



Designing for High Performance and Ease of Use Under Stress

THE ILC DOVER SCAPE® RESPIRATOR'S PROVEN PERFORMANCE
FAR EXCEEDS NIOSH STANDARDS

While escape respirators must perform the same basic protective function as other protective equipment, the conditions of their application demand a different design than most protective hoods and masks.

Standard respirators are typically designed for such environments as laboratories and manufacturing plants. In these places, careful selection, donning, cross-checking and operational testing are not only possible but also generally required by operating manuals and company safety procedures. Moreover, these actions are carried out in a safe environment, before the operator enters any area where protective equipment is required and elapsed time to complete the various tasks is not critical.

THE ESCAPE-RESPIRATOR DIFFERENCE

When a person uses an escape respirator, conditions are vastly different because — except during drills — escape respirators are donned only during an emergency that could be life-threatening, and time is of the essence. Think about the stressors most likely involved at the time:

- Loud sirens or emergency annunciators blaring
- Noxious fumes or strong odors already detectable in the air
- Smoke or particulates reducing vision
- Coworkers or family members agitated or in need of help
- Users' coughing or eyes tearing
- Elevated adrenaline levels and resultant increased heart rate causing breakdown in fine motor skills

It is under these conditions that a person evacuating from danger must locate, remove from storage, don (put on), activate and operate the escape respirator for the total amount of time needed to reach safety.

This can be a daunting task. To ensure successful evacuation under these circumstances requires the availability of protective equipment that recognizes these as prevalent conditions of use. Moreover, escape respirators must meet or exceed a comprehensive standard established by the National Institute of Occupational Safety and Health (NIOSH) for air-purifying escape respirators (APERs).

DESIGN IMPLICATIONS

Let's look in detail at the emergency conditions, required user activity and design accommodations required to ensure the highest probability of successful escape. To provide concrete examples of how the stressful conditions and likely user reactions may be accounted for in escape respirator design, we are going to examine the SCape CO/CBRN³⁰ respirator, designed and manufactured by ILC Dover.

As the name indicates, the SCape CO/CBRN³⁰ respirator includes NIOSH-approved filtration to protect the wearer from carbon monoxide (CO), as well as chemical, biological, radiological and nuclear (CBRN) inhalants for a minimum of 30 minutes while the user escapes to a safe environment. This qualifies the SCape respirator to serve on the front lines of an array of emergency situations covering a wide range of threats, and many are currently in place around the world, ready for use.

FINDING AND REMOVING THE RESPIRATOR FROM STORAGE

The first task, when an emergency occurs, is to locate the escape respirator. Placement of stored escape devices is the responsibility of the owner or operator of the facility, home or building where the protective equipment may be required. However, selecting storage locations is easier if the respirator is self-contained. The user will also find it easier to remove from storage under stress if the number of separate parts is minimized.

For those reasons, each SCape CO/CBRN³⁰ respirator is

stored in its own easily opened, sealed container, and all parts of the SCape respirator are integrated into one assembly. Individual respirators can be safely stored in their containers — in cabinets, drawers, on shelves or in bins distributed throughout a facility.

Once users access the storage location, they can be assured that opening the sealed container and removing the single, integrated SCape unit gives them a complete, fully functioning escape respirator. No additional parts are needed, no assembly is required, and no tabs, tape or other accessories need to be removed to render the unit operational.

DONNING AND ACTIVATING

By the time a respirator is located and removed from its container, the user may be suffering from stress-induced degradation of mental and physical capabilities. Attaching straps, manipulating buckles and snaps or other mechanical devices, placing a breathing apparatus in the mouth, or making sure nose pieces are firmly in place can be difficult, and taking mental inventory to make sure a series of steps has been followed completely, and in proper order, can be extremely demanding, if not impossible.

Consequently, ILC Dover's SCape CO/CBRN³⁰ respirator has been designed to require only one step to achieve complete donning. The user simply opens the neck dam by spreading it out with the hands, similar to putting on a crewneck sweater, and then drawing it over the head. Once in place, the neck dam automatically adjusts to the

wearer, creating a tight, but comfortable, seal.

The SCape respirator uses an integral blower to provide air and keep the clear hood inflated. The blower is activated automatically when the unit is removed from its container, so no additional steps are required for activation once it is in place.

For a person using the SCape respirator, the difference between being exposed and being fully protected is a matter of pulling the unit from its container and slipping it over the head. That's it. There are no more steps involved.



ESCAPING TO SAFETY

While the most crucial step in any escape from an emergency event is finding and donning the protective gear, the ordeal is not over until the user has traveled to a safe location or has been rescued by first responders. Consequently, much of the design of any escape respirator must be keyed to making it as safe and easy as possible for the user to evacuate.

Here again, recognizing the circumstances and capabilities of the user is a critical step in choosing proper design.

DEFINING THE USER POPULATION AND THEIR LIMITS

While we often think of users of escape respirators as being well-trained workers in environments where the potential need for the respirator is firmly established, like chemical plants, pharmaceutical and biopharmaceutical manufacturing installations, nuclear power plants and the like, they are not the only possible users.

For local, state and federal governments, potential users may include civilian populations located near a chemical plant, large pharmaceutical or biopharmaceutical plant, nuclear power plant or weapons decommissioning facility. While not common in the U.S., in countries where the potential for widespread terror attacks is high and chemical weapons could be used, an entire population or large subset of the population may be supplied with escape respirators.

Design, therefore, must account for general health issues, physical infirmities, individual size and age, physical condition, and the unique challenges of the untrained user. It was precisely these conditions, with a very wide spread in all variables, for which the initial SCape CO/CBRN³⁰ respirators were developed.

One size fits all was a design goal that was achieved after much study and innovation in the neck dam design. In government testing, SCape respirators were proved to provide an effective seal and sufficient air for all subjects. Because one respirator fits everyone, inventory can be optimized for the purchasing authority or firm, and no user faces the risk of grabbing a respirator of the wrong size under stress.

Design versatility allows escape respirators to work for everyone. Because the SCape CO/CBRN³⁰ respirator seals against the neck and provides high-volume (64 L/min), positive-pressure airflow, it can accommodate beards, as well as a wide range of hairstyles that can be problematic for other respirator designs.

Powered air eliminates perceived breathing threats. Tests have shown that untrained persons may often feel a sense of panic in the face of a serious or life-threatening emergency. That panic can be enhanced by the use of a respirator and mask, and untrained users can become very sensitive to changes in normal respiratory patterns.



In fact, untrained users can interpret the additional breathing resistance caused by filters, valves and mouthpieces as the onset of suffocation caused by infusion of toxic contaminants. This can significantly increase anxiety — sometimes to the extent that wearers feel a compulsion to remove the mask.

This is particularly problematic in industrial applications where workers don't typically need respirators to perform their jobs and remain untrained in their use, and in civilian populations that can include elderly and infirm people who already suffer from breathing difficulty and who feel changes in breathing resistance quite keenly.

To minimize any hazards from perceived breathing difficulty, the SCape CO/CBRN³⁰ respirator uses a battery-operated blower to provide positive airflow inside the respirator hood. This design tends to eliminate nearly all feeling of breathing difficulty or sense of suffocation, which helps to reduce panic and allow the wearer to evacuate in a more orderly way.

The clear hood provides a wide field of view, aiding communication and calmness. During the 30 minutes that a user may be wearing an escape respirator and moving through a hostile environment, it is important that they be able to recognize others and that they have the best possible field of view, so they can plot an escape route and avoid falling or colliding with objects or debris.

Here again, the completely clear hood of the SCape respirator satisfies all design criteria for recognition and unobstructed field of view. In addition, the SCape respirator requires no mouthpiece, and no straps or pads that might inadvertently cover the ears, which facilitates two-way verbal communication.

Finally, the clear hood and positive-pressure airflow can help eliminate any feeling of claustrophobia, allowing the user to remain calmer during escape.

EVALUATING PROTECTION

No matter how ergonomically sound an escape respirator's design, its effectiveness in successfully saving a life in an emergency depends on its performance in filtering out toxic inhalants before they reach the wearer. To measure filtering performance, NIOSH has established a comprehensive standard for air-purifying escape respirators (APERs), with stipulation of a series of performance tests with challenges to the respirator by exposure to specific toxic agents.

All escape respirators sold in the United States must meet the NIOSH minimum filtering requirements. Through extensive testing, the SCape respirator has been proved to provide performance that far exceeds the NIOSH standards. For instance, NIOSH standards require a Laboratory Respiratory Protection Level (LRPL) of 2,000; that is, air inside the hood must contain only 1 part of any given contaminant for every 2,000 parts outside the hood. The SCape CO/CBRN³⁰ respirator, in all cases, achieves an LRPL of 50,000, as proven by a series of third-party tests. **That's performance 25 times better than NIOSH requirements.**

The SCape CO/CBRN³⁰ respirator is also the only 30-minute APER that is NIOSH-approved for carbon monoxide (CO) as well as CBRN use.

Detailed performance data for the SCape CO/CBRN³⁰ respirator appears below.

NIOSH TESTING: SYSTEM LEVEL AGENT (SMARTMAN)

TEST AGENT	CHALLENGE CONCENTRATION	SERVICE TIME
Mustard (HD)	Vapor — 50 mg/m ³	>30
Mustard (HD)	Liquid — 0.43–0.86 ml	>30
Sarin (GB)	Vapor — 210 mg/m ³	>30

NIOSH TESTING: CHEMICAL TEST AGENTS (FILTER GAS LIFE)

TEST AGENT	CHALLENGE CONCENTRATION, ppm <small>(64 L/min AT 25% AND 80% RH)</small>	ALLOWABLE BREAKTHROUGH, ppm	SERVICE TIME, min
Ammonia (NH ₃)	1,250	25	>30
Cyanogen Chloride (CK)	Liquid — 0.43–0.86 ml	2	>30
Cyclohexane (C ₆ H ₁₂)	1,300	10	>30
Formaldehyde (CH ₂ O)	250	10	>30
Hydrogen Cyanide (HCN)	470	10	>30
Hydrogen Sulfide (H ₂ S)	500/1,500*	30	>30
Nitrogen Dioxide (NO ₂)	100	1	>30
Phosgene (COCl ₂)	125	1.25	>30
Phosphine (PH ₃)	150	0.5	>30
Sulfur Dioxide (SO ₂)	750	5	>30

*1,500 ppm supplemental testing conducted on SCape® CO/CBRN³⁰ at AT labs

SCAPE® CO/CBRN³⁰ CARBON MONOXIDE (CO) 30-MINUTE DURATION PENETRATION PERFORMANCE

CO CHALLENGE CONCENTRATION, ppm	ALLOWABLE MAX. PEAK EXCURSION (DETECTED CO LEVELS), ppm	MEASURED MAX. PEAK EXCURSION (DETECTED CO LEVELS), ppm	ALLOWABLE MAX. CONCENTRATION TIME, ppm-min	MEASURED MAX. CONCENTRATION TIME, ppm-min
3,600	500	<200	12,075	<2,000

For more information about the SCape CO/CBRN³⁰ escape respirator and how its design might help protect your workers or citizens, email customer_service@ilcdover.com, or call +1.302.335.3911 or toll-free +1.800.631.9567 (US & CAN).



BEYOND BOUNDARIES™

Innovators at our core, we develop engineered solutions for our customers' complex problems. Recognized globally for our flexible containment solutions, ILC Dover serves customers in a diverse range of industries, including pharmaceutical and biopharmaceutical manufacturing, personal care, food and beverage, chemical, aerospace, healthcare and government agencies. At ILC Dover, quality is a culture, not a measurement. Our customers will tell you that we cater to their every need and that we're highly innovative, responsive, dedicated and competitive. We have been innovating since 1947. ILC Dover's visionary solutions improve efficiency, safeguard workers and product, and prevent disasters — proof that we are on the front line of business excellence.

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