Quick-Fill® System

Q&A

MSA

The Safety Company

For years, MSA has listened to the needs of the fire service. And we've responded - with personal protection products that set the pace for the entire industry.

One such product is the Quick-Fill System—a proven system that has revolutionized the Fire Service.

It started when MSA began studying the National Fire Protection Association's (NFPA) files on firefighter fatalities. Based on those statistics, we learned that of all the firefighters who died in the line of duty while wearing SCBA, two thirds might have been saved had they been able to "extend" their SCBA air supply—in short, get more air.

That's the premise behind the Quick-Fill System. It's an accessory for MSA Air Masks that can work as an Emergency Breathing System (what firefighters typically call "buddy-breathing). Or serve as a system for recharging SCBA cylinders under routine conditions, without having to remove the air mask and without having to change cylinders. It can even be used in atmospheres classified as IDLH (Immediately Dangerous to Life or Heath)

When a product as innovative and unique as the Quick-Fill System is introduced, questions concerning its use and limitations are certain to follow. It's only natural. For example, how does it work? Where can I use it? Has it been tested, etc.?

The purpose of this bulletin is to answer these and other questions, as well as to dispel some old myths regarding cylinder refilling methods. Although we believe this bulletin is complete, you may have other questions not addressed here. If so, please contact MSA customer service at 1-800-MSA-2222 or your authorized MSA Fire Service Distributor. They will be glad to answer any questions you have in addition to making arrangements for a product demonstration.

First introduced in 1987, the Quick-Fill System has proven itself time and again, with an untarnished record of performance. Undoubtedly, the Quick-Fill method of filling cylinders in the field, while they're worn, is an efficient, viable and proven procedure. It's a procedure that has become commonplace, changing forever, the way firefighters fight fires.

The Quick-Fill System is one more way that MSA has responded to the needs of the fire services. It's a product you'll use with confidence!

Can a firefighter wearing an Air Mask with a 4500 psig cylinder use the Quick-Fill System to transfill air to a fellow firefighter wearing an Air Mask equipped with a low-pressure 2216 psig cylinder?

Yes. The Quick-Fill quick-disconnect fittings are identical for both low-pressure (2216 psig) and high-pressure (4500 psig) air masks. This allows wearers of low- and high-pressure air masks to transfill air between each other. Additionally, the Quick-Fill Male Adapter Assembly is equipped with a special self-reseating relief valve that automatically vents at approximately 2500 psig. This relief valve is designed to prevent over pressurization from accidental over filling from a 4500 psig air source.

Can the Quick-Fill System be used with all MSA cylinders?

MSA has received NIOSH extensions of certifications for the use of Quick-Fill on its NIOSH-certified pressure-demand air masks using MSA carbon wrapped or fully-wound composite cylinders.

Quick-Fill can help "on the scene" of a fire. But, can I use it for routine cylinder filling back in the shop?

Yes. MSA offers a variety of Quick-Fill Hoses with standard CGA fittings or outlets on one end to facilitate connection to your cylinder filling station. If the Quick-Fill System is used in this manner, MSA recommends that the cylinder be allowed to "cool"until the pressure stabilizes, as with any routine filling method. The cylinder must then be "topped off" to ensure that it is fully pressurized prior to storage.

Does the unusually high pressure inside the Quick-Fill Hose make it rigid, or awkward to use?

No. Because of the flexibility of the materials used to construct Quick-Fill Hoses, they remain very pliable even under pressure.

Will the ends of a pressurized Quick-Fill Hose "whip"freely when disconnected?

No. The Quick-Fill fittings incorporate check valves which prevent air from escaping, and thus, the hose from "whipping" when disconnected.

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The Quick-Fill System

What is the basic concept of the Quick-Fill System?

The Quick-Fill System is simply a system that allows for the rapid transfer of air from a high-pressure source into a cylinder with less pressure. This transfer of air is based on one of the oldest and most fundamental laws of physics: Boyle's Gas Law. The law demonstrates that when two sources of gas at different pressures are connected together, they seek to equalize at the same pressure. For example, when an air cylinder pressurized to 2000 psig is connected to an air cylinder of the same size pressurized to 1000 psig, the two cylinders will quickly equalize at 1500 psig each.

Quick-Fill System Efficiency

How long does it take for two 30 minute-rated cylinders to equalize pressure, if one is empty and the other full, when using the EBS (3-foot) Quick-Fill Hose between two SCBA wearers?

Approximately 40 seconds, regardless if the cylinder is low-pressure (2216 psig) or high-pressure (4500 psig).

How long does it take to refill a low-pressure (2216 psig) 30-minute-rated cylinder from a cascade system or a compressor/reservoir pressurized to approximately 2300 psig using the Quick-Fill System?

Approximately 50 seconds.

How long does it take to refill high-pressure (4500 psig) cylinders from a compressor/ reservoir or cascade system pressurized to 4500 psig?

Approximately 45 seconds for 30-minute-rated cylinders and 60 seconds for 60-minute-rated cylinders.

The Quick-Fill System and Average Fill Rates

What is meant by average fill rate?

An average fill rate is the total pressure put into a cylinder divided by the amount of time (in minutes) it takes to reach that total pressure. For example, if it takes 45 seconds to fill a high-pressure (4500 psig) cylinder to 4500 psig, then the average fill rate is 6000 psi/minute. In practice, the speed of air transfer is actually faster than 6000 psi/minute at first and then slow to less than that as the cylinder becomes full. Hence, the fill rate averages at 6000 psi/minute.

What is the maximum average fill-rate allowed by the Quick-Fill System?

The MSA cylinder valve used on all MSA cylinders incorporates a restrictive orifice. This orifice allows a maximum average fill rate of 6000 psi/minute provided that the secondary air source used to fill the cylinder does not exceed 4500 psig.

Effects of Rapidly Filling MSA Cylinders:

Did MSA conduct a test program to determine the structural and thermal effects of rapidly filling MSA cylinders?

Yes. Over many years, MSA and our cylinder suppliers have jointly conducted an extensive testing and research program. This test program was specifically designed to determine the structural and thermal effects of rapidly filling cylinders using average fill rates up to 13,500 psi/minute–more than twice the maximum average fill rate that the Quick-Fill System allows.

The results of this testing and research program overwhelmingly concluded that MSA fully-wound composite cylinders could be filled using an average fill rate of 13,500 psi/minute without any adverse effects.

Based on these finding, and allowing a safety margin of over 2:1, MSA established a maximum average fill-rate recommendation of 6000 psi/minute for all MSA fully-wound composite and steel cylinders.

I thought cylinders had to be placed in a water tank during refilling. Aren't there federal regulations that require this?

No. The practice of placing cylinders in a water tank during normal refilling operations was started when steel cylinders were used predominantly. It was based on the premise that the heat generated from the rapid compression of air would be transmitted through the wall of the steel cylinder to the surrounding water. The dissipation of heat would then reduce the pressure loss as the cylinder air cooled.

For steel cylinders the practice has some merit, but is ineffective with regard to full-wound composite cylinders. Since the fiberglass over-wrap insulates the aluminum liner from the water, this practice has no beneficial effect on reducing internal cylinder temperature. Therefore, MSA does not recommend that cylinders be placed in a water tank during refilling.

Don't most SCBA manufacturers recommend a 300 psi/minute fill rate because higher fill rates could adversely affect air cylinders?

No. The 300 psi/minute fill rate recommendation currently made by most SCBA manufacturers, is not based on concerns that higher fill rates adversely affect air cylinders. The idea behind the very conservative 300 psi/minute fill rate recommendation is to minimize the heat build-up that results from the compression of air during cylinder refilling. This heat build-up forces the air inside the cylinder to expand, thus causing a higher pressure-gauge reading than the actual volume of air would produce at room temperature (70º F.).

Test data from millions of cylinder refills, combined with the fact that many fire departments for years have successfully used fill rates significantly higher than the 300 psi/minute recommendation, have clearly demonstrated that this recommendation is highly conservative and simply not applicable for today's professional firefighter–who may need to replenish his air supply quickly. A much higher fill rate is warranted, needed and certainly more in keeping with today's state-of-the-art technology.

Does the rise in cylinder air temperature/ pressure caused by the Quick-Fill System mean I won't have a "fully pressurized" cylinder?

Not necessarily. With the Quick-Fill System, as with any cylinder refilling method, there is a cooling effect that occurs after the cylinder is refilled, which causes a slight decrease in cylinder pressure. This actual pressure loss occurs at a rate of roughly 2 psi/minute. The rate is based on tests using a Composite II Cylinder at room temperature, a 6000 psi/minute average fill rate and inlet air having a temperature of 70º F. Therefore, when the Quick-Fill System is used at the scene of a fire, where firefighters typically use their cylinders within 30 minutes after refilling, the pressure loss is not discernible.

If however, the Quick-Fill System is used for routine filling operations, MSA recommends the cylinder be allowed to "cool" until the pressure stabilizes. At this point, the cylinder must then be "topped off" to ensure that it's fully pressurized prior to storage. This, of course, is a standard operating procedure with any refilling method.

Doesn't the cylinder liner and air get extremely hot when you use the Quick-Fill System?

No. The temperature of the liner and air may rise a maximum or 46º F., according to our extensive test program, conducted with cylinder manufacturers. This was determined by installing numerous thermocouples along the exterior wall of a production cylinder liner, prior to wrapping that liner with high-strength fiberglass filaments. To achieve the highest temperature increase possible, we used a 60-minute-rated cylinder which has the highest pressure (4500 psig) and the greatest volume. In short, a cylinder that requires the longest filling time. Starting at room temperature (70º F.) for both the cylinder and the inlet air, and using an average fill rate of 6000 psi/minute, the hottest point measured was 116º F. at the bottom of the cylinder–a maximum temperature increase of 46º F.

As long as the temperature of air going into the cylinder, or the temperature of the cylinder liner itself, does not exceed approximately 200º F. (both of which are extremely unlikely), this rise in temperature is not enough to affect the structural integrity of the cylinder.

Doesn't the Quick-Fill System exert tremendous pressure on the cylinder liner, thus making it risky to refill the cylinder on my back?

No. The internal pressure on the cylinder wall during refilling, whether using an average fill rate of 300 psi/minute or 6000 psi/minute (which the Quick-Fill system uses), is no greater than the total stress on the cylinder when fully charged. In other words, there is no greater stress exerted during the filling process than when a fully-charged cylinder is worn, as millions of wearers have safely done over the past five decades.

Does the rapid filling of MSA cylinders weaken the structure of the cylinder over time?

No. Our joint research and testing program concluded that there are no adverse effects on the structural integrity of MSA fully-wound composite cylinders due to rapid filling.

This is further demonstrated by the extensive quality assurance testing that cylinder manufacturers have conducted on MSA cylinders for nearly 15 years.

As part of this on-going test program, a cylinder manufacturer pressurizes production samples of MSA cylinders using a rapid pressurization cycling system similar to the Quick-Fill System. These tests are preformed to meet the required Department of Transportation (DOT) qualification tests. During the 15 year period, over 1,100 MSA cylinders have been rapidly pressurized over 10,000 times each, from 0 psig to their working pressures of 4500 or 2216 psig. What's more, each of these cylinders were pressurized at a fill rate far exceeding 13,500 psi/minute. None of these cylinders exhibited any structural degradation due to the rapid-fill method.

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Corporate Headquarters
P.O. Box 426, Pittsburgh, PA 15230 USA
Phone 412-967-3000
www.MSAFire.com

Fire Customer Service
Phone 1-877-MSA-FIRE
Fax 1-800-967-0398

MSA Canada
Phone 416-620-4225
Fax 416-620-9697

MSA Mexico
Phone 52-55 21 22 5770
Fax 52-55 5359 4330

MSA International
Phone 412-967-3354
Fax 412-967-3451

Offices and representatives worldwide
For further information:

MSA
The Safety Company