Self-Rescuers

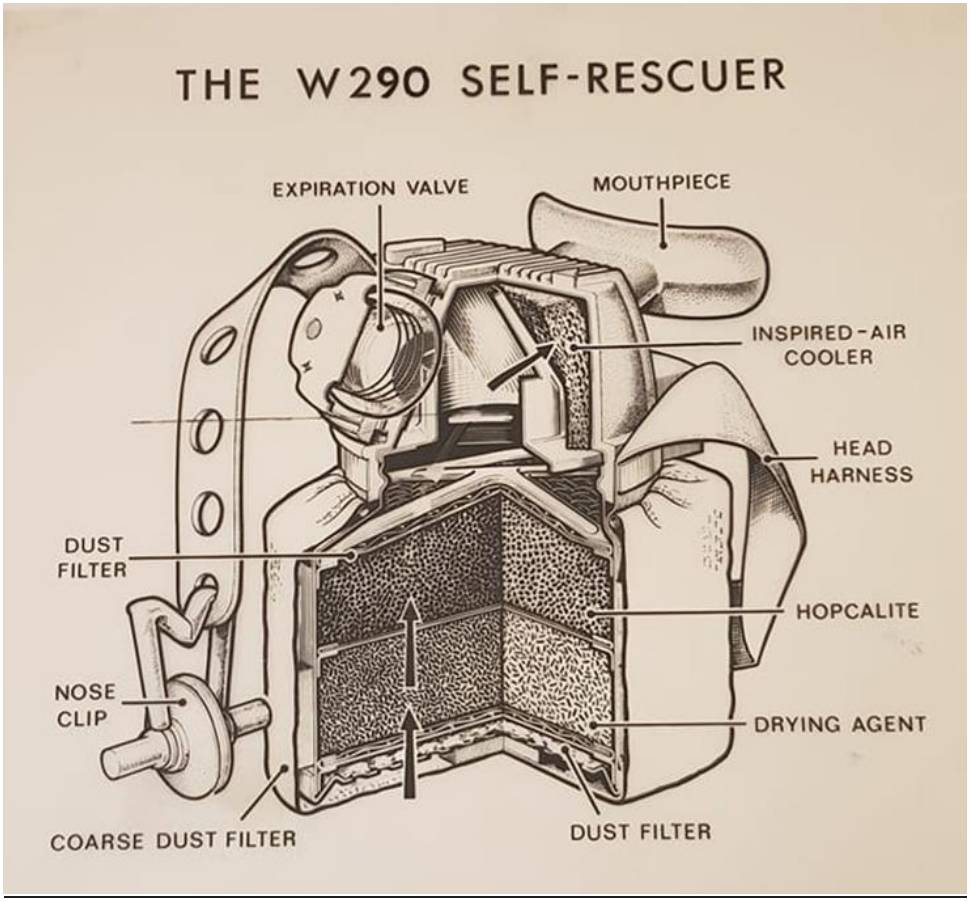
compiled by Roger Gosling with assistance from Les Riley and Rob Vernon

This article, compiled from various sources (see list of references at end) was published in March 2021 in the SGMRG newsletter 60.

Introduction

After a mining explosion, most miners are **NOT** killed by the blast or by fire, but generally by 'Afterdamp' (mainly carbon monoxide, and small percentages of other gases) and smoke. All self-rescuers are designed to counter the effects of carbon monoxide and smoke, usually in the case of fire underground. Carbon monoxide can rapidly kill in concentrations as low as 0.1%. Most versions will not protect against methane and some other gases. The earlier versions work using *activated carbon* as the drying agent (lower right in diagram below) and *hopcalite* to convert carbon monoxide to carbon dioxide. In use the breathed gases become quite hot and it is not uncommon for users to have burned/blistered lips and chins but of course they are still alive. The fact that the air gets hot should be reassuring to the user, as it shows the unit is operating as designed.

The self-rescuer is contained in a steel case; once opened, the unit is activated. The mouthpiece is immediately fitted snugly around the miner's mouth and the nose clip fitted to his nose. The miner then has to breathe steadily through the device, the *hopcalite* converting toxic carbon monoxide to carbon dioxide. The other main components are shown below.



Cut-away diagram of a typical type of self-rescuer

Despite a check of various patent databases, the original Patent for the self-rescuer has not been found. Leaflets produced by the Mine Safety Appliance Company (MSA) suggest that it may have originated in Germany. In the United Kingdom the self-rescuer, in the form shown above, made its appearance around 1960. The design may have been the result of collaboration between the British National Coal Board and MSA.
They were not just used in the Coal Industry; they had wider application. Rob Vernon recollects visiting a show mine in East Germany in 1989. The mine had worked the Mansfeld Copper Shales, and Rob was bemused by the fact that

there were boxes of self-rescuers for visitors to use in an emergency that were located at each end of a long underground train ride, rather than issued to each visitor!

Hopcalite is a mixture mainly consisting of oxides of copper and manganese and is based on research in 1918. It acts as a catalyst to oxidise the carbon monoxide (CO) to carbon dioxide (CO_2) using the oxygen in the air. This will, depending on the level of ventilation, increase the percentage of CO_2; as the level of this increases, asphyxiation will occur at levels between 5% and 10%. This makes them ineffective in some cases, so there is a need for a different type of oxygen-source. The later and largest device works in a similar way to a *catalytic converter* using more valuable materials (noble metals) and is a very effective source of oxygen. These run cooler than the hopcalite types. The cost of the self-rescuers is very much reflected in their size which can be from a few £100 to over £2,000 (today's prices).

The SGMRG Self-rescuers

In *Newsletter* 58 (pp7-9) we noted some donations to the SGMRG, including two self-rescuers from Philip Pegler, a retired sewer worker. Photo below shows two self-rescuers that were donated, alongside a smaller one as more usually used in current mines, including in 'show mines' and other enclosed spaces where poisonous gases can occur.

Three different sizes of self-rescuers (The smallest one is pasted in, as we do not (yet) have one that size).
Sizes and weights are approx.:

- *smallest: 10 x 7½ x 6cm (4 x 3 x 2½in), less than 2lb (1kg)*
- *mid-size: 19 x 18 x 11cm (7½ x 7 x 4in), 4lb (2kg)*
- *largest: 22.5 x 17 x 11cm (9 x 7 x 4in), 6½lb (3kg)*

The smallest one is relatively lightweight and, when used in mining, is normally worn on a belt. If you visit one of the UK 'show mines' you will need to wear one of these. The mid-size one is sometimes worn on a belt depending on the job the miner is doing and how far away from an exit. The largest is more often placed in a strategic position to be picked up in the event of an emergency. They were manufactured by the Mine Safety Appliances Company Limited - MSA (Britain) Ltd.

Philip told us the two the SGMRG now have were used in the sewerage industry, where obviously there could sometimes be needed to save a worker's life. The larger size and weight is not so much of a problem when walking along a sewer!

Historically, the first, smallest, ones date from the 1960s; the larger ones are later developments and are used around the world in many different types of mines. One of the initial designs was the MSA W265 which was designed to give protection for about an hour. Some of the larger and later types could give up to four hours, but are significantly heavier and more bulky. A common size used is for 90 minutes. How long each will actually be effective for depends on the exact specification and how fast and deeply the miner breathes.

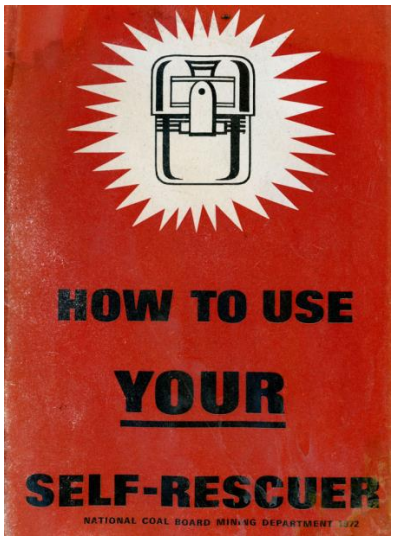
The mid-size one is marked as made to EU specification cє 0158. This is a very broad-based specification for many types of rescue and safety equipment, not specifically for self-rescuers.

Yet another type, known as an oxygen self-rescuer, is designed for use in oxygen-deficient atmospheres. In this, the carbon dioxide and water vapour in exhaled air reacts with *potassium hyperoxide*, in a closed-circuit and produces oxygen. So in this way the oxygen is regenerated.

One of our two is thought to be a training model. The other may be 'live', so it could start working if we opened it. The larger one was made in June 1993 (last serviced in June 2001, so is almost certainly a training unit) and the smaller cє 0158 one made in March 2002. This is now date expired as the shelf life is normally 15 years or alternatively 10 years in use.

All these self-rescuers are contained in a well designed, carefully sealed metal container, normally stainless steel. When the need arises, the miner will open the self-rescuer (normally by pulling on a tab, red on the smallest one) and quickly place the mouthpiece over their mouth, the nose clip over the nose, then breathe as calmly as possible, whilst exiting the mine by a safe route. It is important to keep the nose clip on.

We don't know if there an easy way to tell which of our two is which without opening them and so possibly setting them off. Obviously that is not a good idea due to their age and their contents. Also, both could possibly be live. They could be useful to explain to visitors on our occasional open days (post-COVID) how a self-rescuer works.



NCB Instruction leaflet from the 1960s

Earlier this year I watched a brilliant Zoom talk by Les Riley about iron ore mining near Scunthorpe, north Lincolnshire. This was primarily about Santon and Dragonby stratified iron ore mines. Worked from 1938 to 1981, by British Steel then Corus, now owned by Tata, these mines supplied Scunthorpe's steel works. I asked Les if they used self-rescuers in these mines; I found the answer quite interesting…

Due to local authority edict, upon closure it was not possible to completely abandon the mine. Instead, it is 'mothballed' with requirements for 'care and maintenance' to maintain underground stability even though it is highly unlikely it will ever work again. Les was the former mine manager involved in this work. Nowadays, due to current legislation, they carry self-rescuers (currently W65-2 type). Les said they would only ever be really needed if they were caught in a dead-end passage with a Land-Rover on fire on the way out - not a very likely scenario. However, when the mine was working the miners didn't wear self-rescuers initially but they were introduced later. They were of the W265 type filter rescuers. There would always be a safe way out to avoid any problem areas once you got away from the immediate problem area. Of course, in those days there was a lot of machinery of all kinds, a fire of diesel, leaking overheated oil or an electrical cause would all have been possible. The mine was free of methane and naturally damp/wet with very little timber used, so fires from those hazards were not encountered.

More about Santon & Dragonby can be found at
https://www.28dayslater.co.uk/threads/dragonby-mine-lincs-july-2017.109589/
and
https://en.wikipedia.org/wiki/Scunthorpe_Steelworks

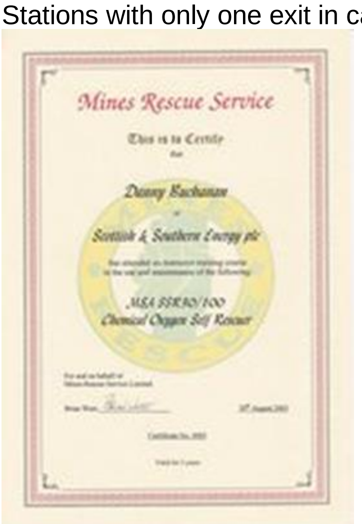
Les also commented:

> *'Current regulations are that the W65-2 rescuers (and similar) all have to be checked for damage by the user daily. Then checked by an approved person every 3 months and also weighed and this recorded. If the weight changes (heavier) it is likely that there is some damage that has allowed air into the unit and started reacting with the chemicals inside. The drying agent gets heavier as it absorbs water vapour from the air. The unit would be removed from service and scrapped. It is not economic to repair them. The units have a 5 year service life but only if the above checks are carried out and recorded.*
>
> *The life may be extended by examination to destruction of 10% of the mine's units at the manufacturers every year after that but in practice that is too expensive for most mines and for small operations the 10% is not enough units for analysis to be meaningful.*
>
> *Self-rescuers have their date of manufacture etched on the base together with their initial service weight. The current price of W65-2 units* is around £450. This has risen considerably since all the large collieries have closed and the market shrunk.'

Comments from some miners

The first set is from a query of mine on the Facebook page **'Coal Mining Memories UK'.** I included the photo of the three different sizes along with my request for comments. Some of these have been edited a little to improve readability. A selection from the multiple responses are below. It seems that the smaller units were standard kit and most coal miners in the UK had them.

RH: The red release one was used in mines - 60 minutes life span. Later replaced by a much longer version lasting 90 minutes if my memory serves me right.
TB: I wore the middle one in South African coal mines, big and bulky.
AH: The right hand one is an oxygen supply. A Maltby heading got evacuated when everybody was inbye, and on walking out at least one showed signs of being on fire. They were in the heading due to high volumes and concentrations of oil from the roof and were too heavy to carry all day. The one on the left was the day to day rescuer.
SW: The smaller self-rescuer just converts carbon monoxide into carbon dioxide. The middle one I'm sure generates oxygen for about 30 minutes use, the larger one would give a longer use time I think. The salt mine at Winsford used the middle one.
NH: The middle one is an oxygen one we had to wear one in a district that had the possibility of a benzine inrush. They were kept on a rack at the head end and we had to carry it as well as our own self-rescuer.
IM: The middle one we used in South Africa as they reckoned that the British one was not up to scratch
PL: Pleased I never had to use one other than under the desk in the training room
AJ: The self-rescuer on the left was common in NCB up 80s, still using then in Bangladesh. The other two generate oxygen and I've seen both in South Africa
DB: The middle one looks like an MSA SSR30/100 and these self-rescuers protect you against toxic contaminants using chemically generated oxygen. An in-built canister in the SSR 30/100 contains potassium hyperoxide (KO_2), which reacts with any exhaled air. This means carbon dioxide is retained and oxygen is released into the breathing bag. It will provide you with 30 minutes breathing air depending on work rate. SSE use them in underground Power Stations with only one exit in case of fire blocking the exit.



SSE Training Certificate

DB: EN401 is the European standard that rescuers are/were manufactured to and the 30 is the time that the rescuer will comply with the standard when in use. (Note that the maximum carbon dioxide content in self-contained self-rescuer operation, under the European Standard EN401-1993 (Chemical Oxygen Escape Apparatus), is limited to a maximum of 3% or 30,000 ppm (and to an average of 1.5%).
AR: The right side ones, had to put one on at the start of a heading with a 16 total man power allowed board, plus you kept the one that you came down the pit with. They would not last long so half way up the heading was a station in the side with a rack of 16. Walk by that to the job and walk by them on the way out and hang the big one back on the rack, but if anything happened while inbye you were protected
NW: Worth noting the size mismatch on the photos. The UK bean can one is about a third of the size of the others. I am familiar with all of them. They are used in the mines here in Australia. There are some even bigger ones 90 mins duration that were stored in caches at the face ends.

More recently another person asked about experiences using self-rescuers on the Facebook page **'Britains Collieries And Pit Disasters'** and a selection of comments are below:
LG: in 20 years underground I was lucky enough to never have to wear one.
MJ B: Lindsay Utd Gallagher no way would I have walked a mile + up a 4-1 drift wearing one of those 😁
MJB: I don't think anyone would like to walk up a drift with one on. But, thank God I never had to use one.
GC: used to make us retrain on these every few years that was bad enough would have hated to use it for real.
JB: Only used in training; that was bad enough. Especially towards the end.

MT: Horrible masks burnt your mouth only used once while training once was enough.
AC: Used twice for real. Horrible.
JL: The first time I can remember taking a training class was at Womwell Main.
TW: Completed my rescuer training only 6 months ago at Aberpergwm 👍
DW: Sure do. Hated 'em in fire practice.
BB: Glad I never had to use one for real.
BW: Used once for real, thankfully never again - only in refresher training ☺
IH: Used to break seal so you could go out early.
PD: The w95 supposedly lasted 4 hours - we still train annually with them.
DO: Thoresby colliery self-rescuer training through pipes, doors, low-workings etc. Absolute bitch when the recycler started getting hot due to use. It burned your chin.
GC: yep sure did and the back of ta throat.
NF: There are still some in use at Gypsum mines etc. and hundreds of unused ones in store. I had to wear mine along with the other shift members and we had to walk out of the mine at Barrow on Soar when I worked for British Gypsum. It was 2,500 metres up a 1 in 6 gradient and bloody hard work. So much for self-rescuer training but everybody had to do it. My last s/rescuer training was at Bagworth colliery as they wouldn't let me U/G without it.
ML: Wore one in anger once! Not very pleasant but a real life saver I suppose.
BR: when, the 9' fire?
ML: Yes me, Otto, his brother Neil had to walk out down the 9' return drift.
TT: Wore one once worked well and got me out of the smoke filled tunnel.
BR: The sequence, started introducing the 30 minute W265 in 1969 after many accident reports on fire and explosions recommended them, but in particular Michael fire. I think Cresswell too but will check on that. Then became the W275 1 hour version, they were £40 each.
Around 1976 became the W290 90 minute with longer opening lever after the Cardigan explosion where guys with burned fingers couldn't open them.
The W95 is a different animal, it uses noble metals to do the CO_2 / CO conversion , stays cooler, lasts UPTO 4 hours in 1% CO, guess what, they went back to the short lever 😳. They are over £900 each now.
It runs in conjunction with the activated carbon / hopcalite W65 90 minute unit, short lever again. £600.
All the MSA units above have a 10 year life.
Some places are using the Polish Faser POG8m 1 hour version, 3 year life, looks almost identical and costs £70 😂
KS: Thank God I never had to use mine, in training they were the most uncomfortable thing I ever knew. I would have hated ever to try running or dashing with that mouthpiece and a vice on your nose.
DJD: I hated it, couldn't stand it in my mouth and sitting on me chin, I used to retch all the time it was on.
DJ: Our safety officer at Bolsover would give everybody a day's training once a year on fire safety. You had to practice running out fire hoses and putting out a fire on pit top. Last thing you did was march around pit top with rescuers on. Snot and slaver everywhere. Not a nice experience.
NF: Did one session in the training tunnels at Mansfield Mines Rescue station. Anyone remember having to don a rescuer in complete darkness? I did that in a cross cut at Bentinck Colliery.
SH: We used to have to walk around the stock yard wearing it for re-training, but just about every one of us used to cheat & take it out of our gobs. Once on the face the gear head sprocket bearings (we were told to run it to destruction) collapsed & started smoking like a chimney, the blokes on the m/g machine got it first & shouted down the tannoy "*Get yer gobblers on lads!*" so we all got off the face & an early ride out the pit. Luckily, we didn't have to wear it very long 'cos it wasn't a nice experience

Effects of increased gas levels

Carbon dioxide
The normal concentration in air is about 0.04%. With increasing levels CO_2 can cause asphyxiation and death.

- In the UK, Workplace exposure limits (WELs) are Long-term exposure limit (8 hour reference period) of 5000ppm or 0.5%.
- Short-term exposure limit (15 minute reference period) of 15000ppm or 1.5%.

With increasing concentration, between 2% and 5%, headache and nausea will start to occur. By 4% the oxygen level is likely to have dropped from its normal 21% to 17% - breathing will become more laboured, especially in confined spaces and in a stressful in a mine. By 10% death may occur, certainly by 30% death will occur in seconds.

Carbon monoxide levels
CO is toxic at very low levels. The normal level of CO in air is 0.5 to 5ppm (0.00005 to 0.0005%).
35ppm (0.0035%) will cause headache, nausea and dizziness in less than 6 to 8 hours.
1600ppm (0.16%) - as above and causes an increased heart rate in less than 20 minutes with death in less than 2 hours.
6400ppm (0.6%) - death in less than 20 minutes.
In a mine situation, oxygen depletion will most likely occur, resulting in the above symptoms in less time.

Other gases
In a coal mine, many gases not normally in air, can be present; the gases most commonly occurring due to natural causes and associated with breathing problems are firedamp (methane); black damp (carbon dioxide); white damp (carbon monoxide) and stinkdamp (hydrogen sulphide). These are a newsletter article in their own right!

In any type of mine, also due mainly to malfunction of equipment, a huge range of gases can occur, particularly organic gases for example benzene; xylene; toluene and many other organic compounds.

Also, the presence of dust, particularly coal dust, can cause breathing problems and, of course, catch fire. In coal mines stone dust is used to supress the likelihood of coal dust contributing to explosion, again another newsletter article possibly.

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