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A Demonstrator's Guide to Gas Masks and Goggles
Everything You Need to Know to Protect Your Eyes and
Lungs from Gas and Projectiles
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A Demonstrator's Guide to Gas Masks and Goggles

Everything You Need to Know to Protect Your Eyes and Lungs from Gas and Projectiles

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September 2, 2020

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One of the basic ways that police maintain violent control of our society is by interfering with our ability to breathe—and sometimes with our ability to see. Nowadays, regardless of whether you employ confrontational tactics, you could be exposed to tear gas or hit by a rubber bullet just by being is in the vicinity of a protest. By taking the proper precautions, we can mitigate the risks while continuing to show up for each other. This guide explores a wide range of options for protecting your eyes and lungs from chemical agents and projectiles, detailing the advantages and disadvantages of each, so you can pick out what's best for you.

This is the second in a series of guides exploring how demonstrators can protect themselves. The contributors have spent countless hours gathering experience, data, and anecdotes to prepare this series—including carrying out impact testing on various masks and goggles. We will be updating this document on an ongoing basis as more information comes in. If you can offer suggestions or corrections, please contact us.

The previous installment in this series details how to choose a proper helmet.

Executive Summary

The best respirator is the one you have access to. Respirators are good at what they do—filtering air—and most of them will serve you well enough in a pinch. If you don't have time to

read the entire text and you need to get some gear in a hurry, here are some options:

The No-Compromise Expensive Option ($260–340)

If you want a new high-quality full-face mask that will work in the apocalypse, the MIRA CM-6M costs $220–240. The 7M is similar, but has a more “tactical” look. You can purchase this mask with two MIRA-brand CBRN cartridges for $50 each; otherwise, filters will cost $70 apiece.

This is all you need. If you don’t want to use $100 worth of filters at a single demonstration, however, leave the CBRNs in their packaging at home (or skip buying them entirely) and get two expired-but-unopened CBRN filters for roughly $20 each via ebay.com. These should work for tear gas and pepper spray, but not for apocalypse-level threats. Each filter should work for approximately eight solid hours of full chemical exposure, which could mean 30–40 hours in the street during demonstrations that involve a lot of tear gas. You should change the filter as soon as you begin to smell gas leaking through.

If you wear glasses, this mask is compatible with the 3M Safety 6878 Spectacle Kit designed for their 6800 mask. You will need to get prescription lenses for that.

The Cheaper Full-Face Protection Option ($40–150)

Civilian style full-face respirators such as the 3M brand 6800 ($150 with filters, using the same ones from the modular option below) offer protection for a much cheaper price. In our impact

it’s presumably uncomfortable, and we have not yet received word from this person as to how it has served in the thick of chemical weapons. If anyone else has experience with this method, please let us know.

Our number one recommendation so far is the **Pyramex V2G Plus.** These are less than $20, ballistic rated, and use dual-lens thermal anti-fogging—one of the more reliable anti-fogging measures. There is a prescription insert available for those who wear glasses. These goggles are indirectly vented, however, so you'll have to seal them with hot glue or tape. The only potential problem is that the two-lens thermal system makes it harder to adequately seal. There is a thin layer of foam between the lenses, allowing moisture to pass through, and if you live in a humid environment, you might trap moisture between the lenses permanently.

Another option is the **Pyramex Capstone.** These goggles are less than $20 and ballistic-rated. They use regular hydrophobic anti-fogging. Like the **V2G Plus,** they are indirectly vented, so you need to seal them.

SolidWork Safety Goggles are slightly more expensive, $30 or so. They use a large rubber seal and seem more capable of sealing securely to your face. These are also indirectly vented, so you will need to seal them.

There are many, many more goggles that can work, and something is almost always better than nothing.

Workarounds

One person we spoke with wears swim goggles under vented ballistic goggles. The swim goggles provide a good seal despite being paired with a half-mask respirator. This approach could also work for those who own prescription swim goggles or are willing to buy a pair. It's more to carry,

testing, we've also found that the JJKK and HAOX brand Chinese imports ($40, with filters) serve just as well to protect your eyes and offer an adequate seal against gas.

The Cheaper and Modular Option ($75)

If you want an affordable option that offers the best combination of ballistic resistance and chemical weapons protection, get a 3M half-mask respirator from the 6000 series for $25. The 6100 is the small, the 6200 is the medium, and the 6300 is the large. Attach a pair of 60926 cartridges ($35 for the pair). If the mask comes with 60921 or 60923 cartridges, you don't need the 60926 cartridges. In addition, get a pair of Pyramex V2G Plus goggles for $15 and seal the vents on them with hot glue. If you wear glasses, get the RX insert and prescription lenses.

The biggest downside of pairing a half-mask with goggles, however, is that it's hard to maintain a good seal between the two, as the goggles and the mask compete for the same real estate on your nose.

The Gambler's Choice ($60)

A surplus Russian PMK-3 will be less than 20 years old. If you can find a version that comes with the full kit, it has ballistic outsert[1] lenses and an adaptor for attaching it to the more common NATO-threaded filter system. Surplus masks are always

[1] Most military gas masks can be equipped with ballistic "outserts" that attach to the outside of the lenses—without these outserts, the lenses are not rated for ballistic impact.

hit-or-miss; we have not found specific documentation on the ballistic rating of the outsert lenses yet.

If you want to double down on your gambling, a Russian PMK-2 can be as cheap as $25, though it could be 30 years old. The PMK-2 can come with ballistic outserts and an expired filter that ought to work for a while—but it will be difficult to replace the filter and who knows what condition the mask itself will be in. The cheapest of these masks ship directly from Russia with a fairly lengthy transit time.

Live Dangerously (Cheap)

Most of the time, you don't get shot in the face with a rubber bullet or a tear gas canister. None of the people who contributed to this guide have been shot in the face yet. Tear gas drives everyone back who isn't protected, whereas impact munitions only kill or blind people every once in a while. Lots of people are getting shot in the face, though. It isn't safe to be on the receiving end of police violence.

We can only recommend eyewear that has impact-rated plastic. But if you don't have access to it and you have to go out anyway, you need either a full-face gas mask (army surplus or otherwise) or a half-mask and goggles. Make sure your filters are either military-style (expired or not) or rated to handle both organic vapors and P100 particulate filtration. Make sure your goggles are sealed as best as you can. Make sure it all stays tight to your face.

Good luck. Don't blame us if anything bad happens—we told you not to.

higher on the nose, labeled Asian-Fit goggles. We are currently looking for Asian-Fit goggles that meet the standards we've outlined, but the ballistic pairs we've found so far use foam as the seal. If anyone has suggestions, please let us know.

Some Common Goggles We *Don't* Recommend

Work glasses: Some work glasses with ballistic lenses also come with straps to turn them into goggles. All three of the models of this style that we've researched do not really form a seal around the eyes.

Fire goggles: Fire goggles are designed for wilderness firefighters, but tend to make use of thick open cell foam for ventilation. This is intended to filter smoke, but not tear gas.

Swim goggles: Swim goggles offer the advantage of being small and providing a good seal, so they pair well with half-mask respirators. However, it is hard to find impact-resistant swim goggles and it's worth considering the potential problem of suction.

Ski goggles: Most ski goggles use open cell foam, rather than rubber, to form a seal. As mentioned above, open cell foam can absorb chemicals

Some Specific Goggles You Could Try

None of the authors have tested the following goggles against tear gas or police munitions, though at least one of us has handled and worn each type. These recommendations are based on a mixture of research and conversation.

- Fill with 40% dawn, 50% baby shampoo, and 10% warm water.
- Mix thoroughly.

Finally, treat your goggles/mask:

- Wash your hands well
- Spray solution on the inside of the mask/goggles
- Scrub lenses and frame with clean fingers
- Let sit for 30 seconds
- Rinse briefly with warm water, making sure to leave a light layer of solution on the lenses, and let it dry.
- If it stings your eyes when you put the goggles on, use less Dawn and more water in your next batch.
- Repeat before every action.

Visors

It is also possible to gain impact protection from a visor mounted to a tactical helmet. This is covered in greater detail in our guide to helmets.

Asian-Fit Goggles

Many people of Asian descent find that goggles do not contour well to their faces. Manufacturers make goggles that sit

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If you want to improve on something you already have access to, or if you have different tactical needs than we've outlined above, read on.

Protect Your Lungs, Protect Your Eyes

We are addressing two distinct goals here: protecting your lungs and protecting your eyes. You protect your lungs with respirators that filter chemicals out of the air. You protect your eyes with goggles, glasses, or visors—whether they are independent of your respirator or combined with it in one full-face system.

Protect Your Lungs: Respirators

A respirator—technically, an APR (air-providing respirator)—is a device that filters the air you breathe before you breathe it.[2] There are several classes of respirators or gas masks, including two that we're going to pass over completely: SCBA

[2] If you look at the hazardous chemical specifications of various chemicals, you'll notice that they list certain "protection factors" that are necessary to interact with them. The National Institute for Occupational Safety and Health (NIOSH) rates various types of respirators according to protection factor. SCBA masks are rated at 10,000, PAPRs are rated at 50–100, full-face APRs are rated at 50, half-mask APRs are rated at 10, and disposable APRs are rated at 5.

(self-contained breathing apparatus), which come with oxygen supplies and are used by divers and some emergency personnel, and PAPRs (powered air-providing respirators) that force air through filters via electrical power. We're going to focus on full-face respirators, half-mask respirators, and, to a lesser degree, disposable respirators. We'll also discuss impromptu air filtration and the current speculation about DIY respirators.

We'll look at two general, non-technical categories of respirators: military/tactical respirators and civilian/workplace respirators.

Military Respirators (Gas Masks)

Military and tactical respirators are chiefly used by the military and militarized police forces around the world. These are all full-face respirators—what you picture when you hear the term "gas mask." Almost all of them use the same kind of filter: a threaded 40mm filter that is NATO-standard, sometimes referred to as a STANAG filter. Current-issue US military (and presumably law enforcement) masks use a proprietary bayonet mount[3] instead that is self-sealing, making it easier to change filters in the field.

These gas masks are often rated for a full range of threats from chemical weapons to nuclear fallout. Newer military models often include features such as speech diaphragms that make it easier to talk, multiple ports for filters that allow maximum airflow and enable you to swap out filters without

[3] The bayonet mount is the same model by which lenses attach to cameras: three tabs fit into three slots, then you twist it into place to lock it down.

prevent fog, while others use baby shampoo (not adult shampoo, which would irritate the wearer's eyes). We consulted an anarchist long-distance swimmer who reports that baby shampoo has been effective for hours at a time in the ocean, while saliva seems to last from 10 to 45 minutes at the very most.

Comrades in Portland have submitted the following anti-fog recipe, which we have not personally tested.

> Materials: Toothpaste/baking soda, water, Dawn anti-grease dish soap, Johnson & Johnson baby shamboo, spray bottle (other brands of similar quality can be used).
>
> If your lenses have an anti-fog coating, wash them with water and a soft rag and let dry. If your goggles *do not* come with an anti-fog coating:
>
> - Wash your hands well.
> - Use a non-whitening and non-gel toothpaste, or baking soda and water. Spread it over the entire lens and the skirt inside the goggles/ mask.
> - Use your fingers or a soft-bristled brush to scrub the lens, then rinse it thoroughly with water.
> - Repeat this step again if your goggles get dirty, oily, or greasy.
>
> Next, mix your anti-fog solution:
>
> - Use a clean spray bottle

you breath it in, while ensuring that exhaled air escapes the valve immediately. Vented goggles—which we don't use—also rely on fresh air to fight fog. Sealed goggles present a disadvantage.

The second most effective anti-fog measure is to use "thermal lenses" or "dual lenses." These goggles employ a dual pane system of lenses with an air gap in between, creating a thermal break (insulation, essentially) that reduces condensation on the lenses.

Finally, the most common anti-fog measure is a hydrophobic surface on the inside of the goggles. Most goggles that say they are "anti-fog" use this method, which consists of a thin layer of oil over the inside of the lens. Oil is hydrophobic, so moisture beads up and falls. The chief weakness of most of these anti-fog coatings is that they eventually wear out, especially if the lenses are washed with soap. Some manufacturers claim that their anti-fog coatings are chemically bonded to the plastic and do not degrade, but we have yet to test their claims ourselves.

One researcher for this article lives in a region where humidity hovers around 80–90% all summer. In these conditions, relying on a regular hydrophobic anti-fog coating is far from adequate, even when using vented goggles; the goggles fog up very quickly. By contrast, indirectly vented thermal goggles can be worn for hours without fogging up. The difference between the two methods is significant.

Anti-fog sprays are available and reasonably cheap, though DIY solutions are just as common. Many swimmers swear by using saliva as a thin coating on the inside of their goggles to

removing the mask, and water systems that can be hooked up to a canteen or water bladder. Most models in use (currently or previously) by armed forces can accept ballistic lens or visor outserts that clip onto the outside of the lens or visor. You're going to want these if they are available for your mask. Military gas masks can be purchased for quite a lot of money new, or outrageously cheap on the surplus market. New military or tactical masks start at $200+ and most are in the $500 range. Some worthwhile surplus ones can be found for $30–100.

The surplus market for gas masks is notoriously hit or miss, and things are often mislabeled. Some, such as some of the old Russian gas masks, can be dangerous: some use glass eyepieces instead of impact resistant plastic, while others might come with expired cartridges that contain asbestos.[4] Below, we will list some common surplus models and discuss whether they meet the needs of modern demonstrators. Yellowed lenses can be fixed, but decayed rubber seals cannot. Older plastic lenses are substantially less impact resistant—in our impact testing, we shattered the lenses of an Israeli gas mask with nothing more than a BB. Surplus masks can range from $30–500 depending on the rarity or usefulness of the mask. Good-enough masks (minus ballistic rating) seem to be consistently available for $80–120.

[4] Realistically, this is only a danger if you manage to find an 80-year-old filter from an Eastern bloc country.

Civilian Respirators

Civilian/workplace respirators come in both half-mask and full-face styles. They are manufactured by a number of companies, many of which use their own proprietary filter attachment systems. We will be focusing on the masks made by 3M because they are the most plentiful and because some other companies employ their “bayonet”-style mounting system for filters (which they call “cartridges”). If you already have a mask with a proprietary filter system, such as the ones made by Honeywell or MSA, make sure your filters are rated to OV and P100 protection. Some of the low-priced Chinese models flooding the US market in response to COVID-19 seem to have their own filter systems, while the ones we’ve tested use 3M’s bayonet system. These cheaper masks could enable you to save money, especially if you are buying them in bulk.

If you are using a mask with a proprietary system, read on to the filter section to identify which filters will work for you.

The half-face COVID-19 masks that are made of cloth but include exhale valves and replaceable carbon filters are unlikely to be much use against chemical weapons. They likely don’t protect people around you from viruses, either, since they don’t filter on the exhale.

We have not been able to find any civilian-style full-face respirators with visors that meet ballistic impact standards (discussed below in the “Protect Your Eyes” section), but the 3M models and some others are rated for general impact resistance and seem to use the same plastic as ballistic-rated masks do, based on our initial impact weapons testing. One

resistant” standard, ANSI Z87.1+, is only 150 fps. We shot goggles at 630 and 840 fps and found no difference between the two standards.

Some manufacturers brag about the standards they meet on their sales pages, but failing that, it can be a lot of work to work out what gear is rated for ballistic impact, especially regarding older equipment like surplus masks. Fortunately, ANSI rated gear has Z87.1+ stamped somewhere onto the frame.

We cannot say for certain which standards are necessary to protect against which particular threats, because these standards were designed with workplace hazards (in civilian models) and shrapnel (in military models) in mind, not impact munitions. We spoke with engineers who suggested that testing is more important than the application of abstract math, since the angle of impact, distance, wear and tear on the plastic, and shape of the visor are all significant factors in determining what will and won’t break a specific piece of plastic. Regardless, wearing impact-resistant eye protection will greatly reduce potential damage to your eye, face, or skull, even if it does break on impact.

Anti-Fog

Glasses and goggles fog up, particular in humid environments. Foggy goggles are annoying—and in a protest situation, potentially dangerous. Manufacturers (and protesters) employ three basic anti-fog measures.

First, and most effective, is airflow. Full-face respirators that are designed to fight fog direct fresh air across the visor before

plastic, the tape might keep the pieces from splintering dangerously, a premise based on the way automobile glass breaks. To test this theory, we taped just one lens on several pairs of goggles and one respirator with Gorilla tape—the strongest clear tape we could find—and shot them with pellets. The areas that were taped had worse penetration, presumably because the tape trapped the pellet and prevented it from bouncing away. Yet pellets are not a particularly realistic threat at demonstrations. So we shot a few with rubber pellets from a 12-gauge shotgun. One shattered, but more safely than those that were untaped, while one did not shatter at all when we fully expected that it would. This is not conclusive research, but it's possible that tape might help.

Impact Standards

The plastic (usually polycarbonate) lenses of respirators, goggles, and glasses are rated to various standards of impact resistance. In the US, civilian goggles can be rated to the ANSI Z87.1+ standard, while military and tactical gear is rated to MIL-PRF-31013 or another MIL ballistic standard; in Europe, EN168A (or, slightly less great, EN168B). Presumably, there are comparable standards in other parts of the world.

Impact standards are generally established by shooting a small steel BB at the glasses, goggles, protective visor, or gas mask at various rates of speed. To qualify for the standard, the lenses must not break or detach from the frame. Most "ballistic" ratings require the lens to survive projectiles striking at a velocity of at least 500 feet per second (fps). The main "impact

street medic we spoke with prefers to wear a 3M 6800 full-face respirator on the grounds that its civilian styling puts patients at ease more readily than a military look would. Full-face civilian respirators range around $60–70 for generic imports and up to $150–200 for name-brand items. Half-masks are substantially cheaper—as little as $8 for generics and $30 for a name brand.

3M manufactures three different models of both half-mask and full-face respirators. Any of them are adequate to our purposes, though some people we've talked to find a better seal with the slightly more advanced silicone facemasks. It's probable that the 7500 series are the best half-mask respirators for our purposes and the FF-400 series is the best civilian full-face respirator for our purposes. The FF-400 series comes equipped with a speaking diaphragm, so your voice will be less muffled.

Each of the 3M models comes in three sizes, but "medium" will fit 80–90% of people and the sizes overlap with each other. To some degree, sizing is more important for comfort than efficacy.

For $15, you can buy an adaptor to shift from 40mm threaded filters to bayonet filters or vice versa—so don't limit your choice of masks based on what filters are available alone.

Appendix: 3M Respirators—A Taxonomy

Half-mask models

—6000 series [basic]:

- 6100: small

- 6200: medium
- 6300: large

—6500 series [silicone rubber]:

- 6501: small
- 6502: medium
- 6503: large

—7500 series [silicone rubber and better breathability]:

- 7501: small
- 7502: medium
- 7503: large

Full-face models

—6000 series [basic]:

- 6700: small
- 6800: medium
- 6900: large

—FF-400 series [more advanced]:

- FF-401: small
- FF-402: medium
- FF-403: large

its your selection of available glasses, goggles, and gas masks, ballistic-lensed eyewear can still be found cheap if you know where to look. Admittedly, in our experience testing different styles of goggles against various impacts, we have yet to find any noticeable difference between the performance of those that are rated only to the civilian impact resistance rating (ANSI Z87.1+) and those that are rated against the higher standard mil-spec (PRF-31013). We also obtained the same results testing one pair that was unrated but was advertised as “shatterproof.” While our experiments are ongoing, our current hypothesis that most shatterproof, impact resistant, and ballistic plastic lenses are constructed in the same way. Still, the higher testing standard also tests whether the entire goggle stays together during impact, even if it breaks.

In any case, some level of impact resistance is vital. Anecdotally, we spoke with a protestor in Puerto Rico whose eye was saved when a large splinter of wood embedded itself in their ballistic goggles after police munitions shattered a nearby tree. While ballistic goggles are not rated to take direct fire from firearms—and we cannot promise that they will protect you from every possible impact munition—their rating exceeds the force projected by pepper balls or even baton rounds. On YouTube, you can see people shoot ballistic goggles with birdshot from a shotgun without breaking the goggles.

We tested unrated lab safety goggles for comparison. They shattered dangerously at impacts that didn’t even dent shatterproof lenses.

Some people have been using clear tape to reinforce their goggles and gas masks, hoping that if a munition breaks the

We speculate that some do-it-yourself methods of sealing vented goggles could mitigate the dangers of suction, as the DIY sealing would likely fail upon impact, normalizing the air pressure. If this is true, DIY sealed goggles could be safer than fully-sealed goggles.

Protestors have been employing at least two strategies to seal the vents on vented goggles—hot glue and duct tape (ideally applied to both the inside and outside of the vents). Hot glue is far preferable, as most tape loses adhesiveness as it gets wet. Fabric-based tapes do not seem to provide enough of a seal, while plastic-backed tapes trap moisture, which loosens the glue, causing it to fall off. Use tape only in an emergency. Even hot glue can sometimes work itself loose.

We haven't tested other glues or epoxies. There are likely additional methods besides hot glue and tape.

Ballistics

Unfortunately, in addition to spraying us with chemicals, the police also shoot impact munitions at us. While every impact munition in production is specifically designated not to be shot at anyone's face, police officers routinely shoot them at our faces. Police have inflicted severe eye injuries on dozens of people in the US in 2020 alone, and many of the victims have permanently lost their vision. Some of them were wearing safety glasses when they were hit, too.

It's probably safest to find eye protection that is rated to offer "ballistic" protection, rather than simply the "impact resistance" designed to mitigate workplace hazards. While this lim-

—7000 series [substantially more expensive]:

- 7800S-S: small
- 7800S-M: medium
- 7800S-L: large

Fitting a Respirator

Whether you are wearing a half-mask or full-face respirator, it is important to check the fit *every time you put it on.* To do this, start by blocking the cartridges with your hands and breathing in. You should create negative pressure in the mask, with no air seeping in. Then put your hand over the exit valve and breath out. It should create positive pressure in the mask, with no air escaping. When it comes to performing this test, some masks are easier than others; with civilian masks, it can be difficult to use your hand to block the filters effectively.

Some workplaces test fit by putting something that smells strongly—like ground coffee—or some kind of mild irritant under the wearer's nose to see how they react.

Respirators are not designed to fit over beards, though people with beards have learned that if you coat your beard and the rubber seal with an awful lot of Vaseline, it will form a seal. This seal is hardly permanent, and it appears that CS powder is fat-soluble, so it might mix painfully with Vaseline the way

it does with skin moisturizers and makeup. A doctor we consulted argued that a chemical burn at your beard is probably better than getting chemicals in your eyes. Regardless, shaving your beard is the safest option. Even a few days of stubble might be a problem, necessitating Vaseline or shaving.

We spoke with one person who does not want to shave their beard; they simply accept that the air will be a little bit "spicy" and still find their mask to be very useful even without a proper seal. We cannot recommend this, but it may be relevant to your own cost-benefit analysis.

It is difficult to source gas masks for children. They exist, but they are not produced in the same quantity. MIRA, the only supplier we were able to find that stocks them was sold out at the time of writing. Sometimes you can find Israeli surplus masks for children, as well. MIRA also makes a gas mask carrying bag that enables the user to safely transport infants or pets.

The biggest disadvantage to pairing a half-mask respirator with goggles is that it becomes hard to get a proper seal on both at the same time. This is especially true with larger masks and larger goggles. The second biggest disadvantage is that it doesn't protect all the skin of your face from chemicals, and chemical weapons burn on your skin as well as in your eyes or lungs.

vents air to the inside. Open-celled foam is a bad idea for situations involving police repression because it absorbs chemicals. The other two means by which goggles form a seal against your face are rubber and close-celled foam. We have not tested the practical difference between those two methods. Our speculation is that rubber seals, like the seals on gas masks, offer better protection against chemical weapons and would get less contaminated, while closed cell foam might protect against the problem of suction.

What problem of suction? The idea is that, if goggles are attached to your face in a sealed manner (especially through suction, like swim goggles), if something hits those goggles, first, positive pressure might damage your eye, then, if air escapes, negative pressure could also damage your eye. Worst-case scenario, this could permanently blind you. We've looked into this a little bit, and talked to an anarchist doctor, and the general consensus regarding whether this is a real risk is… "maybe." Some studies have shown swim goggles causing bruising and some eye damage, and it seems likely—though we have not confirmed this—that this explains why swim goggles are not permitted in full-contact water sports like water polo. It's also possible this is why we've had such a hard time finding fully-sealed ballistic goggles available for sale. Of course, as the aforementioned doctor pointed out, if you get shot in the eye with a projectile, it's better to have the problem of suction than the problem of the projectile hitting your eye. Also, we have yet to find any evidence of ballistic impact causing problems with suction.

One veteran told us that when he was in the army, when he distributed gas masks to civilians in the countries that the army was occupying, his unit told those who wore glasses to cut the stems of the glasses off just long enough to fit inside the rubber gasket of the mask (or goggles) and then glue them into place. Hot glue might work. We'll experiment and edit this text with our findings.

Another style of "universal" prescription insert is a glasses frame with the stems bent down to fit inside the seal of the gas mask.

Prescription inserts can be filled by taking them to an optometrist or by mailing them to some places online.

Sealed Eyewear

Goggles come in three major classes: fully-vented, indirectly vented, and non-vented (sometimes called "sealed"). Fully-vented goggles offer the best protection from fog; they are used for a lot of sports. For most purposes, indirectly-vented goggles offer the best of both worlds: the vents allow enough air in to keep the goggles from fogging, yet the vents are inaccessible enough that they are reasonably safe from chemical splashes and things like sawdust. Unfortunately, they let in tear gas, so they're not ideal for protests. You want fully sealed goggles. Sealed goggles rely solely on chemical treatments and the thermo-conductive properties of the lenses to fight fog, which are not always sufficient.

Be careful: sometimes goggles are listed as "sealed" yet use an open-cell foam for their seal, with the idea that the foam itself

Filters

You need to make sure your filter is rated for both oil-based particulate matter (P100 filtration) and organic vapor.

If you have a NATO-threaded military mask: For a 40mm threaded NATO cartridge, you need *either* a CS/CN/P100 filter, which can be difficult to come by as a civilian but seems to be what is commonly issued to police, or a CBRN filter, which is more commonly available but also more expensive. A CBRN filter is overkill for demonstrations, as it is designed to protect against chemical, biological, radiological, and nuclear threats. Fortunately, expired-but-unopened CBRN filters should do the job and are much cheaper.

If you have a 3M mask, you need either 60921, 60923, or 60926 filters.

If you have something else, read on.

If it is likely that you are going to be exposed to riot control agents, you want your mask to filter two things: airborne particulates and organic vapors.

Particulate filters in the USA are rated by how oil-resistant they are—N are (N)ot, R are somewhat oil (R)esistant, and P are oil (P)roof—and what percent of airborne particulates they filter out—95%, 99%, or 99.97% (called 100). This explains the name of the N95, the mask commonly worn to protect against COVID-19. You're looking for P100, the highest level of protection. These aren't substantially more expensive and there seems to be little reason to use any other particulate filter, unless your particular mask setup only allows access to N95, which is still substantially better than nothing. The Euro-

pean standard does not rate for oil resistance, only particulate filtration: P1 masks filter at least 80% of particles; P2 masks filter at least 94% of particles; P3 masks filter at least 99.95% of particles.

While all of the common tear gasses and pepper sprays are comprised of particulate matter rather than gasses or vapors, the airborne particulates themselves can release organic vapors. You need the particulate filter (generally made of fiberglass paper) to stop the particulates, followed by an organic vapor barrier (generally a bed of activated charcoal). The NIOSH certification for organic vapor protection is “OV”—look for this on your filter or its documentation. Some other OV irritants include pesticides, solvents, and paint fumes, all of which masks often reference in their sales information.

We’ve seen guides for protestors based on front-line experience that claim only OV filtration is necessary. We’ve seen other guides that claim only P100 is necessary. Most seem to agree it is the combination that is necessary, but we suspect that one alone would do in a pinch.

Particulate filters do not become less effective at filtering out particulates over time. Rather, it is necessary to replace them when they become so clogged that they cause difficulty breathing.

Organic vapor barriers *do* become less effective over time with use, as the charcoal becomes saturated. Both heat and humidity reduce the effective lifespan of charcoal filters. Heat causes the charcoal to separate, while water vapor can saturate the charcoal and prevent it from absorbing active agents. You should replace your organic vapor filter as soon as you can

For Those Who Wear Glasses

If you wear corrective lenses, do not wear contacts into a situation in which you might be exposed to chemical weapons. Wear glasses. Some who prefer to wear corrective lenses but don’t absolutely need them have found it simplest to take their glasses off when it’s time to put on their ballistic and/or chemical-proof goggles. Others don’t have that choice. There are options available for those who wear glasses, though this consideration does limit your choices and increase the cost of eye protection.

There are OTG (over-the-glasses) goggles, but we have yet to find a pair that seals adequately. Most use foam sealing, which is not airtight. Some comrades we’ve heard from just accept that their goggles will not be perfectly tight.

Most prescription goggles, including those made by sportsRX, are not ballistic-rated. We’ve found only one model of ballistic prescription goggle—the Wiley X SG-1. It’s unclear how much of a seal they establish around the eyes, however, and they are nearly $300 a pair. There are probably better options.

Many cheaper ballistic glasses, including the Pyramex V2G, can be outfitted with prescription inserts. The V2G, like almost every pair of ballistic goggles we’ve found, are not sealed against chemical weapons, but that can likely be addressed with tape or glue, as we discuss below. Most full-face respirators can be outfitted with prescription inserts as well. Protestors have been creating their own glasses inserts in gas masks, often using tape or suction cups.

But the long-term effects of tear gas can be significant, so it's important to be protected. We don't need more martyrs—we need more people who can continue to live and fight.

In some places and times, the police use a lot of tear gas and other chemical weapons. In other places and times, they use kettling tactics or impact munitions. As with all decisions about what you need to be safe and effective, consider the specifics of your terrain.

Protecting Your Eyes

It's also important to protect our eyes— both from chemical weapons and from impact munitions. This generally involves an impact-rated full-face respirator or a pair of goggles paired with a half-mask respirator. The goggles should be rated for ballistic impact (or at least impact resistant), fully sealed (without open-cell foam), and anti-fog. Unfortunately, all three of these aspects work against each other; it is rare to find goggles that meet all of these requirements at once. In some cases, you might have to seal up the vents on your goggles yourself.

We've heard a few other suggestions worth considering, such as wearing a ballistic-rated visor attached to a tactical helmet over regular, non-ballistic sealed goggles. Demonstrators have sometimes worn masks from baseball and other sports, but many of the projectiles police use can fit through the wide grating such masks employ.

smell chemicals leaking through the filters into the mask from outside. Unopened-but-expired filters are generally considered usable—for organic vapors and particulates only—if they were vacuum-sealed, but if humidity was able to reach the charcoal, they are probably ruined. Multiple comrades who are military veterans told us that the military uses expired filters all the time for the tear gas chamber without any problems. In any case, use expired filters at your own risk.

NATO-Threaded Filters

With 40mm threaded filters, you need "CS/CN/P100" filters at the minimum. AVON, Honeywell, and MSA make versions of these, but they can be hard to source as a civilian—especially amid a pandemic. If you're going for overkill, get a CBRN filter—basically, a single filter that protects against almost any potential threat. MIRA Safety makes a high-quality filter of this kind; 3M also makes them. Be careful buying CBRN filters off of ebay or the surplus market: many are "new" in that they have not been used or opened, but were manufactured decades ago. Look for the manufacturing date, or roll the dice and buy cheap expired ones. Don't trust these for anything but riot control agents.

For all masks, you need at least one filter. Some masks can optionally take two or even three at a time in order to increase airflow, an advantage for situations that might involve running or other strenuous exercise.

3M Bayonet Filters

3M masks and their clones use a three-prong bayonet style filter attachment. Some other proprietary attachment systems are similar but not interchangeable with 3M, but 3M are the most common. If you use these, you'll likely end up with 3M-brand filters/cartridges, though clones of both the masks and cartridges exist. Note that 3M distinguishes between cartridges (the part that absorbs gasses and is usually made of activated charcoal treated with various chemicals) and filters (the part that blocks particulate matter). Make sure you get both. You can do this by buying separate cartridges and filters as well as the adaptors that connect them together, or by buying combination cartridges that come with filters pre-installed. Obviously, the latter is simpler.

Hats off to comrades in Hong Kong who have done the work to figure out what cartridges and filters you need, as they lack easy access to the combination cartridges. We've heard that they are not available in the UK either.

If you want a combination cartridge, your options include the 60921 (organic vapor + P100), 60923 (organic vapor and acid gas + P100), or 60926 (multi-gas + P100). As this goes to press, these are all about $15–20 each on ebay. You need two, and they usually come in pairs.

If you want to build your own, whether because you already have stock available or because you live somewhere without access to the 6092x filters described above, start by buying a set of cartridges—the 6001 (organic vapor), 6003 (organic vapor and acid gas), or 6006 (multi-gas). Next, purchase one of

Do-It-Yourself Masks

It's possible to make DIY gas masks. While we have not tested them ourselves, YouTubers have, and report some success. The idea is to fashion DIY filters out of activated charcoal (to filter organic vapors) and cotton (to filter particulates). These can be attached to anything from repurposed two-liter bottles to SCBA masks. If anyone has experience testing these, please let us know.

Of course, a poorly-made mask might be worse than useless.

A Final Note on Masks

In most situations, you don't need a perfect gas mask to participate in a protest. Even if you are gassed, often all you need is something that can protect you long enough for you to get to the gas canister and deactivate it or throw it back. You don't need to have all the right gear to go out and try to change the world.

To put it differently: changing the world is never going to be completely safe. No mask will make it safe.

Wearing a respirator can be uncomfortable, particularly in the heat, as sweat rolls down your face and the mask digs into your nose. Tight straps can give you a headache. Some masks limit your vision or your ability to communicate. Respirators make you more identifiable: even if everyone is wearing a mask, they might not be wearing the same kind of mask you are.

sources say that because CS adheres to water, a wet bandanna will only make it worse, but others, including people who have actually been exposed to the stuff, say that the wet bandanna diminishes the number of particulates that can reach your airways. It's possible that a wet bandanna will become saturated sooner—but it will be saturated with all the stuff that would otherwise have been in your lungs, and that's a good thing.

For decades, protestors have argued about whether the wet bandanna should be soaked in vinegar, lemon juice, or some other acidic solution. This has not been studied in a laboratory, and the mechanism by which it would work is not clear. However, people have been doing this for a long time, and those who practice it report noticing a difference. A 2009 Pentagon-funded report did mention that a bandanna soaked in lemon juice could mitigate the effects of tear gas.

Comrades in Portland report that some people are using the larger sneeze-guard-style facemasks common in COVID-19 protection and pulling their hoods up, probably with the drawstrings brought in tight around the face. Of course, this is not a perfect seal. One user reported that it delayed the effects of tear gas until after many unmasked people had been compelled to leave the area, that it made it difficult to talk with people, and that the facemask was too large to easily conceal on the way to and from the demonstration.

the various P100 filters, which come in two styles. Some, like the 2091, have their own bayonet connectors, as they are intended for mounting directly onto respirators. Other filters are simple pads, such as the 5p71—which is only a P95 filter and therefore not advised (though we have not tested a P95 ourselves). If you choose a bayonet-connecting filter, you need a 502, which is an adaptor that snaps onto the cartridge and provides a bayonet mount. If you choose a pad filter, you need a 501, which is an adaptor that snaps onto the cartridge and holds the filter directly.

3M marks their P100 cartridges by making them neon pink. Some people have expressed concern about this making the user identifiable, as it violates the all-black black bloc aesthetic—although if enough people are using pink filters, it will be somewhat less of a problem.

Replacing Filters

Studies have shown that under stress, even trained soldiers struggle to replace filters while holding their breath. The current US military model mask, the Avon M50, has self-sealing bayonet-mounted filters that enable the operator to change one filter at a time while continuing to breathe through the other.

Most masks you have access to will not have this feature. To change filters, you'll probably have to hold your breath or exit the impacted area.

A comrade in Portland reported that they prefer the 3M cartridges with separate particulate filters (6001 cartridges with attachable P100 filters) because the P100 filters can be swapped

out without taking the mask off, relying briefly on the cartridge alone for filtration.

Another comrade says that they have been using the same gas mask cartridge (a military-style 40mm one) since 2011 and have never tasted spicy air through it. This supports the theory that most of the important filtration is being done by the particulate filter, which is never used up, only clogged.

Others, in Portland, report that they their filters are lasting about 30–40 hours each.

Some surplus masks employ “cheek” filters located inside the mask. Changing these filters is a laborious process, and some YouTubers have found it’s easy to rip the rubber of the mask while doing so if the mask is old. Still, one person we spoke with prefers these masks, having seen police grab people by the external filters of other masks, since cheek filters do not present an easy handle for grabbing.

Cleaning and Storing

You should clean your respirator after each time it is exposed to chemical weapons. 3M sells a product for this: “504 Respirator Cleaning Wipes.” These are affordable, but likely unnecessary. What they contain is a trade secret. Most people just use soap and water, to good effect. Don’t soak your filters in water, just wipe down the outside with soap and water. Then remove the filters and store them in a ziploc bag or other airproof container so they do not absorb moisture from the air.

the 4A1 has round eye-holes instead of the odd-shaped ones used on the M15. The manufacturer, Shalon Chemical Industries, claims that the plastic lenses are impact resistant, and they don’t appear to be sold with ballistic outserts yet are used by a modern military force. We have not been able to determine if they are rated at a ballistic level, and all plastic lenses degrade with time and UV exposure. These two masks appear to be the most affordable, readily-available, fully-featured surplus gas masks. The 4A1 is the only mask we have impact tested so far—and the lenses shattered easily upon light impact—but we are not sure the age of the mask, as we bought it surplus.

What the Police Use

Police use a mix-and-match array of gear because they source it from military surplus and various funding agencies. As far as we can tell, the two most common masks are the Avon C50 (though it’s possible that the federal police are using the M50 military version instead) and the MSA Advantage 1000 (or its military-grade equivalent, the MSA Millennium). The C50s are often seen equipped with the Avon mask comms unit, which gives them their distinctive mouthpiece. Witnesses have reported seeing police in Portland wearing Honeywell North full-face respirators, presumably the 7600 series.

Impromptu Masks

A bandanna, ideally wet, will filter out enough tear gear to get you out of a situation. This is better than nothing. Some

produces protective outserts for the lenses, but we have not been able to determine their impact rating.

The US Air Force and Navy has used the MCU-2P since the 1970s; any surplus option might be from any year in that range. They range from $150 to $300 on ebay. You can learn how to identify models and years here. While some documentation claims the MCU-2P visor is ballistic, a specific ballistic outsert is available for around $75. This implies that the visor alone is not ballistic.

The Russian PMK-3 (used from 2000 until recently, available for $70) and PMK-4 (in use since 2017, much more expensive) can make use of ballistic outserts as well, which often come with the full kit. Also included in the full kit is an adaptor to connect their proprietary filter system to the NATO-threaded system. The PMK-2 is even cheaper—around $30—and often comes with ballistic lenses, but can only use the 40mm-GOST filter system (used by Warsaw Pact countries).

A National Geographic filmmaker was wearing a Czech M10 (a clone of the US M17) iin Portland, Oregon in July 2020 when federal agents shot him in the face with a .68" round from an FN303 air gun, shattering the plastic lens of his mask and severely damaging his eye. Both of these masks can optionally be used with ballistic outserts, which the filmmaker did not have. These are the two models of mask we've found that use cheek filters, discussed above.

The Israeli M15 is used by the Israeli Defense Forces and its civilian model, the 4A1, is distributed to Israeli citizens. Both are affordable on the surplus market. Most are simply labeled for sale as M15 masks, but you can tell the difference because

A Note on COVID-19

Unlike cloth and surgical masks, respirators do not protect the people around you from your germs. However, much more so than cloth or surgical masks, they *do* protect you from the germs around you. One protestor reported wearing a cloth mask over the exhalation valve in order to block droplets for the sake of other demonstrators.

Visors and Lenses

Full-face masks either use full-face visors or individual lenses over the eyes. Lenses are more common in military models, while visors are more common in civilian models. A full visor offers much better visibility. It's possible that it is harder to make a full visor more impact resistant, although we've found both ballistic and non-ballistic examples of both types.

A mask with lenses can be more convenient for those who are going to be using the optics of a long weapon (like a scope, red dot, or iron sights on a rifle or grenade launcher), as it permits one to shoulder the weapon better to get what is called a cheek weld and view down the barrel more clearly. Of course, this is not generally useful to demonstrators. All in all, a full-face visor seems preferable.

Off-Brand Civilian Masks

We will continue researching off-brand masks, most of which are from China. Some are rated as impact resistant;

some use commonly available filter styles. So far, we have tried the JJKK and HAOX models. Both form an adequate seal against our faces in fit testing, though we have not taken them out into tear gas yet. Both have impact-resistant visors that performed identically to the American brand 3M when we shot them with various impact munitions—which is to say, they performed well. It's been suggested that purchasers should buy from BangGood or Amazon rather than Ali Express, Baidu, or eBay for these types of masks because the quality control is slightly better. A few comrades dealt with a nightmare with a mask order early on in the pandemic as a result of poor quality control.

It might conceivably be possible to work directly with manufacturers to produce masks to your specifications, or at least to purchase them in bulk. Ambitious groups could consider trying to do this for their city or region.

Surplus Masks

Surplus military masks are another cheap option for full-face gas masks. They can be hard to source reliably, as many retailers (or else distributors serving retailers) lie about dates and potentially about features. This is also true for filters, and especially true on ebay. Both the rubber used for the seal and the plastic used for lenses and visors degrade over time, particularly when exposed to sunlight; both in our experience with testing and in anecdotes gathered from the street, they seem to be notoriously prone to breaking. Most surplus masks come in three sizes—small, medium, and large (generally numbered 1,

2, and 3, respectively, with the number displayed in the rubber of the mask)—but often, you cannot choose the size of mask when you purchase it online. Whatever mask you get, make sure it seals tightly to your face. Even a low-quality or wrong-sized mask will protect you as long as it seals to your face and is supplied with an adequate filter.

If you can get a model number and a country of origin, you can cross-reference seller claims with online military gear sites.

Tracking down the ballistic rating of the lenses and visors has been challenging. It would be very useful to identify a surplus mask that accepts 40mm NATO-threaded filters and includes ballistic lenses or visors (usually as a separate outsert). For those willing to forgo ballistic-rated lenses or visors, surplus masks are often the best option.

The primary current US military model is the Avon M50; it can be found for $250. While we generally don't recommend masks that use proprietary filters, the M50 filters are reasonably cheap (currently $50 for a pair) and, as previously mentioned, you can swap them out in the field without exposing yourself to gas. Ballistic outserts are available cheaply for this mask as well; we found one for $20. The C50 model is the civilian model of the same mask, though it is used extensively by law enforcement.. The main difference is that it accepts 40mm NATO filters. For better or worse—usually worse—wearing this mask will make you look quite a bit like a soldier or a cop.

The Avon M40, which the US military used from 1986 to 2009, accommodates ballistic outsert lenses but does not come with ballistic lenses otherwise. 3M produces a civilian clone called the FR-M40 that is identical in every way. 3M also