APPENDIX E

QUANTITATIVE RESPIRATOR FITTING TEST EQUIPMENT

Both NaCl and DOP aerosol systems are commercially available (1975) from Air Techniques, Inc., 1717 Whitehead Road, Baltimore, MD 21207 and Frontier Enterprises, Inc., Box 30041, Albuquerque, NM 87110. The systems these concerns make differ little from the basic designs developed by the Los Alamos Scientific Laboratory (LASL). The cost may vary, depending upon accessories, but it is generally about $8-10,000. Both the NaCl and DOP systems consist of an aerosol generation and dilution air system, an analyzing system, and a test enclosure.

Figure E-1 illustrates a typical NaCl test system consisting of an internal or external compressed air source (1) that provides clean air at 50-100 psig to the aerosol generators (2) and combustion air to the burner (12). A Wright-design nebulizer is used in all commercial systems and has been adopted as the standard means of generating an NaCl aerosol. Operated at 24 psi with a 1% NaCl solution, it produces an aerosol with an aerodynamic mass median diameter (AMMD) of 0.6 μm. Two nebulizers are provided in most systems, although the output from one is sufficient for most purposes.

The aerosol generator injects the liquid droplets perpendicularly into the air stream flowing through the mixing and drying chamber (3), in Fig. E-1. The air for drying the aerosol (~4 cfm) is supplied by an internal blower ahead of which is mounted a high-efficiency filter. In passing through the mixing and drying chamber, the liquid NaCl droplets dry into discrete solid particles that are carried in the aerosol stream to the test enclosure. In this instance, the enclosure (5) is a test hood that covers the subject down to his waist, but particles also could be delivered to a small chamber. This test hood, based on a Harvard School of Public Health design, is commercially available. The aerosol is delivered to the center top of the hood. Directly below the inlet is a

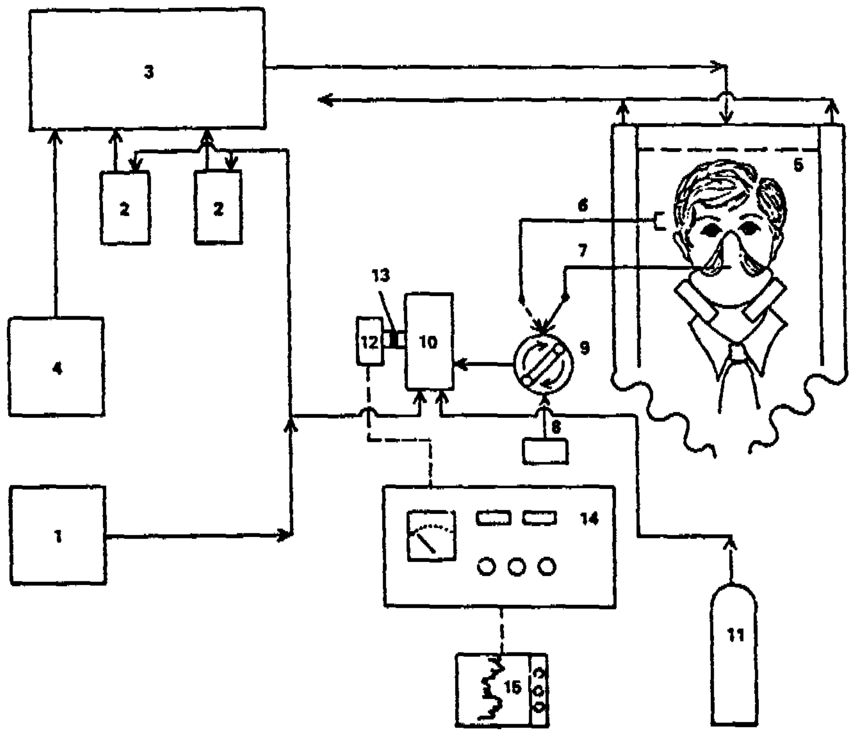

Figure E-1.
NaCl quantitative fitting test system schematic.

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is an oil mist, but to reduce the aerosol mass concentration to an acceptable level and maintain adequate air flow to the test enclosure. The test enclosure (6) is identical to that for the NaCl system, and two sampling tubes sample the DOP aerosol in the hood and the interior of the respirator. A third sampling tube outside the test hood is connected to a small high-efficiency filter (9) to provide clean air to the forward light-scattering photometer (10). The amount of DOP aerosol in the sample stream is determined by the intensity of the light scattered forward from particles passing through the center of the conical scattering chamber. This light strikes the photomultiplier tube (12), and the tube output is fed into the electronic section (13) of the analyzer which is almost identical to that used in the NaCl system.

The DOP concentration in the sample stream from the respirator, expressed as a percentage of the concentration in the test hood is displayed either on a meter or on a separate strip chart recorder (14).

This description applies primarily to the prototype units designed and built at LASL, upon which the commercial systems are based. Improvements and changes are made continually, so presently available systems may not look like those described. The important point is that the hearts of these systems, the aerosol generators, are identical in all respects.

In summary, these quantitative respirator fitting test systems provide the ultimate method for determining respirator fit. However, it is unrealistic to suggest that every respirator program have this capability. These systems are expensive and complex and require trained operators. Therefore, they are most widely used by industrial firms that have very comprehensive respirator programs. On the other hand, if a small industrial firm must protect workers against highly toxic contaminants, the expenditure for a quantitative respirator fit test system may be justified.

small circular plate that helps distribute the aerosol stream evenly inside the hood. Even distribution is further ensured by a large perforated plate that forms the bottom of the aerosol distribution section.

The chamber part of the hood is made of two, slightly separated, cylindrical walls of thin, transparent plastic. At the bottom of the outer wall is a cloth skirt that can be drawn snugly around the subject's waist to minimize leakage into the surrounding area. The aerosol is exhausted through the annular space between the inner and outer walls.

As Fig. E-1 shows, two sampling tubes lead from the hood to the aerosol analyzing system. One tube (6) samples the concentration of NaCl aerosol particles in the chamber atmosphere, and it is used in calibrating the flame photometer. The other tube (7) samples the NaCl aerosol particles in the air inside the respirator. A peristaltic (tubing) pump (9) is used to inject the sample into the flame photometer burner (10).

On the inlet side of this pump are connected the sampling tubes from the test hood as well as a third sampling tube which is connected to a small high-efficiency filter. This tube and filter (8) supply clean sampling air to the burner to calibrate the photometer.

Combustion air for the burner (10) is supplied from the external or internal compressed air source (1), and the propane fuel is supplied from an external tank (11). The amount of NaCl in the sample stream is determined by vaporizing the NaCl particles in the burner and detecting the emitted yellow light characteristic of sodium by using a sensitive photomultiplier tube (12) ahead of which is placed an optical filter (13) that passes only the sodium emission lines. The light intensity is directly related to the concentration of NaCl aerosol particles.

The photomultiplier tube output is fed into the electronics (14) of the test system analyzing section, and the amount of aerosol in the sampled air is displayed as percentage of the ambient concentration in the hood, either on a meter or a separate strip chart recorder (15).

The DOP quantitative respirator fitting test system is very like the NaCl system. As Fig. E-2 shows, an internal or external compressed air source (1) supplies 3- to 5-psig air to the Naval Research Laboratory Model III design DOP generator (2) and LASL-designed round jet impactor (3). The equivalent generator and impactor are found in commercial systems, but external construction details may differ.

The output from the generator and impactor assembly is injected into the dilution air chamber (4), perpendicularly to the air flowing through this chamber. The purpose is not to dry the aerosol, as it

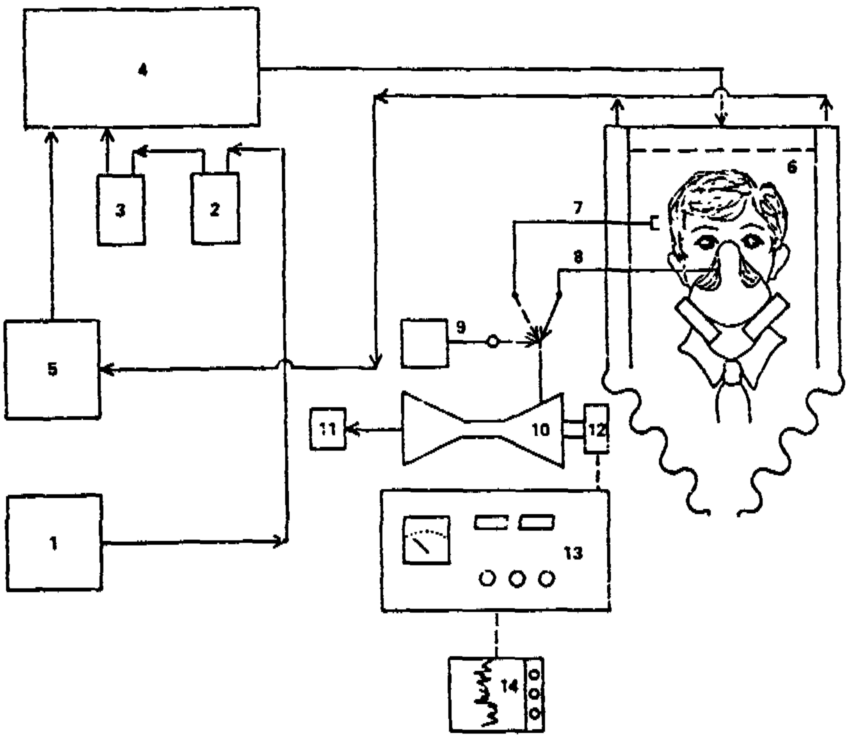

Figure E-2.
DOP quantitative fitting test system schematic.