d)(1) of this section and the wetting of friable asbestos debris as specified by paragraph (d)(3)(i) of this section.

(e) Spraying: There shall be no visible emissions to the outside air from the spray-on application of materials containing more than 1 percent asbestos, on a dry weight basis, used to insulate or fireproof equipment and machinery, except as provided in paragraph (f) of this section. Spray-on materials used to insulate or fireproof buildings, structures, pipes, and conduits shall contain less than 1 percent asbestos on a dry weight basis.

(1) Sources subject to this paragraph are exempt from the requirements of § 61.05(a), § 61.07, and § 61.09.

(2) Any owner or operator who intends to spray asbestos materials to insulate or fireproof buildings, structures, pipes, conduits, equipment, and machinery shall report such intention to the administrator at least 20 days prior to the commencement of the spraying operation. Such report shall include the following information:

(i) Name of owner or operator.

(ii) Address of owner or operator.

(iii) Location of spraying operation.

(iv) Procedures to be followed to meet the requirements of this paragraph.

(f) Rather than meet the no-visible-emission requirements of paragraphs (a), (c), and (e) of this section, an owner or operator may elect to use the methods specified by § 61.23 to clean emissions containing particulate asbestos material before such emissions escape to, or are vented to, the outside air.

§ 61.23 Air-cleaning.

If air-cleaning is elected, as permitted by § 61.22(f), the requirements of this section must be met.

(a) Fabric filter collection devices must be used, except as noted in paragraphs (b) and (c) of this section. Such devices must be operated at a pressure drop of no more than 4 inches water gage, as measured across the filter fabric. The airflow permeability, as determined by ASTM method D737-69, must not exceed 30 ft³/min/ft² for woven fabrics or 35 ft³/min/ft² for felted fabrics, except that 40 ft³/min/ft² for woven and 45 ft³/min/ft² for felted fabrics is allowed for filtering air from asbestos ore dryers. Each square yard of felted fabric must weigh at least 14 ounces and be at least one-sixteenth inch thick throughout. Synthetic fabrics must not contain fill yarn other than that which is spun.

(b) If the use of fabric filters creates a fire or explosion hazard, the administrator may authorize the use of wet collectors designed to operate with a unit contacting energy of at least 40 inches water gage pressure.

(c) The administrator may authorize the use of filtering equipment other than that described in paragraphs (a) and (b) of this section if the owner or operator demonstrates to the satisfaction of the administrator that the filtering of particulate asbestos material is equivalent to that of the described equipment.

(d) All air-cleaning equipment authorized by this section must be properly installed, used, operated, and maintained. Bypass devices may be used only during upset or emergency conditions and then only for so long as it takes to shut down the operation generating the particulate asbestos material.

§ 61.24 Reporting.

The owner or operator of any existing source to which this subpart is applicable shall, within 90 days after the effective date, provide the following information to the administrator:

(a) A description of the emission control equipment used for each process;

(b) If a fabric filter device is used to control emissions, the pressure drop across the fabric filter in inches water gage.

(1) If the fabric filter device utilizes a woven fabric, the airflow permeability in ft³/min/ft²; and, if the fabric is synthetic, indicate whether the fill yarn is spun or not spun.

(2) If the fabric filter device utilizes a felted fabric, the density in oz/yd², the minimum thickness in inches, and the airflow permeability in ft³/min/ft².

(c) Such information shall accompany the information required by § 61.10. The appropriate form is contained in appendix A to this part.

Subpart C—National Emission Standard for Beryllium

§ 61.30 Applicability.

The provisions of this subpart are applicable to the following stationary sources:

(a) Extraction plants, ceramic plants, foundries, incinerators, and propellant plants which process beryllium ore, beryllium, beryllium oxide, beryllium alloys, or beryllium-containing waste.

(b) Machine shops which process beryllium, beryllium oxides, or any alloy when such alloy contains more than 5 percent beryllium by weight.

§ 61.31 Definitions.

Terms used in this subpart are defined in the act, in subpart A of this part, or in this section as follows:

(a) "Beryllium" means the element beryllium. Where weights or concentrations are specified, such weights or concentrations apply to beryllium only, excluding the weight or concentration of any associated elements.

(b) "Extraction plant" means a facility chemically processing beryllium ore to beryllium metal, alloy, or oxide, or performing any of the intermediate steps in these processes.

(c) "Beryllium ore" means any naturally occurring material mined or gathered for its beryllium content.

(d) "Machine shop" means a facility performing cutting, grinding, turning, honing, milling, deburring, lapping, electrochemical machining, etching, or other similar operations.

(e) "Ceramic plant" means a manufacturing plant producing ceramic items.

(f) "Foundry" means a facility engaged in the melting or casting of beryllium metal or alloy.

(g) "Beryllium-containing waste" means material contaminated with beryllium and or beryllium compounds used or generated during any process or operation performed by a source subject to this subpart.

(h) "Incinerator" means any furnace used in the process of burning waste for the primary purpose of reducing the volume of the waste by removing combustible matter.

(i) "Propellant" means a fuel and oxidizer physically or chemically combined which undergoes combustion to provide rocket propulsion.

(j) "Beryllium alloy" means any metal to which beryllium has been added in order to increase its beryllium content and which contains more than 0.1 percent beryllium by weight.

(k) "Propellant plant" means any facility engaged in the mixing, casting, or machining of propellant.

§ 61.32 Emission standard.

(a) Emissions to the atmosphere from stationary sources subject to the provisions of this subpart shall not exceed 10 grams of beryllium over a 24-hour period, except as provided in paragraph (b) of this section.

(b) Rather than meet the requirement of paragraph (a) of this section, an owner or operator may request approval from the Administrator to meet an ambient concentration limit on beryllium in the vicinity of the stationary source of 0.01 $\mu g/m^3$, averaged over a 30-day period.

(1) Approval of such requests may be granted by the Administrator provided that:

(i) At least 3 years of data is available which in the judgment of the Administrator demonstrates that the future ambient concentrations of beryllium in the vicinity of the stationary source will not exceed 0.01 $\mu g/m^3$, averaged over a 30-day period. Such 3-year period shall be the 3 years ending 30 days before the effective date of this standard.

(ii) The owner or operator requests such approval in writing within 30 days after the effective date of this standard.

(iii) The owner or operator submits a report to the Administrator within 45 days after the effective date of this standard which report includes the following information:

(a) Description of sampling method including the method and frequency of calibration.

(b) Method of sample analysis.

(c) Averaging technique for determining 30-day average concentrations.

(d) Number, identity, and location (address, coordinates, or distance and heading from plant) of sampling sites.

(e) Ground elevations and height above ground of sampling inlets.

(f) Plant and sampling area plots showing emission points and sampling sites. Topographic features significantly affecting dispersion including plant building heights and locations shall be included.

(g) Information necessary for estimating dispersion including stack height, inside diameter, exit gas temperature, exit velocity or flow rate, and beryllium concentration.

(h) A description of data and procedures (methods or models) used to design the air sampling network (i.e., number and location of sampling sites).

(f) Air sampling data indicating beryllium concentrations in the vicinity of the stationary source for the 3-year period specified in paragraph (b)(1) of this section. This data shall be presented chronologically and include the beryllium concentration and location of each individual sample taken by the network and the corresponding 30-day average beryllium concentrations.

(2) Within 60 days after receiving such report, the Administrator will notify the owner or operator in writing whether approval is granted or denied. Prior to denying approval to comply with the provisions of paragraph (b) of this section, the Administrator will consult with representatives of the stationary source for which the demonstration report was submitted.

(c) The burning of beryllium and/or beryllium-containing waste, except propellants, is prohibited except in incinerators, emissions from which must comply with the standard.

§ 61.33 Stack sampling.

(a) Unless a waiver of emission testing is obtained under § 61.13, each owner or operator required to comply with § 61.32(a) shall test emissions from his source.

(1) Within 90 days of the effective date in the case of an existing source or a new source which has an initial startup date preceding the effective date; or

(2) Within 90 days of startup in the case of a new source which did not have an initial startup date preceding the effective date.

(b) The Administrator shall be notified at least 30 days prior to an emission test so that he may at his option observe the test.

(c) Samples shall be taken over such a period or periods as are necessary to accurately determine the maximum emissions which will occur in any 24-hour period. Where emissions depend upon the relative frequency of operation of different types of processes, operating hours, operating capacities, or other factors, the calculation of maximum 24-hour-period emissions will be based on that combination of factors which is likely to occur during the subject period and which result in the maximum emissions. No changes in the operation shall be made, which would potentially increase emissions above that determined by the most recent source test, until a new emission level has been estimated by calculation and the results reported to the Administrator.

(d) All samples shall be analyzed and beryllium emissions shall be determined within 30 days after the source test. All determinations shall be reported to the Administrator by a registered letter dispatched before the close of the next business day following such determination.

(e) Records of emission test results and other data needed to determine total emissions shall be retained at the source and made available, for inspection by the Administrator, for a minimum of 2 years.

§ 61.34 Air sampling.

(a) Stationary sources subject to § 61.32(b) shall locate air sampling sites in accordance with a plan approved by the Administrator. Such sites shall be located in such a manner as is calculated to detect maximum concentrations of beryllium in the ambient air.

(b) All monitoring sites shall be operated continuously except for a reasonable time allowance for instrument maintenance and calibration, for changing filters, or for replacemet of equipment needing major repair.

(c) Filters shall be analyzed and concentrations calculated within 30 days after filters are collected. Records of concentrations at all sampling sites and other data needed to determine such concentrations shall be retained at the source and made available, for inspection by the Administrator, for a minimum of 2 years.

(d) Concentrations measured at all sampling sites shall be reported to the Administrator every 30 days by a registered letter.

(e) The Administrator may at any time require changes in, or expansion of, the sampling network.

Subpart D—National Emission Standard for Beryllium Rocket Motor Firing

§ 61.40 Applicability.

The provisions of this subpart are applicable to rocket motor test sites.

§ 61.41 Definitions.

Terms used in this subpart are defined in the Act, in Subpart A of this part, or in this section as follows:

(a) "Rocket motor test site" means any building, structure, facility, or installation where the static test firing of a beryllium rocket motor and/or the disposal of beryllium propellant is conducted.

(b) "Beryllium propellant" means any propellant incorporating beryllium.

§ 61.42 Emission standard.

(a) Emissions to the atmosphere from rocket-motor test sites shall not cause time-weighted atmospheric concentrations of beryllium to exceed 75 microgram minutes per cubic meter of air within the limits of 10 to 60 minutes, accumulated during any 2 consecutive weeks, in any area in which an effect adverse to public health could occur.

(b) If combustion products from the firing of beryllium propellant are collected in a closed tank, emissions from such tank shall not exceed 2 grams per hour and a maximum of 10 grams per day.

§ 61.43 Emission testing—rocket firing or propellant disposal.

(a) Ambient air concentrations shall be measured during and after firing of a rocket motor or propellant disposal and in such a manner that the effect of these emissions can be compared with the standard. Such sampling techniques shall be approved by the Administrator.

(b) All samples shall be analyzed and results shall be calculated within 30 days after samples are taken and before any subsequent rocket motor firing or propellant disposal at the given site. All results shall be reported to the Administrator by a registered letter dispatched before the close of the next business day following determination of such results.

(c) Records of air sampling test results and other data needed to determine integrated intermittent concentrations shall be retained at the source and made available, for inspection by the Administrator, for a minimum of 2 years.

(d) The Administrator shall be notified at least 30 days prior to an air sampling test, so that he may at his option observe the test.

§ 61.44 Stack sampling.

(a) Sources subject to § 61.42(b) shall be continuously sampled, during release of combustion products from the tank, in such a manner that compliance with the standards can be determined. The provisions of § 61.14 shall apply.

(b) All samples shall be analyzed, and beryllium emissions shall be determined within 30 days after samples are taken and before any subsequent rocket motor firing or propellant disposal at the given site. All determinations shall be reported to the Administrator by a registered letter dispatched before the close of the next business day following such determinations.

(c) Records of emission test results and other data needed to determine total emissions shall be retained at the source and made available, for inspection by the Administrator, for a minimum of 2 years.

(d) The Administrator shall be notified at least 30 days prior to an emission test, so that he may at his option observe the test.

Subpart E—National Emission Standard for Mercury

§ 61.50 Applicability.

The provisions of this subpart are applicable to those stationary sources which process mercury ore to recover mercury, and to those which use mercury chlor-alkali cells to produce chlorine gas and alkali metal hydroxide.

§ 61.51 Definitions.

Terms used in this subpart are defined in the act, in subpart A of this part, or in this section as follows:

(a) "Mercury" means the element mercury, excluding any associated elements, and includes mercury in particulates, vapors, aerosols, and compounds.

(b) "Mercury ore" means a mineral mined specifically for its mercury content.

(c) "Mercury ore processing facility" means a facility processing mercury ore to obtain mercury.

(d) "Condenser stack gases" mean the gaseous effluent evolved from the stack of processes utilizing heat to extract mercury metal from mercury ore.

(e) "Mercury chlor-alkali cell" means a device which is basically composed of an electrolyzer section and a denuder (decomposer) section and utilizes mercury to produce chlorine gas, hydrogen gas, and alkali metal hydroxide.

(f) "Mercury chlor-alkali electrolyzer" means an electrolytic device which is part of a mercury chlor-alkali cell and utilizes a flowing mercury cathode to produce chlorine gas and alkali metal amalgam.

(g) "Denuder" means a horizontal or vertical container which is part of a mercury chlor-alkali cell and in which water and alkali metal amalgam are converted to alkali metal hydroxide, mercury, and hydrogen gas in a short-circuited, electrolytic reaction.

(h) "Hydrogen gas stream" means a hydrogen stream formed in the chlor-alkali cell denuder.

(i) "End box" means a container(s) located on one or both ends of a mercury chlor-alkali electrolyzer which serves as a connection between the electrolyzer and denuder for rich and stripped amalgam.

(j) "End box ventilation system" means a ventilation system which collects mercury emissions from the end-boxes, the mercury pump sumps, and their water colection systems.

(k) "Cell room" means a structure(s) housing one or more mercury electrolytic chlor-alkali cells.

§ 61.52 Emission standard.

Emissions to the atmosphere from stationary sources subject to the provisions of this subpart shall not exceed 2,300 grams of mercury per 24-hour period.

§ 61.53 Stack sampling.

(a) Mercury ore processing facility.

(1) Unless a waiver of emission testing is obtained under § 61.13, each owner or operator processing mercury ore shall test emissions from his source.

(i) Within 90 days of the effective date in the case of an existing source or a new source which has an initial start-up date preceding the effective date; or

(ii) Within 90 days of startup in the case of a new source which did not have an initial startup date preceding the effective date.

(2) The Administrator shall be notified at least 30 days prior to an emission test, so that he may at his option observe the test.

(3) Samples shall be taken over such a period or periods as are necessary to accurately determine the maximum emissions which will occur in a 24-hour period. No changes in the operation shall be made, which would potentially increase emissions above that determined by the most recent source test, until the new emission level has been estimated by calculation and the results reported to the Administrator.

(4) All samples shall be analyzed, and mercury emissions shall be determined within 30 days after the source test. Each determination will be reported to the Administrator by a registered letter dispatched before the close of the next business day following such determination.

(5) Records of emission test results and other data needed to determine total emissions shall be retained at the source and made available, for inspection by the Administrator, for a minimum of 2 years.

(b) Mercury chlor-alkali plant—hydrogen and end-box ventilation gas streams.

(1) Unless a waiver of emission testing is obtained under § 61.13, each owner or operator employing mercury chlor-alkali cell(s) shall test emissions from his source.

(i) Within 90 days of the effective date in the case of an existing source or a new source which has an initial startup date preceding the effective date; or

(ii) Within 90 days of startup in the case of a new source which did not have an initial startup date preceding the effective date.

(2) The Administrator shall be notified at least 30 days prior to an emission test, so that he may at his option observe the test.

(3) Samples shall be taken over such a period or periods as are necessary to accurately determine the maximum emissions which will occur in a 24-hour period. No changes in the operation shall be made, which would potentially increase emissions above that determined by the most recent source test, until the new emission has been estimated by calculation and the results reported to the Administrator.

(4) All samples shall be analyzed and mercury emissions shall be determined within 30 days after the source test. All the determinations will be reported to the Administrator by a registered letter dispatched before the close of the next business day following such determination.

(5) Records of emission test results and other data needed to determine total emissions shall be retained at the source and made available, for inspection by the Administrator, for a minimum of 2 years.

(c) Mercury chlor-alkali plants—cell room ventilation system.

(1) Stationary sources using mercury chlor-alkali cells may test cell room emissions in accordance with paragraph (c)(2) of this section or demonstrate compliance with paragraph (c)(4) of this section and assume ventilation emissions of 1,300 gms/day of mercury.

(2) Unless a waiver of emission testing is obtained under § 61.13, each owner or operator shall pass all cell room air in forced gas streams through stacks suitable for testing.

(i) Within 90 days of the effective date in the case of an existing source or a new source which has an initial startup date preceding the effective date; or

(ii) Within 90 days of startup in the case of a new source which did not have an initial startup date preceding the effective date.

(3) The Administrator shall be notified at least 30 days prior to an emission test so that he may at his option observe the test.

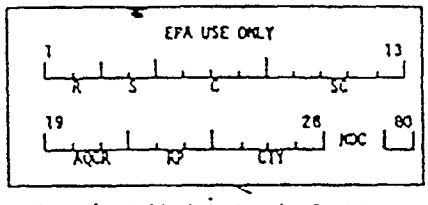
(4) An owner or operator may carry out approved design, maintenance, and housekeeping practices. A list of approved design, maintenance, and housekeeping practices may be obtained from the Administrator.

APPENDIX A

National Emission Standards for Hazardous Air Pollutants

Compliance Status Information

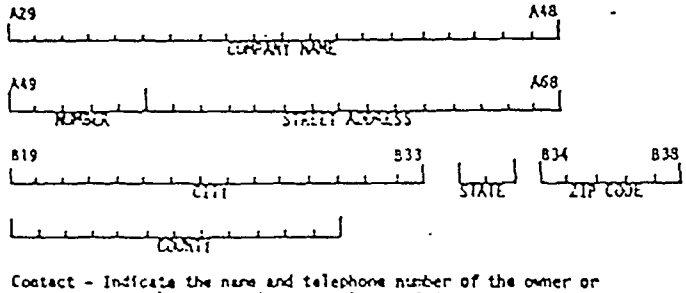
I. SOURCE REPORT.



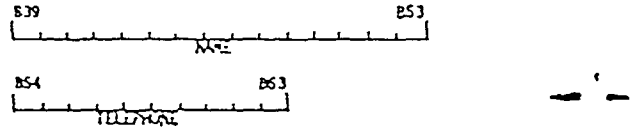
Instructions: Owners or operators of sources of hazardous pollutants subject to the National Emission Standards for Hazardous Air Pollutants are required to submit the information contained in Section I to the appropriate Environmental Protection Agency Regional Office before (date which is 90 days after the standards are promulgated). A listing of regional offices is provided in § 61.04.

A. SOURCE INFORMATION.

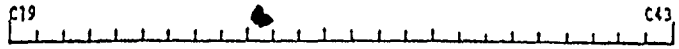
1. Identification/Location - Indicate the name and address of each source.



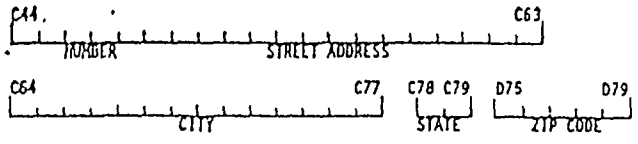
2. Contact - Indicate the name and telephone number of the owner or operator or other responsible official whom EPA may contact concerning this report.



3. Source Description - Briefly state the nature of the source (e.g., "Chlor-alkali Plant", or "Machine Shop").



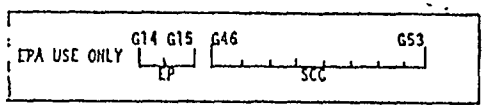
4. Alternative Mailing Address - Indicate an alternative mailing address if correspondence is to be directed to a location different than that specified above.



5. Compliance Status - The emissions from this source can cannot meet the emission limitations contained in the National Emission Standards on or before (date which is 90 days after the promulgation of the standards).

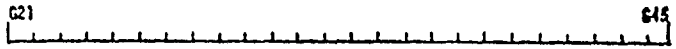
Signature of owner, operator or other responsible official

NOTE: If the emissions from the source will exceed those limits set by the National Emission Standards for Hazardous Air Pollutants, the source will be in violation and subject to Federal enforcement actions unless granted a waiver of compliance by the Administrator of the Environmental Protection Agency. The information needed for such waivers is listed in Section II of this form.



B. PROCESS INFORMATION. Part B should be completed separately for each point of emission for each hazardous pollutant.

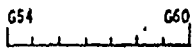
1. Process Description - Provide a brief description of each process (e.g., "hydrogen end box" in a mercury chlor-alkali plant, "grinding machine" in a beryllium machine shop). Use additional sheets if necessary.



2. Pollutant Emitted - Indicate the type of hazardous pollutant emitted by the process. Indicate "AS" for asbestos, "BE" for beryllium, or "HG" for mercury.

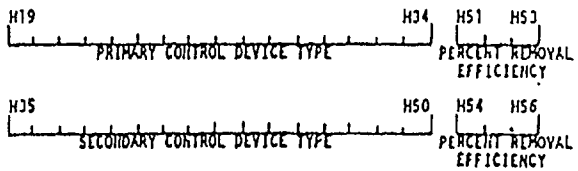


3. Amount of Pollutant - Indicate the average weight of the hazardous material named in item 2 which enters the process in pounds per month (based on the previous twelve months of operation).



4. Control Devices

a. Indicate the type of pollution control devices, if any, used to reduce the emissions from the process (e.g., venturi scrubber, baghouse, wet cyclone) and the estimated percent of the pollutant which the device removes from the process gas stream.



b. Asbestos Emission Control Devices Only

1. If a baghouse is specified in item 4a give the following information:

- The air flow permeability in cubic feet per minute per square foot of fabric area:

Air flow permeability = _____ cfm/ft^2

RULES AND REGULATIONS

- The pressure drop in inches water gauge across the filter at which the baghouse is operated

  Operating pressure drop = _____ inches w.g.

- If the baghouse material contains synthetic fill yarn, check whether this material is spun ☐ or not spun ☐.

  If the baghouse utilizes a felted fabric, give the minimum thickness in inches and the density in ounces per square yard.

  Thickness = _____ inches Density = _____ oz/yd^2

11. If a wet collection device is specified in item 4a, give the designed unit contacting energy in inches water gauge,

    Unit contacting energy = _____ inches w.g.

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II. WAIVER REQUESTS

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X S C SC

A. WAIVER OF COMPLIANCE. Owners or operators of sources unable to operate in compliance with the National Emission Standards for Hazardous Air Pollutants by (date which is 90 days after the standards are promulgated) may request a waiver of compliance from the Administrator of the Environmental Protection Agency for the time period necessary to install appropriate control devices or make modifications to achieve compliance. The Administrator may grant a waiver of compliance with the standard for a period not exceeding two years from the effective date of the hazardous pollutant standards if he finds that such period is necessary for the installation of controls and that steps will be taken during the period of the waiver to assure that the health of persons will be protected from imminent endangerment.

The reporting information provided in Section I must accompany this application. Applications should be sent to the appropriate EPA regional office.

1. Processes involved - Indicate the process or processes emitting hazardous pollutants to which emission controls are to be applied.

   _____

   _____

   _____

2. Controls

   a. Describe the proposed type of control device to be added or modification to be made to the process to reduce the emissions of hazardous pollutants to an acceptable level. Use additional sheets if necessary.

   _____

   _____

   _____

   b. Describe the measures that will be taken during the waiver period to assure that the health of persons will be protected from imminent endangerment. Use additional sheets if necessary.

   _____

   _____

   _____

3. Increments of Progress - specify the dates by which the following increments of progress will be met.

   Date by which contracts for emission control systems or process modifications will be awarded; or date by which orders will be issued for the purchase of the component parts to accomplish emission control or process modification.

   LS4 [MONTH] [DAY] LS9 [YEAR] 01

   Date of initiation of on-site construction or installation of emission control equipment or process change.

   LS4 [MONTH] [DAY] LS9 [YEAR] 02

6

Date by which on-site construction or installation of emissio control equipment or process modification is to be completed.

L54 L59 03
MONTH DAY YEAR

Date by which final compliance is to be achieved.

L54 L59 04
MONTH DAY YEAR

Signature of owner or operator

B. WAIVER OF EMISSION TESTS. A waiver of emission testing may be granted to owners or operators of sources of beryllium or mercury pollutants if, in the judgment of the Administrator of the Environmental Protection Agency the emissions from the source comply with the appropriate standard or if the owners or operators of the source have requested a waiver of compliance or have been granted a waiver of compliance.

This application should accompany the reporting information provided in Section 1.

1. Reason - State the reasons for requesting a waiver of emission testing. If the reason stated is that the emissions from the source is within the prescribed limits, documentation of this condition must be attached.

_____

_____

Date

Signature of the owner or operator

APPENDIX B—TEST METHODS

METHOD 101. REFERENCE METHOD FOR DETERMINATION OF PARTICULATE AND GASEOUS MERCURY EMISSIONS FROM STATIONARY SOURCES (AIR STREAMS)

1. *Principle and applicability*—1.1 *Principle.* Particulate and gaseous mercury emissions are isokinetically sampled from the source and collected in acidic iodine monochloride solution. The mercury collected (in the mercuric form) is reduced to elemental mercury in basic solution by hdroxylamine sulfate. Mercury is aerated from the solution and analyzed using spectrophotometry.

1.2 *Applicability.* This method is applicable for the determination of particulate and gaseous mercury emissions when the carrier gas stream is principally air. The method is for use in ducts or stacks at stationary sources. Unless otherwise specified, this method is not intended to apply to gas streams other than those emitted directly to the atmosphere without further processing.

2. *Apparatus*—2.1 *Sampling train.* A schematic of the sampling train used by EPA is shown in figure 101-1. Commercial models of this train are available, although construction details are described in APTD-0581,[1] and operating and maintenance procedures are described in APTD-0576. The components essential to this sampling train are the following:

[1] These documents are available for a nominal cost from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Va. 22151.

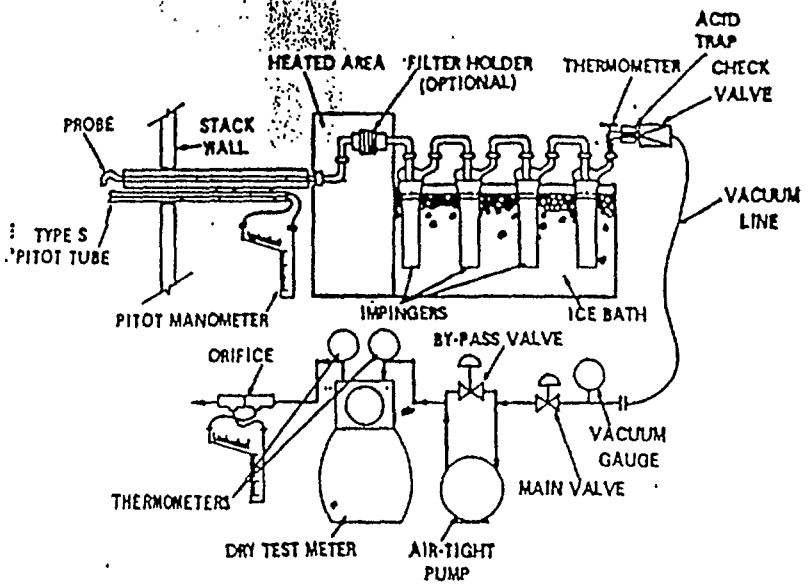


Figure 101-1. Mercury sampling train

2.1.1 *Nozzle.* Stainless steel or glass with sharp, tapered leading edge.

2.1.2 *Probe.* Sheathed Pyrex[4] glass. A heating system capable of maintaining a minimum gas temperature of 250° F at the probe outlet during sampling may be used to prevent condensation from occurring.

2.1.3 *Pitot tube.* Type S (Figure 101-2), or equivalent, with a coefficient within 5 percent over the working range, attached to probe to monitor stack gas velocity.

2.1.4 *Impingers.* Four Greenburg-Smith impingers connected in series with glass ball joint fittings. The first, third, and fourth impingers may be modified by replacing the tip with a one-half inch ID glass tube extending to one-half inch from the bottom of the flask.

2.1.5 *Acid Trap.* Mine Safety Appliances Air Line Filter, Catalogue Number 81857, with acid absorbing cartridge and suitable connections, or equivalent.

[4] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

2.1.6 *Metering system.* Vacuum gauge, leakless pump, thermometers capable of measuring temperature to within 5° F, dry gas meter with 2 percent accuracy, and related equipment, described in APTD-0581, to maintain an isokinetic sampling rate and to determine sample volume.

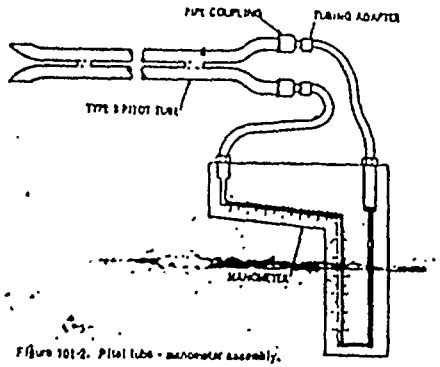


Figure 101-2. Pitot tube - manometer assembly.

2.1.7 *Filter Holder (optional)-Pyrex glass.* A filter may be used in cases where the gas stream to be sampled contains large quan-

tities of particulate matter. The filter holder must provide a positive seal against leakage from outside or around the filter. A heating system capable of maintaining the filter at a minimum temperature of 250° F. should be used to prevent condensation from occurring.

2.1.8 *Barometer.* To measure atmospheric pressure to ±0.1 in Hg.

2.2 *Measurement of stack conditions (stack pressure, temperature, moisture and velocity).*—2.2.1 *Pitot tube.* Type S, or equivalent, with a coefficient within 5 percent over the working range.

2.2.2 *Differential pressure gauge* Inclined manometer, or equivalent, to measure velocity head to within 10 percent of the minimum value. Micromanometers should be used if warranted.

2.2.3 *Temperature gauge.* Any temperature measuring device to measure stack temperature to within 1° F.

2.2.4 *Pressure gauge.* Pitot tube and inclined manometer, or equivalent, to measure stack pressure to within 0.1 in Hg.

2.2.5 *Moisture determination.* Wet and dry bulb thermometers, drying tubes, condensers, or equivalent, to determine stack gas moisture content to within 1 percent.

2.3 *Sample recovery.*—2.3.1 *Leakless glass sample bottles,* 500 ml and 100 ml with Teflon lined tops.

2.3.2 *Graduated cylinder.* 250 ml.

2.3.3 *Plastic jar.* Approximately 300 ml.

2.4 *Analysis.*—2.4.1 *Spectrophotometer.* To measure absorbance at 253.7 nm. Perkin Elmer Model 303, with a cylindrical gas cell (approximately 1.5 in. O.D. x 7 in.) with quartz glass windows, and hollow cathode source, or equivalent.

2.4.2 *Gas sampling bubbler.* Tudor Scientific Glass Co., Smog Bubbler, Catalogue No. TP-1150, or equivalent.

2.4.3. *Recorder.* To match output of spectrophotometer.

3. *Reagents.*—3.1 *Stock reagents.*—3.1.1 *Potassium iodide.* Reagent grade.

3.1.2 *Distilled water.*—3.1.3 *Potassium iodide solution, 25 percent.* Dissolve 250 g of potassium iodide (reagent 3.1.1) in distilled water and dilute to 1 to 1.

3.1.4 *Hydrochloric acid.* Concentrated.

3.1.5. *Potassium iodate.* Reagent grade.

3.1.6 *Iodine monochloride (ICl) 1.0M.* To 800 ml. of 25% potassium iodide solution (reagent 3.1.3), add 800 ml. of concentrated hydrochloric acid. Cool to room temperature. With vigorous stirring, slowly add 135 g. of potassium iodate and continue stirring until all free iodine has dissolved to give a clear orange-red solution. Cool to room temperature and dilute to 1800 ml. with distilled water. The solution should be kept in amber bottles to prevent degradation.

3.1.7 *Sodium hydroxide pellets* Reagent grade.

3.1.8 *Nitric acid.* Concentrated

3.1.9 *Hydroxylamine sulfate.* Reagent grade.

3.1.10 *Sodium chloride.* Reagent grade.

3.1.11 *Mercuric chloride.* Reagent grade.

3.2 *Sampling.*—3.2.1 *Absorbing solution, 0.1M ICl.* Dilute 100 ml. of the 1.0M ICl stock solution (reagent 3.1.6) to 1 to 1 with distilled water. The solution should be kept in glass bottles to prevent degradation. This reagent should be stable for at least 2 months; however, periodic checks should be performed to insure quality.

3.2.2 *Wash acid.* 1:1 V/V nitric acid—water.

3.2.3 *Distilled, deionized water.*

3.2.4 *Silica gel.* Indicating type, 6 to 16 mesh dried at 350° F. for 2 hours.

3.2.5 *Filter (optional).* Glass fiber, Mine Safety Appliances 1106BH, or equivalent. A filter may be necessary in cases where the gas stream to be sampled contains large quantities of particulate matter.

3.3 *Analysis.*—3.3.1 *Sodium hydroxide, 10 N.*—Dissolve 400 g of sodium hydroxide pellets in distilled water and dilute to 1 l.

3.3.2 *Reducing agent, 12 percent hydroxylamine sulfate, 12 percent sodium chloride.*—To 60 ml of distilled water, add 12 g of hydroxylamine sulfate and 12 g of sodium chloride. Dilute to 100 ml. This quantity is sufficient for 20 analyses and must be prepared daily.

3.3.3 *Aeration gas.*—Zero grade air

3.3.4 *Hydrochloric acid, 0.3N.*—Dilute 25 5 ml of concentrated hydrochloric acid to 1 to 1 with distilled water

3.4 *Standard mercury solutions.*—3.4.1 *Stock solution.*—Add 0.1354 g of mercuric chloride to 80 ml of 0.3N hydrochloric acid. After the mercuric chloride has dissolved, add 0.3N hydrochloric acid and adjust the volume to 100 ml. One ml of this solution is equivalent to 1 mg of free mercury

3.4.2 *Standard solutions.*—Prepare calibration solutions by serially diluting the stock solution (3.4.1) with 0.3N hydrochloric acid. Prepare solutions at concentrations in the linear working range for the instrument to be used. Solutions of 0.2 μg/ml, 0.4 μg/ml and 0.6 μg/ml have been found acceptable for most instruments. Store all solutions in glass-stoppered, glass bottles. These solutions should be stable for at least 2 months; however, periodic checks should be performed to insure quality.

4. *Procedure.*—4.1 Guidelines for source testing are detailed in the following sections. These guidelines are generally applicable; however, most sample sites differ to some degree and temporary alterations such as stack extensions or expansions often are required to ensure the best possible sample site. Further, since mercury is hazardous, care should be taken to minimize exposure. Finally, since the total quantity of mercury to be collected generally is small, the test must be carefully conducted to prevent contamination or loss of sample.

4.2 Selection of a sampling site and minimum number of traverse points:

4.2.1 Select a suitable sampling site that is as close as is practicable to the point of atmospheric emission. If possible, stacks smaller than 1 foot in diameter should not be sampled.

4.2.2 The sampling site should be at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, or contraction. For a rectangular cross section, determine an equivalent diameter from the following equation:

$$D_e = \frac{2LW}{L+W} \qquad \text{eq. 101-1}$$

where:

D_e = Equivalent diameter.
L = Length.
W = Width.

4.2.3 When the above sampling site criteria can be met, the minimum number of traverse points is four (4) for stacks 1 foot in diameter or less, eight (8) for stacks larger than 1 foot but 2 feet in diameter or less, and twelve (12) for stacks larger than 2 feet.

4.2.4 Some sampling situations may render the above sampling site criteria impractical. When this is the case, choose a convenient sampling location and use figure 101-3 to determine the minimum number of traverse points. However, use figure 101-3 only for stacks 1 foot in diameter or larger.

4.2.5 To use figure 101-3, first measure the distance from the chosen sampling location to the nearest upstream and downstream disturbances. Divide this distance by the diameter or equivalent diameter to determine the distance in terms of pipe diameters. Determine the corresponding number of traverse points for each distance from figure 101-3. Select the higher of the two numbers of traverse points, or a greater value, such that for circular stacks the number is a multiple of four, and for rectangular stacks the number follows the criteria of section 4.3.2.

4.2.6 If a selected sampling point is closer than 1 inch from the stack wall, adjust the location of that point to ensure that the sample is taken at least 1 inch away from the wall.

4.3 Cross sectional layout and location of traverse points:

4.3.1 For circular stacks locate the traverse points on at least two diameters according to figure 101-4 and table 101-1. The traverse axes shall divide the stack cross section into equal parts.

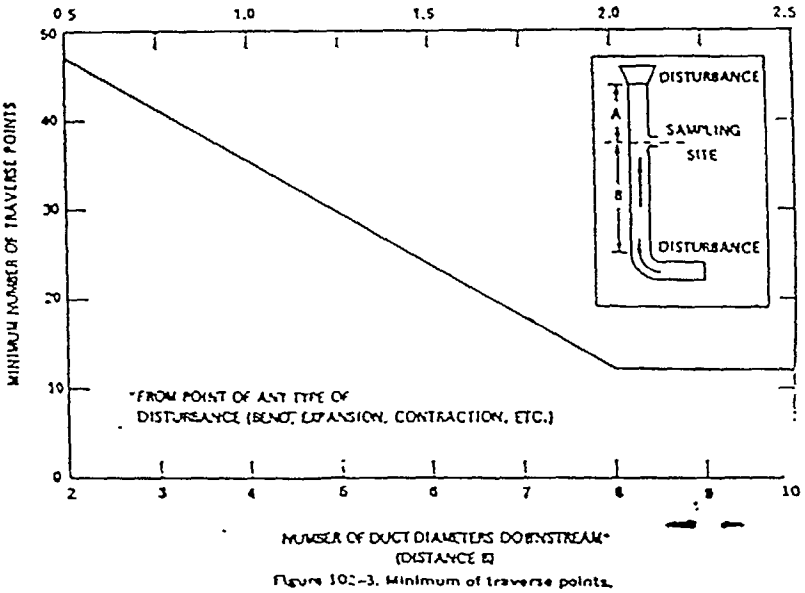


Figure 101-3. Minimum of traverse points.

Table 101-1. Location of traverse points in circular stacks
(Percent of stack diameter from inside wall to traverse point)

Traverse point number on a diameter	Number of traverse points on a diameter											
	2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.7	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.5	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.3	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	80.6	65.8	35.5	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.5	36.6	28.3	23.6	20.4	18.0	16.1
8				96.7	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.1	23.0
10					97.5	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.9	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

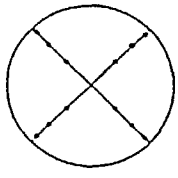


Figure 101-4. Cross section of circular stack showing location of traverse points on perpendicular diameters.

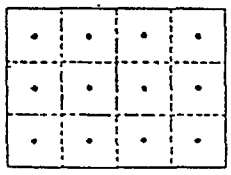


Figure 101-5. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

4.3.2 For rectangular stacks divide the cross section into as many equal rectangular areas as traverse points, such that the ratio of the length to the width of the elemental areas is between one and two. Locate the traverse points at the centroid of each equal area according to figure 101-5.

4.4 Measurement of stack conditions:

4.4.1 Set up the apparatus as shown in figure 101-2. Make sure all connections are tight and leak-free. Measure the velocity head and temperature at the traverse points specified by section 4.2 and 4.3.

4.4.2 Measure the static pressure in the stack.

4.4.3 Determine the stack gas moisture.

4.4.4 Determine the stack gas molecular weight from the measured moisture content and knowledge of the expected gas stream composition. A standard Orsat analyzer has been found valuable at combustion sources. In all cases, sound engineering judgment should be used.

4.5 Preparation of sampling train:

4.5.1 Prior to assembly, clean all glassware (probe, impingers, and connectors) by rinsing with wash acid, tap water, 0.1M ICl, tap water, and finally distilled water. Place 100 ml of 0.1M ICl in each of the first three impingers, and place approximately 200 g of preweighed silica gel in the fourth impinger. Save 60 ml of the 0.1M ICl as a blank in the sample analysis. Set up the train and the probe as in figure 101-1.

4.5.2 If the gas stream to be sampled is excessively dirty or moist, the first impinger may clog or become dilute too rapidly for sufficient testing. A filter can be placed ahead of the impingers to collect the particulates. An initial empty impinger may also be used to remove excess moisture. If a fifth impinger is required, the final impinger may have to be carefully taped to the outside of the sample box.

4.5.3 Leak check the sampling train at the sampling site. The leakage rate should not be in excess of 1 percent of the desired sampling rate. If condensation in the probe or filter is a problem, probe and filter heaters will be required. Adjust the heaters to provide a temperature of at least 250° F. Place crushed ice around the impingers. Add more ice during the test to keep the temperature of the gases leaving the last impinger at 70° F or less.

4.6 Mercury train operation:

4.6.1 For each run, record the data required on the example sheet shown in figure 101-6. Take readings at each sampling point at least every 5 minutes and when significant changes in stack conditions necessitate additional adjustments in flow rate.

4.6.2 Sample at a rate of 0.5 to 1.0 cfm. Samples shall be taken over such a period or periods as are necessary to accurately determine the maximum emissions which would occur in a 24-hour period. In the case of cyclic operations, sufficient tests shall be made so as to allow accurate determination or calculation of the emissions which will occur over the duration of the cycle. A minimum sample time of 2 hours is recommended. In some instances, high mercury concentrations can prevent sampling in one run for the desired minimum time. This is indicated by reddening in the first impinger as free iodine is liberated. In this case, a run may be divided into two or more subruns to ensure that the absorbing solutions are not depleted.

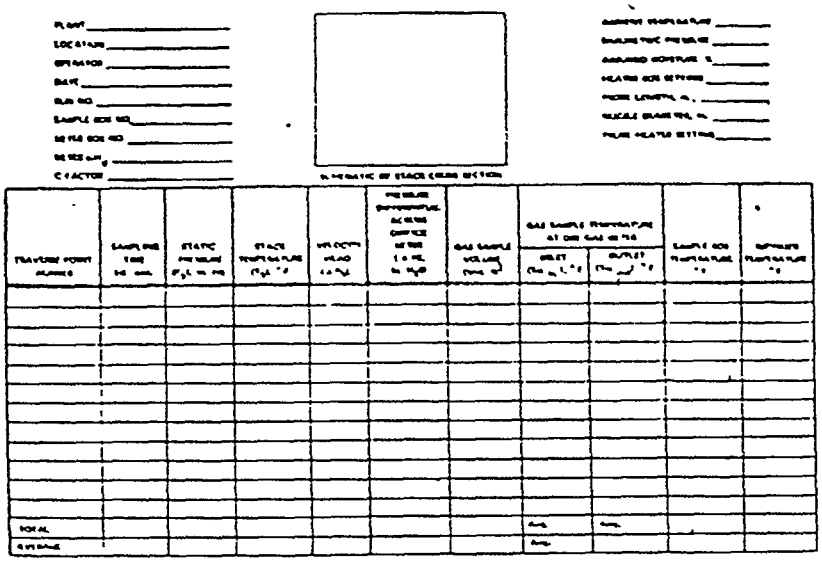


Figure 101-6. Field data.

4.6.3 To begin sampling, position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Sample for at least 5 minutes at each traverse point; sampling time must be the same for each point. Maintain isokinetic sampling throughout the sampling period. Nomographs which aid in the rapid adjustment of the sampling rate without other computations are in APTD-0576 and are available from commercial suppliers. Note the standard nomographs are applicable only for type S pitot tubes and air or a stack gas with an equivalent density. Contact EPA or the sampling train supplier for instructions when the standard nomograph is not applicable.

4.6.4 Turn off the pump at the conclusion of each run and record the final readings. Immediately remove the probe and nozzle from the stack and handle in accordance with the sample recovery process described in section 4.7.

4.7 Sample recovery:

4.7.1 (All glass storage bottles and the graduated cylinder must be precleaned as in section 4.5.1). This operation should be performed in an area free of possible mercury contamination. Industrial laboratories and ambient air around mercury-using facilities are not normally free of mercury contamination. When the sampling train is moved, care must be exercised to prevent breakage and contamination.

4.7.2 Disconnect the probe from the impinger train. Place the contents (measured to ±1 ml) of the first three impingers into a 500 ml sample bottle. Rinse the probe and all glassware between it and the back half of the third impinger with two 50 ml portions of 0.1M ICl solution. Add these rinses to the first sample bottle. For a blank, place 60 ml of the 0.1M ICl in a 100 ml sample bottle. If used, place the filter along with 100 ml of 0.1M ICl in another 100 ml sample bottle. Retain a filter blank. Place the silica gel in the plastic jar. Seal and secure all containers for shipment. If an additional test is desired, the glassware can be carefully double rinsed with distilled water and reassembled. However, if the glassware is to be out of use more than 2 days, the initial acid wash procedure must be followed.

4.8 Analysis:

4.8.1 *Apparatus preparation.*—Clean all glassware according to the procedure of section 4.5.1. Adjust the instrument settings according to the instrument manual, using an absorption wavelength of 253.7 nm.

4.8.2 *Analysis preparation.*—Adjust the air delivery pressure and the needle valve to obtain a constant airflow of about 1.5 to 1/min. The analysis tube should be bypassed except during aeration. Purge the equipment for 3 minutes. Prepare a sample of mercury standard solution (3.4.3) according to section 4.8.3. Place the analysis tube in the line, and aerate until a minimum peak height is reached on the recorder. Remove the analysis tube, flush the lines, and rinse the analysis tube with distilled water. Repeat with another sample of the same standard solution. This purge and analysis cycle is to be repeated until peak heights are reproducible.

4.8.3 *Sample preparation.*—Just prior to analysis, transfer a sample aliquot of up to 50 ml to the cleaned 100 ml analysis tube. Adjust the volume to 50 ml with 0.1M ICl if required. Add 5 ml of 10 N sodium hydroxide, cap tube with a clean glass stopper and shake vigorously. Prolonged, vigorous shaking at this point is necessary to obtain an accurate analysis. Add 5 ml of the reducing agent (reagent 3.3.2), cap tube with a clean glass stopper and shake vigorously and immediately in sample line.

4.8.4 *Mercury determination.*—After the system has been stabilized, prepare samples from the sample bottle according to section 4.8.3. Aerate the sample until a maximum peak height is reached on the recorder. The mercury content is determined by comparing the peak heights of the samples to the peak heights of the calibration solutions. If collected samples are out of the linear range, the samples should be diluted. Prepare a blank from the 100 ml bottle according to section 4.8.3 and analyze to determine the reagent blank mercury level.

5 *Calibration.*—5.1 *Sampling train.*—5.1.1 Use standard methods and equipment as detailed in APTD-0576 to calibrate the rate meter, pitot tube, dry gas meter, and probe heater (if used). Recalibrate prior to each test series.

5.2 *Analysis.*—5.2.1 Prepare a calibration curve for the spectrophotometer using the standard mercury solutions. Plot the peak heights read on the recorder versus the concentrations of mercury in the standard solutions. Standards should be interspersed with the samples since the calibration can change slightly with time. A new calibration curve should be prepared for each new set of samples run.

6 *Calculations.*—6.1 Average dry gas meter temperature, stack temperature, stack pressure and average orifice pressure drop. See data sheet (fig. 101-6).

6.2 *Dry gas volume.*—Correct the sample volume measured by the dry gas meter to stack conditions by using equation 101-2.

$$V_{s_1} = V_m \frac{T_s}{T_m} \frac{\left(P_{bar} + \frac{\Delta H}{13.6}\right)}{P_s} \qquad \text{eq. 101-2}$$

where:

V_{s_1} = Volume of gas sample through the dry gas meter (stack conditions), ft³.

V_m = Volume of gas sample through the dry gas meter (meter conditions), ft³.

T_s = Average temperature of stack gas, °R.

T_m = Average dry gas meter temperature, °R.

P_{bar} = Barometric pressure at the orifice meter, inHg.

ΔH = Average pressure drop across the orifice meter, inH_2O.

13.6 = Specific gravity of mercury.

P_s = Stack pressure, $P_{bar} \pm$ static pressure, inHg.

6.3 *Volume of water vapor.*

$$V_{w_e} = K_w V_{e_e} \frac{T_e}{P_e} \qquad \text{eq. 101-3}$$

where:

V_{w_e} = Volume of water vapor in the gas sample (stack conditions), ft³.

K_w = 0.00267 $\frac{\text{in. Hg-ft}^3}{\text{ml.-°R}}$, when these units are used.

V_{t_e} = Total volume of liquid collected in impingers and silica gel (see figure 101-7), ml.

T_e = Average stack gas temperature, °R.

P_e = Stack pressure, P_{bar} ± static pressure, in. Hg.

6.4 Total gas volume.

$$V_{total} = V_{m_e} + V_{w_e} \qquad \text{eq. 101-4}$$

where:

V_{total} = Total volume of gas sample (stack conditions), ft³.

V_{m_e} = Volume of gas through gas meter (stack conditions), ft³.

V_{w_e} = Volume of water vapor in gas sample (stack conditions), ft³.

	VOLUME OF LIQUID WATER COLLECTED	
	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL		
INITIAL		
LIQUID COLLECTED		
TOTAL VOLUME COLLECTED		g* ml

CONVERT WEIGHT OF WATER TO VOLUME BY dividing total weight INCREASE BY DENSITY OF WATER. (1 g/ml)

$$\frac{\text{INCREASE, g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

Figure 101-7. Analytical data.

6.5 Stack gas velocity. Use equation 101-5 to calculate the stack gas velocity.

$$(v_s)_{avg.} = K_p C_p (\sqrt{\Delta P})_{avg.} \sqrt{\frac{(T_s)_{avg.}}{P_s M_s}} \qquad \text{eq. 101-5}$$

where:

$(v_s)_{avg.}$ = Average stack gas velocity, feet per second.

K_p = 85.53 $\frac{\text{ft.}}{\text{sec.}} \left(\frac{\text{lb.-in. Hg}}{\text{lb.mole-°R-in.H}_2\text{O}}\right)^{1/2}$, when these units are used.

C_p = Pitot tube coefficient, dimensionless.

$(T_s)_{avg.}$ = Average stack gas temperature, °R.

$(\sqrt{\Delta P})_{avg.}$ = Average square root of the velocity head of stack gas (in. H_2O)$^{1/2}$ (see fig. 101-8).

P_s = Stack pressure, P_{bar} ± static pressure, in. Hg.

M_s = Molecular weight of stack gas (wet basis), the summation of the products of the molecular weight of each component multiplied by its volumetric proportion in the mixture, lb./lb. mole.

Figure 101-8 shows a sample recording sheet for velocity traverse data. Use the averages in the last two columns of figure 101-8 to determine the average stack gas velocity from equation 101-5.

6.6 Mercury collected. Calculate the total weight of mercury collected by using equation 101-6.

$$W_t = V_t C_t - V_0 C_0 \ (+ V_f C_f) \qquad \text{eq. 101-6}$$

where:

W_t = total weight of mercury collected, μg.

PLANT_____

DATE_____

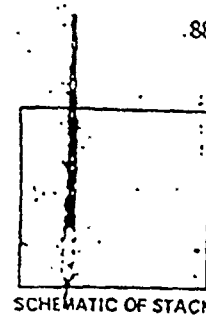
RUN NO._____

STACK DIAMETER, in._____

BAROMETRIC PRESSURE, in. Hg._____

STATIC PRESSURE IN STACK (P_g), in. Hg._____

OPERATORS_____



SCHEMATIC OF STACK CROSS SECTION

Traverse point number	Velocity head, in. H_2O	$\sqrt{\Delta_P}$	Stack Temperature (T_S), °F
	AVERAGE:		

Figure 101-8. Velocity traverse data.

V_t = Total volume of condensed moisture and ICl in sample bottle, ml.
C_t = Concentration of mercury measured in sample bottle, μg/ml.
V_s = Total volume of ICl used in sampling (impinger contents and all wash amounts), ml
C_s = Blank concentration of mercury in ICl solution, μg/ml
V_f = Total volume of ICl used in filter bottle (if used), ml.
C_f = Concentration of mercury in filter bottle (if used), μg/ml.

6.7 Total mercury emission. Calculate the total amount of mercury emitted from each stack per day by equation 101-7. This equation is applicable for continuous operations. For cyclic operations, use only the time per day each stack is in operation. The total mercury emissions from a source will be the summation of results from all stacks.

$$R = \frac{W_s (v_s)_{avg} A_s}{V_{sstd}} \times \frac{86{,}400 \text{ seconds/day}}{10^6 \mu g/g}$$

eq. 101-7

where:
R = Rate of emission, g/day.
W_s = Total weight of mercury collected, μg.
V_{sstd} = Total volume of gas sample (stack conditions), ft³.
$(v_s)_{avg}$ = Average stack gas velocity, feet per second.
A_s = Stack area, ft².

6.8 Isokinetic variation (comparison of velocity of gas in probe tip to stack velocity).

$$I = \frac{100 V_{sstd}}{A_n \theta (v_s)_{avg}} \qquad \text{eq. 101-8}$$

where:
I = Percent of isokinetic sampling.
V_{sstd} = Total volume of gas sample (stack conditions), ft³.
A_n = Probe tip area, ft²
θ = Sampling time, sec
$(v_s)_{avg}$ = Average stack gas velocity, feet per second.

7. *Evaluation of results*—7.1 *Determination of compliance.*—7.1.1 Each performance test shall consist of three repetitions of the applicable test method. For the purpose of determining compliance with an applicable national emission standard, the average of results of all repetitions shall apply.

7.2 *Acceptable isokinetic results.*—7.2.1 The following range sets the limit on acceptable isokinetic sampling results:

If $90\% \leq I \leq 110\%$, the results are acceptable; otherwise, reject the test and repeat.

8. *References.*—1. Addendum to Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, Dec. 6, 1967.

2. Determining Dust Concentration in a Gas Stream, ASME Performance Test Code No. 27, New York, N.Y., 1957.

3. Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, Calif., Nov. 1963.

4. Hatch, W. R. and W. L. Ott, "Determination of Sub-Microgram Quantities of Mercury by Atomic Absorption Spectrophotometry," Anal. Chem., 40:2085–87, 1968.

5. Mark, L. S., Mechanical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1951.

6. Martin, Robert M., Construction Details of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0581.

7. Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases, Western Precipitation Division of Joy Mfg. Co., Los Angeles, Calif. Bul WP-50, 1968.

8. Perry, J. H., Chemical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1960.

9. Rom, Jerome J., Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0576.

10. Shigehara, R. T., W. F. Todd, and W. S. Smith, Significance of Errors in Stack Sampling Measurements, Paper presented at the Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14-19, 1970.

11. Smith, W. S., et al., Stack Gas Sampling Improved and Simplified with New Equipment, APCA paper No. 67-119, 1967.

12. Smith, W. S., R. T. Shigehara, and W. F. Todd, A Method of Interpreting Stack Sampling Data, Paper presented at the 63d Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14-19, 1970.

13. Specifications for Incinerator Testing at Federal Facilities PHS, NCAPC, 1967.

14. Standard Method for Sampling Stacks for Particulate Matter, In: 1971 Book of ASTM Standards, part 23, Philadelphia, 1971, ASTM Designation D-3926-71.

15. Vennard, J. K., Elementary Fluid Mechanics, John Wiley and Sons, Inc., New York, 1947.

METHOD 102. REFERENCE METHOD FOR DETERMINATION OF PARTICULATE AND GASEOUS MERCURY EMISSIONS FROM STATIONARY SOURCES (HYDROGEN STREAMS)

1. *Principle and applicability*—1.1 *Principle.*—Particulate and gaseous mercury emissions are isokinetically sampled from the source and collected in acidic iodine monochloride solution. The mercury collected (in the mercuric form) is reduced to elemental mercury in basic solution by hydroxylamine sulfate. Mercury is aerated from the solution and analyzed using spectrophotometry.

1.2 *Applicability.*—This method is applicable for the determination of particulate and gaseous mercury emissions when the carrier gas stream is principally hydrogen. The method is for use in ducts or stacks at stationary sources. Unless otherwise specified, this method is not intended to apply to gas streams other than those emitted directly to the atmosphere without further processing.

2. *Apparatus*—2.1 *Sampling train.*—A schematic of the sampling train used by EPA is shown in figure 102-1. Commercial models of this train are available, although complete construction details are described in APTD-0581,[4] and operating and maintenance procedures are described in APTD-0576. The components essential to this sampling train are the following:

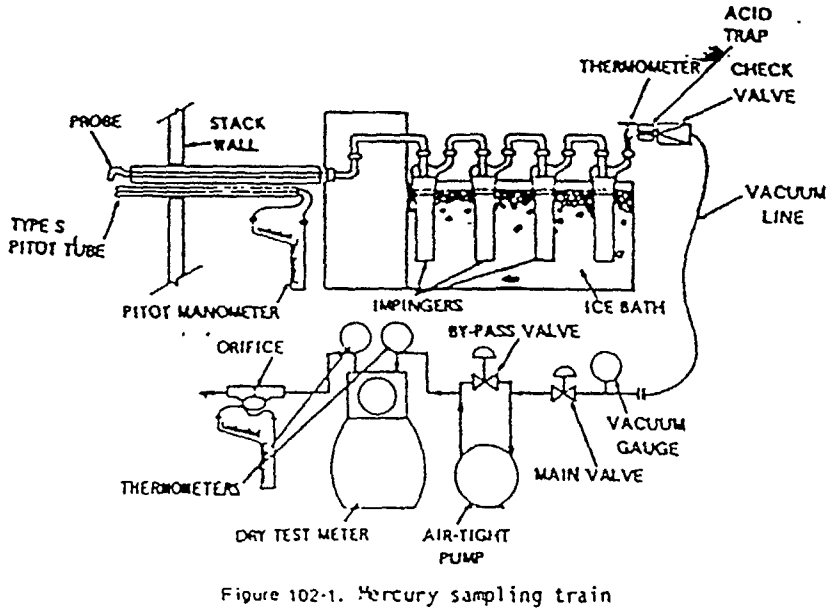


Figure 102-1. Mercury sampling train

2.1.1 *Nozzle.* Stainless steel or glass with sharp, tapered leading edge.

2.1.2 *Probe.* Sheathed Pyrex[5] glass.

2.1.3 *Pitot tube.* Type S (figure 102-2), or equivalent, with a coefficient within 5 percent over the working range, attached to probe to monitor stack gas velocity.

2.1.4 *Impingers.* Four Greenburg-Smith impingers connected in series with glass ball-joint fittings. The first, third, and fourth impingers may be modified by replacing the tip with one-half inch ID glass tube extending to one-half inch from the bottom of the flask.

2.1.5 *Acid trap.* Mine safety appliances air line filter, catalogue No. 81857, with acid absorbing cartridge and suitable connections, or equivalent.

2.1.6 *Metering system.* Vacuum gage, leakless pump, thermometers capable of measuring temperature to within 5° F, dry gas meter with 2 percent accuracy, and related equipment, described in APTD-0581, to maintain an isokinetic sampling rate and to determine sample volume.

2.1.7 *Barometer.* To measure atmospheric pressure to ± 0.1 in hg.

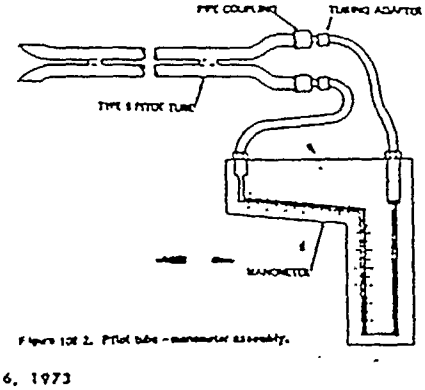


Figure 102-2. Pitot tube - manometer assembly.

[4] These documents are available for a nominal cost from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Va. 22151.

[5] Mention of trade names or commercial products does not constitute endorsement by the Environmental Protection Agency.

2.2 *Measurement of stack conditions (stack pressure, temperature, moisture, and velocity).*—2.2.1 *Pitot tube.* Type S, or equivalent, with a coefficient within 5 percent over the working range.

2.2.2 *Differential pressure gage.* Inclined manometer, or equivalent, to measure velocity head to within 10 percent of the minimum value. Micromanometers should be used if warranted.

2.2.3 *Temperature gage.* Any temperature-measuring device to measure stack temperature to within 1° F.

2.2.4 *Pressure gage.* Pitot tube and inclined manometer, or equivalent, to measure stack pressure to within 0.1 in hg.

2.2.5 *Moisture determination.* Drying tubes, condensers, or equivalent, to determine stack gas moisture content to within 1 percent.

2.3 *Sample recovery.*—2.3.1 *Leakless glass sample bottles.* 500 ml and 200 ml with Teflon-lined tops.

2.3.2 *Graduated cylinder.* 250 ml.

2.3.3 *Plastic jar.* Approximately 300 ml.

2.4 *Analysis.*—2.4.1 *Spectrophotometer.* To measure absorbance at 253.7 nm. Perkin Elmer model 303, with a cylindrical gas cell (approximately 1.5 in o.d. x 7 in) with quartz glass windows, and hollow cathode source, or equivalent.

2.4.2 *Gas sampling bubbler.* Tudor Scientific Co. Smog Bubbler, catalogue No. TP-1150, or equivalent.

2.4.3 *Recorder.* To match output of spectrophotometer.

3. *Reagents.*—3.1 Stock reagents.—3.1.1 Potassium iodide. Reagent grade.

3.1.2 *Distilled water.*

3.1.3 *Potassium iodide solution, 25 percent.*—Dissolve 250 g of potassium iodide (reagent 3.1.1) in distilled water and dilute to 1 to 1.

3.1.4 *Hydrochloric acid.* Concentrated.

3.1.5 *Potassium iodate.* Reagent grade.

3.1.6 *Iodine monochloride (ICl) 1.0M.* To 800 ml of 25 percent potassium iodide solution (reagent 3.1.3), add 800 ml of concentrated hydrochloric acid. Cool to room temperature. With vigorous stirring, slowly add 135 g of potassium iodate and continue stirring until all free iodine has dissolved to give a clear orange-red solution. Cool to room temperature and dilute to 1,800 ml with distilled water. The solution should be kept in amber bottles to prevent degradation.

3.1.7 *Sodium hydroxide pellets.* Reagent grade.

3.1.8 *Nitric acid.* Concentrated.

3.1.9 *Hydroxylamine sulfate.* Reagent grade.

3.1.10 *Sodium chloride.* Reagent grade.

3.1.11 *Mercuric chloride.* Reagent grade.

3.2 *Sampling.* 3.2.1 *Absorbing solution, 0.1M ICl.* Dilute 100 ml of the 1.0M ICl stock solution (reagent 3.1.6) to 1 l with distilled water. The solution should be kept in glass bottles to prevent degradation. This reagent should be stable for at least 2 months; however, periodic checks should be performed to insure quality.

3.2.2 *Wash acid.* 1:1 V/V nitric acid-water.

3.2.3 *Distilled, deionized water.*

3.2.4 *Silica gel.* Indicating type, 6 to 16 mesh, dried at 350° F for 2 hours.

3.3 *Analysis.*—3.3.1 *Sodium hydroxide, 10N.* Dissolve 400 g of sodium hydroxide pellets in distilled water and dilute to 1 l.

3.3.2 *Reducing agent, 12 percent hydroxylamine sulfate, 12 percent sodium chloride.* To 60 ml of distilled water, add 12 g of hydroxylamine sulfate and 12 g of sodium chloride. Dilute to 100 ml. This quantity is sufficient for 20 analyses and must be prepared daily.

3.3.3 *Aeration gas.* Zero grade air.

3.3.4 *Hydrochloric acid, 0.3N.* Dilute 25.5 ml of concentrated hydrochloric acid to 1 l with distilled water.

3.4 *Standard mercury solutions.*—3.4.1 *Stock solution.* Add 0.1354 g of mercuric chloride to 80 ml of 0.3N hydrochloric acid. After the mercuric chloride has dissolved, add 0.3N hydrochloric acid and adjust the volume to 100 ml. One ml of this solution is equivalent to 1 mg of free mercury.

3.4.2 *Standard solutions.* Prepare calibration solutions by serially diluting the stock solution (3.4.1) with 0.3N hydrochloric acid. Prepare solutions at concentrations in the linear working range for the instrument to be used. Solutions of 0.2 μg/ml, 0.4 μg/ml and 0.6 μg/ml have been found acceptable for most instruments. Store all solutions in glass-stoppered, glass bottles. These solutions should be stable for at least 2 months; however, periodic checks should be performed to insure quality.

4. *Procedure.* 4.1 Guidelines for source testing are detailed in the following sections. These guidelines are generally applicable; however, most sample sites differ to some degree and temporary alterations such as stack extensions or expansions often are required to insure the best possible sample site. Further, since mercury is hazardous, care should be taken to minimize exposure. Finally, since the total quantity of mercury to be collected generally is small, the test must be carefully conducted to prevent contamination or loss of sample.

4.2 Selection of a sampling site and minimum number of traverse points.

4.2.1 Select a suitable sampling site that is as close as is practicable to the point of atmospheric emission. If possible, stacks smaller than 1 foot in diameter should not be sampled.

4.2.2 The sampling site should be at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion or contraction. For rectangular cross section, determine an equivalent diameter from the following equation:

$$D_e = \frac{2LW}{L+W} \qquad \text{eq. 102-1}$$

where:

D_e = equivalent diameter.
L = length.
W = width.

4.2.3 When the above sampling site criteria can be met, the minimum number of traverse points is four (4) for stacks 1 foot in diameter or less, eight (8) for stacks larger than 1 foot but 2 feet in diameter or less, and twelve (12) for stacks larger than 2 feet.

4.2.4 Some sampling situations may render the above sampling site criteria impractical. When this is the case, choose a convenient sampling location and use figure 102-3 to determine the minimum number of traverse points. However, use figure 102-3 only for stacks 1 foot in diameter or larger.

4.2.5 To use figure 102-3, first measure the distance from the chosen sampling location to the nearest upstream and downstream disturbances. Divide this distance by the diameter or equivalent diameter to determine the distance in terms of pipe diameters. Determine the corresponding number of traverse points for each distance from figure 102-3. Select the higher of the two numbers of traverse points, or a greater value, such that for circular stacks the number is a multiple of four, and for rectangular stacks the number follows the criteria of section 4.3.2.

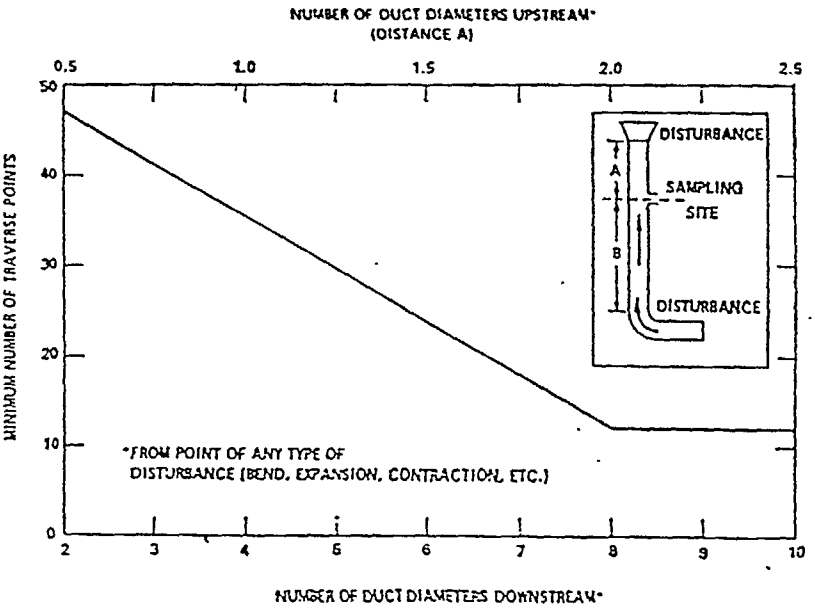


Figure 102-3. Minimum number of traverse points.

4.2.6 If a selected sampling point is closer than 1 inch from stack wall, adjust the location of that point to insure that the sample is taken at least 1 inch away from the wall.

4.3 Cross-sectional layout and location of traverse points.

4.3.1 For circular stacks locate the traverse points on at least two diameters according to figure 102-4 and table 102-1. The traverse axes shall divide the stack cross section into equal parts.

4.3.2 For rectangular stacks divide the cross-section into as many equal rectangular areas as traverse points, such that the ratio of the length to the width of the elemental areas is between one and two. Locate the traverse points at the centroid of each equal area according to figure 102-5.

4.4 Measurement of stack conditions.

4.4.1 Set up the apparatus as shown in figure 102-2. Make sure all connections are tight and leak free. Measure the velocity head and temperature at the traverse points specified by section 4.2 and 4.3.

4.4.2 Measure the static pressure in the stack.

4.4.3 Determine the stack gas moisture.

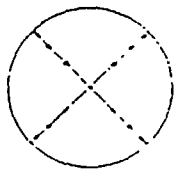


Figure 102-4. Cross section of circular stack showing location of traverse points on perpendicular axes.

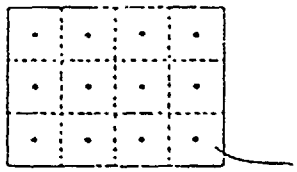


Figure 102-5. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

Table 102-1. Location of traverse points in circular stacks
(Percent of stack diameter from inside wall to traverse point)

Traverse point number on a diameter	Number of traverse points on a diameter											
	2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.7	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.5	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.3	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	80.6	65.8	35.5	26.9	22.0	18.8	16.5	14.5	13.2
7				89.5	77.4	64.5	36.6	28.3	23.6	20.4	18.0	16.1
8				96.7	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.1	23.0
10					97.5	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.9	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

4.4.4 Determine the stack gas molecular weight from the measured moisture content and knowledge of the expected gas stream composition. Sound engineering judgment should be used.

4.5 Preparation of sampling train.

4.5.1 Prior to assembly, clean all glassware (probe, impingers, and connectors) by rinsing with wash acid, tap water, 0.1M ICl, tap water, and finally distilled water. Place 100 ml of 0.1M ICl in each of the first three impingers, and place approximately, 200 g. of preweighed silica gel in the fourth impinger. Save 80 ml of the 0.1M ICl as a blank in the sample analysis. Set up the train and the probe as in Figure 102-1.

4.5.2 Leak check the sampling train at the sampling site. The leakage rate should not be in excess of 1 percent of the desired sampling rate. Place crushed ice around the impingers. Add more ice during the run to keep the temperature of the gases leaving the last impinger at 70° F or less.

4.6 Mercury train operation.

4.6.1 Safety procedures. It is imperative that the sampler conduct the source test under conditions of utmost safety, since hydrogen and air mixtures are explosive. The sample train essentially is leakless, so that attention to safe operation can be concentrated at the inlet and outlet. The following specific items are recommended:

4.6.1.1 Operate only the vacuum pump during the test. The other electrical equipment, e.g. heaters, fans and timers, normally are not essential to the success of a hydrogen stream test.

4.6.1.2 Seal the sample port to minimize leakage of hydrogen from the stack.

4.6.1.3 Vent sampled hydrogen at least 10 feet away from the train. This can be accomplished easily by attaching a ¼-in i.d. Tygon tube to the exhaust from the orifice meter.

4.6.2 For each run, record the data required on the sample sheet shown in figure 102-6. Take readings at each sampling point at least every 5 minutes and when significant changes in stack conditions necessitate additional adjustments in flow rate.

4.6.3 Sample at a rate of 0.5 to 1.0 cfm. Samples shall be taken over such a period or periods as are necessary to accurately determine the maximum emissions which would occur in a 24-hour period. In the case of cyclic operations, sufficient tests shall be made so as to allow accurate determination or calculation of the emissions which will occur over the duration of the cycle. A minimum sample time of 2 hours is recommended. In some instances, high mercury concentrations can prevent sampling in one run for the desired minimum time. This is indicated by reddening in the first impinger as free iodine is liberated. In this case, a run may be divided into two or more subruns to insure that the absorbing solutions are not depleted.

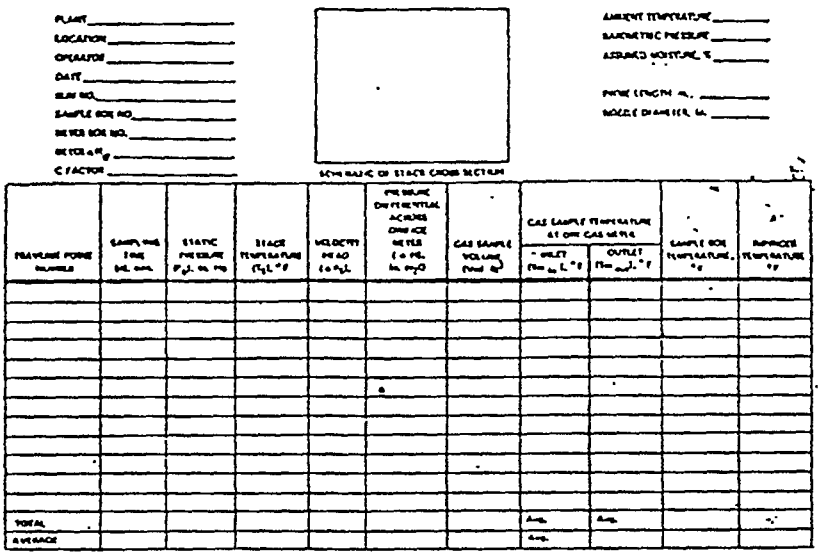


Figure 102-6. Field data

4.6.4 To begin sampling, position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Sample for at least 5 minutes at each traverse point; sampling time must be the same for each point. Maintain isokinetic sampling throughout the sampling period, using the following procedures.

4.6.4.1 Nomographs which aid in the rapid adjustment of the sampling rate without other computations are in APTD–0576 and are available from commercial suppliers. The available nomographs, however, are set up for use in air streams, and minor changes are required to provide applicability to hydrogen.

4.6.4.2 Calibrate the meter box orifice. Use the techniques as described in APTD–0576.

4.6.4.3 The correction factor nomograph discussed in APTD–0576 and shown on the reverse side of commercial nomographs will not be used. In its place, the correction factor will be calculated using equation 102-2.

$$C = 0.01 \frac{(C_p M_s)^2}{\Delta H_{@}} \frac{P_s}{P_m} \frac{T_m}{M_s}$$

eq. 102-2

where:

C = Correction factor.
C_p = Pitot tube coefficient.
M_s = Mole fraction dry gas.
P_s = Stack pressure, inHg.
P_m = Meter pressure, inHg.
T_m = Meter temperature, °R.
M_s = Molecular weight of stack gas (from 4.4.4), lb/lb mole.
$\Delta H_@$ = Meter box calibration factor, obtained in step 4.6.4.2.

4.6.4.4 Set the calculated correction factor on the front of the operating nomograph. Select the proper nozzle and set the K-factor on the nomograph as detailed in APTD–0576.

4.6.4.5 Read the velocity head in the stack at each sample point from the manometer in the meter box. Convert the hydrogen ΔP to an equivalent value for air by multiplying by a ratio of the molecular weight of air to hydrogen at the stack moisture content. Insert this value of ΔP onto the nomograph and read off ΔH. Again, convert the ΔH, which is an air equivalent value, to the ΔH for hydrogen by dividing by 13. This factor includes the ratio of the dry molecular weights and a correction for the different orifice calibration factors for hydrogen and air. This procedure is diagrammed below:

(Observe ΔP)—Multiply by $\left(\frac{MW\ \text{air}}{MW\ H_2}\right)_{wet}$—Set this on nomograph.

Read off ΔH—Divide by 13 = ΔH to be used on meter box.

4.6.4.6 Operate the sample train at the calculated ΔH at each sample point.

4.6.5 Turn off the pump at the conclusion of each run and record the final readings. Immediately remove the probe and nozzle from the stack and handle in accordance with the sample recovery process described in section 4.7.

4.7 Sample recovery.

4.7.1 (All glass storage bottles and the graduated cylinder must be precleaned as in section 4.5.1). This operation should be performed in an area free of possible mercury contamination. Industrial laboratories and ambient air around mercury-using facilities are not normally free of mercury contamination. When the sampling train is moved, care must be exercised to prevent breakage and contamination.

4.7.2 Disconnect the probe from the impinger train. Place the contents (measured to ±1 ml) of the first three impingers into a 500 ml sample bottle. Rinse the probe and all glassware between it and the back half of the third impinger with two 50 ml portions of 0.1M ICl solution. Add these rinses to the first bottle. For a blank, place 80 ml of the 0.1M ICl in a 100 ml sample bottle. Place the silica gel in the plastic jar. Seal and secure all containers for shipment. If an additional test is desired, the glassware can be carefully double rinsed with distilled water and reassembled. However, if the glassware is to be out of use more than 2 days, the initial acid wash procedure must be followed.

4.8 *Analysis*—4.8.1 *Apparatus preparation.*—Clean all glassware according to the procedure of section 4.5.1. Adjust the instrument settings according to the instrument manual, using an absorption wavelength of 253.7 nm.

4.8.2 *Analysis preparation.*—Adjust the air delivery pressure and the needle valve to obtain a constant air flow of about 1.3 l/min. The analysis tube should be bypassed except during aeration. Purge the equipment for 2 minutes. Prepare a sample of mercury standard solution (3.4.2) according to section 4.8.3. Place the analysis tube in the line, and aerate until a maximum peak height is reached on the recorder. Remove the analysis tube; flush the lines, and rinse the analysis tube with distilled water. Repeat with another sample of the same standard solution. This purge and analysis cycle is to be repeated until peak heights are reproducible.

4.8.3 *Sample preparation.*—Just prior to analysis, transfer a sample aliquot of up to 50 ml to the cleaned 100 ml analysis tube. Adjust the volume to 50 ml with 0.1M ICl if required. Add 6 ml of 10 *N* sodium hydroxide, cap tube with a clean glass stopper and shake vigorously. Prolonged, vigorous shaking at this point is necessary to obtain an accurate analysis. Add 5 ml of the reducing agent (reagent 3.3.2), cap tube with a clean glass stopper and shake vigorously and immediately place in sample line.

4.8.4 *Mercury determination.*—After the system has been stabilized, prepare samples from the sample bottle according to section 4.8.3. Aerate the sample until a maximum peak height is reached on the recorder. The mercury content is determined by comparing the peak heights of the samples to the peak heights of the calibration solutions. If collected samples are out of the linear range, the samples should be diluted. Prepare a blank from the 100 ml bottle according to section 4.8.3 and analyze to determine the reagent blank mercury level.

5. *Calibration.*—5.1 *Sampling Train.* 5.1.1 Use standard methods and equipment as detailed in APTD–0576 to calibrate the rate meter, pitot tube and dry gas meter. Recalibrate prior to each test series.

5.2 *Analysis.*—5.2.1 Prepare a calibration curve for the spectrophotometer using the standard mercury solutions. Plot the peak heights read on the recorder versus the concentration of mercury in the standard solutions. Standards should be interspersed with the samples since the calibration can change slightly with time. A new calibration curve should be prepared for each new set of samples run.

6. *Calculations.*—6.1 *Average dry gas meter temperature, stack temperature, stack pressure and average orifice pressure drop.*—See data sheet (fig. 102-6).

6.2 *Dry gas volume.*—Correct the sample volume mensured by the dry gas meter to stack conditions by using equation 102-3.

$$V_{m_s} = V_m \frac{T_s}{T_m} \frac{\left(P_{bar} + \frac{\Delta H}{13.6}\right)}{P_s}$$

eq. 102-3

where:

V_{m_s} = Volume of gas sample through the dry gas meter (stack conditions), ft³.
V_m = Volume of gas sample through the dry gas meter (meter conditions), ft³.
T_s = Average temperature of stack gas, °R.
T_m = Average dry gas meter temperature, °R.
P_{bar} = Barometric pressure at the orifice meter, inHg.
ΔH = Average pressure drop across the orifice meter, inH₂O.
13.6 = Specific gravity of mercury.
P_s = Stack pressure, $P_{bar} \pm$ static pressure, inHg.

6.3 *Volume of water vapor.*

$$V_{w_s} = K_w V_{t_s} \frac{T_s}{P_s} \qquad \text{eq. 102-4}$$

where:

V_{w_s} = Volume of water vapor in the gas sample (stack conditions), ft³.

$K_w = 0.00267 \frac{\text{in. Hg} \cdot \text{ft}^3}{\text{ml} \cdot {}^\circ\text{K}}$, when these units are used.

V_{t_s} = Total volume of liquid collected in impingers and silica gel (see figure 102-7), ml.

T_s = Average stack gas temperature, °K.

P_s = Stack pressure, $P_{bar} \pm$ static pressure, in. Hg.

6.4 *Total gas volume.*

$$V_{total} = V_{m_s} + V_{w_s} \qquad \text{eq. 102-5}$$

where:

V_{total} = total volume of gas sample (stack conditions), ft³.

V_{m_s} = Volume of gas through dry gas meter (stack conditions), ft³.

V_{w_s} = Volume of water vapor in gas sample (stack conditions), ft³.

	VOLUME OF LIQUID WATER COLLECTED	
	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL		
INITIAL		
LIQUID COLLECTED		
TOTAL VOLUME COLLECTED		ml

*CONVERT WEIGHT OF WATER TO VOLUME BY dividing total weight INCREASE IN DENSITY OF WATER, 1 g/ml.

$\frac{\text{INCREASE, g}}{1 \text{ g/ml}}$ = VOLUME WATER, ml

Figure 102-7. Analytical data.

6.5 *Stack gas velocity*—Use equation 102-6 to calculate the stack gas velocity.

$$(v_s)_{avg} = K_p C_p (\sqrt{\Delta P})_{avg} \sqrt{\frac{(T_s)_{avg}}{P_s M_s}} \qquad \text{eq 102-6}$$

where:

$(v_s)_{avg}$ = Average stack gas velocity, feet per second.

$K_p = 86.53 \frac{\text{ft}}{\text{sec}} \left(\frac{\text{lb} \cdot \text{in Hg}}{\text{lb} \cdot \text{mole}^\circ \cdot \text{K} \cdot \text{in H}_2\text{O}} \right)^{1/2}$, when these units are used.

C_p = Pitot tube coefficient, dimensionless.

$(T_s)_{avg}$ = Average stack gas temperature, °K.

$(\sqrt{\Delta P})_{avg}$ = Average square root of the velocity head of stack gas (in H₂O)[1/2] (see figure 102-8).

P_s = Stack pressure, $P_{bar} \pm$ static pressure, in Hg.

M_s = Molecular weight of stack gas (wet basis), the summation of the products of the molecular weight of each component multiplied by its volumetric proportion in the mixture, lb/lb-mole.

Figure 102-8 shows a sample recording sheet for velocity traverse data. Use the averages in the last two columns of figure 102-8 to determine the average stack gas velocity from equation 102-6.

6.6 Mercury collected. Calculate the total weight of mercury collected by using eq. 102-7.

PLANT_____

DATE_____

RUN NO._____

STACK DIAMETER, in._____

BAROMETRIC PRESSURE, in. Hg._____

STATIC PRESSURE IN STACK (P_g), in. Hg._____

OPERATORS_____

SCHEMATIC OF STACK CROSS SECTION

Traverse point number	Velocity head, in. H_2O	$\sqrt{\Delta_p}$	Stack Temperature (T_s), °F
	AVERAGE:		

Figure 102-8. Velocity traverse data.

$$W_t = V_s C_t - V_c C_c \quad \text{eq. 102-7}$$

where:

W_t = Total weight of mercury collected, μg.
V_t = Total volume of condensed moisture and ICl in sample bottle, ml.
C_t = Concentration of mercury measured in sample bottle, $\mu g/ml$.
V_c = Total volume of ICl used in sampling (impinger contents and all wash amounts), ml.
C_c = Blank concentration of mercury in ICl solution, $\mu g/ml$.

6.7 *Total mercury emission.*—Calculate the total amount of mercury emitted from each stack per day by equation 102-8. This equation is applicable for continuous operations. For cyclic operations, use only the time per day each stack is in operation. The total mercury emissions from a source will be the summation of results from all stacks.

$$R = \frac{W_t (v_s)_{ave} A_s}{V_{total}} \times \frac{86{,}400 \text{ seconds/day}}{10^6 \mu g/g} \quad \text{eq. 102-8}$$

where:

R = Rate of emission, g/day.
W_t = Total weight of mercury collected, μg.
V_{total} = Total volume of gas sample (stack conditions), ft^3.
$(v_s)_{ave}$ = Average stack gas velocity, feet per second.
A_s = Stack area, ft^2.

6.8 *Isokinetic variation (comparison of velocity of gas in probe tip to stack velocity).*

$$I = \frac{100 V_{total}}{A_n \theta (v_s)_{ave}} \quad \text{eq. 102-9}$$

where:

I = Percent of isokinetic sampling.
A_n = Total cross-sectional area of nozzle, ft^2.
V_{total} = Total volume of gas sample (stack conditions), ft^3.
A_n = Probe tip area, ft^2.
θ = Sampling time, sec.
$(v_s)_{ave}$ = Average stack gas velocity, feet per second.

7. *Evaluation of results.*—7.1 Determination of compliance.—7.1.1 Each performance test shall consist of three repititions of the applicable test method. For the purpose of determining compliance with an applicable national emission standard, the average of results of all repetitions shall apply.

7.2 *Acceptable isokinetic results.*—7.2.1 The following range sets the limit on acceptable isokinetic sampling results: If $90\% \leq I \leq 110\%$, the results are acceptable; otherwise, reject the test and repeat.

8. *References.*—1. Addendum to Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, Dec. 6, 1967.

2. Determining Dust Concentration in a Gas Stream, ASME Performance Test Code No. 27, New York, N.Y., 1957.

3. Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, Calif., Nov. 1963.

4. Hatch, W. R. and W. L. Ott, "Determination of Sub-Microgram Quantities of Mercury by Atomic Absorption Spectrophotometry," Anal. Chem., 40: 2085–87, 1968.

5. Mark, L. S., Mechanical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1951.

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7. Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases, Western Precipitation Division of Joy Manufacturing Co., Los Angeles, Calif. Bull. WP–50, 1968.

8. Perry, J. H., Chemical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1960.

9. Rom, Jerome J., Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD–0576.

10. Shigehara, R. T., W. F. Todd, and W. S. Smith, Significance of Errors in Stack Sampling Measurements, Paper presented at the Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14–19, 1970.

11. Smith, W. S., et al., Stack Gas Sampling Improved and Simplified with New Equipment, APCA paper No. 67–119, 1967.

12. Smith, W. S., R. T. Shigehara, and W. F. Todd, A Method of Interpreting Stack Sampling Data, Paper presented at the 63d Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14–19, 1970.

13. Specifications for Incinerator Testing at Federal Facilities PHS, NCAPC, 1967.

14. Standard Method for Sampling Stacks for Particulate Matter, In: 1971 Book of ASTM Standards, part 23, Philadelphia, 1971, ASTM Designation D–2928–71.

15. Vennard, J. K., Elementary Fluid Mechanics, John Wiley and Sons, Inc., New York, 1947.

METHOD 103. BERYLLIUM SCREENING METHOD.

1. *Principle and applicability.*—1.1 *Principle.*—Beryllium emissions are isokinetically sampled from three points in a duct or stack. The collected sample is analyzed for beryllium using an appropriate technique.

1.2 *Applicability.*—This procedure details guidelines and requirements for methods acceptable for use in determining beryllium emissions in ducts or stacks at stationary sources, as specified under the provisions of § 61.14 of the regulations.

2. *Apparatus.*—2.1 *Sampling train.*—A schematic of the required sampling train configuration is shown in figure 103–1. The essential components of the train are the following:

2.1.1 *Nozzle.*—Stainless steel or equivalent, with sharp, tapered leading edge.

2.1.2 *Probe.*—Sheathed Pyrex glass.

2.1.3 *Filter.*—Millipore AA, or equivalent, with appropriate filter holder that provides a positive seal against leakage from outside or around the filter. It is suggested that a Whatman 41, or equivalent, be placed immediately against the back side of the Millipore filter as a guard against breakage of the Millipore. Include the Whatman 41 in the analysis. Equivalent filters must be at least 99.95 percent efficient (DOP Test) and amenable to the analytical procedure.

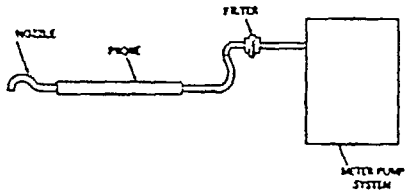

Figure 103-1. Beryllium screening method; sample train schematic.

2.1.4 *Meter-pump system.*—Any system that will maintain isokinetic sampling rate, determine sample volume, and is capable of a sampling rate of greater than 0.5 cfm.

2.2 *Measurement of stack conditions (stack pressure, temperature, moisture and velocity).*—The following equipment shall be used in the manner specified in section 4.3.1.

2.2.1 *Pitot tube.*—Type S, or equivalent, with a coefficient within 5 percent over the working range.

2.2.2 *Differential pressure gauge.*—Inclined manometer, or equivalent, to measure velocity head to within 10 percent of the minimum value.

2.2.3. *Temperature gauge.*—Any temperature measuring device to measure stack temperature to within 5°F.

2.2.4 *Pressure gauge.*—Any device to measure stack pressure to within 0.1 in. Hg.

2.2.5 *Barometer.*—To measure atmospheric pressure to within 0.1 in. Hg.

2.2.6 *Moisture determination.*—Wet and dry bulb thermometers, drying tubes, condensers, or equivalent, to determine stack gas moisture content to within 1 percent.

2.3 *Sample recovery.*—2.3.1. *Probe cleaning equipment.*—Probe brush or cleaning rod at least as long as probe, or equivalent. Clean cotton balls, or equivalent, should be used with the rod.

2.3.2 *Leakless glass sample bottles.*

2.4 *Analysis.*—2.4.1 Equipment necessary to perform an atomic absorption, spectrographic, fluorometric, chromatographic, or equivalent analysis.

3. *Reagents.*—3.1 *Sample recovery.*—3.1.1 *Acetone.*—Reagent grade.

3.1.2 *Wash acid.*—1:1 V/V hydrochloric acid-water.

3.2 *Analysis.*—3.2.1 Reagents as necessary for the selected analytical procedure.

4. *Procedure.*—4.1 Guidelines for source testing are detailed in the following sections. These guidelines are generally applicable; however, most sample sites differ to some degree and temporary alterations such as stack extensions or expansions often are required to insure the best possible sample site. Further, since beryllium is hazardous, care should be taken to minimize exposure. Finally, since the total quantity of beryllium to be collected is quite small, the test must be carefully conducted to prevent contamination or loss of sample.

4.2 *Selection of a sampling site and number of traverses.*—4.2.1 Select a suitable sampling site that is as close as practicable to the point of atmospheric emission. If possible, stacks smaller than 1 foot in diameter should not be sampled.

4.2.2 The sampling site should be at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion or contraction. For rectangular cross-section, determine an equivalent diameter using the following equation:

$$D_e = \frac{2LW}{L+W} \quad \text{eq. 103-1}$$

where:

D_e = equivalent diameter
L = length
W = width

4.2.3 Some sampling situations may render the above sampling site criteria impractical. When this is the case, an alternate site may be selected but must be no less than two diameters downstream and one-half diameter upstream from any point of disturbance. Additional sample runs are recommended at any sample site not meeting the criteria of section 4.2.2.

4.2.4 Three runs shall constitute a test. The runs shall be conducted at three different points. The three points shall proportionately divide the diameter, i.e. be located at 25, 50 and 75 percent of the diameter from the inside wall. For horizontal ducts, the diameter shall be in the vertical direction. For rectangular ducts, sample on a line through the centroid and parallel to a side. If additional runs are required per section 4.2.3, proportionately divide the duct to accommodate the total number of runs.

4.3 *Measurement of stack conditions.* 4.3.1 Measure the stack gas pressure, moisture, and temperature, using the equipment described in § 2.2. Determine the molecular weight of the stack gas. Sound engineering estimates may be made in lieu of direct

[1] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

measurements. The basis for such estimates shall be given in the test report.

4.4 *Preparation of sampling train.*—4.4.1 Assemble the sampling train as shown in figure 103-1. It is recommended that all glassware be precleaned by soaking in wash acid for 2 hours.

4.4.2 Leak check the sampling train at the sampling site. The leakage rate should not be in excess of 1 percent of the desired sample rate.

4.5 *Beryllium train operation.*—4.5.1 For each run, measure the velocity at the selected sampling point. Determine the isokinetic sampling rate. Record the velocity head and the required sampling rate.

4.5.2 Place the nozzle at the sampling point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. At the conclusion of the test, record the sampling rate. Again measure the velocity head at the sampling point. The required isokinetic rate at the end of the period should not have deviated more than 20 percent from that originally calculated.

4.5.3 Sample at a minimum rate of 0.5 ft³/min. Samples shall be taken over such a period or periods as are necessary to determine the maximum emissions which would occur in a 24-hour period. In the case of cyclic operations, sufficient tests shall be made so as to allow determination or calculation of the emissions which would occur over the duration of the cycle. A minimum sampling time of 2 hours is recommended.

4.5.4 All pertinent data should be included in the test report.

4.6 *Sample recovery.*—4.6.1 It is recommended that all glassware be precleaned as in § 4.4.1. Sample recovery should also be performed in an area free of possible beryllium contamination. When the sampling train is moved, exercise care to prevent breakage and contamination. Set aside a portion of the acetone used in the sample recovery as a blank for analysis. The total amount of acetone used should be measured for accurate blank correction. Blanks can be eliminated if prior analysis shows negligible amounts.

4.6.2 Remove the filter and any loose particulate matter from filter holder and place in a container.

4.6.3 Clean the probe with acetone and a brush or long rod and cotton balls. Wash into the container. Wash out the filter holder with acetone and add to the same container.

4.7 *Analysis.*—4.7.1 Make the necessary preparation of samples and analyze for beryllium. Any currently acceptable method such as atomic absorption, spectrographic, fluorometric, chromatographic, or equivalent may be used.

5. *Calibration and standards.*—5.1 *Sampling train.*—5.1.1 As a procedural check, sampling rate regulation should be compared with a dry gas meter, spirometer, rotameter (calibrated for prevailing atmospheric conditions), or equivalent, attached to nozzle inlet of the complete sampling train.

5.1.2 Data from this test and calculations should be shown in test report.

5.2 *Analysis.*—5.2.1 Standardization is made as suggested by the manufacturer of the instrument or the procedures for the analytical method.

6 Calculations.—6.1 *Total beryllium emission.* Calculate the total amount of beryllium emitted from each stack per day by equation 103-2. This equation is applicable for continuous operations. For cyclic operations, use only the time per day each stack is in operation. The total beryllium emissions from a source will be the summation of results from all stacks.

$$R = \frac{W_s(p_s)_{avg} A_s}{V_{std}} \times \frac{86{,}400 \text{ seconds/day}}{10^6 \rho K t}$$

where

R = Rate of emission, g/day.
W_s = Total weight of beryllium collected, g.
V_{std} = Total volume of gas sampled, ft³.
$(p_s)_{avg}$ = Average stack gas velocity, feet per second.
A_s = Stack area, ft².

7. *Test report.* 7.1 A test report shall be prepared which shall include as a minimum:

7.1.1 A detailed description of the sampling train used and results of the procedural check with all data and calculations made.

7.1.2 All pertinent data taken during test, the basis for any estimates made, calculations, and results.

7.1.3 A description of the test site, including a block diagram with a brief description of the process, location of the sample points in the cross section, dimensions and distances from any point of disturbance.

METHOD 104. REFERENCE METHOD FOR DETERMINATION OF BERYLLIUM EMISSIONS FROM STATIONARY SOURCES

1. *Principle and applicability.*—1.1 *Principle.*—Beryllium emissions are isokinetically sampled from the source, and the collected sample is digested in an acid solution and analyzed by atomic absorption spectrophotometry.

1.2 *Applicability.*—This method is applicable for the determination of beryllium emissions in ducts or stacks at stationary sources. Unless otherwise specified, this method is not intended to apply to gas streams other than those emitted directly to the atmosphere without further processing.

2. *Apparatus.*—2.1 *Sampling train.*—A schematic of the sampling train used by EPA is shown in figure 104-1. Commercial models of this train are available, although construction details are described in APTD-0581,[1] and operating and maintenance procedures are described in APTD-0576. The components essential to this sampling train are the following:

2.1.1 *Nozzle.*—Stainless steel or glass with sharp, tapered leading edge.

2.1.2 *Probe.*—Sheathed Pyrex[2] glass. A heating system capable of maintaining a minimum gas temperature in the range of the stack temperature at the probe outlet during sampling may be used to prevent condensation from occurring.

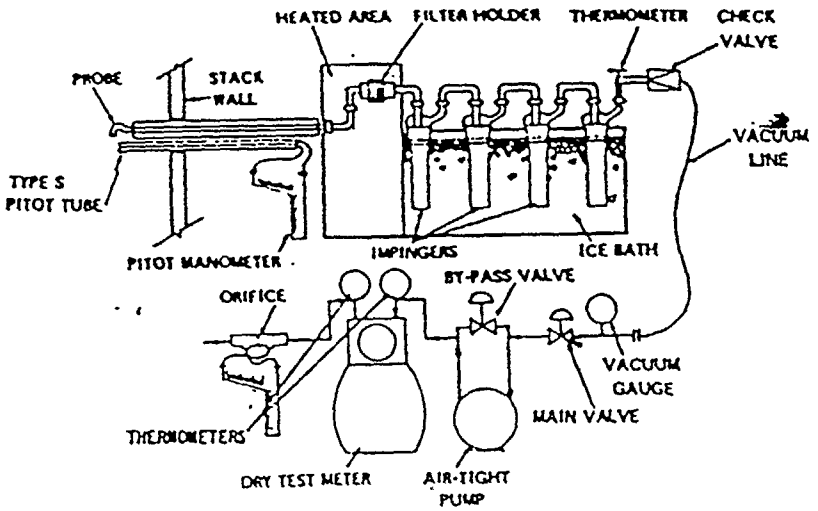

Figure 104-1. Beryllium sampling train

2.1.3 *Pitot tube.*—Type S (figure 104-2), or equivalent, with a coefficient within 5 percent over the working range, attached to probe to monitor stack gas velocity.

2.1.4 *Filter holder.*—Pyrex glass. The filter holder must provide a positive seal against leakage from outside or around the filter. A heating system capable of maintaining the filter at a minimum temperature in the range of the stack temperature may be used to prevent condensation from occurring.

2.1.5 *Impingers.*—Four Greenburg-Smith impingers connected in series with glass ball joint fittings. The first, third, and fourth impingers may be modified by replacing the tip with a ½-inch i.d. glass tube extending to one-half inch from the bottom of the flask.

2.1.6 *Metering system.*—Vacuum gauge, leakless pump, thermometers capable of measuring temperature to within 5° F, dry gas meter with 2 percent accuracy, and related equipment, described in APTD-0581, to maintain an isokinetic sampling rate and to determine sample volume.

2.1.7 *Barometer.*—To measure atmospheric pressure to ± 0.1 in Hg.

2.2 *Measurement of stack conditions (stack pressure, temperature, moisture and velocity).*—2.2.1 *Pitot tube.*—Type S, or equivalent, with a coefficient within 5 percent over the working range.

2.2.2 *Differential pressure gauge.*—Inclined manometer, or equivalent, to measure velocity head to within 10 percent of the minimum value.

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[1] These documents are available for a nominal cost from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Va. 22151.

[2] Mention of trade names on specific products does not constitute endorsement by the Environmental Protection Agency.

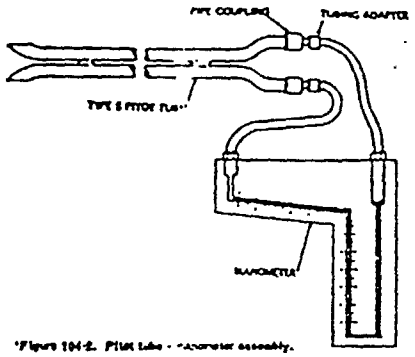

Figure 104-2. Pitot tube - manometer assembly.

2.2.3 *Temperature gage.*—Any temperature measuring device to measure stack temperature to within 5° F.

2.2.4 *Pressure gage.*—Pitot tube and inclined manometer, or equivalent, to measure stack pressure to within 0.1 in Hg.

2.2.5 *Moisture determination.*—Wet and dry bulb thermometers, drying tubes, condensers, or equivalent, to determine stack gas moisture content to within 1 percent.

2.3 *Sample recovery*—2.3.1 *Probe cleaning rod.*—At least as long as probe.

2.3.2 *Leakless glass sample bottles.*—500 ml.

2.3.3 *Graduated cylinder.*—250 ml.

2.3.4 *Plastic jar.*—Approximately 300 ml.

2.4 *Analysis*—2.4.1 *Atomic absorption spectrophotometer.* To measure absorbance at 234.8 nm, Perkin Elmer Model 303, or equivalent, with N_2O-acetylene burner.

2.4.2 *Hot plate.*

2.4.3 *Perchloric acid fume hood.*

3. *Reagents*—3.1 *Stock reagents.*—3.1.1 *Hydrochloric acid.*—Concentrated.

3.1.2 *Perchloric acid.*—Concentrated, 70 percent.

3.1.3 *Nitric acid.*—Concentrated.

3.1.4 *Sulfuric acid.*—Concentrated.

3.1.5 *Distilled and deionized water.*

3.1.6 *Beryllium powder.*—98 percent minimum purity.

3.2 *Sampling*—3.2.1 *Filter.* — Millipore AA, or equivalent. It is suggested that a Whatman 41 filter be placed immediately against the back side of the Millipore filter as a guard against breaking the Millipore filter. In the analysis of the filter, the Whatman 41 filter should be included with the Millipore filter.

3.2.2 *Silica gel.*—Indicating type, 6 to 16 mesh, dried at 350° F for 2 hours.

3.2.3 *Distilled and deionized water.*

3.3 *Sample recovery*—3.3.1 *Distilled and deionized water.*

3.3.2 *Acetone.*—Reagent grade.

3.3.3 *Wash acid.*—1:1 V/V hydrochloric acid-water.

3.4 *Analysis.*—3.4.1 *Sulfuric acid solution, 12 N.*—Dilute 333 ml of concentrated sulfuric acid to 1 l with distilled water.

3.4.2 *25 percent V/V hydrochloric acid-water.*

3.5 *Standard beryllium solution*—3.5.1 *stock solution.*—1 mg/ml beryllium. Dissolve 10 mg of beryllium in 80 ml of 12 N sulfuric acid solution and dilute to a volume of 1000 ml with distilled water. Dilute a 10 ml aliquot to 100 ml with 25 percent V/V hydrochloric acid, giving a concentration of 1 μg/ml. This dilute stock solution should be prepared fresh daily. Equivalent strength (in beryllium) stock solutions may be prepared from beryllium salts as $BeCl_2$ and $Be(NO_3)_2$ (98 percent minimum purity).

4. *Procedure.* 4.1 Guidelines for source testing are detailed in the following sections. These guidelines are generally applicable; however, most sample sites differ to some degree and temporary alterations such as stack extensions or expansions often are required to insure the best possible sample site. Further, since beryllium is hazardous, care should be taken to minimize exposure. Finally, since the total quantity of beryllium to be collected is quite small, the test must be carefully conducted to prevent contamination or loss of sample.

4.2 Selection of a sampling site and minimum number of traverse points.

4.2.1 Select a suitable sampling site that is as close as practicable to the point of atmospheric emission. If possible, stacks smaller than 1 foot in diameter should not be sampled.

4.2.2 The sampling site should be at least 8 stack or duct diameters downstream and 2 diameters upstream from any flow disturbance such as a bend, expansion or contraction. For a rectangular cross-section, determine an equivalent diameter from the following equation:

$$D_e = \frac{2LW}{L+W} \qquad \text{eq. 104-1}$$

where:

D_e = equivalent diameter
L = length
W = width

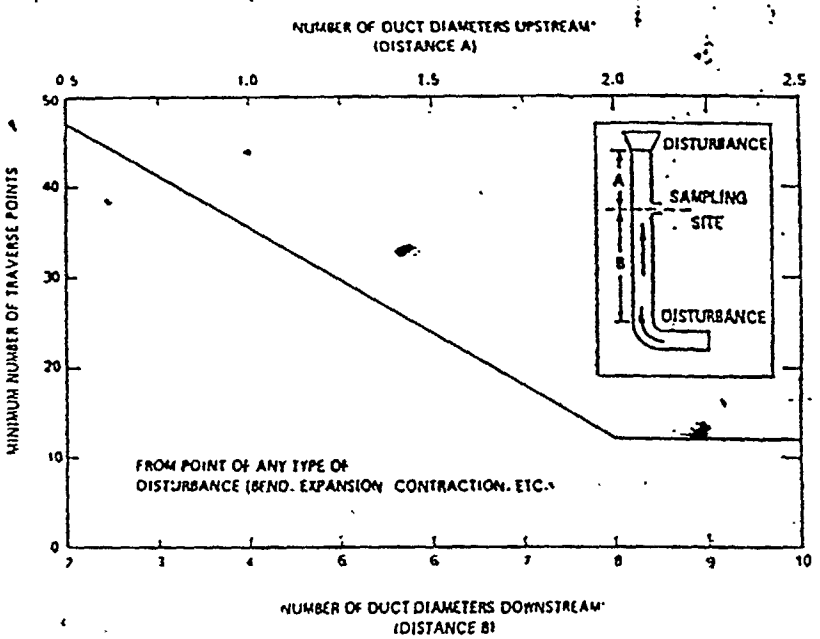

Figure 104-3. Minimum number of traverse points.

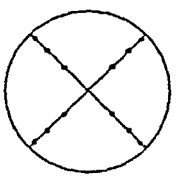

Figure 104-4. Cross section of circular stack showing location of traverse points on perpendicular diameters.

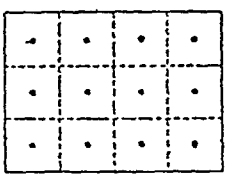

Figure 104-5. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

4.2.3 When the above sampling site criteria can be met, the minimum number of traverse points is four (4) for stacks 1 foot in diameter or less, eight (8) for stacks larger than 1 foot but 2 feet in diameter or less, and twelve (12) for stacks larger than 2 feet.

4.2.4 Some sampling situations may render the above sampling site criteria impractical. When this is the case, choose a convenient sampling location and use figure 104-3 to determine the minimum number of traverse points. However, use figure 104-3 only for stacks 1 foot in diameter or larger.

4.2.5 To use figure 104-3, first measure the distance from the chosen sampling location to the nearest upstream and downstream disturbances. Divide this distance by the diameter or equivalent diameter to determine the distance in terms of pipe diameters. Determine the corresponding number of traverse points for each distance from figure 104-3. Select the higher of the two numbers of traverse points, or a greater value, such that for circular stacks the number is a multiple of four, and for rectangular stacks the number follows the criteria of section 4.3.2.

4.2.6 If a selected sampling point is closer than 1 inch from the stack wall, adjust the location of that point to ensure that the sample is taken at least 1 inch away from the wall.

4.3 Cross-sectional layout and location of traverse points.

Table 104-1. Location of traverse points in circular stacks
(Percent of stack diameter from inside wall to traverse point)

Traverse point number on a diameter	Number of traverse points on a diameter											
	2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.7	10.6	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.5	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.3	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	80.6	65.8	35.5	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.5	36.6	28.3	23.6	20.4	18.0	16.1
8				96.7	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.1	23.0
10					97.5	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.9	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

4.3.1 For circular stacks locate the traverse points on at least two diameters according to figure 104-4 and table 104-1. The traverse axes shall divide the stack cross section into equal parts.

4.3.2 For rectangular stacks divide the cross section into as many equal rectangular areas as traverse points, such that the ratio of the length to the width of the elemental areas is between 1 and 2. Locate the traverse points at the centroid of each equal area according to figure 104-5.

4.4 *Measurement of stack conditions.*—4.4.1 Set up the apparatus as shown in figure 104-3. Make sure all connections are tight and leak free. Measure the velocity head and temperature at the traverse points specified by §§ 4.2 and 4.3.

4.4.2 Measure the static pressure in the stack.

4.4.3 Determine the stack gas moisture.

4.4.4 Determine the stack gas molecular weight from the measured moisture content and knowledge of the expected gas stream composition. A standard Orsat analyzer has been found valuable at combustion sources. In all cases, sound engineering judgment should be used.

4.5 *Preparation of sampling train.*—4.5.1 Prior to assembly, clean all glassware (probe, impingers, and connectors) by soaking in wash acid for 2 hours. Place 100 ml of distilled water in each of the first two impingers, leave the third impinger empty, and place approximately 200 g of preweighted silica gel in the fourth impinger. Save a portion of the distilled water as a blank in the sample analysis. Set up the train and the probe as in figure 104-1.

4.5.2 Leak check the sampling train at the sampling site. The leakage rate should not be in excess of 1 percent of the desired sampling rate. If condensation in the probe or filter is a problem, probe and filter heaters will be required. Adjust the heaters to provide a temperature at or above the stack temperature. However, membrane filters such as the Millipore AA are limited to about 228° F. If the stack gas is in excess of about 200° F., consideration should be given to an alternate procedure such as moving the filter holder downstream of the first impinger to insure that the filter does not exceed its temperature limit. Place crushed ice around the impingers. Add more ice during the test to keep the temperature of the gases leaving the last impinger at 70° F. or less.

4.6 *Beryllium train operation.*—4.6.1 For each run, record the data required on the example sheet shown in figure 104-6. Take readings at each sampling point at least every 5 minutes and when significant changes in stack conditions necessitate additional adjustments in flow rate.

4.6.2 Sample at a rate of 0.5 to 1.0 ft.³/min. Samples shall be taken over such a period or periods as are necessary to accurately determine the maximum emissions which would occur in a 24-hour period. In the case of cyclic operations, sufficient tests shall be made so as to allow accurate determination or calculation of the emissions which will occur over the duration of the cycle. A minimum sample time of 2 hours is recommended.

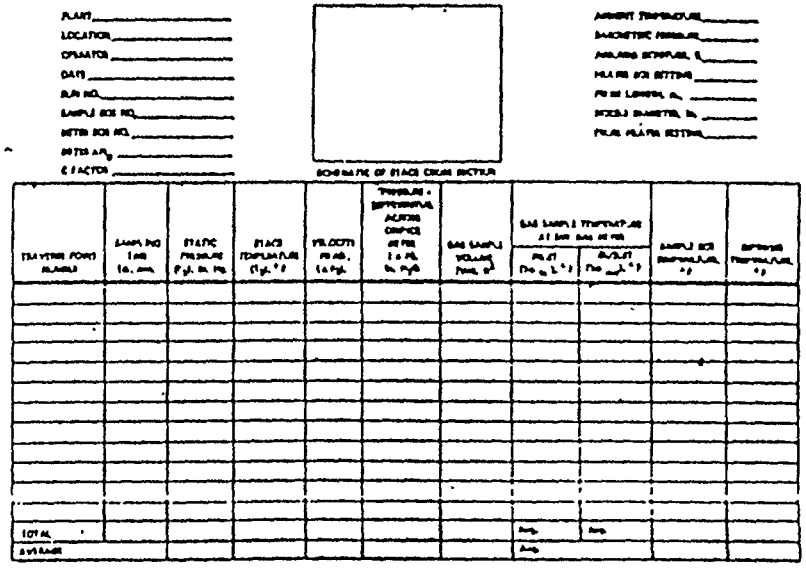

Figure 104-6. Field data.

4.6.3 To begin sampling, position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Sample for at least 5 minutes at each traverse point; sampling time must be the same for each point. Maintain isokinetic sampling throughout the sampling period. Nomographs which aid in the rapid adjustment of the sampling rate without other computations are in APTD-0576 and are available from commercial suppliers. Note that standard monographs are applicable only for type S pitot tubes and air or a stack gas with an equivalent density. Contact EPA or the sampling train supplier for instructions when the standard monograph is not applicable.

4.6.4 Turn off the pump at the conclusion of each run and record the final readings. Immediately remove the probe and nozzle

from the stack and handle in accordance with the sample recovery process described in § 4.7.

4.7 *Sample recovery.*—4.7.1 (All glass storage bottles and the graduated cylinder must be precleaned as in § 4.5.1.) This operation should be performed in an area free of possible beryllium contamination. When the sampling train is moved, care must be exercised to prevent breakage and contamination.

4.7.2 Disconnect the probe from the impinger train. Remove the filter and any loose particulate matter from the filter holder and place in a sample bottle. Place the contents (measured to ±1 ml) of the first three impingers into another sample bottle. Rinse the probe and all glassware between it and the back half of the third impinger with water and acetone, and add this to the latter sample bottle. Clean the probe with a brush or a long slender rod and cotton balls. Use acetone while cleaning. Add these to the sample bottle. Retain a sample of the water and acetone as a blank. The total amount of wash water and acetone used should be measured for accurate blank correction. Place the silica gel in the plastic jar. Seal and secure all sample containers for shipment. If an additional test is desired, the glassware can be carefully double rinsed with distilled water and reassembled. However, if the glassware is to be out of use more than 2 days, the initial acid wash procedure must be followed.

4.8 Analysis.

4.8.1 *Apparatus preparation.*—Clean all glassware according to the procedure of section 4.5.1. Adjust the instrument settings according to the instrument manual, using an absorption wavelength of 234.8 nm.

4.8.2 *Sample preparation.*—The digestion of beryllium samples is accomplished in part in concentrated perchloric acid. *Caution:* The analyst must insure that the sample is heated to light brown fumes after the initial nitric acid addition; otherwise, dangerous perchlorates may result from the subsequent perchloric acid digestion. Perchloric acid also should be used only under a perchloric acid hood.

4.8.2.1 Transfer the filter and any loose particulate matter from the sample container to a 150 ml beaker. Add 35 ml concentrated nitric acid. Heat on a hotplate until light brown fumes are evident to destroy all organic matter. Cool to room temperature and add 5 ml concentrated sulfuric acid and 5 ml concentrated perchloric acid. Then proceed with step 4.8.2.4.

4.8.2.2 Place a portion of the water and acetone sample into a 150 ml beaker and put on a hotplate. Add portions of the remainder as evaporation proceeds and evaporate to dryness. Cool the residue and add 35 ml concentrated nitric acid. Heat on a hotplate until light brown fumes are evident to destroy any organic matter. Cool to room temperature and add 5 ml concentrated sulfuric acid, and 5 ml concentrated perchloric acid. Then proceed with step 4.8.2.4.

4.8.2.3 Weigh the spent silica gel and report to the nearest gram.

4.8.2.4 Samples from 4.8.2.1 and 4.8.2.2 may be combined here for ease of analysis. Replace on a hotplate and evaporate to dryness in a perchloric acid hood. Cool and dissolve the residue in 10.0 ml of 25 percent V/V hydrochloric acid. Samples are now ready for the atomic absorption unit. The beryllium concentration of the sample must be within the calibration range of the unit. If necessary, further dilution of sample with 25 percent V/V hydrochloric acid must be performed to bring the sample within the calibration range.

4.8.3 *Beryllium determination.*—Analyze the samples prepared in 4.8.2 at 234.8 nm using a nitrous oxide/acetylene flame. Aluminum, silicon and other elements can interfere with this method if present in large quantities. Standard methods are available, however, to effectively eliminate these interferences (see Reference 5).

5. *Calibration.*—5.1 *Sampling train.*—5.1.1 Use standard methods and equipment as detailed in APTD-0576 to calibrate the rate meter, pitot tube, dry gas meter and probe heater (if used). Recalibrate prior to each test series.

5.2 *Analysis.*—5.2.1 Standardization is made with the procedure as suggested by the manufacturer with standard beryllium solution. Standard solutions will be prepared from the stock solution by dilution with 25 percent V/V hydrochloric acid. The linearity of working range should be established with a series of standard solutions. If collected samples are out of the linear range, the samples should be diluted. Standards should be interspersed with the samples since the calibration can change slightly with time.

6. *Calculations.*—6.1 *Average dry gas meter temperature, stack temperature, stack pressure and average orifice pressure drop.*—See data sheet (figure 104-6).

6.2 *Dry gas volume.*—Correct the sample volume measured by the dry gas meter to stack conditions by using equation 104-2.

$$V_{m_s} = V_m \frac{T_s}{T_m} \frac{\left(P_{bar} + \frac{\Delta H}{13.6}\right)}{P_s} \qquad \text{eq. 104-2}$$

where:

V_{m_s} = Volume of gas sample through the dry gas meter (stack conditions), ft³.

V_m = Volume of gas sample through the dry gas meter (meter conditions), ft³.

T_s = Average temperature of stack gas, °R.

T_m = Average dry gas meter temperature, °R.

P_{bar} = Barometric pressure at the orifice meter, in Hg.

ΔH = Average pressure drop across the orifice meter, in H_2O.

13.6 = Specific gravity of mercury.

P_s = Stack pressure, $P_{bar} \pm$ static pressure, in Hg.

6.3 *Volume of water vapor.*

$$W_{v_s} = K_w V_{l_c} \frac{T_s}{P_s} \qquad \text{eq. 104-3}$$

where:

W_{v_s} = Volume of water vapor in the gas sample (stack conditions), ft³.

K_w = 0.00267 $\frac{\text{in Hg-ft}^3}{\text{ml-°R}}$, when these units are used.

V_{l_c} = Total volume of liquid collected in impingers and silica gel (see figure 104-7), ml.

T_s = Average stack gas temperature, °R.

P_s = Stack pressure, $P_{bar} \pm$ static pressure, in Hg.

6.4 *Total gas volume.*

$$V_{total} = V_{m_s} + V_{w_s} \qquad \text{eq. 104-4}$$

where:

V_{total} = Total volume of gas sample (stack conditions), ft³.

V_{m_s} = Volume of gas through dry gas meter (stack conditions), ft³.

V_{w_s} = Volume of water vapor in gas sample (stack conditions), ft³.

6.5 *Stack gas velocity.*

Use equation 104-5 to calculate the stack gas velocity.

$$(v_s)_{ave.} = K_p C_p (\sqrt{\Delta p})_{ave.} \sqrt{\frac{(T_s)_{ave.}}{P_s M_s}} \qquad \text{eq. 104-5}$$

where:

$(v_s)_{ave.}$ = Average stack gas velocity, feet per second.

K_p = 85.53 $\frac{\text{ft}}{\text{sec}} \left(\frac{\text{lb-in Hg}}{\text{lb mole-°R-in H}_2\text{O}}\right)^{1/2}$, when these units are used.

C_p = Pitot tube coefficient, dimensionless.

$(T_s)_{ave.}$ = Average stack gas temperature, °R.

$(\sqrt{\Delta p})_{ave.}$ = Average square root of the velocity head of stack gas $(\text{in H}_2\text{O})^{1/2}$ (see figure 104-6).

P_s = Stack pressure, $P_{bar} \pm$ static pressure, in Hg.

M_s = Molecular weight of stack gas (wet basis)—the summation of the products of the molecular weight of each component multiplied by its volumetric proportion in the mixture, lb/lb-mole.

	VOLUME OF LIQUID WATER COLLECTED	
	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g
FINAL		
INITIAL		
LIQUID COLLECTED		
TOTAL VOLUME COLLECTED		g* ml

*CONVERT WEIGHT OF WATER TO VOLUME BY dividing total weight INCREASE BY DENSITY OF WATER. (1 g/ml):

$$\frac{\text{INCREASE, g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

Figure 104-7. Analytical data.

PLANT_____

DATE_____

RUN NO._____

STACK DIAMETER, in._____

BAROMETRIC PRESSURE, in. Hg._____

STATIC PRESSURE IN STACK (P_g), in. Hg._____

OPERATORS_____

SCHEMATIC OF STACK CROSS SECTION

Traverse point number	Velocity head, in. H_2O	$\sqrt{\Delta_p}$	Stack Temperature (T_s), °F
AVERAGE:			

Figure 104-8. Velocity traverse data.

Figure 104-8 shows a sample recording sheet for velocity traverse data. Use the averages in the last two columns of figure 104-8 to determine the average stack gas velocity from equation 104-5.

6.6 *Beryllium collected.*—Calculate the total weight of beryllium collected by using equation 104-6.

$$W_t = V_t C_t - V_w C_w - V_a C_a \quad \text{eq. 104-6}$$

where:

W_t = Total weight of beryllium collected, µg.

V_t = Total volume of hydrochloric acid from step 4.8.2.4, ml.

C_t = Concentration of beryllium found in sample, µg/ml.

V_w = Total volume of water used in sampling (impinger contents plus all wash amounts), ml.

C_w = Blank concentration of beryllium in water, µg/ml.

V_a = Total volume of acetone used in sampling (all wash amounts), ml.

C_a = Blank concentration of beryllium in acetone, µg/ml.

6.7 *Total beryllium emissions.*—Calculate the total amount of beryllium emitted from each stack per day by equation 104-7. This equation is applicable for continuous operations. For cyclic operations, use only the time per day each stack is in operation. The total beryllium emissions from a source will be the summation of results from all stacks.

$$R = \frac{W_t (r_s)_{av} A_s}{V_{total}} \times \frac{56{,}400 \text{ seconds/day}}{10^6 \text{ µg/g}} \quad \text{eq. 104-7}$$

where:

R = Rate of emission, g/day.

W_t = Total weight of beryllium collected, µg.

V_{total} = Total volume of gas sample (stack conditions), ft³.

$(v_s)_{av}$ = Average stack gas velocity, feet per second.

A_s = Stack area, ft².

6.8 *Isokinetic variation (comparison of velocity of gas in probe tip to stack velocity).*

$$I = \frac{100 V_{total}}{A_n \theta (v_s)_{av}} \quad \text{eq. 104-8}$$

where:

I = Percent of isokinetic sampling.

V_{total} = Total volume of gas sample (stack conditions), ft³.

A_n = Probe tip area, ft².

θ = Sampling time, sec.

$(v_s)_{av}$ = Average stack gas velocity, feet per second.

7. *Evaluation of results.*—7.1 *Determination of compliance.*—7.1.1 Each performance test shall consist of three repetitions of the applicable test method. For the purpose of determining compliance with an applicable national emission standard, the average of results of all repetitions shall apply.

7.2 *Acceptable isokinetic results.*—7.2.1 The following range sets the limit on acceptable isokinetic sampling results:

If 90 percent $\leq I \leq$ 110 percent, the results are acceptable; otherwise, reject the test and repeat.

7. *References.*—1. Addendum to Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, December 6, 1967.

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