6

Carbon Monoxide (CO)

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Introduction

Carbon Monoxide (CO) is one of the most lethal gases known. Its toxicity is due to its ability to strongly bind with haemoglobin which greatly reduces the oxygen-carrying capacity of a person's blood. Areas of the brain sensitive to ischaemia (low oxygen level) are affected severely and a rapid, peaceful death is the common result. The gas is particularly dangerous, as it is a colourless, odourless and a non-irritating gas. Without specialized monitoring equipment, there is no way of knowing that carbon monoxide is present.

Death by poisoning from carbon monoxide can be reliable, quick and peaceful, provided the concentration of the inhaled gas is sufficiently high. In the 1990s, Dr Jack Kevorkian helped more than 50 seriously ill people to end their lives peacefully, using carbon monoxide. Those present at these deaths described the effectiveness and peacefulness of the approach.

PPM [CO]	Time	Symptoms
35	8 hours	Maximum exposure allowed by OSHA in the workplace over an eight hour period.
200	2-3 hours	Mild headache, fatigue, nausea and dizziness.
400	1-2 hours	Serious headache-other symptoms intensify. Life threatening after 3 hours.
800	45 minutes	Dizziness, nausea and convulsions. Unconscious within 2 hours. Death within 2-3 hours.
1600	20 minutes	Headache, dizziness and nausea. Death within 1 hour.
3200	5-10 minutes	Headache, dizziness and nausea. Death within 1 hour.
6400	1-2 minutes	Headache, dizziness and nausea. Death within 25-30 minutes.
12,800	1-3 minutes	Rapid Death

Table 6.1 Effect of carbon monoxide exposure

It is important to establish that monoxide concentration is high enough as periods of time spent in sub-lethal gas levels can lead to serious irreparable damage. From the accompanying table (Table 6.1) it is clear that although death will occur at much lower levels, if one is in the environment for some time, it is strongly recommended that concentrations greater than 1% (10,000 ppm) are generated by the method chosen.

There are often no specific clinical findings to identify this agent as the cause of death, although occasionally the red colouration of 'venous' blood gives a flushed pink colour to the skin of the corpse. This colouration may indicate the cause of death to an examining doctor and its presence will be detected at autopsy. If it is important that the death look 'natural' (and 'suicide' not be stated on the death certificate), then poisoning by carbon monoxide may not be the best choice.

Testing the Concentration of Carbon Monoxide

To ensure that the monoxide concentration is sufficiently high for a peaceful death, it is wise to test the gas concentration. To do this one needs an appropriate meter capable of reading carbon monoxide concentration levels.

Exit has tested several meters for this purpose. The cheapest monitors have only a warning light set to alarm when levels of 50ppm are exceeded. These are of limited use.

Fig 6.2
a) RKI sampling multi-gas meter
b) TPI 707 high level monoxide analyser
c) TPI 770 monitor with sampling probe

Gauges with a digital readout of up to to 1000 ppm (0.1%) can be easily obtained. It is advisable to have a sampling facility on the gauge so that the level produced can be sampled before using this method. Sampling gauges can be modified with a 10:1 reduction, so that levels up to and greater than 1% can be measured.

Gauges used by Exit are shown in Fig 6.2. The multi-gas sampling meter (RKI Eagle) enables the monitoring of carbon monoxide levels, carbon dioxide levels as well as the concentration of available oxygen. This gauge retails for over US$2000 and is primarily used as a research tool. A smaller hand-held device (TPI model 701 carbon monoxide analyser) that measures aspirated gas of up to 10,000 ppm is also shown. This useful gauge costs ~ US$600. A cheaper TPI gauge used by Exit with a modified 10:1 sampling probe (TPI model 770) costs ~US$200.

Sources of Carbon Monoxide

<u>From Commercial Gas Suppliers:</u>
Cylinders of compressed carbon monoxide, either as the pure gas or as a mixture (eg 5% in Nitrogen) are available from scientific gas supply companies. There are no special restrictions but an account will be needed. Table 6.1 lists some available packaging for pure compressed carbon monoxide from BOC. http://www.boc.com/

Cylinders of special gas mixtures that contain lethal levels of monoxide are also used as source gases for some industrial lasers (eg 6% CO in gas used in the Rofin CO_2 slab laser).

See: *http://www.praxair.com/gases/buy-carbon-monoxide-gas*

Carbon Monoxide (CO)

a toxic, flammable, colourless and odourless gas

Grade	Minimum Purity (%)	Cylinder Size	Contents	Pressure (kPa)*	BAR	Valve	Equipment Recommended
Australia							
Chemically Pure Grade 2.5 Gas Code 156	99.5	LB (A)	0.05 m^3	10300	103	CGA170	Regulators for CGA170 See Section on Regulators
		1A (G)	4.8 m^3	11300	113	CGA350	Regulators for CGA350 See Section on Regulators
		D	0.66 m^3	7000	70	Type 20	Regulators for Type 20 See Section on Regulators
		2 (E)	1.8 m^3	1100	11	CGA350	Regulators for CGA350 See Section on Regulators
		200	4.85 m^3	11300	113		
		300	7.36 m^3	11300	113		

Table 6.3. Compressed CO cylinder sizes

Vehicle Exhaust Gas

Carbon Monoxide is produced as an exhaust gas from internal combustion engines. The concentration of the monoxide in the exhaust gas varies, depending on a number of factors and establishing this is critical.

Formic Acid

Carbon Monoxide is produced by a chemical reaction that occurs when the formic acid (HCOOH) is broken down into water (H_2O) and carbon monoxide (CO). The catalyst for this breakdown is concentrated sulphuric acid. The sulphuric acid remains chemically unchanged but is diluted by the water released.

Monoxide generation ceases when all of the formic acid is broken down, or when the sulphuric acid becomes too dilute to catalyze the reaction. Heat is generated in the reaction and this can lead to traces of formic and sulphuric acid in the emerging carbon monoxide. One mole of formic acid (46gm) will produce ~22 litres of carbon monoxide.

The chemical equation is: $HCOOH \Rightarrow H_2O + CO$

Oxalic Acid

Concentrate sulphuric acid can be used to breakdown anhydrous oxalic acid to produce carbon monoxide (and carbon dioxide). Again the sulphuric acid remains chemically unchanged but is diluted by the water produced in the reaction. Less heat is generated in the reaction and there is less likelihood of contamination with vapour from the sulphuric acid. One mole of oxalic acid (~90gm) produces equal molar amounts of carbon dioxide and carbon dioxide.

The chemical equation is: $HO_2CCO_2H \Rightarrow H_20 + CO_2 + CO$

Carbon (charcoal)

The incomplete oxidation of carbon can produce copious amounts of carbon monoxide. As the oxygen available to a charcoal fire decreases the production of carbon dioxide decreases and carbon monoxide increases.

The chemical equation is: $2C + O2 \Rightarrow 2CO$

Zinc and Calcium Carbonate

Powdered zinc can be mixed with calcium carbonate and heated to produce carbon monoxide, along with calcium and zinc oxide. Heat is needed for the process and this offers the opportunity of controlling the process (using an electrical heater).

The chemical equation is: $Zn + CaCO_3 \rightarrow ZnO + CaO + CO$

Vehicle Exhaust Gas as a Source of Carbon Monoxide

Internal combustion engines produce a small percentage of carbon monoxide in the exhaust gas. If this gas is inhaled, death will result. Piping the gas into the car, or running the car in a closed shed are common approaches. In all cases, though, the carbon monoxide will be mixed with a large amount of other foul-smelling exhaust products. One of the benefits of using this gas, peacefulness, is lost.

Older cars tend to produce the highest levels of exhaust carbon monoxide. With the introduction of unleaded petrol in the 80s, there have been controls on the monoxide levels in exhaust gases to meet environmental standards. Since 1997 new cars can emit no more that 10% of the levels of carbon monoxide acceptable in 1976. Mandatory catalytic convertors oxidize most of the produced carbon monoxide to form carbon dioxide.

Despite these significant changes in the emission levels of carbon monoxide, motor vehicle exhaust gas suicides continue to occur at a surprisingly high rate. Indeed, in the period from 1976 to 1995 the rate of exhaust gas suicides in some countries increased faster than the rate of motor vehicle registrations (Routley & Ozanne-Smith, 1998). Possible explanations include the fact that idling motors do not necessarily comply with international standards. Additionally, catalytic convertors do not function when cold. Rather, they require several minutes to warm from a cold start. Of significance though is the increasing number of failed suicide attempts from breathing exhaust gas reported in this period.

This is not to say that the motor car cannot be used as a source of carbon monoxide to effect a reliable death, but there are problems associated with the method. One concern is the mechanical connection of the exhaust to the hose carrying gas to the car. Many modern vehicles have elliptical exhaust outlets. Coupling the exhaust to a round hose, often using plastic tape, can cause problems because of the heat of exhaust gas. If the tape or tube melts or is destroyed by the heat, failure is likely. Fig 6.4 shows a carefully engineered system using metal connections and clamps and heat resistant tubing.

Fig 6.4. The car as a carbon monoxide source

This approach demands meticulous attention to detail and testing is strongly recommended. A carbon monoxide meter should be used for testing. The meter should be placed on the front seat. The car should then be run using the planned setup. The meter can be watched safely from outside the car. The meter reading will soon show if the system will work. If the meter moves quickly off-scale (>500ppm), the method is unlikely to fail. If the meter struggles to rise, even when the motor is started cold and allowed to idle, the system should be avoided.

In addition, careful planning is required to avoid the possibility of intervention. A car running with a hose fed into the back window will almost certainly attract attention. And, even if effective, sitting in an environment of hot, foul smelling, burnt engine waste, just to make use of the tiny percentage of monoxide present, is an unpleasant way to die. In Exit's research of our elderly members' attitudes, only a small number showed interest in using exhaust carbon monoxide.

Fig 6.5
The early CoGen

Fig 6.6. COGen 4 on fume cupboard test bench with acid bottles and CO monitor

Making Carbon Monoxide (the COGen)

For over a decade, Exit International has investigated the use of carbon monoxide. Since the compressed gas is difficult to source, Exit has developed generators that produce the carbon monoxide gas when and as required. The first carbon monoxide generator (the COGen) made use of the chemical reaction (catalytic breakdown) that takes place when formic acid is added to sulphuric acid.

In the original model (Fig 6.5) the formic acid was placed in an intravenous bag and allowed to drip into the reaction chamber containing the sulphuric acid. The gas produced was then fed to the mannequin using nasal prongs. Filmmaker Janine Hosking recorded this first demonstration at Exit's laboratory in late 2002, and the sequence was shown in the film *Mademoiselle and the Doctor*.

Since that time other methods of carbon monoxide generation have been investigated. Methods include the partial oxidation of carbon (charcoal), the reduction and catalytic conversion of oxalic acid, and the reaction between powdered zinc and calcium carbonate.

How the COGen Works

The COGen consists of two PVC chambers ('A' & 'C', Fig 6.7). The inner chamber "A' is mounted to the screw lid of the larger outer 10cm (3.9 inch) container and has a drip exit 'F' in its base. The drip rate is controlled by a screw 'E'.

150 ml of 85% formic acid is placed in chamber ('A') with the control-valve shut.

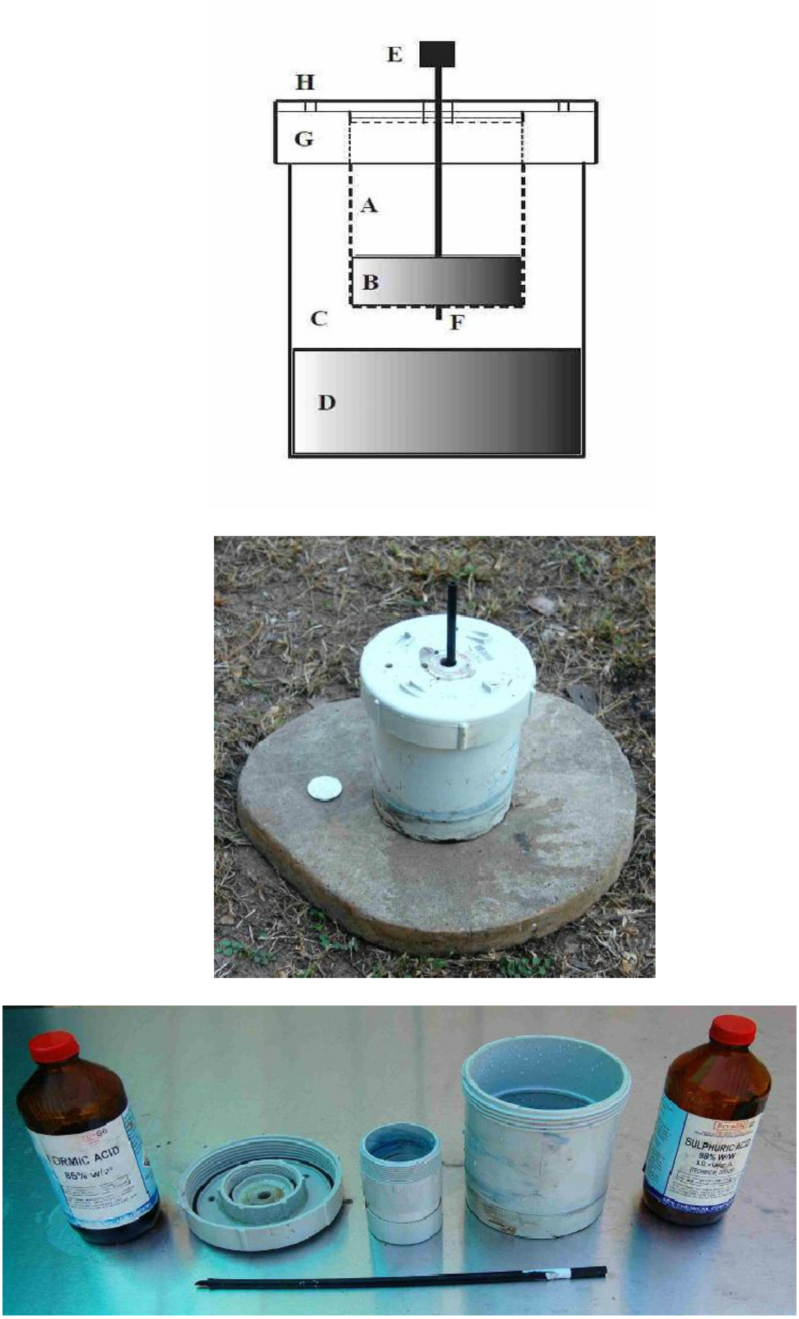

Fig 6.7 The COGen & acids

250ml of concentrated sulphuric acid (98%) is placed in the outer chamber ‘D’ and the COGen assembled.

Opening the screw ‘E’ allows the formic acid to drip into the concentrated sulphuric acid. Copious amounts of carbon monoxide are released and exit the chamber through vent holes in the lid ‘H’.

The Video shows the COGen being armed and placed in a small car. The carbon monoxide concentration in the car was continuously sampled with a probe positioned near the head of the mannequin. The graph (Fig 6.8) shows the measured concentration in ppm, plotted over the first 30 minutes. Lethal concentrations were reached a few minutes after switching on the generator. A peak level of ~3% CO was recorded.

Sourcing the Acids

Concentrated sulphuric acid (98%) can be purchased from chemical suppliers or at hardware stores where it is sold as a drain cleaner. Concentrated laboratory sulphuric acid is an oily clear liquid, whereas the drain-cleaner sulphuric acid can be dark brown in colour because of additives, but this does not effect the generator’s operation.

Formic acid is available from chemical supply companies. Home hobbyists use formic acid in tanning or bee-keeping. Formic acid can also be purchased online through chemical supply websites.

Oxalic acid is used as rust and stain cleaner and can be purchased from hardware stores.

Safety Note

Concentrated formic and sulphuric acids are corrosive liquids. They should be kept secured in glass or polyethylene containers (plastic soft drink/ soda bottles are not suitable). When using sulphuric acid, rubber gloves should be worn along with eye-protecting goggles and a face-splash protector. Spills of acids on to the skin should be washed off immediately with copious amounts of water. If either of these acids gets in the eyes, wash the eyes continuously for several minutes and then seek medical assistance.

Generating Carbon Monoxide using a Charcoal Burner

This method of generation is commonly used as it is simple to set up and all necessary items are readily obtained. A charcoal burner can made from a steel container or by using a brazier or using a pre-packaged charcoal BBQ grill.

If you make your own burner, obtain good quality charcoal to reduce the level of unwanted smoke. You will also need a car, or other small room that can be sealed.

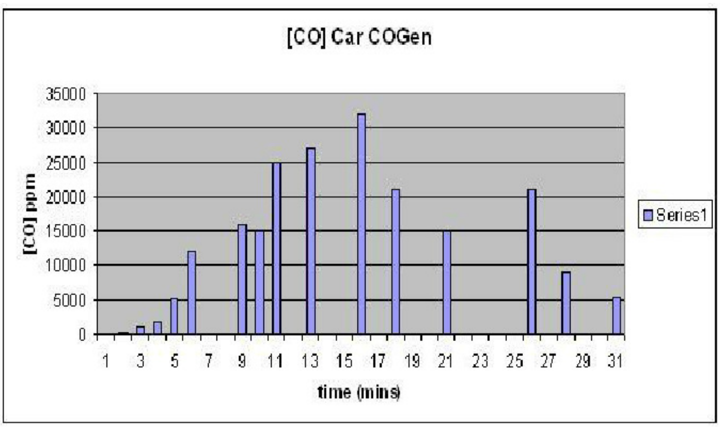

Table 6.8 CO concentration with time using COGen in a vehicle

In the series of experiments carried out by Exit, a small pre-packaged charcoal burner was set alight and placed on the floor in a small car. The level of carbon monoxide inside the car was continuously monitored.

Other tests were carried out using a sealed 20ft shipping container as the closed environment. A brazier was loaded with 1.5 Kgm of good quality charcoal which was then set alight and placed in the centre of the floor. The container doors were shut (see Fig 6.10). Again, the carbon monoxide concentration within the container was continuously sampled from outside using a sampling probe.

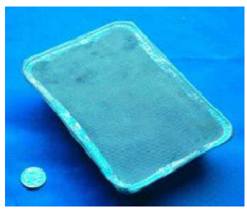

Fig 6.9 Test vehicle with BBQ charcoal burner

Fig 6.10. Charcoal burner.brazier and test shipping container

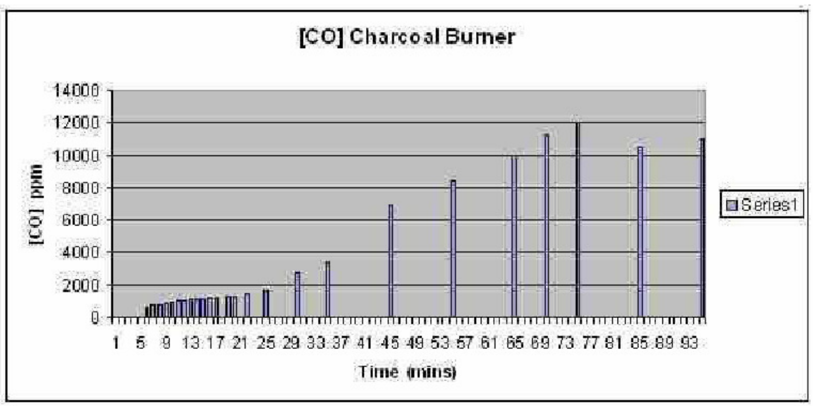

Table 6.11. CO concentration with time in test shipping container

The Destiny Euthanasia Machine

In early 2012 Philip Nitschke was contacted by Mr Paul Bowen QC who was for acting for British man, Tony Nicklinson. Tony suffered from 'locked-in syndrome' following a stroke some years earlier. See: *http://bit.ly/1KIEhqz*

Tony and Paul wanted to know if it was possible to build a new Deliverance Machine; a machine that would enable Tony to blink an eye and receive a dose of a lethal gas. Dr Nitschke grasped the opportunity and set to work on a euthanasia machine that could be easily operated by a person with limited mobility. The goal was a machine that would reliably and peacefully cause death, and would require no special skill to apply. One whose operation could be initiated by a button press, or by a

Table 6.12. Destiny CO Machine

voice or eye movement. The result was the 'Destiny Machine' first shown publicly as part of Philip Nitschke's 'Dicing with Dr Death' show at the Edinburgh Fringe in August 2015. Media stemming from the Edinburgh Fringe is at:

The Independent: *http://ind.pn/1VRumkf*
The Daily Mail: *http://dailym.ai/1Jf8FGz*
The Daily Record: *http://bit.ly/1iC6cvI*
TV Bomb Review: *http://bit.ly/1Q6hYZX*

Design Considerations

Following discussions with Neal Nicol, a long-time associate of Dr Jack Kevorkian, features of the earlier Deliverance Machine and Dr Kevorkian's own Mercitron Machine were integrated. The Mercitron had been used by Kevorkian and Nicol in the assisted suicides of ~ 50 patients in the US in the 1990s.

The gas that is used in the Destiny is the same compressed carbon monoxide/ nitrogen mixture (9%/91%) that was used in the original Mercitron. Delivery of the gas at ~4 liters/min is through simple nasal prongs. Gas control is determined by a modification of the original Deliverance program where a positive response to three separate questions, either through button press or other means, activates the gas control relay.

As a safety measure, a finger cuff provides the person's cardiac rate and oxygen saturation input to the Rasberry Pi microprocessor. This microprocessor controls the process and presents the questions. The person's cardiac trace, heart rate and oxygen saturation is displayed . When cardiac function ceases and oxygen saturation drops to zero, the microprocessor terminates the gas flow.

Construction of Destiny

Construction of Destiny began in 2014. Input for the first machine is a 'Yes' green button and a 'No' red button which both feed into the Raspberry Pi microprocessor case. Secondary input is from a pulse oximeter (CONTEC CMS50D+) which provides pulse waveform, heart rate and saturation via USB input of 5.2v power from a USB source. Output in the form of a visual display is via HDMI to a screen displaying the person's cardiac trace, oxygenation and pulse, along with the sequential presentation of the three questions.

- *Are you aware that if you proceed to the last screen and press the 'yes' button you will be given a lethal dose of fast and die?*
- *Are you certain you understand that if you proceed and press the 'yes' button to go to the next screen that you will die?*
- *If you press this button in 15 seconds you will die*

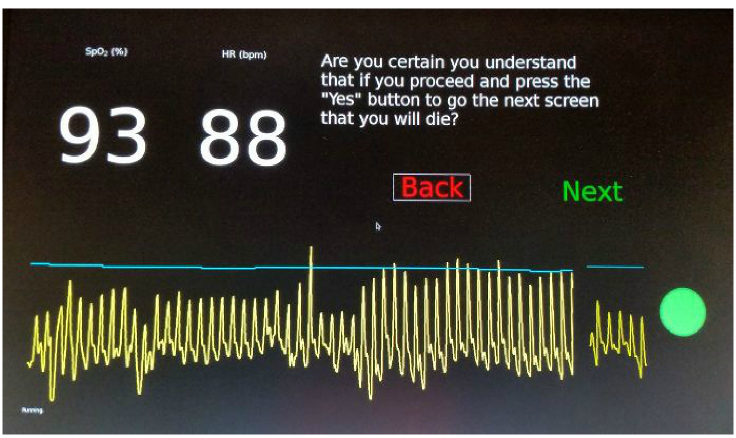

Table 6.13. Destiny screenshot

The gas source is a compressed Nitrogen/CO mixture (91%/ 9%) at 2000psi, regulated with a Max Dog Brewing nitrogen regulator. This provides a flow rate of 4 litres per minute. The 91%/9% combination was chosen because it is quickly and effectively lethal. Importantly, this concentration of carbon monoxide is also not considered flammable. Flow is controlled by the microprocessor which activates a relay gas valve. Power is provided from a 9v battery pack.

Testing & Use of Destiny

At the time of publication, the Destiny Machine has not been used to end life. The machine has undergone extensive testing with volunteers. The Destiny Machine has shown itself to be 100% reliable in operation and gas control, when used with nitrogen gas.

The sourcing of small (150 litre/ 5 cu ft) cylinders of the Nitrogen/ Carbon Monoxide mix is currently under examination and will be reported on when available.

Warning

It is stressed that carbon monoxide is an extremely lethal gas. A person using this gas to end their life should be aware of potential risks to other people present. Always place a warning sign in a prominent position to prevent any accidental exposure to other people. This danger is greatly reduced when administration is via the Destiny Machine because of the minimal amount of lethal gas used.

Legal Comment

Carbon monoxide, much like the inert gases mentioned in the previous Chapter, are also able to be obtained and possessed lawfully in countries such as the United States, the United Kingdom and Australia. This includes cylinders, charcoal burners and other items described that can be used to produce carbon monoxide.

Conclusion

Carbon Monoxide can provide a person with a peaceful death. The gas can be obtained in a variety of ways ranging from direct purchase, simple burners, or more sophisticated generating devices. Tests should be made to ensure that concentrations of over 1% can be delivered. The Destiny machine addresses many of these issues.

Most interest in this method has come from those who reject the taking of drugs orally (eg. for fear of vomiting) and by others who reject the use of helium because of the need for a plastic bag to be placed over one's head. The Destiny machine and the COGen address these concerns. In particular the Destiny machine has the ability to be used by persons with significant disability (quadriplegics, people with advanced MND etc).

Exit RP Test for Carbon Monoxide

The method loses points in the subcategories of Preparation, Undetectability and Safety.

Preparation is not simple (Pr=2), there is equipment present at the death, and if using a COGen preparation with concentrated acids requires care. Using compressed nitrogen/ carbon monoxide mix will greatly simplify Preparation moving from 1/5 to 3/5.

This method may be detectable on inspection of the body (U=1), and can present some risk to others (Sa=1). The action of the Destiny machine in reducing the amount of monoxide used to a minimum significantly reduces the danger to others. Safety moving from 1/5 to 3/5

RP test result 33 (66%), for Destiny RP is 35 (70%)

Criteria	**Score**
Reliability	***9/10***
Peacefulness	***8/10***
Availability	***3/5***
Preparation	***2/5***
Undetectability	***1/5***
Speed	***5/5***
Safety	***1/5***
Storage	***4/5***
Total	***33 (66%)***