5.6 Self-Contained Self Rescuers (SCSRs)

5.6-1 Breathing Hazards Following an Explosion

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5.6 Self-Contained Self-Rescuers (SCSRs)

We now know that the miners at Sago appeared to have responded in accordance with their training. Most donned their self-contained self-rescuers (SCSRs). They attempted escape. When all else failed, they barricaded and attempted to alert those on the surface. We may never know exactly what happened on 2nd-left or their experience with their SCSRs but we must learn from what we know.

- Currently acceptable training does not provide miners with sufficient knowledge to make decisions when confronted by unexpected situations.
- Operators, miners, and inspectors need to ensure that SCSRs are treated as the life saving devices that they are.
- Miners need more emergency breathing options to encourage escape and provide protection when barricading.

The function of the SCSR is to provide breathable air while isolating the miner from hazardous gases following a fire or explosion. The miners at Sago were taught to don their SCSRs at the first sign of a problem, "They tell you to put your --- in case of a fire or an explosion put your rescuer on, get everybody in one spot and head for the outside. And they say if escape is cut off, then you barricade on last resort." noted mine examiner Ronald Grall.[1]

When asked if the 2nd-left crew felt like there was no way out, Randal L. McCloy replied "Yeah. Well, because there really wasn't. I mean, there was just no way of doing anything that you wanted to do as far as getting out. Anything that led you to point A, to point B, no, it just couldn't work.

[1] Starting on page 130 of the statement under oath of Ronald Grall

All of our options were diminished to nothing". In addition to encountering increasingly dense smoke he noted escape was blocked by "…whatever had fallen to block the track."[2]

If reported problems with SCSRs had a bearing on the deaths of the Sago miners it is not known. One of those that perished suffered significant injuries during the explosion and could not have donned his SCSR. The eleven miners who perished in the 2nd-left barricade were probably exposed to a hazardous atmosphere for a medically significant period prior to donning their SCSRs, were exposed to a hazardous atmosphere when they took the mouthpieces out to talk or work, and were exposed to a hazardous atmosphere in the barricade after their SCSRs were no longer able to produce oxygen. The significance of such exposures was not given enough emphasis in training materials provided by the NIOSH, MSHA, or the manufacturer. These training materials were used by trainers throughout the industry. While testimony by survivors indicates an awareness of the risk posed by such exposure, the medical consequences were less understood both in their descriptions and their actions. Those that perished in the 2nd-left barricade did so in an atmosphere that had sufficient oxygen to sustain life but also contained toxic levels of carbon monoxide.

While directly in the path of the blast, the miners from the 1st-left section were further away. Like the 2nd-left crew they survived the initial blast and moved quickly to attempt escape. They did not don their SCSRs at one time, but rather on an ad hoc basis. Of the thirteen miners on the 1st-left section mantrip when the blast hit, only six actually donned their SCSRs and those at different points during their escape. These miners were in smoke so dense that they could not see their feet, they could hear their handheld gas detectors alarming yet seven chose not to don. The 2nd-left crew appears to have donned as a group indicating an organized escape effort. As with the 1st-left crew they waited. However, they waited longer and in potentially higher concentrations of toxic gases. Part of the answer as to why the miners waited may lie in their perception of the challenges they faced. Paul Avington of the 1st-left crew explained that he delayed donning because, "…we've been more or less told that these rescuers last one hour … I thought, well, I might have to walk out of here. I keep hearing them telling me it takes two hours to walk out of there. So

[2] From statement under oath by Randal L. McCloy June 19, 2006

what I'm doing is saving mine, and trying to go as far as I can."[3] Additionally, those that entered the mine in the first response also chose not to don their SCSRs even though they were often in smoke and their detectors were indicating high carbon monoxide.

5.6- 1 Breathing Hazards Following an Explosion

In a mine explosion the fuel, methane and/or coal dust, combine with oxygen (O) to produce heat and carbon dioxide (CO_2). Typical air has about 21 percent oxygen and as the oxygen is consumed in the explosion insufficient oxygen remains to create only CO_2 and the reaction begins to produce carbon monoxide (CO) until either the fuel or oxygen is depleted. This happened very quickly, on the order of 0.001 second or less. The result is an atmosphere of nitrogen and some oxygen mixed with carbon dioxide, carbon monoxide and trace amounts of other combustion byproducts with possibly some un-combusted methane.

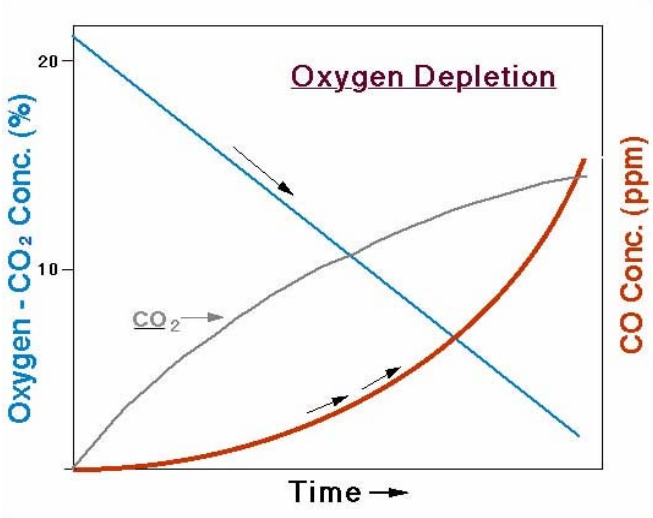
Predominates at 21 percent oxygen...

$$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O + \text{energy}$$

Predominates at 16 percent oxygen...

$$CH_4 + 1.5\ O_2 \rightarrow CO + 2\ H_2O + \text{energy}$$

In the aftermath of an explosion four gases are of primary concern to those that survive; oxygen, methane, carbon dioxide, and carbon monoxide.



Oxygen is a critical chemical required by our bodies in generating the energy needed by our cells. State and Federal regulations require that oxygen levels be maintained above 19.5 percent in all operating sections of a mine. This value, 19.5 percent oxygen was established on the basis of adverse physiological effects of insufficient oxygen[4]. The medical term for insufficient oxygen is

[3] From statement under oath by Arnett Perry, February 14, 2006 starting page 38

[4] While MSHA discusses a level of 16 percent oxygen in PIB96-19 as "life threatening", multiple federal regulation stipulate 19.5 percent as the minimum oxygen concentration, i.e.: 42CFR84.2(y) defines an "oxygen-deficient atmosphere" as an atmosphere which contains an oxygen partial pressure of less than 148 millimeters of mercury (19.5 percent by volume at sea level). This value is also used by OSHA in 29CFR1910.134(b). NIOSH Publication

hypoxia with symptoms that include fatigue, lassitude[5], somnolence[6], dizziness, headache, breathlessness, and euphoria. Intellectual impairment is an early sign and makes it difficult for individuals to comprehend their degree of disability. Thinking is slow. Calculations are unreliable. Memory is faulty. Judgment is poor. Reaction time is delayed.

Methane is a light, colorless, gaseous, inflammable hydrocarbon that is a natural product of the process of forming coal. Often referred to by its chemical symbol, CH_4, it is naturally liberated from coal as the hydrogen is slowly released as coal changes from peat to anthracite. Methane is nontoxic, however, can displace all or part of the atmosphere in a confined space. With only five percent displacement, methane produces an atmosphere which, while adequate for respiration, can explode violently. By contrast, with twenty percent displacement, methane will not burn or explode, but it will asphyxiate an unprotected miner within about five minutes from lack of oxygen.

Carbon dioxide is a colorless, odorless, incombustible gas formed during respiration, combustion, and organic decomposition. It is often referred to by its chemical symbol CO_2. State and federal rules have assigned a maximum level for carbon dioxide of 5,000 ppm or 0.5 percent. The concentration of carbon dioxide must be over about 2.0 percent (20,000 ppm) before most people can sense its presence. Above 2.0 percent, carbon dioxide may cause a feeling of heaviness in the chest and/or more frequent and deeper breathing. As the carbon dioxide concentration climbs above a few percent, the concentration of oxygen in the air inhaled begins to be affected.[7] At six percent carbon dioxide, for instance, the concentration of oxygen in air has decreased from 20.96 to 19.9 percent.

No. 2005-100 notes that "The minimum requirement of 19.5 percent oxygen at sea level provides an adequate amount of oxygen for most work assignments and includes a safety factor. The safety factor is needed because oxygen-deficient atmospheres offer little warning of the danger, and the continuous measurement of an oxygen-deficient atmosphere is difficult. At oxygen concentrations below 16 percent at sea level, decreased mental effectiveness, visual acuity, and muscular coordination occur. At oxygen concentrations below 10 percent, loss of consciousness may occur, and below 6 percent oxygen, death will result. Often only mild subjective changes are noted by individuals exposed to low concentrations of oxygen, and collapse can occur without warning."

[5] state of exhaustion

[6] drowsiness, sleepiness

[7] Martin, T.G., and J.L. Burgess. *Dreisbach's Handbook of Poisoning.* 13th ed. Pearl River, NY: Parthenon Publishing, 2001.

Carbon monoxide (CO) is a colorless, odorless, tasteless gas that is toxic. Carbon monoxide, sometimes called coal gas, has been known as a toxic substance since the third century B.C. It was used for executions in early Rome. Today it is the leading cause of accidental poisoning in the United States. According to the National Institute for Occupational Safety and Health[8], 1,500 Americans die each year from accidental exposure to CO, and another 2,300 from intentional exposure (suicide). An additional 10,000 people seek medical attention after exposure to carbon monoxide. It is an asphyxiant[9]. When inhaled, carbon monoxide quickly binds with hemoglobin in the blood stream with an affinity 200 to 250 times greater than that of oxygen to from carbooxyhemoglobin[10] (COHb)[11]. The result is a decrease in blood oxygen carrying ability of the blood and the onset of acute hypoxic symptoms (primarily neurologic[12] and cardiac). A person suffering from carbon monoxide intoxication may first experience euphoria, then headache, followed by nausea and possibly vomiting as the concentration of carbooxyhemoglobin (cells affected by carbon monoxide) in the blood increases.[13] To protect miners, MSHA sets the limit for carbon monoxide in 30 CFR Part 75.322 [14] at 50 ppm average over a 10 hour shift with no more than a 15 minute concentration of up to 400 ppm.

It was carbon monoxide that posed the greatest danger following the Sago explosion. There are no readings or reports of oxygen concentrations low enough to have been life threatening. While smoke and dust were discussed by all the survivors, it was this odorless gas that ultimately inflicted the harm.

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[8] Unintentional Non-Fire-Related Carbon Monoxide Exposures — United States, 2001–2003 - http://www.cdc.gov/od/oc/media/pressrel/fs050120.htm

[9] an agent that causes asphyxia, for example, a toxic gas

[10] Hemoglobin that has carbon monoxide instead of the normal oxygen bound to it.

[11] Hardy KR, Thom SR. Pathophysiology and treatment of carbon monoxide poisoning. J Clin Toxicol 1994;32(6):613-29

[12] The branch of medicine that deals with the structure and function of the nervous system and the treatment of the diseases and disorders that affect it

[13] Haddad, Lester M. "Acute Poisoning" Cecil Textbook of Medicine, edited by Lee Goldman, and J. Claude Bennett. 21st ed. Philadelphia: W.B. Saunders, 2000, pp. 515-522.

[14] Concentrations of noxious or poisonous gases, other than carbon dioxide, shall not exceed the threshold limit values for time weighted averages (TLV-TWA) as specified and applied by the American Conference of Governmental Industrial Hygienists in "Threshold Limit Values for Substance in Workroom Air" (1972) Detectors or laboratory analysis of mine air samples shall be used to determine the concentrations of harmful, noxious, or poisonous gases. The ACGIH has a TLV-TWA of 50 ppm with a TLV-STEL of 400 ppm. (Threshold Limit Value, Short Term Exposure Limit, is the maximum concentration permitted for a continuous 15-minute exposure period. There may be

The primary protection available to miners is their SCSR.

5.6-2 SCSR Background

It is important to understand how SCSRs work and how units recovered after an accident are examined. A total of seventeen SCSRs used by Sago miners were found in the mine during the investigation. (Others found were brought in my rescue teams and used to evacuate Mr. McCloy) Their locations were marked on recovery maps and plotted to understand their positions in the mine along with their relationship to victims and other items. They were then transferred to the custody of federal investigators[15] and examined.

The examination process includes inspection of the hoses and exterior parts for any damage. Next the sealed stainless steel canister is cut open and the condition of the chemical bed examined for signs of reaction. Based upon expertise in examining previous SCSRs, an estimate is made of the amount of the chemical that has reacted.[16] Then the units are taken to the manufacturer's laboratory where a representative sample of the chemical is reacted to produce gas. The volume of the gas produced is compared to the volume produced for the same amount of chemical for deployed SCSRs and a percentage is calculated.[17] Both values are provided to the investigators.

The CSE SR-100 is a belt-wearable chemical based self-contained self-rescuer that uses potassium superoxide (KO_2), a yellow solid which reacts readily with carbon dioxide and water to produce oxygen. The SR-100 consists of a stainless steel canister with an opening

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a maximum of four such periods per day, with at least 60 minutes between exposure periods, and provided the daily TLV-TWA is not exceeded)

[15] MSHA took custody of the SCSRs and placed them in sealed plastic bags for transfer to NIOSH's National Personal Protection Technology Laboratory in Bruceton PA

[16] NIOSH "Investigation Protocol for Self-Contained Self-Regulators (SCSRs) Removed from the Sago Mine Disaster", 24 March 2006

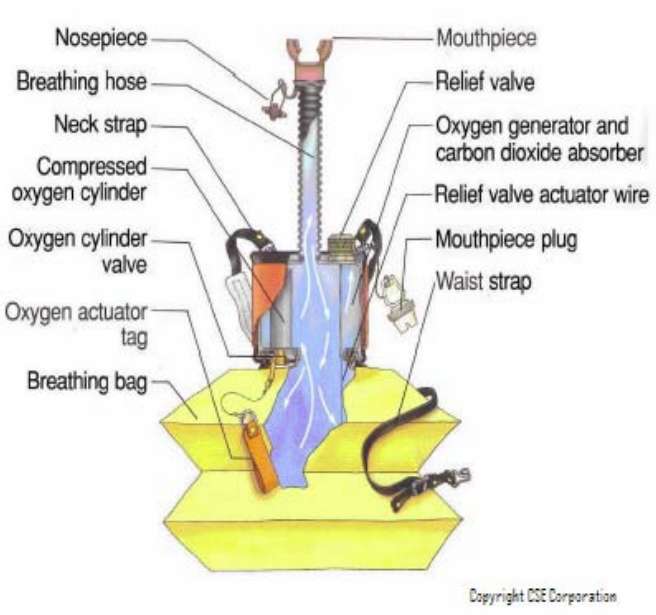
[17] Conversations with Sam Shearer, Chairman, and Scott Shearer, President, CSE Corp April 2006. CSE's stated their preferred method for recovered unit examination would be to first run an air flow measurement through the bed to determine the degree of chemical bed solidification then open the canister to examine the particles, then conduct a chemical analysis of the material – Randall Harris OMHS&T consultant

for a breathing hose on one end and a breathing bag on the other. The breathing bag serves as a mixing chamber where exhaled breath is mixed with produced oxygen prior to inhalation.

The chemical SCSR uses the carbon dioxide and water vapor produced by the body in reactions with the potassium superoxide and lithium hydroxide to reduce carbon dioxide and generate oxygen.

Component	Atmospheric Air %	Exhaled Air %
Nitrogen	78.62	74.9
Oxygen	20.85	15.3
Carbon Dioxide	0.03	3.6
Water vapor	0.5	6.2

Exhaled air passes through the mouthpiece into the canister where some of the carbon dioxide is removed by the lithium hydroxide and the rest through a reaction with the water vapor and the potassium superoxide to produce oxygen. The oxygen rich air passes through to the breathing bag where it mixes with either the pure oxygen from the oxygen cylinder or previous air breathed through the canister. On inhalation air from the breathing bag passes back through the chemicals in the canister where it is further enhanced by additional scrubbing of carbon dioxide as it and remaining water vapor create additional oxygen.



The purpose of the compressed oxygen cylinder is to inflate the breathing bag with oxygen as an initial reserve while the chemical reaction begins. It plays no role in starting the chemical reaction. The chemical reaction begins with the introduction of exhaled breaths that provide

the carbon dioxide and water vapor needed. If the oxygen cylinders do not inflate the breathing bag, either because they have leaked all their oxygen or because the user removed the mouth plug prior to pulling the tag, the chemical reaction can be started by expelling enough breaths to fill the bag using the mine atmosphere. When the bag is filled, the miner is trained to start breathing normally. As the carbon dioxide and water vapor react with the potassium superoxide the oxygen concentration will increase. The time before oxygen concentrations reach the 19.5 percent value defined as oxygen deficient[18] will vary. Tests by OMHS&T and NIOSH using automated breathing simulators indicate that value may exceed seven minutes if the compressed oxygen cylinder fails.[19]

Because the SR-100 is a closed circuit breathing device, any toxic gases introduced into it remain there. They would have recirculated between the lungs and the device until the body fully absorbed them.

As potassium superoxide reacts with carbon dioxide and water vapor at the surface of the particle it produces potassium bicarbonate ($KHCO_3$) which is white crystalline compound.

$$4\ KO_2 + 2\ H_2O \rightarrow 4\ KOH + 3\ O_2 + \text{heat}$$
$$2\ KOH + CO_2 \rightarrow K_2CO_3 + H_2O + \text{heat}$$
$$K_2CO_3 + CO_2 + H_2O \rightarrow 2\ KHCO_3 + \text{heat}$$

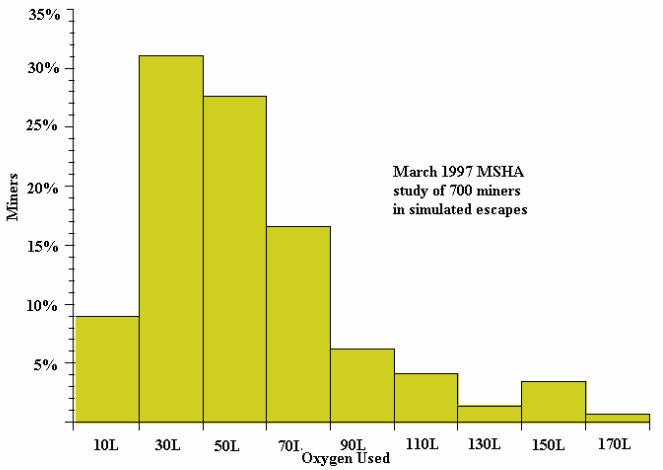
The SR-100 also utilizes a proprietary chemical catalyst that works with these reactions to ensure complete reaction of available potassium superoxide.

While the oxygen generation reaction is progressing, there is enough heat being generated by the reaction that the potassium bicarbonate remains a liquid. If the user stops breathing once the reaction has started, the lack of carbon dioxide and water vapor reduces the temperature in the canister and the potassium bicarbonate solidifies, forming a hard coating around any of the un-reacted portions of potassium superoxide particle. This coating tends to protect the

[18] 42CFR84.2(y) defines an "oxygen-deficient atmosphere" as an atmosphere which contains an oxygen partial pressure of less than 148 millimeters of mercury (19.5 percent by volume at sea level)
[19] NIOSH field study data and OMHS&T inspector's SCSR testing both 2006

particle, thus making it difficult to re-start a chemical based SCSR once it has been allowed to cool from lack of use.

The potassium superoxide (KO_2) reaction is controlled by the volume of exhaled breath blown into the canister. Breathing hard and rapidly moves more air in and out, thus more carbon dioxide and water vapor is moved through the canister. Trying to push or pull a volume of air through the chemical bed greater than it was designed to handle will generate breathing resistance. Too much water vapor and carbon dioxide will cause the heat generated to be such that the air pathways will become blocked by particles fused from reaction by-products. This channeling of air open pathways will isolate the surface of some potassium superoxide particles from the moisture rich air inhibiting the production of oxygen.



The federal approval of the SR-100 is based upon procedures contained in Title 42 of the Code of Federal Regulations Part 84. The approvals are based on a SCSR's ability to produce oxygen and remove carbon dioxide over a specified set of human exercise levels for a time period stipulated by the manufacturer in addition to several other ergonomic issues. The manufacturer stipulates the duration of the test in their application. In the case of the SR-100, it was subjected to the requested one hour testing protocol. The one-hour rating simply means that an SCSR can repeatedly demonstrate the ability to pass this test. Use at exercise rates different than those used in the approval test or by individuals whose physical conditioning varies significantly from those stipulated in the Federal regulations will produce different results.

Because it is unknown how hard or how rapidly the 2nd-left miners were breathing when they donned their SCSRs, how many times and for how long SCSRs sat idle, or how

breathing rates changed while in the barricade, it is impossible to predict how long the SCSRs should have lasted. If breathing very hard and very rapidly at the time donned, it is possible SCSRs reaction rates would have been high resulting in higher breathing resistance not only from higher than design volumes but increased reactions rates would have sped the chemical reaction, prematurely obstructing air flow and limiting ability to produce oxygen. If the SCSR is allowed to cool sufficiently, the potassium bicarbonate shell could solidify reducing oxygen potential.

The visual examination of recovered SCSRs was performed by federal investigators, followed by a chemical examination conducted by the manufacturer and supervised by federal examiners. The visual examination produces a subjective estimate of spent potassium superoxide based upon comparing the approximate quantity that is unreacted (yellow) to those that have been reacted (pale yellow or white-coated with white potassium bicarbonate).

The chemical examination grinds the entire recovered chemical into a homogeneous batch and then combines a portion of the batch with a liquid catalyst in a reaction that releases all the oxygen. The results are compared to the oxygen produced by the same amount of new chemical and a percentage calculated.

Either process may indeed accurately depict the oxygen producing potential of the chemical outside the canister. Such a test does not, however, take into account any reduction in air flow as a result of particle fusing of the chemicals in the canister or rendering of particles as unavailable due to coating and thus may not provide a meaningful representation of the miners' experience with the assembled device. While reported in this discussion these values confirm the initiation of the chemical reaction but their use as a forensic tool beyond that is limited. Still the number of 2nd-left SCSRs which did not demonstrate significant levels of spent potassium superoxide is perplexing.

In January 2006 there was no state requirement that a consolidated record of SCSR inspections be kept and no state or federal requirement that there be the ability to trace a unit to an individual miner. The records kept at the Sago mine regarding their SCSRs do not

provide all the information necessary to correlate serial numbers and individuals to whom assigned to the physical evidence. Several of the miners underground on January 2, 2006 had recently transferred from other mines. Some of these individuals brought their SCSRs from those mines further complicating the recordkeeping. At least one SCSR deployed by the 2nd-left crew had exceeded its 10-year service life in August 2005. This was not recognized when most of the SCSRs at the mine were inspected in November 2005.

Under manufacturer's directions, miners should inspect their SCSRs daily for signs of physical damage. At least one SCSR was unable to be removed from the fabric holster because it was glued to it by block-bond adhesive.

The SR-100 is approved as a belt-wearable device. The testing done during the federal approval process to ensure the devices survivability assumes that the units are in their approved holster on the miners' belts. Several of the holsters were found on the ground near the covers that were removed when the SCSRs were donned. Of the twenty-four recovered SCSRs, federal examiners found seven had impact dents in the stainless steel canisters that may not have been detectable in routine inspections. These findings imply that the SCSRs were carried by miners in their hands or placed loose on equipment rather than on their belts. If the units were subjected to physical impacts greater than those designed against, that could subject internal components to damage that could not be observed under typical inspections.

The Sago mine provided SCSRs for each miner but no checks were in place to ensure that miners did not pick up the wrong unit in the bathhouse, at the dinner hole, or after turning the units in for 90-day inspections. It would not be unusual that every miner underground would have an SCSR but not necessarily the one assigned in the company logs.

When not underground, miners would leave their belts and gear in the bathhouse. Lockers were provided for personal items and clean clothes. Boots and belts would be hoisted, that is elevated toward the top of the room to dry. It is not known if any of the individuals took their gear with them in personal vehicles. Since very few of the SR-100's used at the mine of January 2, 2006 were manufactured after August 2004 when heat damages detectors were

added, there is no way of determining heat related damage other than external evaluation. The principal damage caused by heat is to rubber parts inside the unit such as hoses and the breathing bag. The examination of recovered SCSRs revealed no heat related damage to hoses or bags beyond minor deformation and discoloring. There is indication that the rubber gaskets between the canister and the covers may have been impacted represented by binding of the rubber to the parts resulting in difficulty in removing covers.

5.6-3 Miner Statements Regarding SCSR Performance

A total of 33 persons were underground[20] after the explosion for periods of time and exposed to the hazardous gases that resulted. Of these, fifteen donned SCSRs[21] that operated adequately, fourteen choose not to don their SCSRs[22], four SCSRs were reported as not functioning properly[23], and one suffered injuries such that he could not have donned his SCSR.

Interviews were conducted with all 21 surviving miners. These are the experts in what happened. The following summarizes the testimony from these interviews with respect to SCSRs, including their experience donning and breathing through them, their observations of other miners using the devices, and their SCSR training. Where appropriate any available results of federal recovered SCSR examinations are included in the discussion.

5.6-3a Miners who DID NOT DON their SCSRs

Fourteen of the 21 miners interviewed DID NOT DON their SCSRs after the explosion occurred. Their reasons provide an insight into how miners with similar levels of experience would respond in the face of an explosion. These individuals were not new to mining, many

[20] The 2nd-left mantrip carried twelve, the 1st-left mantrip carried fifteen, one remained underground from the pre-shift examination, one walked in for his shift, and four entered in the initial attempt to assess the situation and save the first- and 2nd-left crews

[21] From Statements under oath – Denver Anderson, Alva Bennett, James Bennett, George Hamner, Eric Hess, Hoy Keith, David Lewis, Randal McCloy, Arnett Roger Perry, Harley Joe Ryan, Alton Wamsley, Fred Ware, Jackie Weaver, and Marshal Winans

[22] From statements under oath – Paul Avington, John Nelson Boni, John Patrick Boni, Gary Carpenter, Ron Grall, Randall Helmick, Vernon Keith Hofer, James Jamison. Owen Jones, Gary Rowan, James Allen Schoonover, Christopher Tenny, Jeffrey Keith Toler, and Denver Wilfong

[23] From statements under oath – Thomas Anderson, Jerry Groves, Jesse Jones, and Martin Toler Jr

had more than 20 years experience. They include certified mine foremen and certified trainers who would have been exposed to the knowledge that hazardous gases posed a threat greater than the smoke in their training.[24] Ironically those who did protect themselves by donning their SCSRs often credited these very people with teaching them that they should don immediately.

"The reason I didn't put mine on is because I didn't smell any smoke. I could smell --- the taste of dust, sulfur taste, but you couldn't see --- couldn't taste no --- smell no smoke or anything so I figured as long as I could breathe, I wasn't putting mine on. And Paul Avington asked me if we should go ahead and put them on. I said, not yet, because I was trying to get the fresh air" said Ronald Grall whose reasons were typical[25]. In retrospect he added "We should have probably put them on."

The opinions of those in small groups played a role in the decisions of several miners not to don their SCSRs. For example when asked why he did not don his SCSR Gary Rowan responded "Well, I don't know. I just --- I remember asking Ron, I said, do you think we better stop and put our rescuers on. And he said, no, let's keep going. So I --- we just kept going, didn't put it on." [26]

Several of the outby crew were far enough from the explosion to not have been affected by the blast. However, even knowing there had been an explosion, they based their decision not to don SCSRs. John Patrick Boni was typical of this group. He said simply "I knew I was in good air" [27]

Others indicated that they were holding it in reserve, not knowing what they might encounter during their escape. "I keep hearing them telling me it takes two hours to walk out of there. So what I'm doing is saving mine, and trying to go as far as I can" remarked Arnett Perry[28].

[24] From statement under oath by Eric Hess February 14, 2006 starting page 76 Q. In the foremen trainee class have you covered gasses yet? A. Yeah. A lot of gasses
[25] From statement under oath of Ronald Grall January 19, 2006 starting on page 66
[26] From statement under oath of Gary Rowan February 15, 2006 starting on page 33
[27] From statement under oath of John Patrick Boni January 19, 2006 starting on page 43
[28] From statement under oath of Arnett Perry January 26, 2006 starting on page 38

Of those interviewed, several, but not all, were asked if they heard that other miners had problems using the device. Most were not aware of any trouble. One miner said, "I did hear a couple of comments after we were in the intake that they weren't working. They (unidentified) couldn't breathe with them on --- a couple comments that these things aren't working --- they didn't state as to why, just said they were having trouble breathing with them on."[29] However, even those who were noted by others as having made such remarks about trouble or were thought by observers to have been having trouble, when directly asked said their SCSRs functioned adequately.

5.6-3b Miners who DONNED their SCSRs

Seventeen miners DONNED their SCSRs. Six of those were in the first left crew; eleven were in the 2nd-left crew. Four of those on the 2nd-left crew were reported as not working properly.

Most miners go through an entire career without donning an SCSR in an emergency. While they are regularly trained in the donning procedure there is always doubt about if they could don the units in an actual emergency. This was best explained by Eric Hess of the 1st-left crew when he said "…it's always been a big question in the back of my head, you know, if you have to put this thing on, do you think you could do it?. And they tell you, you know, it takes approximately 30 seconds to get it on. That's about right. To get that thing broke down and get it and get it working, it doesn't take very long. I mean, at the point of course you're nervous, but you know you've got to get that thing on. If you want to start breathing good air, you've got to get it on. So you know once I got it on and got --- you know, got everything strapped on and got it where it needed to be, you know, a little bit of calmness starts setting in because you know you're breathing and you know you're going to be all right. Or you think you're going to be all right. But at the time, we didn't know what was happening. But just having that thing on and breathing fresh air gives you a little bit of a sense that, you know ---" [30]

[29] From statement under oath of Christopher Tenney January 23, 2006

Some donned as soon as they could like Alton Wamsley "… the smoke was really --- it was really un-breathable. I just tried to take short breaths until I got my rescuer on. As far as I can remember, I'm the first one that put my rescuer on."[31] Others tried walking to the intake first as did Mr. Hess, "Just as soon as we got out of the mantrip and walked down --- like I said, the mantrip was sitting in 50 block four-belt, that's where the switch is. The mantrip was sitting right there at the switch. We got out of the mantrip and went to the first crosscut and we knew that that's where power --- the power shutters were. So we went to the next crosscut back and there was a man door. So we went through the door and noticed that we didn't have any fresh air at that point. So that's when me and Alton Wamsley, that's when we put ours on, just immediately. We both agreed, you know, this is bad. You know, we're breathing --- we don't know what we're breathing, but it's bad, we need to get them on. So that's when we put them on." [32] Mr. Hess said.

Even those that said they had trouble in donning or using their SCSRs stated that they felt that it performed as they thought it would. Denver Anderson said it worked "I heard they get warm, you know, if they were working, and mine got warm. And I heard one of the other guys complaining about his getting pretty warm. Mine didn't get --- I mean, enough, noticeable, you know ---. I breathed with it,"[33] he said.

Four individuals were able to don their SCSRs only with assistance from those that had already donned their units. Two of these had pre-existing health conditions, one was suffering from blast driven dirt in his eyes, and another had block-bond adhesive on his SCSR holster keeping him from opening his unit. This assistance by fellow miners is a trait that has been documented in other accident reports. However, this assistance is only possible because those assisting first donned their SCSRs. The record from previous accidents also contains examples of miners helping others only with all perishing because they did don their SCSR.

5.6-3c Hoy Keith's Experience

[30] From statement under oath by Eric Hess February 14, 2006 starting on page 41
[31] From statement under oath by Alton Wamsley February 14, 2006 starting on page 31
[32] From statement under oath by Eric Hess February 14, 2006 starting on page 41
[33] From statement under oath by Denver Anderson starting on page 34

Mr. Keith's experience was the most frequently discussed by his fellow miners during their statements. Most related his trouble breathing and some said that they were not sure that his SCSR was functioning. When asked if it was easier to breathe with the unit on, Mr. Hoy stated "I can't say it was, because I had so much of that dust and stuff in my lungs, and stuff like that. You couldn't hardly breathe. When I did get the fresh air, the guy gave me his water jug, and I rinsed my mouth out some. And that helped a lot."[34] Gary Rowan who helped Mr. Keith don his SCSR and stayed with him as he escaped said "I'm not sure that he actually even had any trouble with his. Like I said, he just kind of --- I know that the bag was out on his and everything like that. I mean, it looked like it was working. I mean --- but you know, like I said, he was just --- he was panicked pretty bad and he --- I mean, he told us just leave him in there." [35]

5.6-3d Arnett Roger Perry's Experience

Mr. Perry was facing inby on the mantrip when the blast hit. His cap lamp lens was broken by a piece of debris, his hat and safety glasses blown off and his eyes filled with dirt. In addition, Mr. Perry has a prosthetic leg and had difficulty moving on the uneven surface. Harley Joe Ryan assisted him in opening his SCSR and donning. Mr. Perry said that "It didn't [work] at first. I was sucking the bag together, I was breathing so hard because I'm short-winded and I was sucking that bag up in until it sucked --- collapsed. So I breathed into it and blew it way out…" [36] When asked about pulling the activation tag, Mr. Perry said "No, I didn't yank anything that I can recall." If he did not pull the oxygen starter then the performance he encountered is consistent with a cold start as described by the manufacturer.

Examination of the SCSR assigned Mr. Perry indicated that the compressed oxygen cylinder had been activated but there is no way of knowing if it were at the point of donning or later. Additionally there is no way of knowing for certain that the unit assigned Mr. Perry was the unit he donned. Not all the donned SCSRs from 1st-left crew were recovered.

5.6-3e Harley Joe Ryan's Experience

[34] From statement under oath by Hoy Keith January 23, 2006 starting on page 25
[35] From statement under oath by Gary Rowan February 15, 2006 starting page 65
[36] From statement under oath by Arnett Roger Perry January 26, 2006 starting page 49

Mr. Ryan required assistance in donning his SCSR he remembered being "Panicked --- scared --- scared to a point. More panicked I think than anything else due to the fact that I just thought everybody is leaving us, and I was trying to get Doc down out of there and he was --- Doc was a little worse off than I was."[37] Mr. Ryan had his SCSR in his hand trying to pull the tab to release the bands that hold the covers. He said "You just couldn't get the tab off. You couldn't get a hold of it for one thing."[38] Alton Wamsley assisted him getting the bands off "We took the top part of it --- we broke the band, took the top part off. I took my hat off. He threw the band around my --- the strap around my neck. I put my hat back on. He had the nose clips. And as he was putting the nose clips on, I made sure that the mouthpiece wasn't tangled, and I put it in my mouth. And then that's when either him or me, I don't know which, grabbed the bottom and jerked, and we had to jerk a couple, three times to get it to come loose. When it popped loose, he handed me the goggles, and he grabbed the cord and popped the rescuer open,"[39] he said.

When asked if he was able to breathe with it normally he responded "Yes". He notes that later while in the intake "the bottom part of my bag collapsed"[40] The breathing bag of the CSE SR-100 is actually two bags interconnected. Under normal ventilation only one 'bag' would be fully inflated. Both bags will inflate when the user is breathing near the capacity of the unit. Mr. Ryan did comment on problems using the mouthpiece since he does not have teeth "I kept it in my mouth. I had trouble keeping it in, but I kept it in. You had to clamp on it," [41] he said.

Mr. Ryan's SCSR was recovered and tested by federal examiners. The visual examination indicated 40-50 percent spent. Mr. Ryan indicated that he donned his SCSR as quickly as possible after the 6:30 a.m. explosion and did not remove it until 7:30 a.m. The mouthpiece of his SCSR was partly blocked by foreign matter, believed to be snuff.

5.6-3f Denver (Doc) Anderson's Experience

[37] From statement under oath by Harley Joe Ryan January 26, 2006
[38] From statement under oath by Harley Joe Ryan January 26, 2006 starting page 55
[39] From statement under oath by Harley Joe Ryan January 26, 2006 starting page 55
[40] From statement under oath by Harley Joe Ryan January 26, 2006 starting page 58
[41] From statement under oath by Harley Joe Ryan January 26, 2006 starting page 57

Mr. Anderson had difficultly removing his SCSR from its fabric holster. Eric Hess said, "He's like the utility man, so he does a lot of stoppings and does…a lot of the B-Bond and plastering, and his rescuer had B-Bond on it and he was having trouble with where it was on his belt, getting it up out of the pouch. So he had the channel locks down in his pouch, too, so I pulled those out and of course, you know, I'm beside him so I kept my hands under it and got it pushed up out. And I pulled the strap off, the metal band off for him and got it broke down, and then gave it to him and he got it --- he got it put on and got it working."[42] According to the manufacturer, in order to properly conduct the required daily inspection of the SR-100, the miner has to remove the unit from its cloth holster.[43]

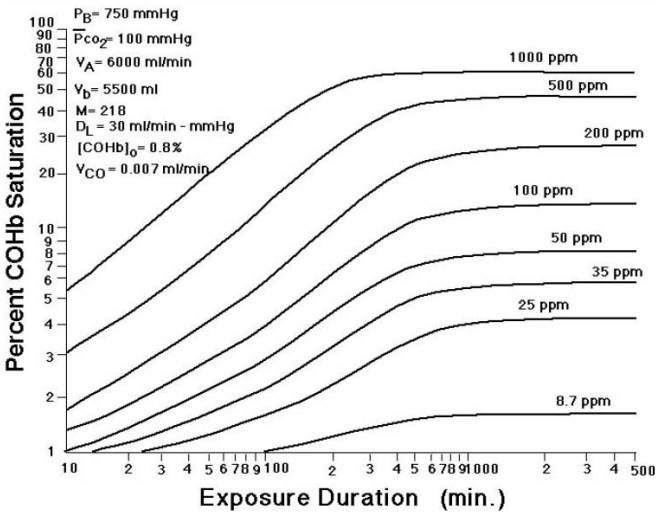
5.6-3g 2nd-left's Experience

The 2nd-left story is told by Randal L. McCloy and by the physical evidence. The crew was near the face when the blast occurred. They were engulfed by a cloud of dust, smoke and, most likely, toxic gases. Some if not all of the crew moved back to the mantrip and attempted to escape. Finding the track blocked somewhere short of the main, they reversed to approximately 10-block six-belt where the mantrip was abandoned. The crew then made its way inby and at the crosscut near 12-block six-belt on the intake entry all donned their SCSRs. It is difficult to determine how long that would have been after the blast. Based upon the distances involved and the time to load and unload the mantrip, it was likely no less than 20 minutes nor longer than 45 minutes.

During that time they would have been exposed to high levels of carbon monoxide, carbon dioxide, smoke, dust and possibly low oxygen. When the borehole was drilled into the 2nd-left section approximately 24 hours later the levels were 1,280 ppm carbon monoxide with oxygen levels of 20.3 percent and methane at 0.4 percent. Almost 40 hours after the event when the rescue teams reached the point where the SCSRs had been donned, the carbon monoxide was 450 ppm, oxygen was over 20.3 percent, and methane at 0.2 percent[44]. It is

[42] From statement under oath by Eric Hess February 14, 2006 starting on page 41
[43] The CSE manual discusses that the pouch must be loose fitting and the SCSR must be easily removed. This and the directions for examining the case and seals require that unit be removed from the cloth holster daily.
[44] Statement under oath of Christopher Lilly March 23, 2006 starting on page 48

possible that the value at the time prior to donning SCSRs was above this 1,280 ppm value but how high may never be known.



Log-log plot of carbon monoxide uptake by humans from very low ambient carbon monoxide concentrations as computed from the Coburn-Forster-Kane equation. [45]

Levels above 1,280 ppm even for short periods of time would have caused some physiological affects in those that inhaled it. Inhalation of carbon monoxide affects the ability of the blood to use oxygen. The measure is the carbooxyhemoglobin saturation level (COHb) and is shown as percentage of blood cells affected. Based upon the table to the left such an exposure would have resulted in a COHb between 10 and 20 percent within the estimated exposure period. Twenty percent is considered a toxic exposure.[46]

The symptoms of carbon monoxide poisoning and the speed with which they appear depend on the concentration of carbon monoxide in the air and the rate and efficiency with which a person breathes. Heavy smokers can start off with up to nine percent of their hemoglobin already bound to carbon monoxide, which they regularly inhale in cigarette smoke. This makes them much more susceptible to environmental carbon monoxide. With exposure to 200 ppm for two to three hours, a person begins to experience headache, fatigue, nausea, and dizziness. These symptoms correspond to 15-25 percent COHb in the blood. COHb levels of over 20 percent in healthy individuals and over 15 percent in patients with a history of heart

[45] Peterson, J.E. & Stewart, R.D., 1975, "Predicting the Carbooxyhemoglobin Levels Resulting From Carbon Monoxide Exposures". J. Appl. Physiol., 39, 633-638. Abbreviations: Pco2 = mean partial pressure of O2 in lung capillaries, VA = alveolar ventilation rate, Vb = blood volume, M = equilibrium constant, DL = diffusing capacity of lungs, [COHb]0 = value prior to carbon monoxide exposure, Vco = rate of endogenous carbon monoxide production

[46] Noted on West Virginia medical examiner reports

or lung disease indicate the need for hospitalization[47]. During sedentary activities, immediate and severe symptoms of carbon monoxide toxicity occur at levels greater than 30 percent COHb; above this level a person could not take action for self-protection. Thirty percent COHb is equivalent to 0.5 L/min of oxygen. It is assumed that death occurs at 60 percent COHb as oxygen is reduced to 0.25 L/min. Between 30 percent and 60 percent COHb, a person would be alive but likely be unconscious.[48]

Mr. McCloy states that three of the SCSRs donned by the 2nd-left crew did not work. This would have resulted in those that had working units having to share their units, inhaling the toxic gases while others used their units. In addition, some of the crew participated in constructing a barricade[49] and attempting to signal the surface by hitting a roof bolt[50] with a sledge hammer. During these periods the individuals also removed their SCSRs for talking and other reasons, exposing themselves to toxic gases. As the SCSR reached the end of the production and miners were forced to inhale mine air they were also exposed to toxic levels of carbon monoxide.

All those that perished at Sago had COHb levels ranging from 64 percent to 78 percent. Since the rate at which carbon monoxide binds with hemoglobin is affected by individual factors, the lack of correlation between COHb levels of those whose SCSRs did not function and those that did does not reveal a relationship with SCSR use. The final stage of carbon monoxide poisoning is coma. Mr. McCloy speaks of others appearing to go "…to sleep or appeared to be asleep." He did not remember if everyone was asleep before he did because "really I didn't know because I really couldn't, per se --- the way it was --- looked like, there was like a corner, a place where they had mined --- stopped mining… a crosscut. But some

[47] Allred EN, Bleecker ER, Chaitman BR, Dahms TE, Gottlieb SO, Hackney JD, *et al.* "Acute Effects Of Carbon Monoxide Exposure On Individuals With Coronary Artery Disease". Health Effects Institute (HEI) Research Report No twenty-five. Cambridge (MA): HEI, 1989.

[48] A Thomas, E. Bernard and J Duker, "Modeling Carbon Monoxide Uptake During Work", United States Bureau of Mines, Pittsburgh, PA - Am. Ind. Hyg. Assoc. J(42) May, 1981

[49] "…it was already activated. Yeah. But I just took it out when I had to do that." McCloy page 50

[50] "…Probably set it down beside me where I was sitting, just leave it where I was sitting, and then get up, grab the hammer and hit the bolt, the same bolt and hit --- bang on the bolt." McCloy page 70

people were on down the ways, and they were a little bit difficult to see because of the distance. They were, yeah, within distance, but it's kind of hard to see."[51]

The physical evidence is that twelve SCSRs were found in the barricaded area. All had been deployed and examination of the chemicals inside the canisters indicated that they all had started producing oxygen. There is no way of knowing who used which SCSR as events unfolded since Mr. McCloy notes that those with SCSRs were sharing with those that did not have one. In addition, there was not a strict relationship between the location of the victims and the location of their assigned SCSR. In most cases the SCSR was found close to the victim to whom it was assigned however, in other cases they were found near other victims. Mr. McCloy's SCSR was found at the outby end of the barricade near the crosscut while he was at the extreme inby portion of the barricaded number three-entry directly adjacent to a pool of water. Several victims were found distant from their SCSRs as if they had abandoned them, in other cases they would have been within arm's length. It appears that at least one individual had tried to take an SCSR apart by breaking the outer protective cover.

There is no apparent relationship between the COHb levels reported by the medical examiner and reported operation of the SCSR. Of the three individuals whose SCSRs were reported nonfunctioning, one had the second highest COHb level, one the second lowest with the third only slightly higher. For those whose assigned SCSRs were found within arm's reach there is not a relationship between the visual or chemical analysis of the spent potassium superoxide and the reported COHb values.

Recovered 2nd-left SCSR examination revealed that one SCSR exhibited oxygen production far greater than all the other units. The COHb levels for the individual who was assigned that unit were not significantly lower than other victims as would be expected if his unit had performed better. There was also no other victim whose COHb was significantly lower indicating that he would have been using that unit, nor was Mr. McCloy found with an SCSR. The individual who was assigned this unit was found farthest inby on the right rib.

[51] From statement under oath by Randal L. McCloy June 19, 2006 starting page 84

Some of the victims wrote notes with the last entry dated at 4:25 p.m. It is unclear how many of the victims were conscious at that point. Because the atmospheric concentrations of carbon monoxide likely varied across the period and there was a difference in physiological tolerances, it is not possible to determine the point at which individuals would have reached the fatal COHb threshold[52].

When the rescue teams arrived on January 3, 2006 they did not find any standing water in 2nd-left. When evidence was surveyed starting on January 27, 2006 there was a pool of water approximately four feet from the point where the furthest inby victim was found. There was evidence that at least two miners had been lying in the area later found with standing water.[53] Many of the victims had cut pieces of ventilation curtain upon which to lie, and those who worked on the mine recovery reported that sitting on the floor would draw water into their clothing. Two of the recovered SCSRs examined between March 27 and March 31, 2006 at NIOSH's National Personal Protection Technology Laboratory were reported by federal examiners as having evidence of moisture within the canister and three others were reported as showing signs of mineralization. The three SCSRs with the greatest spent potassium superoxide percentages also were noted as having signs of moisture or mineralization in the sealed canisters.[54] One unit in this group was observed to have signs that dirt appeared to have leaked into the breathing bag. The only openings to the outside on the SR-100 are the relief valve and the breathing tube. It is uncertain what role ambient moisture prior to recovery or storage in sealed plastic bags while awaiting examination may have played in the observed results.

5.6-3h Randal McCloy's Experience

[52] The individual that wrote the 4:25 p.m. note had a COHb of 67 percent while other had values as high 78 percent. The partial pressure of CO required to achieve these levels at the point of death fall between 0.15 and 0.18 mm Hg. If respiration ceased at 4:30 pm (as estimated by the medical examiner) then the average CO over the 10 hours would have been between 700 ppm and 625 ppm as extrapolated from "The Rate of Carbon Monoxide Uptake by Normal Men" Am. J. Physiolol. 143, 594-608

[53] Conversation with Bill Tucker OMHS&T mine rescue team member who found Randal McCloy

[54] Conversation with NISOH/MSHA indicated they found what appeared to be material that had been dissolved in water then had dried – Randall Harris OMHS&T consultant

Mr. McCloy was interviewed on June 19, 2006 by MSHA. The OMHS&T was not given prior notice of the interview thus was not able to participate. Mr. McCloy, while able to respond to questions, was still recovering from the affects of carbon monoxide poisoning. Carbon monoxide causes neurological damage not only from the lack of oxygen while COHb is high but from the chemical reactions that occur as the body detoxifies itself[55]. As a result he had difficulty comprehending some of the questions he was asked and his responses were occasionally incomplete and differed from physical evidence. However, most of the information he provided does correlate with the physical evidence and is thus relevant. (There is no reason to believe that the facts presented by Mr. McCloy do not represent his recall of the events on 2nd-left.)

When he donned his SCSR Mr. McCloy remembers smoke he said, "Some, but not much. Not much at the time, but some"[56] Mr. McCloy commented on the breathing characteristics of the SCSR. Regarding temperature of the air he noted, "The heat in your lungs, because that's what you're breathing because of occolite (phonetic)[57], a chemical that's in it, which converts carbon dioxide into oxygen. It's a chemical reaction. " Regarding breathing resistance he noted "Well, you kind of had to work with it a little bit."[58]

Federal examination of Mr. McCloy's assigned SCSR indicated that it had only utilized 20-25 percent of its potassium superoxide. When the rescue teams entered the barricade Mr. McCloy was in a seated position with his back against the rib, his head slumped and was unconscious. His SCSR was located approximately 30 feet from where he was found. Additional SCSRs brought in by rescue teams were used to provide oxygen to Mr. McCloy until he was evacuated to a place where a positive pressure oxygen breathing mask could be placed on him.

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[55] Christian Tomaszewski MD, "Carbon Monoxide Poisoning" Vol 105 / No 1 / January 1999 / Postgraduate Medicine -- When carbon monoxide binds to cytochrome oxidase, it causes mitochondrial dysfunction that result in oxidative stress. The release of nitric oxide from platelets and endothelial cells, which forms the free radical peroxynitrite, can further inactivate mitochondrial enzymes and damage the vascular endothelium of the brain. The end result is lipid peroxidation of the brain, which starts during recovery from carbon monoxide poisoning. With reperfusion of the brain, leukocyte adhesion and the subsequent release of destructive enzymes and excitatory amino acids all amplify the initial oxidative injury. The net result is cognitive defects, particularly in memory and learning, and movement disorders that may not appear for days, weeks, or months following the initial poisoning..

[56] From statement under oath by Randal L. McCloy June 19, 2006 starting page 29

[57] The actual name is potassium superoxide but Mr. McCloy is correct in that the function of the chemical is to convert carbon dioxide and water vapor into oxygen.

[58] From statement under oath by Randal L. McCloy June 19, 2006 starting page 36

5.6-3i Regarding Jerry Groves SCSR

"I shared mine with my bolting buddy. What's his name? Jerry Groves.", Mr. McCloy said "I fought with it for I don't know how long, trying to mess with that valve, blow air through it or anything I could do, but nothing would work." When asked if Mr. Groves had tried to exhale into it in order to get the bags inflated, Mr. McCloy responded "Right. That's when I knew that he handed it over to me, because he couldn't get it started. And then I messed with the valve on it because I didn't know what else to do about it. Because I'm really --- I'm not too familiar with the inside --- inner workings of it because I don't build them." [59] When asked to describe how he shared his SCSR, Mr. McCloy stated, "I just sat up and handed it to him."[60]

Mr. Groves was found next to Mr. McCloy. His assigned SCSR was found approximately two feet from him. Federal examination determined it had produced 40-50 percent of maximum oxygen but also noted evidence of moisture in the canister.

5.6-3j Regarding Martin Toler Junior's SCSR

Mr. McCloy indicated that Mr. Toler had problems getting his SCSR to work. When asked if Mr. Toler had a functional self-rescuer on at that time he was making decisions and talking about where to go Mr. McCloy responded "He did not." [61]

While there was one SCSR for each individual in the barricade, neither Mr. Toler's nor Mr. Hamner's assigned SCSRs were recovered from the barricade, two unassigned SCSRs on records provided OMHS&T were recovered. Company records indicate that Mr. Toler was assigned SCSR serial number 106022 and Mr. Hamner was assigned SCSR serial number 101838. Two SCSRs were recovered that were not listed and whose serial numbers were 101868 and number 92652. One of these is likely the unit Mr. Toler carried into the mine that day and the other belonged to Mr. Hamner. Federal examinations indicated that unit

[59] From statement under oath by Randal L. McCloy June 19, 2006 starting on page 33
[60] From statement under oath by Randal L. McCloy June 19, 2006 starting on page 47
[61] From statement under oath by Randal L. McCloy June 19, 2006 starting on page 59

number 101868 had spent 25 percent potassium superoxide while unit 92652 had spent 40 percent but showed signs of moisture. The average for 2nd-left SCSRs spent potassium superoxide was 38.2 percent.

5.6-3k Regarding Thomas Anderson's SCSR

Mr. McCloy stated that Mr. Anderson's SCSR also did not work. He was unable to provide any indication regarding what was wrong with the unit.

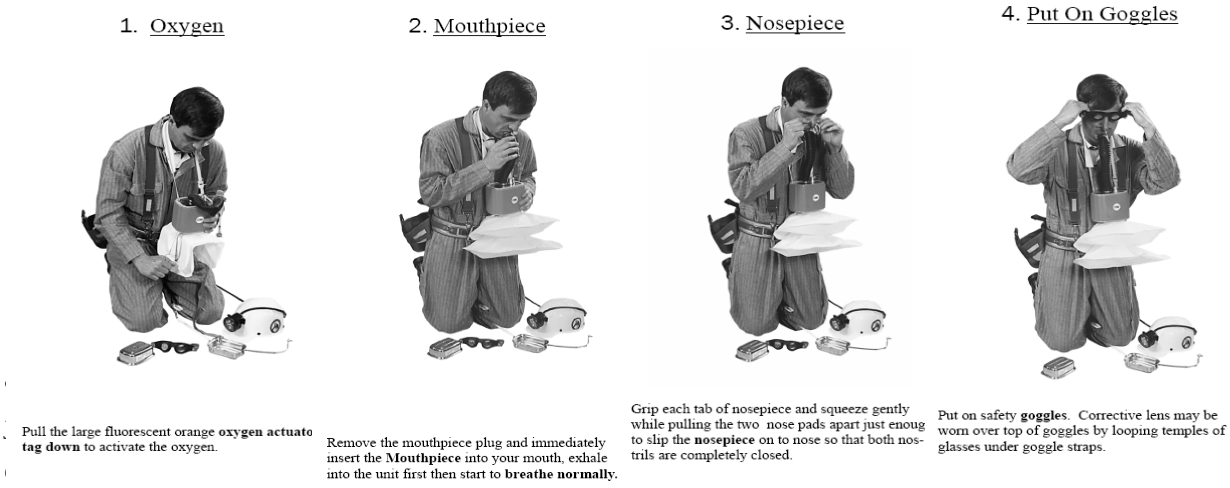
Mr. Anderson and Mr. Toler made at least one effort and possibly more efforts to check the air in the section and listen for rescuers after the barricade was built. Mr. McCloy was asked if they took a self-rescuer when they left the barricade. He responded, "I don't know. I don't think." He thought they went out without a self-rescuer. Mr. McCloy also remembered that "…there'd be like two people and Toler or whoever would be the furthest away from the other nine, they would talk to each other, like yell to get words across, just like, did you see anything, just like that." The use of messengers spaced in a smoke-filled entry is a standard practice in mine rescue that the miners would know.

Mr. Anderson's assigned SCSR was found approximately 10 feet away. However within two feet were two other SCSRs belonging to other miners. It is unclear as to the significance of this. One of the two that were near him, had its protective outer case broken off as if someone tried to get inside the unit. Federal examination revealed that Mr. Anderson's assigned SCSR had produced 25 percent of its oxygen while the two units found near him, number 57604 had produced 10-15 percent and the previously mentioned unassigned number 92652 had produced 40 percent. SCSR 92652 is the unit previously mentioned with signs of dirt leaking into the breathing bag.

5.5-4 SCSR Training

State and Federal rules require at least annual training on SCSRs. The training conducted appears to have met these requirements and in some respects exceeded the SCSR specific

training recommended by the manufacturer and NIOSH[62]. Gary Rowan said, "It's the only mine I've ever worked at that they actually had other classes you went to and stuff there on safety and stuff like this. We have them down at the office, everybody comes in."[63] He went on to describe the process "… first they go up there, you know, one of them would sit in front of the --- in front of everybody, you know, and show them, go across everything and all the stuff there. And a lot of times they would have each person come up and don it and do everything except for put the mouthpiece in."[64]



r steps in donning an SR-100 from a NIOSH SR-100 instructor's manual.

The training conducted at Sago included review of the donning and inspection processes. The Sago miners also were required to individually demonstrate their ability to don the SCSR. The benefit of the training was a lack of confusion about getting the SCSRs on as Mr. Perry said, "It was more or less an automatic thing…"[65] This was reinforced by Mr. Hess who said,"…it's always been a big question in the back of my head, you know, if you have to put this thing on, do you think you could do it? And they tell you, you know, it takes approximately 30 seconds to get

[62] NIOSH SR-100 Instructors Guide
[63] From statement under oath by Gary Rowan February 15, 2006 starting on page 100
[64] From statement under oath by Gary Rowan February 15, 2006 starting on page 45
[65] From statement under oath by Arnett Perry January 26, 2006 starting on page 38

it on. That's about right. To get that thing broke down and get it on and get it working, it doesn't take very long." [66]

The conditions of recovered SCSRs provide hints that daily inspections were not conducted or at least were not done rigorously. This combined with no mention of the need to do daily inspections by any of those interviewed (see excerpt to right) indicate a likely lack of emphasis on this aspect of SR-100 use in training. This training information is conspicuous in the CSE document on Daily and 90 Day Inspections[67] distributed with their Acoustic Solid Movement Detector and takes up two of the six pages of the NIOSH SR-100 instructors guide distributed by MSHA.

PASS **Remain in Service**	**FAIL** **Remove from Service**
Date of Manufacture, less than 10 years	Date of Manufacture, if date exceeds 10 years.
Security band is secure.	Security band has been become slack, unattached, or unfastened.
Top and bottom moisture indicators are blue. Temperature indicator, located on the side of the unit should be pink or white.	If the top and bottom moisture indicators of either indicator is white or pink or damaged do not attempt to use. If the temperature indicator, located on the side of the unit is red, do not attempt to use.
Top and bottom covers are properly aligned.	Top and bottom covers are jarred or misaligned.
Top and bottom cover seals are properly aligned.	Top and bottom cover seals are cut, split or displaced.
No signs of significant trauma	Signs of significant trauma (beyond normal wear and tear) such as substantial dents in the top and bottom covers or substantial dents, breaks or punctures in the orange plastic outer cover. If the unit has been crushed, burnt, or suffered any damage that cause the security strap to become slack , unattached, or unfastened.

While the MSHA and NIOSH websites have documents that might have provided insights helpful to trainers, they were not commonly known nor were they commonly called out to instructors or miners. The common materials used by trainers did not focus on ways to maximize the duration of an SCSR once it is donned, what to if units did not perform as expected, or the physiological affects of carbon monoxide beyond that it is hazardous. In January 2006 there effectively was little information in the hands of instructors or miners regarding how SCSR's worked, what to do to maximize oxygen production or what to do if something did not work as expected.

[66] From statement under oath by Eric Hess February 14, 2006 starting on page 41
[67] CSE Corporation document SR-100 ASMD 10/02

Donned	Donned - Trouble	Not Donned	Miner	Crew Assignment	From Sworn Testimony			
					Deployed	Belt/Block	Removed	Belt/Block
1	0	0	Anderson, Denver (doc)	First-left	06:30+	46-block 4-belt	07:00	37-block 4-belt
0	1	0	Anderson, Thomas[1]	Second-left	Did not work	n/a	n/a	n/a
0	0	1	Avington, Paul	First-left	n/a	n/a	n/a	n/a
1	0	0	Bennett, Alva[2]	Second-left	06:30	12-block 7-belt	When outside	unknown
1	0	0	Bennett, James[3]	Second-left	06:30	12-block 7-belt	When outside	unknown
0	0	1	Boni, John Nelson	Outby	n/a	n/a	n/a	n/a
0	0	1	Boni, John Patrick	Outby	n/a	n/a	n/a	n/a
0	0	1	Carpenter, Gary	First-left	n/a	n/a	n/a	n/a
0	0	1	Grall, Ron	First left	n/a	n/a	n/a	n/a
0	1	0	Groves, Jerry[4]	Second-left	Did not work	n/a	n/a	n/a
1	0	0	Hamner, George[5]	Second-left	06:30	12-block 7-belt	When outside	unknown
0	0	1	Helms, Terry	Outby	n/a	n/a	n/a	n/a

[1] From statement under oath by Randal McCloy
[2] From statement under oath by Randal McCloy
[3] From statement under oath by Randal McCloy
[4] From statement under oath by Randal McCloy
[5] From statement under oath by Randal McCloy

Donned	Donned - Trouble	Not Donned	Miner	Crew Assignment	From Sworn Testimony			
					Deployed	Belt/Block	Removed	Belt/Block
0	0	1	Helmick, Randall	First-left	n/a	n/a	n/a	n/a
1	0	0	Hess, Eric	First-left	06:30+	46-block 4-belt	unknown	unknown
0	0	1	Hofer, Vernon Keith	Mine Maintenance	n/a	n/a	n/a	n/a
0	0	1	Jamison, James	Outby	n/a	n/a	n/a	n/a
1	0	0	Jones, Jesse[6]	Second-left	Did not work	12-block 7-belt	n/a	n/a
0	0	1	Jones, Owen	First-left	n/a	n/a	n/a	n/a
1	0	0	Keith, Hoy	First-left	Did not work	n/a	n/a	n/a
1	0	0	Lewis, David[7]	Second-left	06:30	12-block 7-belt	When outside	unknown
1	0	0	McCloy, Randal[8]	Second-left	06:30-06:45	12-block 7-belt	When outside	Unknown
1	0	0	Perry, Arnett Roger	First-left	06:40~	43-block 4 belt	07:00~	In mantrip at 37-block
0	0	1	Rowan, Gary	First-left	06:45~	43-block 4-belt	07:30	On surface
1	0	0	Ryan, Harley Joe	First-left	06:30+	46-block 4-belt	07:30	On surface
0	0	1	Schoonover, James Allen	Safety Director	n/a	n/a	n/a	n/a

[6] From statement under oath by Randal McCloy
[7] From statement under oath by Randal McCloy
[8] From statement under oath by Randal McCloy

Donned	Donned - Trouble	Not Donned	Miner	Crew Assignment	From Sworn Testimony			
					Deployed	Belt/Block	Removed	Belt/Block
0	0	1	Tenney, Christopher	First-left	n/a	n/a	n/a	n/a
0	0	1	Toler, Jeffrey Keith[9]	Superintendent	n/a	n/a	n/a	n/a
0	1	0	Toler Jr., Martin[10]	Second-left	Did not work	12-block 7-belt	n/a	n/a
1	0	0	Wamsley, Alton	First-left	06:30+	46-block 4-belt	07:45	One-belt
1	0	0	Ware, Fred[11]	Second-left	06:30	12-block 7-belt	When outside	unknown
1	0	0	Weaver, Jackie[12]	Second-left	06:30	12-block 7-belt	When outside	unknown
0	0	1	Wilfong, Denver	Maintenance Director	n/a	n/a	n/a	n/a
1	0	0	Winans, Marshall[13]	Second-left	06:30	12-block 7-belt	When outside	unknown
15	3	15						

33 people were underground at some point w/o apparatus
15 donned SCSRs and they worked
4 donned SCSRs and they did not work
14 chose not to don SCSRs
1 whose injuries did not allow donning

[9] From statement under oath by Randal McCloy
[10] From statement under oath by Randal McCloy
[11] From statement under oath by Randal McCloy
[12] From statement under oath by Randal McCloy
[13] From statement under oath by Randal McCloy

Photo 1

Example of debris from overcast at the mouth of second-left the crew would have encountered

Photo 2

Example of debris on the belt at the mouth of second-left

Photo 3

After the second-left crew abandoned their mantrip they crossed over into the intake and donned their SCSRs at 12-block leaving the covers on the floor in a circle – one unit's plastic outer casing was ripped off in an effort to remove a cover that apparently was stuck

Photo 4

Example of debris from stoppings near end of second-left track.

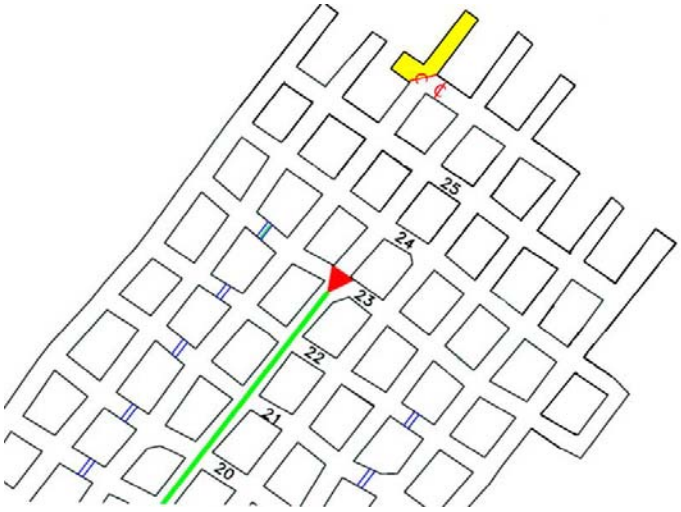


Figure 1

Location of second-left barricade in number three-entry at the face – shorter yellow area is the crosscut and the longer the number three entry

Photo 5

View into the barricaded crosscut looking from number four entry towards number three entry with the diagonal barricade curtain partly down

Photo 6

View into the number three entry barricade at looking toward the face

(The case of SCSRs in right foreground were brought by mine rescue teams for use in evacuation of survivors – some were used for evacuating Mr. McCloy)

Photo 7

Mr. McCloy's hat and several of the SCSRs used by the rescue team as they provided aid while bringing him out

These items were located on the left rib closest to the face of the number three-entry portion of the barricade

Photo 8

Second-left SCSR as found

Photo 9

Second-left SCSR as found

Photo 10

Second-left SCSR as found

Photo 11

Second-left SCSR as found

Photo 12

Second-left SCSR as found

Photo 13

Second-left SCSR as found

Photo 14

Second-left SCSR as found – white areas are where dust deposited by explosion has been disturbed revealing applied rock dust

Photo 15

Contents of Sago SCSR from unit with 10% spent potassium superoxide

Note large percentage of bright yellow potassium superoxide – bright white particles are lithium hydroxide – pale yellow and gray particles are reacted potassium superoxide

Photo 16

Contents of Sago SCSR from unit with 40-50% spent potassium superoxide

Note percentage of pale yellow potassium superoxide and moderate caking of chemical in canister mesh support

Photo 17

Contents of Sago SCSR from unit with 80-90% spent potassium superoxide

Note lack of yellow potassium superoxide and extensive caking of chemical in canister mesh support