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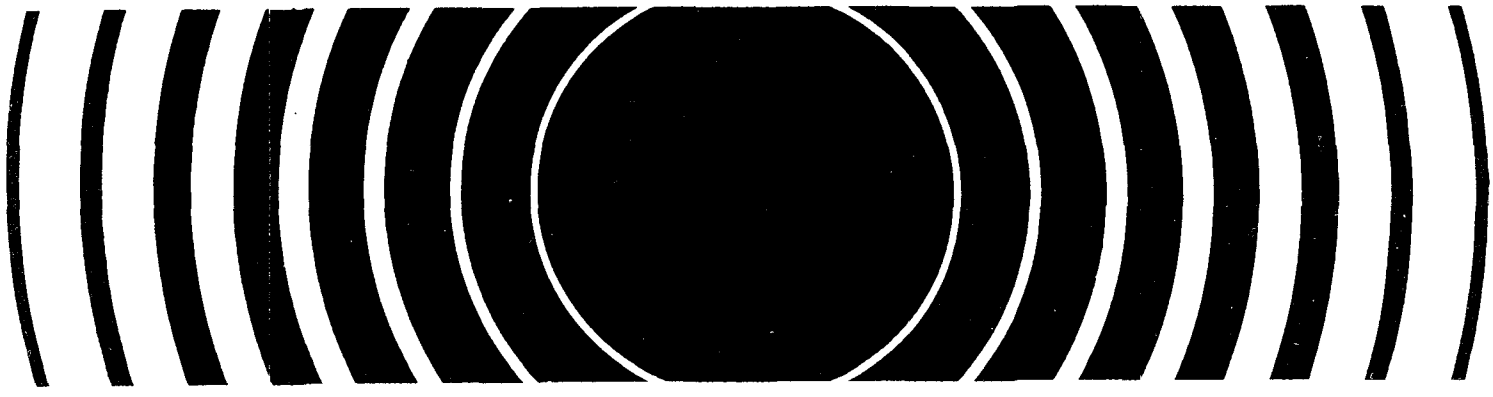

Design and Development of an Air Sampler for the Environmental Radiation Ambient Monitoring System (ERAMS)

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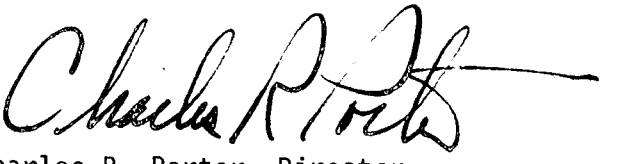
FOREWORD

The Eastern Environmental Radiation Facility (EERF) in Montgomery, Alabama, is a field installation of the U.S. Environmental Protection Agency's Office of Radiation Programs. Broadly, the EERF helps solve environmental radiation problems and provides radiation data of national concern as directed by the Office of Radiation Programs. More specifically, the EERF conducts field studies on particular radiation problems; operates a national scope emergency response program; provides technical assistance to State and local health departments, EPA regional offices, and other Federal agencies; and maintains a complete radiological laboratory to support these various activities. A growing segment of the EERF's work is radiation surveillance. Toward this end, the EERF operates the Environmental Radiation Ambient Monitoring System (ERAMS) -- a nationwide network of sampling stations monitoring environmental radiation in air, water, and milk.



Charles R. Porter, Director
Eastern Environmental Radiation Facility

Introduction

The U.S. Environmental Protection Agency's Office of Radiation Programs operates, through its Eastern Environmental Radiation Facility (EERF) in Montgomery, Alabama, a national network of stations that monitor levels of environmental radioactivity. This network, called the Environmental Radiation Ambient Monitoring System (ERAMS), was formed in 1973 from a group of separate networks that had been established some years earlier to monitor fallout from above-ground nuclear weapons testing.

A principal task of the ERAMS program is to determine radioactivity in airborne particulates. This is done through a network of continuously operating air monitoring stations in 67 cities throughout the United States (see Figure 1). The EERF provides the air sampling equipment and supplies for each of the stations, which are usually operated by volunteers from state or local health departments. Particulate filters on the air samplers are changed twice weekly, and, after an initial field estimate of radioactivity, are sent to the EERF for detailed radiological analyses.

The air samplers used in the ERAMS network must operate continuously for several years. Limited availability of parts, escalating purchase and operating costs, and several features of the pump used by ERAMS for many years dictated that the ERAMS air sampler be replaced. This paper describes the replacement air sampler and its advantages over the one previously used.

Fig. 1. ERAMS air monitoring stations

Limitations of Previous Samplers

Over the many years of operation, most stations have been equipped with positive displacement air samplers that used rotating lobe pumps (see Figure 2) driven by a 1.5 horsepower motor, a combination that proved to be very durable and dependable. The samplers typically operated for 3-5 years or longer with no maintenance except for a routine change of lubricating oil in the pump. The samplers would move 30 to 40 cubic feet per minute (CFM) of air through the 4 inch diameter filters used in the ERAMS network, thus affording large sample volume. The samplers run most efficiently on 220 volts, and the EERF recommends this if possible.

The current replacement cost for these samplers is $1,200 for parts plus about 12 man-hours of assembly. The pump can be rebuilt by the manufacturer for an average cost of $450 plus shipping to the factory and return.

Even though the samplers are durable and dependable, the initial cost and repair cost continue to escalate. The weight of the systems, 325 pounds, often makes it difficult to get the samplers to their operating locations, which, at some stations, is on the roof of a building, thus requiring rental of a crane. Preference for 220 volts power often necessitates running special power services. Also, annual power costs to operate the 1.5 horsepower motor amounts to $963.00 at $.065 per kilowatt hour of electricity. At some locations, noise from the pumps was objectionable, measuring 85 dB at 3 feet from the pump during operation.

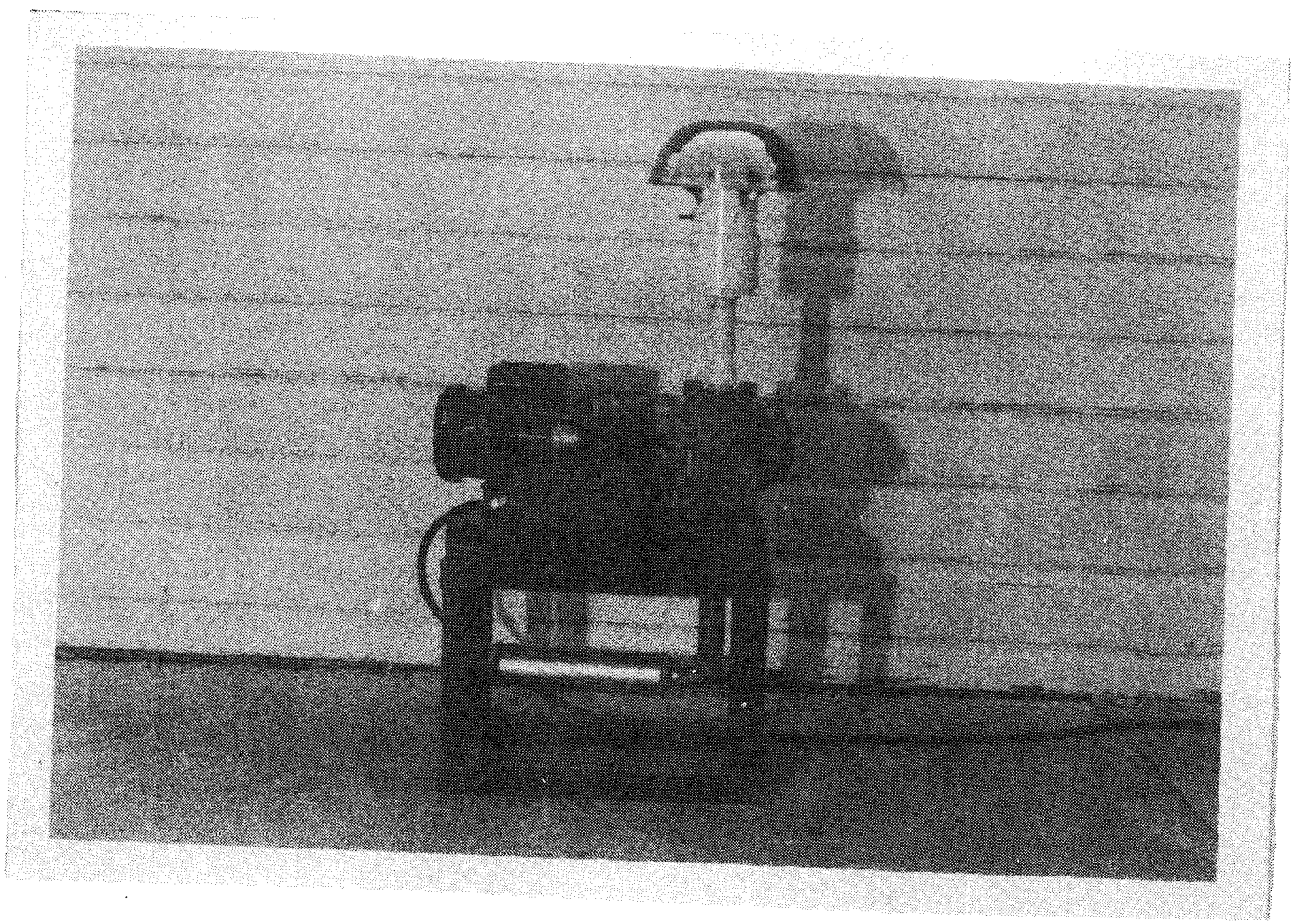


Fig. 2. Air particulate pump and motor assembly

Description of New Sampler

The problems noted above and the lack of a suitable commerically available replacement led to the development of the replacement air sampler. The new air sampler had to meet the following requirements:

-capable of moving 20-40 cfm of air through a 4 inch diameter filter
-capable of operating 3-5 years with little or no maintenance
-low power consumption to reduce operating cost
-low initial purchase and replacement cost
-ease of operator use, safe
-lightweight for low shipping cost and ease of placement into operating location
-durable, weatherproof enclosure
-quiet operation

The new sampler assembled for the ERAMS network meets these requirements. The air mover in the new sampler, which is available from Lamb Electric Motor Division of Amtek, Incorporated, is a seven stage, dynamically balanced, centrifugal blower driven by a 120 volt, 60 Hz motor. The centrifugal design blower has a minimum of moving parts -- no pistons, lobes, valves, etc., to wear out. The unit is operated in the vacuum mode and is capable of providing 24 inches water lift at 0 cfm flow.

The centrifugal design blower is driven by a fractional horsepower motor that draws only about 2 amperes current at 120 volts AC while operating in the normal configuration used in the ERAMS samplers. Annual cost for electricity to operate the unit is $145.00 at $.065 per kilowatt hour, compared to $963.00 annually to operate the previously used pump. The small motor and centrifugal design also reduce operating noise, 60 dB at 3 feet compared to 85 dB at 3 feet for the previously used sampler.

Unlike some of the high volume samplers used by ERAMS in the past, the Amtek motor uses no brushes, which results in extended operating life for the units. According to Amtek, life of the blower is usually limited by deterioration of the bearings supporting the fan shaft. Since heat build-up contributes to this deterioration, a special air deflector and a cooling fan were installed on each sampler to reduce operating temperature and provide extended operating lifetime. The first samplers built for the network have been in use since May 1, 1983 without a failure. We expect the units to meet our design criteria of 3-5 years normal operating lifetime.

For air particulate sampling, the ERAMS network uses a 4-inch diameter filter mounted in a sampling head designed and built at the EERF. With this filter and sampling head the blower draws 27 to 31 cfm of air through the filter, a volume suitable for collecting the desired sample. Filters are routinely changed twice weekly, except when the network is in alert status and filters are changed daily.

The enclosure for the blower and the air sampling head is durable, lightweight, and weather resistant. Extensive louvers and a thermostatically controlled fan cool the pump. One complete side of the enclosure is hinged as a door for easy removal and replacement of the blower unit. The entire blower unit is mounted on a "slide-out" tray for blower replacement in the field. All electrical connections are plug-in and the blower connects to the sampling head through a flexible rubber hose attached with automotive type hose clamps. A defective blower may be replaced in the field by non-technical personnel in about 15 minutes using only a screw driver and a 7/16" wrench. All electrical connections in the unit are enclosed in a utility box and meet electrical safety codes. The enclosures are made of aluminum to provide long-term durability with no maintenance and minimum weight. A complete unit weighs about 60 pounds. Initial installation requires only that the unit be placed at the desired location and plugged into any 120 VAC outlet. No special wiring is required. It is desirable in some locations to bolt the sampler legs to a stable surface to present tipping over by high winds. The sampler should be mounted in a near vertical position to allow maximum accuracy of the magnehelic gauge attached to the enclosure door. A photograph of an assembled sampler is shown in Figure 3.

Costs of producing and maintaining the described samplers are much lower than those of the previously used samplers. The blower assemblies cost about $350.00 each and the enclosures $250.00 each. Other small parts cost about $50.00 plus 8 man-hours each for assembly. Because of

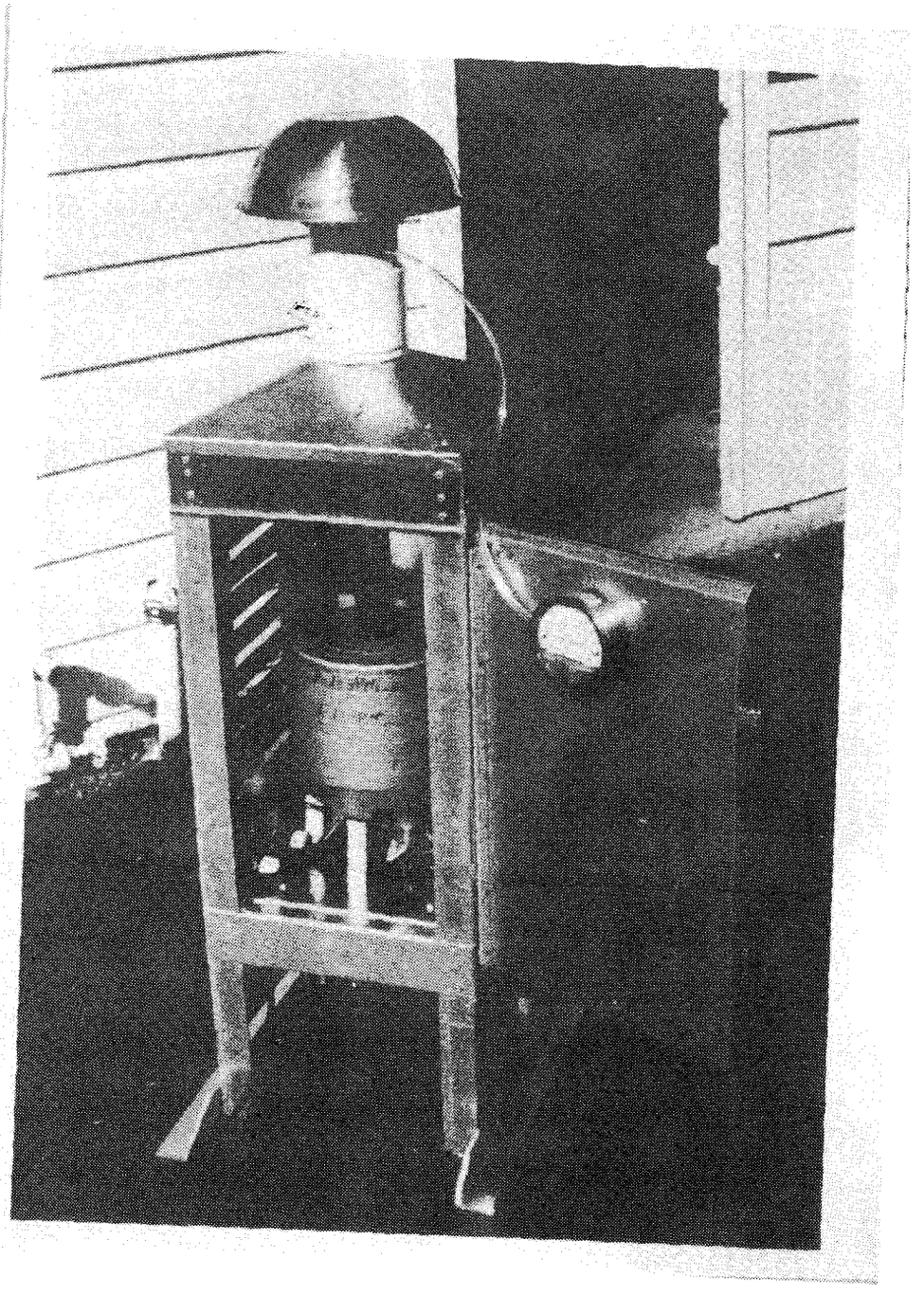


Fig. 3. Air particulate blower-motor assembly

the lighter weight of the new blower shipping costs are greatly reduced. For example, to ship one of the new blowers to the ERAMS operator at Columbus, Ohio, costs $48.00, compared to $118.00 for shipping one of the previously used heavier pumps to the same location. Should one of the new blowers fail at the sampling station in Columbus, Ohio, it is necessary to ship only a replacement blower assembly. The replacement blower costs $350.00 plus $8.00 shipping, a considerable savings compared to rebuilding the previously used samplers.

Summary

The newly designed air sampler for the ERAMS network meets all the desired design characteristics. Units have been in use at some ERAMS stations for more than two years and have operated satisfactorily. No samples have been lost due to inoperative samplers. Sampling air flow rates are adequate to collect the desired sample volume.

Purchase cost, operating costs, and repair costs are greatly reduced compared to the previously used samplers. The small physical size and light weight result in a unit which is inexpensive and easy to ship and to get into the operating location. Operating life of the blower is adequate to minimize the inconvenience and cost associated with frequent replacement. Ease of operator use and low operating noise result in a unit that has been readily accepted by the station operators.

Additional details of the sampler may be obtained by contacting the Eastern Environmental Radiation Facility at 1890 Federal Drive, Montgomery, Alabama, 36109 or telephone (205)272-3402.