

# SCSR Capacity

## Abstract

Many miners believe that their one-hour-rated self-contained self-rescuer (SCSR) will last them one hour in all circumstances. This is not the case, however, and this mistaken belief may lead to behavior that could endanger the lives of these miners in an emergency. For example, if they have used an SCSR escaping a mine after a fire or explosion and it took them only half an hour to escape, they may believe that they have another half-hour to go back in and look for a friend, a practice that is discouraged in any case. In reality, however, there is a certain quantity of oxygen in the SCSR which, if used at a rate greater than that used during certification tests, may last less than an hour. The faster the oxygen is used, the shorter the duration. So, if the miner is very heavy, or if he ran up-hill during his escape, he will not get another half-hour out of it and he risks running out of oxygen while in bad air. In addition, if the chemical reaction in chemical-oxygen apparatus is stopped for some period of time, perhaps 30 minutes or longer, the molten chemical solidifies and forms a barrier between the user and the unused chemical, possibly preventing the rest of the oxygen in the SCSR from being used. This paper will help miners understand what to expect from their SCSRs.

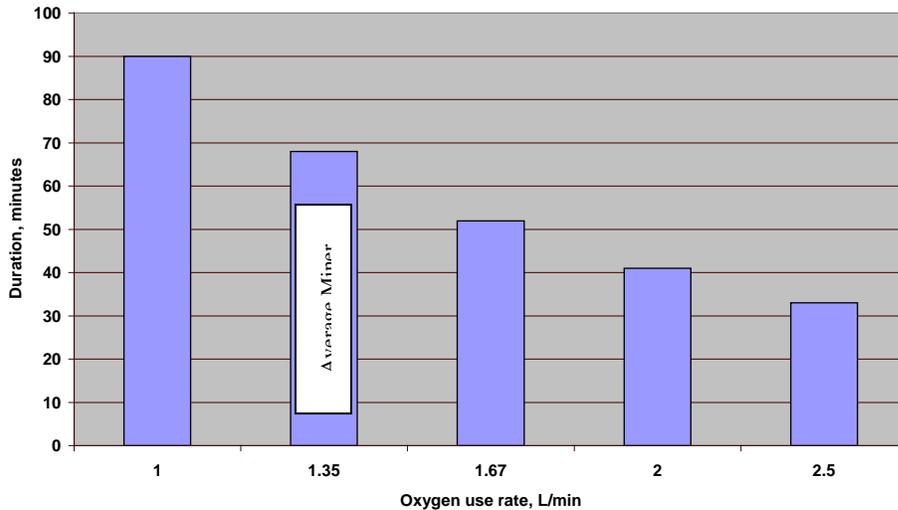
## Introduction

As of June 21, 1981, coal mine operators in the United States are required to make an SCSR certified for one hour of respiratory protection, as classified by NIOSH, available to each underground coal miner. The NIOSH one-hour capacity is based on a test on a human subject performing a standard set of exercises requiring approximately 80 liters of oxygen for an average-size miner. Classifying SCSRs by duration, however, is a misleading concept. A comparable example would be like classifying automobile fuel tanks by duration. All SCSRs contain a certain amount of oxygen, just like a car has a certain amount of gasoline in its fuel tank. In both cases, if you use the substance of the tank up faster, it won't last as long.

## First concept

*The faster you walk, the higher your oxygen use rate, the faster you will use up the oxygen in the SCSR, and the lower the duration you will get.*

Just as you will use up a tank of gasoline in a car faster if you drive at a higher speed, you will use up the oxygen in an SCSR faster if you run instead of walk. Figure 1 illustrates this concept for an SCSR containing 90 L of oxygen. The average oxygen use rate for the average miner (192 lb.) performing the one-hour NIOSH Man-Test 4 is 1.35 L/min. (The author, weighing 150 lb., uses 1.35 L/min walking 4.2 mph.) For example, a miner who uses 2 L/min of oxygen will get only about 40 min of duration from the SCSR.



**Figure 1: Duration vs. Oxygen Use Rate**

## Second concept

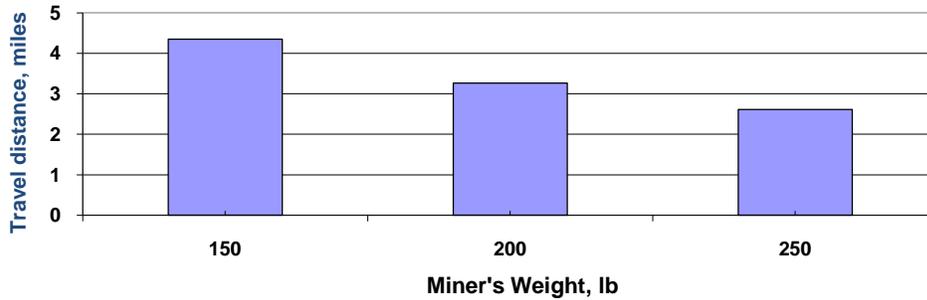
*Whether you travel fast or slow, your self-rescuer will take you the same distance.*

Consider the car and gasoline analogy with regard to gas mileage. The gas mileage for a particular model of car is given in miles per gallon. It tells you how far you can go on a gallon of gas. It says nothing about time. That number simply represents the distance per quantity of fuel. If you drive faster, you will use up the gas faster, but you will still go the same distance. The same applies to SCSRs. If you walk faster, you use oxygen at a faster rate and the SCSR will not last as long, but since you are moving faster, you will still go the same distance.

## Third concept

*The lighter you are, the further your self-rescuer will take you.*

Again, consider the car and gasoline analogy, this time with regard to car model. Some cars get better mileage than others. This is largely due to the weight of the car. Small, light cars usually get better gas mileage than large, heavy cars. The same principle applies to people using SCSRs. The less you weigh, the less oxygen it takes to move you a certain distance. If you give two people the same quantity of oxygen, the lighter person can usually go further along the same path because it takes more oxygen to move the heavier person a given distance. Therefore, a miner weighing 250 pounds, walking upright on level ground can travel about 2 ½ miles compared to a miner weighing 200 pounds who can travel slightly more than 3 miles. Figure 2 shows possible travel distances with 100 L of oxygen for three different body weights.

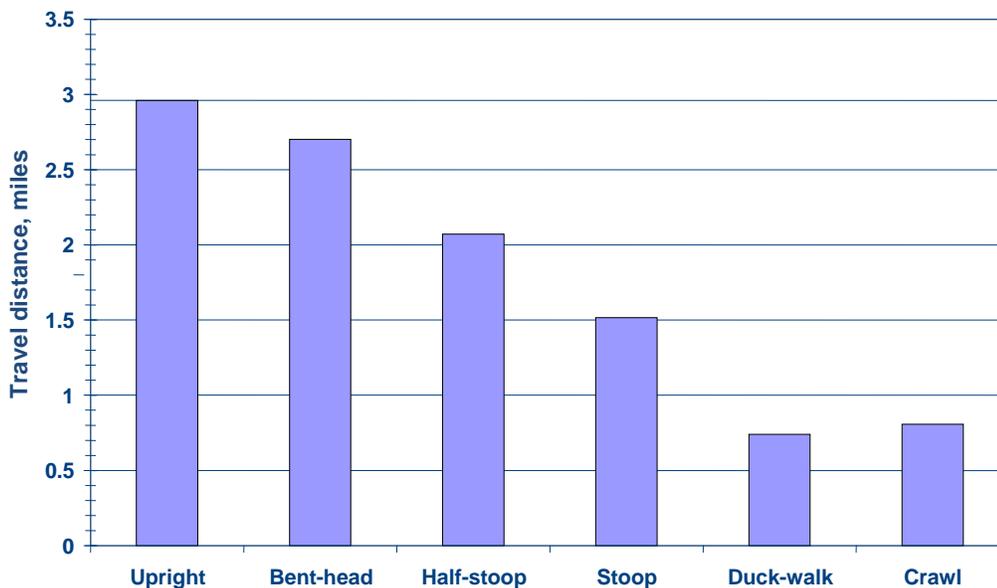


**Figure 2: Possible Travel Distance vs. User's Weight Upright walking, level ground, 100 L of Oxygen**

#### Fourth concept

*Your body posture also affects how far you can travel.*

There is no car and gasoline analogy for this concept, unfortunately. It is fairly intuitive, however. The more muscles you use, the more oxygen you need to supply those muscles in order to do work. Lying down requires less oxygen than sitting. Sitting requires less oxygen than standing. Standing upright requires less oxygen than bending over. And moving requires your muscles to do more work than just supporting your body. Upright walking is the most efficient mode of travel. If you can't walk fully erect, and must bend at the neck or at your waist, you are using other muscles which require more oxygen. Figure 3 shows travel distances on level ground with 100 L of oxygen for a 220-lb person in different body postures.

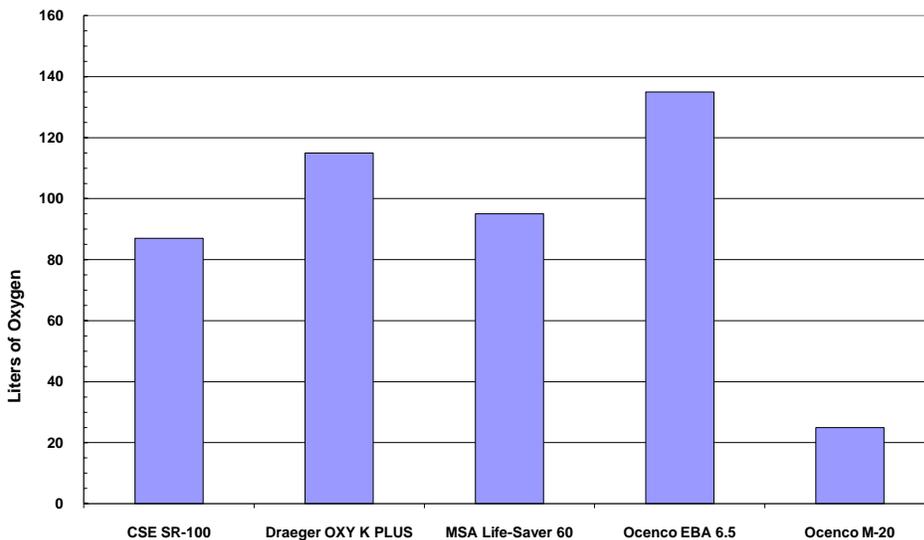


**Figure 3: Possible Travel Distance vs. Posture for 220-lb Person with 100 L of Oxygen on level ground**

## Fifth concept

*Different SCSRs contain different quantities of oxygen.*

All of the commercially available SCSRs have different quantities of oxygen. Figure 4 shows the actual amounts obtained on an automated breathing and metabolic simulator. As might be expected, the biggest and heaviest SCSR (Ocenco EBA 6.5) contains the greatest quantity of oxygen and the smallest and lightest SCSR (Ocenco M-20) contains the smallest quantity of oxygen. All of the devices are approved as 1-hour-rated self-contained self-rescuers, except the Ocenco M-20 which is a 10-minute-rated unit.



**Figure 4: Quantity of Usable Oxygen**

## Estimating oxygen need

Each miner should be assured that his SCSR can carry him to a point of safety in the event of a mine fire or explosion. The best way to ensure that everyone has enough oxygen is to have the heaviest miner don an apparatus and walk the escape route until it is empty. If it doesn't get him to a point of safety, the mine either needs to buy an apparatus with more oxygen, or place a cache of apparatus at a location prior to where he runs out of oxygen. It should be kept in mind that carrying extra equipment or someone else's body weight will increase your oxygen needs. Below is a rough guide to how much oxygen is needed by a 220-pound miner to travel a mile on level ground:

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Body Posture	Liters of oxygen needed for a 220-lb miner to travel one level mile
Upright walking	34
Bent-head walking	37
Half-stoop walking	48
Full-stoop walking	66
Duck-walking	135
Crawling	124

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## Summary

Don't assume that just because an SCSR is certified for a certain duration, it will last that long for everyone under any circumstance. Every SCSR contains a certain quantity of oxygen which your muscles use to transport your body. The distance that you can travel with that oxygen depends on your weight, your body posture, and the conditions along your escape route. Make sure that your SCSR will carry you all the way to safety.

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Department of Health and Human Services  
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National Institute for Occupational Safety and Health



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