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Dear Ms. Silvey,

Please find below additional comments in regards to 30 CFR Parts 7 and 75 Refuge Alternatives for Underground Coal Mines; Proposed Rule.

#### **SECTION 7.501**

*MSHA solicits comments on the estimated service life of the pre-fabricated self-contained units.*

MineARC Systems has had refuge chambers in service in metal/non metal mines for more than 10 years. Our experience has shown that replacement or refurbishment of our chambers has commenced around the 7-8 year mark. This is generally due to the damage that occurs during transport. In coal mines this issue is going to be exacerbated due to the requirement to move chambers as frequently as once a week in some mines.

Refuge chambers that have reached their service life are returned to MineARC for an evaluation. In most cases the steel structure is simply repaired, sand blasted, and repainted. The breathable air system has been replaced due to improvements in our technology.

It is MineARC's opinion that placing a timeline on either the structure or components will result in both dilapidated chambers remaining in service for up to 10 years and components that still have useful life being discarded before 5 years.

The decision to replace components and/or refuge chambers must be performed by a qualified representative of the manufacturer.

#### **SECTION 7.504**

*MSHA requests comments on including a requirement that refuge alternatives be designed with a means to signal rescuers on the surface.*

Whilst the inclusion of a signaling device to the surface is a valuable addition, it should not be a requirement in the final rule. This is an area of technology that requires a different set of expertise not usually found in a refuge chamber manufacturer. Whilst it is possible to engage consultants to provide services in this field, it adds additional cost to the chamber. As far as MineARC is aware, no refuge chamber manufacturer has incorporated a signaling device in their design thus far.

This device should be excluded from the rule to ensure that it does not delay the deployment of proven refuge chambers. The crucial features of a refuge chamber is the design, development, and testing of its breathable air and cooling systems.

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Additionally, a signaling device would require full scale testing in a coal mine to confirm its effectiveness. This type of testing need not be a priority when there are currently approved refuge chambers that have not undergone human testing to validate their life support systems.

It is MineARC's opinion that the responsibility for ensuring the exact location of the refuge alternative should fall on the mine operator in being required to maintain up to date mine maps.

MineARC would prefer to work with our customers individually to determine if a signaling device is a preferred option as opposed to a mandate.

*MSHA requests comments on the types, sources, and magnitude of lighting needed for the proper functioning of a refuge alternative and the needs of the occupants.*

In MineARC's discussions with lighting companies, few products are specified in foot candles. It is MineARC's opinion that the illumination unit should be changed to the more relevant lux.

The recommended 1 foot candle of lighting per miner per day is referenced as being the minimum requirement for a bomb shelter. From the referenced source, TABLE XV. *Specific task illumination requirements (Concluded)*, the recommended values are measured at the task object or 76 cm (30 in) above the floor. Therefore, the stated value is effectively the recommended intensity of the light source.

Since illuminance follows the inverse-square law, doubling the distance between the light and the object results in one quarter of the light hitting the subject. As refuge chambers are closed vessels, the strength of the light provided inside the refuge chamber will be directly dependent on the final ruling on the space and volume requirements. As an example, a pre-constructed refuge alternative typically has a significantly larger volume than a portable system and should therefore technically require a higher per miner lighting rate.

In MineARC's opinion it is necessary to discuss with lighting experts the effect of varying refuge alternative volumes on lighting intensity. Alternatively, the manufacturer should determine the amount of light necessary for safe and effective operation of their refuge chambers.

## **SECTION 7.505**

*MSHA solicits comments on these minimum space and volume requirements.*

The volume and space per person requirement is solely a comfort factor for the occupants. However, as you increase the volume it creates additional complexities for the design of pre-fabricated refuge alternatives. An increased volume affects the following design considerations:

- A steel refuge alternative that is required to provide 60ft<sup>3</sup> per person is extremely long and unpractical for most coal mines mine design constraints. As an example, a MineARC COAL SAFE refuge alternative rated for 20 persons would be almost 37ft long with an air lock and life support systems. This sized unit is difficult to maneuver around cross cuts without substantially increasing the size of cross-cuts or causing damage to the refuge alternative.

- The increased cost to coal mine operators for pre-fabricated steel refuge alternatives with sizeable volume requirements will be significant. The cost of steel continues to rise and contributes anywhere up to 50% of a manufacturers cost of goods sold. The increased size of the refuge would drastically increase the economic impact to implement this final rule. More likely though, it will force manufacturers of steel refuge chambers into a position where they cannot compete in cost with the inflatable styles. With a lot of mining companies preferring the steel units due to their ability to survive a secondary explosion, the coal mining companies will be forced to choose on the basis of economics and not safety.
- A critical factor for determining the required flow rate of the scrubber is the volume of the refuge alternative. To ensure reaction of the CO<sub>2</sub> chemical, the entire volume of air in the refuge must pass through the scrubber multiple times every hour. If the volume is too large and the scrubber flow not sufficient, there will be insufficient mixing of the air in the closed space. Consequently, the CO<sub>2</sub> gas will settle out on the floor of the refuge alternative due to its molecular weight being 50% greater than air. This causes the overall concentration of CO<sub>2</sub> in the refuge to begin to rise. As you increase the volume, the required characteristics of the scrubbing system change. With a larger volume it is necessary to increase the flow of the scrubber to ensure sufficient air exchanges each hour. If you increase the flow in the scrubber you then need to ensure the resonance time in the bed remains constant by increasing the absorber bed size. This will necessitate additional power sources for active scrubbing refuge alternatives and increased cost per refuge alternative.
- The proposed rule states that, '*the NIOSH recommended value of maximum concentration of carbon monoxide is 25ppm*'. MineARC testing has proven that this threshold can be exceeded by simply having cigarette smokers expiring air inside the chamber. It will therefore be necessary to scrub the entire chamber for CO. As you increase the volume of the chamber the quantity of chemical required to control CO increases drastically. Carbon monoxide catalysts typically use precious metal catalysts and are expensive. An increased volume will add significant cost to each individual chamber.

MineARC's standard metal/non metal refuge chambers allow approximately 35ft<sup>3</sup> volume per person.

### *MSHA solicits comments on the proposed 96- hour supply of breathable air.*

A rationale should be used for developing an entrapment duration based on empirical evidence in conjunction with current day and future mine rescue capacities. The state of West Virginia has already done this research and determined that 48 hours was the average time in which to reach entrapped persons.

Western Australia similarly did the same study for the metal/non metal industry and developed a standard of 36 hours based on empirical research.

Whilst additional duration is always welcome from a mine rescue standpoint, it must be noted that it creates additional design challenges and will significantly impact the cost and size of refuge alternatives.

All refuge alternatives should include a factor of safety for the specified breathable air duration. This is to guarantee that under adverse conditions (additional occupants, temperature changes, and efficiency variations) the refuge chamber will still achieve the rated duration.

If 48 hours of breathable air is specified, MineARC's Coal SAFE Chamber will operate for 62 hours at full load and similarly 125 hours if the final rule is 96 hours.

### **SECTION 75.360**

*MSHA requests comments on the proposed setting for pressure relief and whether a higher pressure relief should be required.*

The effective sealing of a refuge chamber is a prerequisite for ensuring contaminants do not enter into the chamber. However studies have shown that only a very small positive pressure is required to ensure contaminants remain outside the refuge chamber. Venter<sup>1</sup> has shown that positive pressures of less than 0.015psi are sufficient to prevent the ingress of noxious gases.

The proposed requirement for 0.25psi for pressure relief inside a refuge chamber is dangerously large and creates hazards for the occupants.

As an example, MineARC's standard metal/non metal refuge chamber's entry door is 35"W x 74"H and weighs approximately 450lb. At a pressure of 0.25Psi there would be an additional 647.5lb of force against the door. This is almost 150% more than the weight of the door alone. From MineARC's testing experience it would be impossible to open the door from inside the refuge chamber. If the door did somehow come open, it would be a danger to anyone standing within the swing radius.

MineARC currently utilizes an overpressure value of 0.05psi and is of the opinion that any proposed rule should be no higher than 0.1psi

We appreciate the opportunity to comment and hope that our suggestions are of value in your decision making process.

Yours sincerely,



James Rau, B. Mining Engineering  
General Manager

<sup>1</sup> Venter J, van Vuren, 1998. *Portable refuge chambers: aid or tomb in underground escape strategies*, Proceedings Mine Rescue: Into the New Millennium, pp 55-78, (Mine Ventilation Society of South Africa)