

really offered dependable protection was not made available in the United States until the United States Bureau of Mines set up approval schedules and procedures for permissibility tests. These schedules¹ are revised from time to time to conform with advances in research and development. It was not until 1935 that dust respirators became available to American industry, when the first respirator passed the official schedule of tests. Scores of inferior, and in many instances useless, devices were discarded after these tests demonstrated their unsatisfactory performance.

These tests now cover oxygen-breathing apparatus, canister gas mask, self-contained masks, abrasive-blasting and other air-line respirators, filter-type dust respirators, and chemical cartridge respirators. The tests specify the minimum permissible performance and the maximum permissible resistance to inhalation and exhalation. Certificates of approval issued by the Bureau for the accepted devices are the basis for all lists of approved industrial respiratory protective equipment published by any agency in the United States. No data are published enabling the public to choose the respirator giving the best performance, but lists of all devices meeting the minimum requirements are published. However, these requirements are raised occasionally to keep pace with the more progressive manufacturers, and holders of early approvals are encouraged to improve the performance of their devices to meet these higher standards in order to retain the approval label. Nominal fees charged for approval testing vary with the time required for men to perform the scheduled tests. All approved devices are stamped with an approval label or number, such as BM-1400, in which the first two digits of the number refer to the schedule of tests under which the device was approved, and the last two are specific for the particular device.

II. Types and Uses of Respiratory Protective Devices

Respiratory protective devices are used to supplement other methods of control and are more frequently used as an emergency measure. Respiratory protection against all classes and combinations of air contaminants is available under two general classifications: (1) air-purifying respirators, which purify the air by removal of the contaminant, and (2) atmosphere-supplying respirators, which supply respirable, uncontaminated air or oxygen to the wearer.

A. AIR-PURIFYING RESPIRATORS

Air-purifying respirators provide protection only by removing specific contaminants from the atmosphere. Obviously, sufficient oxygen must already be present in the atmosphere to support life.

¹ Self-contained breathing apparatus, *U. S. Bur. Mines, Schedule 13C* (1946). Gas mask, *U. S. Bur. Mines, Schedule 14F* (1955). Filter-type dust, fume, and mist respirators, *U. S. Bur. Mines, Schedule 21A* (1955). Supplied-air respirators, *U. S. Bur. Mines, Schedule 19B* (1955). Nonemergency gas respirators, *U. S. Bur. Mines, Schedule 23A* (1955).

1. Gas Masks (Canister Type)

A canister gas mask usually consists of a full facepiece connected by a breathing tube to a canister containing materials for purifying the air, and equipped with a suitable supporting harness. A check valve in the canister and an exhalation valve in the facepiece control the direction of flow of air through the device. The air-purifying materials in the canister vary with the type of contaminant since no one substance will remove all contaminants. Alkaline materials such as Caustite and soda lime combine with and remove any of the acid gases except nitrogen oxides; silica gel and activated carbon adsorb organic vapors; ammonia is removed by various materials, such as silica gel adsorbent or some other substance that has been impregnated with copper or cobalt salts to combine with the ammonia; while carbon monoxide is catalytically oxidized to carbon dioxide by Hopcalite, a trade preparation of manganese and copper oxides. Filters may be provided within the canister for removal of particulate matter. The provision that a canister provides determines its type, and depends upon the material with which it is filled. It may be for a single gas, one or more classes of gases, or for all gaseous contaminants. The types of canisters are designated by patterns and a color code, as listed in Table 1.

TABLE 1
Color Code for Canisters

Canister Type	Contaminants to be protected against	Color
AC	Acid gases	White
OC	Organic vapors	Black
AM	Ammonia	Green
CM	Carbon monoxide	Blue
AD	Dusts, fumes, mists, fogs, and smokes in combination with any of the above gases or vapors	1/2 in. contrasting black or white stripe (on the respective color)
AB	Acid gases and organic vapors	Yellow
ABC	Acid gases, organic vapors, and ammonia	Brown
N	All of the above atmospheric contaminants	Red

The canister gas mask is emergency equipment and is not suitable to wear for prolonged periods of work, because of discomfort and fatigue due to the resistance to inhalation and exhalation. This type of respirator is approved for use at concentrations of acid gases and organic vapors up to 2 per cent by volume, and up to 0.5 per cent ammonia. The service life of a canister depends upon the concentration of gas encountered, the volume of air inhaled by the wearer, the characteristics and amount of the chemical absorbents, and other factors. Obviously, the universal type of canister must be filled with a variety of materials in order to protect against practically all gaseous contaminants. For protection against a single known gas, or class of gases, a single-absorbent type of canister is