SWAGELOK MEET THE CUSTOMER

Pillar Innovations

RELIABLE, PORTABLE UNITS DESIGNED TO SHELTER MINERS FROM DISASTER

Following an explosion in the Sago Mine in West Virginia, 13 miners where trapped with the escape route blocked by lethal carbon monoxide and methane gas. They retreated to a coal rib and hung a curtain for protection. Some of the miners' emergency oxygen packs were not functioning. They were trapped for nearly two days, and only one survived. A refuge shelter may have saved their lives.

In the wake of the January 2, 2006 Sago Mine disaster, West Virginia enacted legislation that requires underground mines to have accessible refuge shelters that can sustain life for 96 hours. The shelters must be located near mining operations, have sufficient emergency supplies and, above all else, operate reliably. West Virginia approved five such shelters, including the Fresh Air Bay (FAB) manufactured by Pillar Innovations LLC and sold by Strata Products Inc. Strata's FAB, which features an expandable, inflatable refuge chamber, was the only shelter found to comply with all of the tests conducted by the National Institute of Safety and Health (NIOSH) in its initial review of the five shelters.

Reliable Swagelok® components in the FAB's air systems, as well as other key factors, contributed to this passing grade and the resulting jump in FAB orders. When demand for FABs escalated, Pillar needed a quick turnaround on the vital air systems and looked to Pittsburgh Valve & Fitting Company, an Swagelok Company sales and service center, for help.

CREATING A SAFE HAVEN

In the event of an underground fire or explosion, miners must escape or quickly isolate themselves from the potentially poisonous environment and await rescue. Miners are trained to build barricades out of available resources to provide a breathable atmosphere while blocking contaminated air. However, NIOSH reports that "barricading is not considered to be a viable refuge alternative."1 Instead, chambers and in-place shelters are preferred.

In-place shelters can offer a higher volume per occupant and better environmental and sanitary conditions than chambers. However, it is impractical to move in-place shelters frequently, which means miners may have long travel times to reach them in an emergency.

Self-contained, portable chambers like Strata's FABs are transported along the working face of mining operations. With FABs placed strategically near active operations, miners encounter less distance – and less time – to reach safety.

FABs feature an expandable tent-like refuge shelter (the "bay"), which is inflated in a similar manner to airplane emergency slides. The inflatable shelter and a variety of items necessary for survival are housed in explosion-resistant steel "containers" (known as FAB skids). The skids are available in sizes as long as 16 feet and as high as 45 inches. The inflatable bays are available in heights up to 66 inches tall when deployed. Skid contents include first aid supplies, emergency equipment, a toilet, an active carbon dioxide (CO2) scrubber and enough food, water and oxygen to sustain life for 96 hours. All supplies are accessible from inside the inflatable chamber (bay).

The skid also stores compressed gas cylinders and a sophisticated air delivery subassembly that is one of the most critical components to the reliability and effective operation of FABs.

"Following an explosion, miners must locate a nearby Fresh Air Bay, deploy the shelter and activate the unit's compressed air systems," explains Jerry Maust, division manager of Pillar Innovation's Northern Garrett office. "The FAB skids are transported all over the mine, getting bumped and jostled frequently. We needed air delivery components that would ensure leak-tight operation not just during manufacturing and testing but also when it counts the most – during an emergency."

Pillar leveraged an existing relationship with Pittsburgh Valve & Fitting Company to investigate component solutions for the four air systems housed inside FAB skids. Pittsburgh V&F offered a variety of Swagelok tube fittings, VCO® O-ring face seal fittings and tubing as solutions (Figure 2).

"The leak integrity of Swagelok products is especially important because this high-pressure application needs to be pressurized with a very minimal leak rate for a period of five years. For our product to remain serviceable and within the minimal allowable pressures, we need to ensure connection leak rates of 10-6 where possible, sometimes 10-7 [std cm3/s], which Swagelok meets," says Michael Bishoff, mechanical engineer, P.E. for Pillar Innovations.

The four high-pressure FAB air systems include:

1. Inflation – A 6,000-psig (413 bar) compressed air system rapidly inflates the durable tent-like shelter that serves as the refuge for trapped miners. Miners open the FAB's door, unfold the shelter and pull a cord to activate the air system. The airtight shelter inflates in about five minutes. To ensure fast deployment, the shelter's inflation system is maintained in a fully pressurized state ready for activation. The other three systems are activated at the time of an emergency by opening three master control valves.

2. Purge – A 6,000-psig (413 bar) purge system offers a first line of protection for miners before taking refuge. The inflatable shelter features an air-lock entry in which miners decontaminate themselves as best as possible using high-pressure air before entering the actual shelter. This system helps minimize the air contaminants entering the main chamber:

3. Oxygen – Medical-grade oxygen cylinders set at 4,500 psig (310 bar) provide 96 hours of breathable air to miners inside the shelter. Miners set a flow meter to the number of people inside the shelter to ensure proper regulation of oxygen levels. Miners can sit and breathe normally while in the shelter.

4. Fan (Ventilation) – A 6,000-psig air system powers an active soda lime CO2 scrubbing system that absorbs CO2 and circulates air to help maintain a breathable atmosphere inside the chamber. The FAB skid, which is accessible from inside the shelter via a hermetically-sealed opening, houses enough replacement soda lime cartridges to meet or exceed a 96-hour duration at the FAB's full-rated occupancy.

DELIVERING SAFETY AND RELIABILITY

With the high demand for FABs that occurred in the wake of the West Virginia policies and NIOSH testing, Pillar had to move quickly on filling orders from Strata. As a result, Pittsburgh V&F moved from being a component supplier to playing a larger role in production.

Pittsburgh V&F had recently set up an Integrated Service Solutions Division, which offers custom fabrication and assembly. Through this service, Pittsburgh V&F takes customer specifications, builds assemblies, and ships them to the field for final installation. Capabilities range from building small assemblies to large skids, panels and cabinets, as well as specialized tube bending and orbital welding services. This was just the service Pillar needed at just the right time.

"Because of the legislation, mines are required to issue a plan and timeframe for implementation. Therefore, it's very important that we are able to issue a production schedule with dates that we are able to meet," explains Bishoff. "We weren't sure that we could find anybody that would be able to use the components that Swagelok provides and assemble the regulators, pressure gauges and valves that are also part of the system. Through Pittsburgh Valve & Fitting, we were able to purchase those major systems complete and leak tested."

Pillar Innovations placed an immediate order for Pittsburgh V&F to assemble more than 380 air system subassemblies. Later, Pillar placed an order for 63 additional units. The orders required

a total of 4,873 tube fittings, 1,772 VCO fittings and 25,251 lineal feet of tubing.

Pittsburgh V&F went to Swagelok with the large order in hopes that inventories were available. Of particular concern was the availability of parts for FAB oxygen systems. While the other three air systems contain stainless steel components, the oxygen system requires parts made from alloy 400, a material that can withstand a fire in pure oxygen. “Swagelok had products that were readily available in alloy 400, which is not necessarily common across the industry,” notes Bishoff.

Pittsburgh V&F handles full fabrication and testing of the air system subassemblies in its 2,500 square-foot, multi-level shop. Tubing is first cut, cleaned, deburred, and bent to specification. It is then staged in bulk for assembly. To speed up production and ensure a proper, uniform fit when the subassemblies reach Pillar for installation, Pittsburgh V&F created a custom assembly jig (Figure 4). The jig features a separate plate for each of the four air lines. All measurements are clearly marked to ensure that the tubing is bent and angled to precise specifications for each system.

Pittsburgh V&F has had as many as 30 subassemblies ready for delivery to Pillar at one time. The company is able to ship 12 units per van load using custom-fabricated boards that protect the units during transport. When demand was at its highest, Pittsburgh V&F made deliveries every week to keep up with Pillar’s production schedule.

ENSURING LEAK-TIGHT PERFORMANCE

Before air system subassemblies leave Pittsburgh V&F’s shop, they are carefully tested to ensure no leaks are present. The company created a custom testing apparatus that enables technicians to test up to four subassemblies at a time (Figure 7a). In less than 20 minutes, four subassemblies can be mounted and connected to a gas line on one end and an exhaust hose on the other. Jim Salvatore, division manager for Pittsburgh V&F, then purges each subassembly with air before piping in a mixture of 30 percent helium and 70 percent compressed air.

Safety is paramount during testing due to the required system pressures of 4,500 psig (310 bar) and 6,000 psig (413 bar). During purging and pressurization, Salvatore stays behind a large, transparent blast shield.

Once the lines are filled, Salvatore closes the exhaust valves, leaving the high pressures on the lines. He then meticulously checks every joint, valve and connection using a leak detector.

Pillar also performs a final leak test during FAB manufacturing (Figure 7b). After the four air systems are installed and before a unit is packed and sealed, Pillar technicians pressurize the systems using the same helium/compressed air mixture and check connections for leaks.

“The mine safety chambers are all about safety, reliability and integrity. That’s what makes Swagelok and Pillar good partners in this project,” notes Bishoff.

CONCLUSION

West Virginia is currently the only state to require refuge alternatives to be used in active underground mining operations. However, mine operators in the state are adding FABs to their operations in other states. Strata plans to market its shelters to other states and countries, with an eye on targeting mining and construction industries beyond coal mining.

While refuge alternatives like Strata’s FAB units have the potential to save lives of mine workers, NIOSH recommends that mine operators also implement comprehensive escape and rescue plans to further enhance worker safety.

END NOTES:

1. “Research Report on Refuge Alternatives for Underground Coal Mines,” National Institute of Safety and Health. December 2007.