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PROGRAM INFORMATION BULLETIN NO. P10-21

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SUBJECT: Breathable Air, Air-Monitoring and Harmful Gas Removal Components for Use in Refuge Alternatives Consisting of 15-psi Stoppings

Who needs this information?
This Program Information Bulletin (PIB) applies to operators of underground coal mines, miners' representatives, Mine Safety and Health Administration (MSHA) enforcement personnel, and other interested parties.

What is the purpose of this bulletin?
This Program Information Bulletin (PIB) provides information to the mining community on breathable air, air-monitoring, and harmful gas removal components that may be used with refuge alternatives consisting of 15-psi stoppings. This information is being provided since refuge alternatives consisting of materials prepositioned for miners to deploy in a secure space with an isolated atmosphere that MSHA has accepted in approved Emergency Response Plans (ERP) that were in use prior to March 2, 2009 are permitted only until December 31, 2010, or until replaced, whichever comes first.

Information
Until breathable air, air-monitoring, and harmful gas removal components approved by MSHA under Title 30 Code of Federal Regulations (C.F.R.) Part 7 are commercially available for use with refuge alternatives consisting of 15-psi stoppings, mine operators may comply with the Federal Mine Safety and Health Act (Mine Act) by:

1. Using breathable air, air-monitoring, and harmful gas removal components that are grandfathered for use until December 31, 2013 under 30 C.F.R. § 75.1506(a)(3). These include breathable air, air-monitoring and harmful gas removal components that MSHA accepted in ERPs and that were in mines prior to March 2, 2009 for use with brattice cloth or other pre-positioned material for miners to deploy after an event to create a secure space with an isolated atmosphere. While brattice cloth or other pre-positioned material may not be used as the structural component of a refuge alternative after December 31, 2010, other components initially approved for use with brattice cloth or other pre-positioned material may be used until December 31, 2013 if approved for use in a 15-psi stopping refuge unit as part of a revised ERP. In reviewing the ERP, the District Manager will determine whether the components will maintain trapped individuals for a sustained period of time if used in conjunction with the 15-psi stopping unit specified in the revised ERP. The guidance document "Use of Non-Part 7 Approved Components with 15 psi Stoppings" is attached to this PIB to provide further information.

2. Purchasing a packaged system designed for these applications from a manufacturer of State-approved prefabricated refuge alternatives having a rated capacity for persons that is equivalent to the capacity of the 15-psi stopping unit. While the breathable air, air-monitoring, and harmful gas removal components' capacities should be at least equivalent to the capacities of corresponding components in the State-approved prefabricated units, purge air capacity should be sized to fit the dimensions of the 15-psi stopping unit, including the air lock system. The breathable air, air-monitoring and harmful gas removal components are subject to review and approval by the District Manager to assure that they are capable of maintaining individuals for a sustained period of time if used in conjunction with the 15-psi stopping unit specified in the revised ERP.

3. Connecting a compressor or fan to an existing 15-psi stopping unit via a borehole or via horizontal, buried (or otherwise protected) line such that breathable air can be provided immediately after an event that may require miners to seek refuge. This system is subject to review and approval by the District Manager to assure that it is capable of maintaining individuals for a sustained period of time if used in conjunction with the 15-psi stopping unit specified in the revised ERP. While this option is available to any mine operator, MSHA recognizes that it may be most viable for new mines or existing mines establishing an additional working section.

What is the background for this PIB?
A number of mine operators have expressed an interest in using refuge alternatives consisting of 15-psi stoppings constructed prior to an event. These units must be used in conjunction with breathable air, air-monitoring and harmful gas removal components that have been approved for use pursuant to 30 C.F.R. Part 7 or that have been grandfathered for use until December 31, 2013. However, Part 7-approved breathable air, air-monitoring, and harmful gas removal components presently are not commercially available, and not every mine operator has access to grandfathered components.

An operator who wants to use 15-psi stoppings to provide refuge may design a plan for construction of the stoppings for a District Manager to consider during the ERP review process. See MSHA Program Policy Letter No. P09-V-14, *15 psi Stoppings as Structural Components for Refuge Alternatives* (12/18/09). This PIB provides guidance for the use of 15-psi stopping refuge alternatives until December 31, 2013 and prior to the commercial availability of Part 7-approved components.

What is MSHA's authority for this PIB?
Section 316 of the Federal Mine Safety and Health Act of 1977, as amended, 30 U.S.C. § 876; 30 C.F.R. §§ 75.1506 and 75.1507.

Is this PIB on the Internet?
This PIB may be viewed on the Internet by accessing the MSHA home page (www.msha.gov) then choosing "Compliance Info" and "Program Information Bulletins."

Who is the MSHA contact person for this PIB?
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Who will receive this PIB?
MSHA Program Policy Manual Holders
Underground Coal Mine Operators
Coal Special Interest Groups

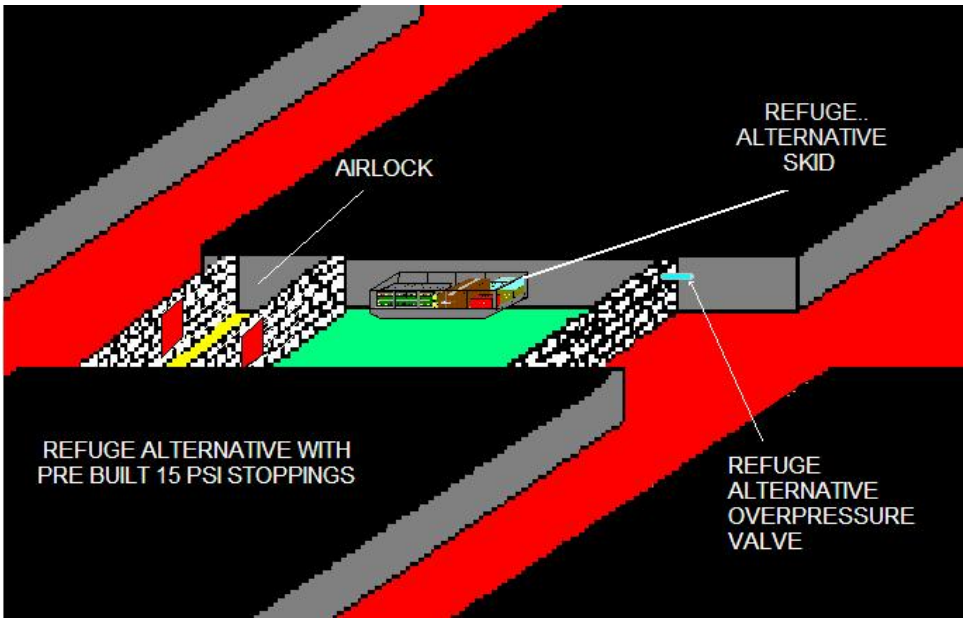
Attachment

Use of Non-Part 7 Approved Components with 15 psi Stoppings

This supplement is intended to provide guidance for underground coal mine operators and other interested parties with respect to refuge alternatives utilizing 15 psi stoppings. This guidance is being provided as per PIB No. 10-21 for non-MSHA Part 7 approved components placed behind a 15 psi stopping after March 2, 2009. This guidance will apply on an interim basis and expire on 12-31-2013. After December 31, 2013, all components for use inside 15 psi stoppings will have to be MSHA Part 7 Approved. This guidance does not supersede or replace any provisions of the Final Rule for Refuge Alternatives.

General

The illustration below depicts an example that consists of a skid located between two 15 psi stoppings with an inner wall that is constructed to provide for the airlock. The inner wall is not required to be rated for 15 psi. The skid contains all of the components and provisions required to sustain trapped miners for the period of time designated in the ERP. The refuge alternative must have the ability to be pre-shifted as defined by §75.360 (d).



The stoppings should be inset in the crosscut as much as possible and still allow the required area for the number of intended occupants. A flush location is less desirable since this would expose stoppings to higher pressure and debris from an explosion.

Refuge alternatives must provide at least 15 square feet of floor space per person and at least 30 to 60 cubic feet of volume per person as outlined in the Final Rule §75.1506(b)(1). The airlock measurements can be used to meet the space and volume requirement if waste is disposed outside the refuge alternative and airlock areas.

Among other things, the ERP must include the rated capacity of each refuge alternative, the number of persons expected to use each refuge alternative, and the duration of breathable air provided per person by the approved breathable air component of each refuge alternative. The actual dimensions of the airlock and internal space (location of skid) should be provided in the ERP. A district manager may refuse to approve an ERP if the operator does not demonstrate that the maximum apparent temperature inside the refuge will not exceed 95 degrees F when the refuge is used at its maximum capacity throughout the entire period of time that it may be used.

The methods for operation of the refuge alternative components (breathable air, air-monitoring and harmful gas removal) should be included in the ERP. These methods also must be made readily accessible at the refuge alternative, and they should provide the necessary level of detail to allow the miners to operate the refuge alternative as intended and be formatted to be easily read and understood by miners while subjected to the stress of an emergency. This material should be used in quarterly and annual expectations training. Additionally, information should be provided for pre-shift examinations, maintenance, and maintenance training. Maintenance procedures or methods should include scheduled refuge alternative examinations and checks for expired components and provisions.

The refuge alternative must have a two-way communication facility that is a part of the mine communication system, which can be used from inside the refuge alternative; and accommodations for an additional communication system and other requirements as defined in the communications portion of the operator's approved ERP.

The refuge alternative needs to be stocked with the following provisions:

- Lighting sufficient for persons to perform tasks.
- A means to contain human waste effectively and minimize objectionable odors.
- First aid supplies.
- Materials, parts, and tools for repair of components.
- A fire extinguisher that meets the requirements for portable fire extinguishers used in underground coal mines under part 75.
- Food and water.

Containers used for storage of refuge alternative components or provisions should be

- Airtight, waterproof, corrosion resistant and rodent proof;
- Easy to open and close without the use of tools; and
- Conspicuously marked with the expiration date of the corresponding contents and instructions for use.

Components should not liberate harmful or irritating gases or particulates into the structure. Some nonmetallic materials liberate "off-gas." Vapors, aerosols or particulates should not be released into the refuge alternative. Materials used in a refuge alternative or component should be evaluated to verify that they do not release harmful or irritating gases. Materials that have a potential to ignite should not be used or should be stored in a sealed noncombustible container.

All miners should be trained on the safe use and potential hazards of oxygen and compressed gases, and they must be trained on the operation of the components. Additionally, the transportation (including placement) of the skid and use of its contents and components should be covered during all training sessions including new miner and all training required by the final rule.

For miners who will be constructing the 15 psi stoppings prior to an event, the guidance given in Program Policy Letter P09-V-14 should be followed.

A statement should be included stating that the components or parts are compatible with other components and, upon replacement, are equivalent to the original components or parts. The intent is to assure that components or parts must be interchangeable or must integrate with the other components or parts in the refuge alternative so that the refuge alternative will continue to operate as intended

The information submitted should include the components' make and model number, if applicable. Documentation should include features of each component and contain sufficient information to document the technical specifications. The information should include the dimensions and layout of the refuge alternative components, controls, and materials necessary for proper operation.

Each component's or part's in-mine shelf life, service life, and recommended replacement schedule should be included.

Spare regulators and tools to make repairs should be provided in the event of failure of the primary regulator on the compressed breathable air and oxygen system.

All electrical components located inside the refuge alternative must be either MSHA approved as intrinsically safe or permissible.

Breathable Air

The methods for providing breathable air with sufficient detail of the component's capability to provide breathable air over the duration stated in the ERP must be provided.

Breathable air should be supplied by compressed air cylinders and / or compressed breathable-oxygen cylinders or from boreholes with fans or compressors installed on the surface. Only uncontaminated breathable air should be supplied to the refuge alternative. As referenced in the final rule, MSHA recommends using Grade D compressed air. Grade D air specifications:

- O2 = 19.5 to 23.5 %
- CO = 10 PPM max
- CO2 = 1000 PPM max
- Oil = 5 mg/m3 max
- Odor = lack of noticeable odor

When using refuge alternatives designed for 5 or fewer miners, operators should consider using only compressed air due to the increased risk of fire associated with compressed oxygen systems. Compressed air in lieu of an oxygen system uses 5 times the number of cylinders, however, with fewer people, the number of cylinders needed to provide breathable air is still practical. The use of compressed air cylinders that deliver 6.6 cubic feet of air per hour per person would still require CO_2 scrubbing.

Mechanisms generally should be provided and procedures included so that the refuge alternatives sustain each person for at least 96 hours. Mechanisms include gauges, valves, manifolds, adjustable flow-rate control and associated charts for required flow-rate based on occupancy.

Oxygen should be delivered at a rate of 1.32 cubic feet per hour per person.

The oxygen concentration should be maintained at levels between 18.5 and 23 percent, and the average carbon dioxide concentration maintained at 1.0 percent or less, with excursions not to exceed 2.5 percent.

The following table is used to determine the minimum number of oxygen cylinders needed for maintaining breathable air for 96 hours within the refuge. The table is based on an oxygen consumption rate of 1.32 cubic feet per hour per person.

Total Quantities of Oxygen for 96 Hours						
Persons	**O_2 (Ft^3)**	**4500 psi cylinders**		**Persons**	**O_2 (Ft^3)**	**4500 psi cylinders**
1	127	1		19	2,408	5
2	253	1		20	2,534	6
3	380	1		21	2,661	6
4	507	2		22	2,788	6
*5	634	*2		23	2,915	6
6	760	2		24	3,041	7
7	887	2		25	3,168	7
8	1,014	3		26	3,295	7
9	1,140	3		27	3,421	8
10	1,267	3		28	3,548	8
11	1,394	3		29	3,675	8
12	1,521	4		30	3,802	8
13	1,647	4		31	3,928	9
14	1,774	4		32	4,055	9
15	1,901	4		33	4,182	9
16	2,028	5		34	4,308	9
17	2,154	5		35	4,435	10
18	2,281	5		36	4,562	10

* From the paragraph above the table related to using refuge alternatives with 5 or less persons, the number of compressed air cylinders (4500 psi) required for 5 persons would be 5 times the quantity of Oxygen cylinders or 10 cylinders of compressed air required for breathable air. Other compressed air cylinders are required for purging requirements and would be in addition to the 10 in this situation.

Oxygen Hazard Identification and Prevention

An analysis or study should evaluate the potential fire and ignition risks of compressed oxygen systems. The results of this analysis or study should be included in the ERP.

Oxygen fire hazards can be avoided by plumbing the oxygen cylinders into a manifolded system in a **certified** oxygen clean facility. The term "certified" means that manufacturers, suppliers, and rebuilders of oxygen systems and components ascertain and confirm that a part or system is (a) clean, (b) suitable for use with oxygen in accordance with industry standards, and (c) able to withstand (i.e., compatible with) the corresponding pressures given industry recognized safety factors. The reference cited in the Refuge Alternatives Final Rule preamble was: *Safe Use of Oxygen and Oxygen Systems: Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation*, ASTM Stock No.: MNL 36
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Picture showing secured cylinders with manifold

Oxygen systems should not be assembled or maintained underground to minimize the contaminant ignition hazard. Plumbing of these systems should incorporate flow valves that prevent a leaking cylinder from evacuating the entire system. Individual gauges should be used for each cylinder valve to facilitate pre-shift inspection.

Sharp angled bends and fittings should be avoided to prevent particle ignition inside of the system. This can be accomplished by the use of smooth radius bends, as shown in the illustration. Use only commercially available parts that have been tested as suitable for oxygen use,

including ‘no oil’ gages. The system should be designed such that flow velocities will be below 100 ft. per second to alleviate the possibility of particle ignition. As a reminder, velocity in ft/second is not to be confused with flow in cubic ft/second as shown on flow gauges. Please see the relationship between velocity and flow rate in the chart below:

Relationship Between Velocity and Flow Rate				
Nominal Diameter (inches)	Inside Diameter (inches)	Velocity (ft/sec)	Flow Rate (cfm)	Flow Rate (lpm)
1/8	0.125	100	0.6	14.4
1/4	0.25	100	1.8	58.2
3/8	0.375	100	4.8	130.2
1/2	0.5	100	8.4	231.6
5/8	0.625	100	12.6	361.8
3/4	0.75	100	18.6	521.4
7/8	0.875	100	25.2	709.2
1	1	100	33	926.4

Maintain a minimum distance of pipe length to 10 times the pipe diameter downstream of a potential high velocity component, such as valves, tees, or at any location where the flow changes directions. Particle ignition can occur with velocities greater than 150 ft per second. Do not use non-metallic hoses in the oxygen system.

Cylinder valves should remain in either the on or off position depending on the circuit design. Turning cylinder valves on and off should not be part of the pre-shift inspection procedure. Turning oxygen valves on and off is a potential source of particle impact, frictional flow, and/or adiabatic compression ignition. The proper procedure is to open the valves on oxygen cylinders slowly to prevent potential impingement induced fires or explosions in the systems. The ERP should include instructions for use that includes language about the importance of proper deployment. Additionally, a label detailing this procedure should be affixed in the area of the manifold.

Oxygen systems should be housed so as to prevent corrosion to the system, and the housing should be ventilated to avoid oxygen enrichment of the enclosure. Firefighting accessibility should be taken into consideration when approving the system.

A compressed breathable oxygen system should not be used with a previously used compressed air system because a fire or explosion could occur when pure oxygen contacts oil and grease from the previously used compressed air system.

Harmful Gas Removal

Airlock / Purging

Each refuge alternative should include means for removing harmful gases. Purging or other effective procedures should be provided for the airlock to dilute the carbon monoxide concentration to 25 ppm or less and the methane concentration to 1.0 percent

or less as persons enter, within 20 minutes of persons deploying the refuge alternative. A minimum of four purge cycles would be required.

The airlock should have a volume of compressed air designed for repeat purging to allow multiple uses of the airlock by persons entering to accommodate the structure's maximum occupancy. The sum of these purging volumes will determine the total amount of compressed air needed for purging.

The procedures for monitoring and maintaining breathable air in the airlock, before and after purging should be specified. The instructions for determining the quality of the atmosphere in the airlock and refuge alternative interior and a means to maintain breathable air in the airlock should be specified.

The air that is used to purge the airlock must be in addition to the breathable air needed to sustain persons for 96 hours.

The airlock should be configured to accommodate a stretcher that allows the doors to be closed with the stretcher in the airlock.

Without an airlock, the interior volume must be purged to bring the harmful gas concentrations to an acceptable level prior to persons removing breathing apparatus after entry and within 20 minutes of persons deploying the refuge alternative.

Chemical Scrubbing

Carbon dioxide removal components should be designed and sized to have the capability to remove carbon dioxide at a rate of 1.08 cubic feet per person per hour for the stated duration of breathable air based on the maximum designed occupancy of the refuge.

Mechanisms (controls and monitoring) should be provided so that the average carbon dioxide concentration is 1.0 percent or less, and excursions do not exceed 2.5 percent within the refuge alternative. The oxygen concentration should be maintained at levels between 18.5 and 23 percent. Procedures describing these controls should be provided and kept for ready reference inside the refuge alternative. These procedures for the chemical scrubbing should include deployment, operation and temporary disposal of spent scrubbing material.

The ERP should include information from the manufacturers of chemical scrubbing material that is relevant to the specific refuge alternative design. This information should include calculations demonstrating that their product meets the 1.08 cubic feet per hour of CO_2 per person basis for an approval consideration. As an example, the ERP should indicate the calculations and number of curtains or quantity (if a powered system is used) of scrubbing material required on a per person/per hour basis.

Harmful gas removal components should meet the following:

- Chemicals should be contained such that when stored they cannot come in contact with persons, the mine atmosphere, moisture, and they cannot release airborne particles. When the product is used, it should not come in contact with persons or release airborne particles.
- Provided with all materials, parts (such as hangers, racks, and clips), equipment, temporary disposal containers, and instructions necessary for deployment and use.
- Stored in an approved container that is conspicuously marked with the manufacturer's instructions for disposal of used chemical.
- Chemicals used for removal of carbon dioxide and its associated packaging should be evaluated for potential ignition and fire hazard.
- A powered scrubber should not produce continuous noise levels in excess of 85 dBA in the structure's interior. Continuous noise above 85 dBA can interfere with communication and could adversely affect hearing.
- Carbon dioxide removal components should be used when breathable air cylinders or oxygen cylinders are necessary for breathable air.

Air-monitoring

The air-monitoring component provides occupants with the ability to determine the concentrations of carbon dioxide, carbon monoxide, oxygen, and methane both immediately outside and inside the refuge alternative structure, including the airlock. Occupants need to be able to measure gas concentrations outside the refuge alternative without exiting the structure or allowing exterior gases to enter the breathable air space of the structure.

The operating range, type of sensor, gas or gases measured, and environmental limitations, including the cross-sensitivity to other gases, of each detector or device in the air-monitoring component should be specified in the ERP.

The following chart provides guidance on methods of gas detection, and the associated sensors, recommended for various gases:

Gas to be monitored	Recommended Primary Method of Detection	Type of Sensor
Oxygen	Electronic gas detector	electrochemical
Carbon Dioxide	Electronic gas detector (stain tube as secondary means)	Infrared
Carbon Monoxide	Electronic gas detector (stain tube acceptable as secondary means for sampling outside of refuge alternative)	electrochemical
Methane	Electronic gas detector	catalytic or infrared

While not recommended as a primary means to measure gas concentrations in a refuge alternative, stain tubes provide a supplemental method for measuring carbon dioxide and for measuring carbon monoxide outside of the refuge alternative.

In all cases, the methods for monitoring gas concentrations, including charging and calibration of devices, must be described in the ERP. The procedure for operation of the individual devices should be included in the ERP to demonstrate the instruments' capability to function as necessary to test gas concentrations as appropriate over the period specified in the ERP for providing breathable air. The use of multiple detectors is preferred. Detectors that will be turned on and off to conserve the battery must be approved for use in this manner.

Structural

The refuge alternative skid should secure and protect the components including compressed gas cylinders during transportation. The skid also should be protected from falling roof and rib during storage and transportation. The enclosure should permit ready access to components for pre-shift and maintenance examinations. Electronic devices should be arranged so that they can be readily checked for battery charge and function.

Valves, regulators, and piping should be protected against damage from handling and roof and rib falls by guarding, metal enclosures or other appropriate protective methods.

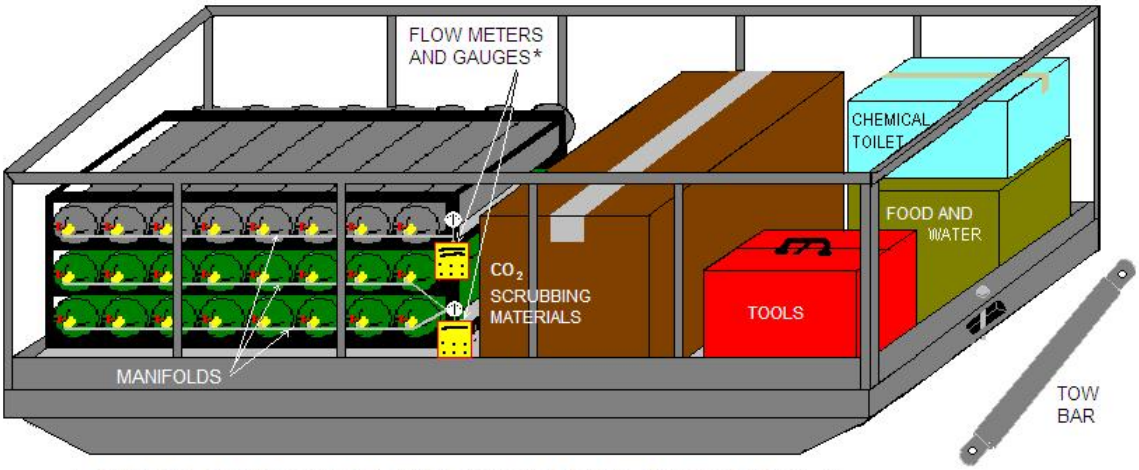
A procedure should be described for keeping the internal area of the skid free from contamination of dust and debris, and a regular schedule should be provided for periodic housekeeping of the internal contents of the skid, including the cleaning of coal dust and other material.

The skid should be provided with a means to indicate unauthorized entry or tampering.

The skid generally is not subject to 15 psi overpressure or flash fire requirements if the 15 psi stopping door remains closed. If the District Manager requires the doors to be left open (for example to ventilate the interior to prevent gas accumulations) the skid should meet overpressure and flash fire requirements in the final rule.

The cleanliness of oxygen systems is critical for their safe operation. Small combustible particles and oils could provide a fuel source for a fire and explosion if they enter a compressed oxygen system.

Tow bars or other appropriate devices should be used to transport the skid. Inadequate rigging and towing devices could result in hazards to miners. As shown below, the skid should be designed with proper connections for tow bars to eliminate the need for chains, ropes, or slings.



TOP AND SIDE PANELS SHOWN REMOVED FOR VISIBILITY

*When panels are in place, the gauges must be visible for pre shift examination.

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