

RESPIRATOR RESEARCH NEEDS

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Ideally, respirator research should be developing a light-weight full face respirator with no decrease in peripheral vision; which clings to every valley, mountain, and dip in the facial contours making a perfect seal with the skin at all times; has a sorbent filter of low resistance and infinite capacity for gases, vapors, and particulates of all sizes; which in an emergency can generate oxygen. We have not reached this goal and it will be some time before we do. Regardless, there are attainable goals that can improve the use of respirators.

Before discussing specific research needs, we should mention respirator certification regulations. Without such regulations, researchers would be free to develop and sell any type of respiratory protection. The user could then determine what is good and what is bad. Unfortunately, the user would also be the guinea pig who could suffer harm from using inadequately designed respiratory protection. This leads to a respirator regulation program which inhibits our desire to research and market respirators of bizarre approaches but provides the user with some minimum protective standards. Any regulatory act tends to inhibit choice and funnels research into products which can be designed to successfully pass the regulations. If the regulations are defined in detail, there is little chance for deviation in product design. The respirator approval regulations, as presently written, tend to be detailed test procedures which a respirator must pass in order to be certified. Is our goal a respirator which satisfies a detailed test procedure or one that meets the criteria of protecting the user from specified hazards? How necessary are these detailed test procedures which may not apply to the hazards in the work place?

The certification regulations contain four separate aerosol tests with specifications as to the allowable penetration by weight in a set period of time. Should our interest be in the total aerosol weight which penetrates the filter, or in the percentage penetration of a certain size range of aerosols? A separate loading test at the maximum use dust concentration could record the time to reach the upper limit of inhalation resistance.

The regulations for sorbent cartridges test only a few gases and vapors for one condition only. Shouldn't our interest be in the total quantity of each particular contaminant which can be absorbed? Pesticide cartridges are tested for carbon tetrachloride sorption. Isn't our interest in the quantity of each particular pesticide which can be absorbed?

The 30 minute SCBA unit which is 30 minutes in name only must pass a detailed series of tests of questionable value. Why not specify how much air each SCBA class must contain and the minimum air flow rate?

In essence, certification regulations should be performance requirements with a minimum of data on the particular test required. If this is done, then the respirator regulations will have minimum impact on respirator research and allow innovations within the approval criteria.

What are the needs in respirator research? In examining the use of respirators, we have three major components--the respirator, the user, and devices to determine the compatibility of respirator and the user. All areas deserve increased research.

EQUIPMENT RESEARCH

Air purifying respirators need additional research in the area of filter and sorption agents.

We need to develop a particulate filter which has the low resistance of resin felt for fume particulates without suffering a loss of filtration efficiency when exposed to high heat and humidity. This would decrease the size of fume respirators.

We use air purifying respirators for a variety of organic solvents and tell the user when you smell it, its time to change the cartridge. We value this advice so much that we warn the user not to use the respirator with gases and vapors which have poor odor warning properties. Trusting your life and health to a test instrument as untrustworthy as the human nose is a questionable decision which may result in a fatal mistake. Rather, why not determine the sorbent cartridge life to various concentrations of a wide range of materials used in industry. The user can then set the time of use by the concentration of the vapor or mixture of vapors encountered. Presently, the respirator is not to be used unless the conditions under which it is used are known--a fundamental principle not often practiced. If the user must know the concentration of the contaminant to determine the life of the cartridge, it would be an incentive for the user to find such data.

During the last few years, the constant flow powered air purifying respirator has been shown to be a practical and desirable unit for particulate protection. A sorbent cartridge for gases and vapors should be developed; however, the 1900 cubic feet air flow per day may be a problem. The design of a pressure demand powered air purifying respirator should be considered which reduces the amount of air required to approximately a quarter of that required for a continuous flow version. This may make a sorbent cartridge practical. It would also be of great value to users of such devices in winter.

At present, air supplied respirators in demand mode are not as efficient as the continuous flow or pressure demand modes. Research into this type of respirator appears to offer little reward in the area of increased protection for the user. For any tight fitting face piece, it would be of interest to reduce the supplied air regulators in size and weight since these factors on the face mounted regulators may affect fit.

The air flow through the air supplied respirator is critical if protection is to be maintained. A simple inexpensive method to allow the user to monitor the air flow quickly, easily, and directly, is needed to ensure the minimum flow required is maintained.

Cleaning and maintenance of respirators are important issues which are not always given much thought. Most air purifying respirators designed for reuse are relatively simple to clean. That is not always true of air line respirators. The air line respirator, either a tight fitting facepiece or an air supplied hood, can be difficult to take apart and assemble for cleaning.

The person who wrote the provision that respirators be cleaned at the end of each shift never had to take apart an air supplied hood to clean it and reassemble it.

HUMAN RESEARCH

Our data is still not complete concerning the adverse physiological and psychological effects of wearing a respirator. The data we have is usually related to the healthy, young male who makes up a part of the **nation's** work force which is not young, not healthy, and not 100% male.

A respirator may impose high resistance to inhalation and exhalation during use. Complaints are received and **aprehension** is shown by the user on this subject. How is the human respiratory system affected by high resistance during both inhalation and exhalation? We need the **information** for pulmonary systems in excellent, good, fair, and bad health during low and high work rates since all these variables are encountered in the workplace.

As I mentioned, there is also the psychological problem of wearing a respirator. How do we identify personnel who have such fears? While they may not be large in number, they are present in our work force. We **must** provide some means for those in charge of respirator programs to be able to identify them and assist them in successfully wearing respirators.

As an Administrator of a State OSHA Program, the need for this information is apparent. We require approval by a physician on questions concerning an **employee's** ability to wear a respirator. We provide no guidelines with our request to assist the physician in making his decision.

Research in this area is minimal. Some research by work physiologists has been started but the funding level is low. Research into the stresses caused by wearing a respirator, such as the work of Dr. Peter Raven should be encouraged and funded on a realistic level.

RESPIRATOR FIT TESTING

Respirator fit tests both qualitative and quantitative are available to determine if the respirator is servicing the user efficiently. Qualitative tests are more widely used and their usefulness is discussed endlessly. While quantitative fit testing is preferable, there are many times in the field when quantitative fit testing is impractical and a good qualitative fit test method is needed. A fault of some qualitative fit tests is that they require the understanding and cooperation of the respirator user. Three essential items are not always present. We should have definitive research to develop a qualitative test method which does not require the understanding and **cooperation** of the user and provides a minimum known standard of **protection**.

The preferred method of testing is quantitative fit **testing**. The present quantitative fit **testing procedures** have given us voluminous research data on how respirators **fit** a wide range of facial **sizes**. This has allowed manufacturers to design masks in **multi** sizes so it is easier for large and small facial sizes to obtain a respirator that fits. While the present system has proven extremely **useful**, it takes into account two dimensions only, face **width**, and face length. I believe it is necessary to add the third dimension of depth to accurately fit the face to the respirator. The facial topography can be accurately mapped and stored in our modern computers. Surely this **promising** area of **research**, which would make available facial contours for every size of **American face**, would be of value to respirator designers. The problem of facial dimension is further complicated by our need for an up to date **anthropometric** study of our work force. **Presently**, anthropometric data ranges in age from 15 - 60 years and is not data from the work force since the data available is from military personnel surveys. Considering the **military's** need for a physically fit and interchangeable **population**, it is probable that this data adequately reflects the average population but does not reflect the working population in both size extremes on either side of the average. We need an anthropometric study of our work force to provide needed data for designers of respirators, other personal protective **equipment**, and engineering controls.

While the present Quantitative Fit Test procedure has provided us with PF data that is **extremely** useful, additional validation should be done under conditions of **actual use**. With the availability of approved respirator with sampling probes, it becomes practical to obtain PF data under real work conditions. A series of tests should be carried out to compare PF data in the field and in the laboratory.

At this time, the quantitative fit test equipment available is large, expensive, and **requires** dedicated people to utilize it. This equipment has **provided us** with **much** useful research data and has provided day to day quantitative fit **test** data primarily for the nuclear industries which have safety and health protection programs of **much greater precision** than those in general use in other industries. This does not help the general run of industry which would like to **utilize** or **may be required** to use quantitative fit testing. Quantitative fit testing denotes precision but we do not set the limits of this precision. The present quantitative fit test systems provide precision that many industries believe necessary but may not be necessary in other industries. **There** needs to be developed a quantitative fit testing system of known lesser precision which is readily portable, easily operated by the average **employer**, and modest in cost.

Most of my thoughts for the future are not new or revolutionary. They have been suggested in the past more than once. Regardless, new and untried ideas must be explored. A continuation of our present program of respirator manufacture, **certification**, and use provides little incentive for change and will continue the **respirator's** reputation as an uncertain means of **protection**.