



State of West Virginia
Earl Ray Tomblin, Governor

WV Office of Miners' Health, Safety & Training
C. A. Phillips, Director
1615 Washington Street East • Charleston, West Virginia • 25311-2126
Telephone 304-558-1425 • Fax 304-558-1282
www.wvminesafety.org

TO: WV Underground Mine Operators and Shelter Manufacturers

FROM: C. A. Phillips, Director *C.A. Phillips*

DATE: October 14, 2011 (Supersedes September 29, 2011 Order of same name)

SUBJECT: **Order to Refit Approved Underground Mine Shelters**

UNDERGROUND MINE SHELTER SAFETY ISSUE

On Sunday, January 9, 2011, a catastrophic failure occurred in a high pressure gas cylinder fitting connected to the breathable air system in an approved shelter located in an underground West Virginia coal mine. The West Virginia approved shelter, model number 4042-35, was manufactured by the A.L. Lee Corporation on March 21, 2008. This inflatable design shelter was equipped with 12 high pressure oxygen cylinders, each pressurized at 4,500 psi and connected to a manifold. This catastrophic failure allowed a rapid release of oxygen, which pressurized the interior of the steel structure. Following an inspection of the failed shelter, OMHS&T and MSHA initially determined that the pressure build-up inside the container forced open both the tent deployment door and the air-lock access door and ejected a supply container and 5-gallon water containers from the access door area onto a nearby rib.

ANALYSIS

Subsequent analysis of the failed shelter led to the discovery of cracks on multiple valves and fittings and identification of fittings that did not meet Compressed Gas Association dimensional specifications. Inspections of additional underground mine shelters conducted at OMSH&T's request discovered similar issues on valves and fittings of high pressure oxygen, air cylinders and associated distribution manifolds used in approved shelters produced by all manufacturers. A significant number of fittings and valves on high pressure cylinders had developed cracks after only three years of service. Specifically, in one instance, half of the valves and fittings in a refuge shelter had developed cracks that were classified by valve

manufacturer, Sherwood, as “moderate to severe.” In addition, multiple fittings were found during subsequent inspections by manufacturers, OMHS&T, and MSHA to be manufactured to improper dimensional specifications (see attached).

Additionally, Sherry Laboratories of Daleville, Indiana, conducted a metallurgical analysis of valves and fittings utilized in underground mine shelters. The results pointed to fracture by stress-corrosion cracking resulting from the interaction of an agent with the zinc in the brass. Corrosion occurs as a chemical process on the atom level changing zinc into an oxide and reaction preferentially progresses through areas of current or residual stress in the brass until a crack develops (see attached).

Finally, the Salt Lake Technical Center (SLTC) of the Occupational Safety and Health Administration (OSHA) performed a metallurgical analysis of the valves and fittings from inspected shelters. Their analysis confirmed that the failures were a result of stress-corrosion cracking. The SLTC report also stated that the stress-corrosion cracks in the fittings and valves examined, which had not yet failed, indicated that they were on the path to failure. SLTC noted generally that brass is susceptible to corrosion cracking in moist atmospheres that contain certain chemical compounds (see attached).

ORDER

After reviewing the issues and investigations associated with the premature failure of brass valves and fittings in multiple underground shelters, OMHS&T hereby orders, in accordance with W. Va. Code § 22A-1-4 and consistent with the mandates of W. Va. Code R. § 56-4-8, the following:

1) All underground mine shelters required by the mine’s approved Shelter Plan and in service under an approval granted by the Director pursuant to W. Va. Code R. §56-4-8 shall be inspected by a qualified representative of the manufacturer to determine the condition of every brass compressed gas cylinder valve and associated fitting, and such inspection shall be attested to have occurred by a person certified by OMHS&T (“Certified Person”) and employed by the permit holder. The inspections required by this paragraph 1 shall include physical examinations of all brass valves and fittings specifically designed to detect signs of corrosion, stress-corrosion cracking, and fittings that do not meet the standard dimensions required by the current Compressed Gas Association dimensional specifications. Inspections performed after January 13, 2011, but prior to the date hereof that were conducted consistent with this Order and for which Inspection Reports, Attestations and Manufacturer’s Statements, as applicable, are submitted to and approved by the Director as set forth herein shall satisfy the requirements of this paragraph 1.

Inspections of all shelters performed by a qualified representative of the manufacturer following the January 13, 2011, Equipment Failure Notice shall be recorded. For each inspection completed, the manufacturer’s representative shall submit a written inspection report (an “Inspection Report”) to the Director, which shall include the date of the inspection, serial number(s) of the shelter inspected, manufacture date of the shelter, name and permit number of the mine in which such shelter is located, location at the mine, number of brass fittings inspected,

number of brass valves inspected, and a listing of any visible signs of corrosion, stress-corrosion cracking or out of dimensional tolerance. Each Inspection Report shall be signed by the manufacturer's qualified representative who completed the inspection and, when filed with the Director, shall be accompanied by a written attestation ("Attestation") signed by a Certified Person employed by the permit holder attesting that the inspection was completed on the date indicated in the inspection report.

Shelters found to contain valves or fittings showing signs of corrosion, stress corrosion cracking or having improper dimensions shall be immediately taken out of service, unless a responsible representative of the manufacturer provides a signed statement ("Manufacturer Statement") that the shelter is safe to remain in service until the scheduled date of refit required by paragraph 2 below. In either case a report shall be made to the permit holder and the Director of the action taken within 24 hours.

All inspections required by this paragraph 1 shall be completed by no later than October 31, 2011, unless an alternative schedule is approved in writing by the Director. If a shelter was deployed less than twelve months prior to October 31, 2011 an alternative schedule should be proposed by the manufacturer for the Director's approval. Permit holders shall submit to the Director for approval Inspection Reports, Attestations, and Manufacturer Statements applicable to each completed inspection on or before October 31, 2011, unless modified by an approved alternative schedule provided for herein.

Each manufacturer shall submit to the Director for approval by October 31, 2011, unless an alternative schedule is approved in writing by the Director, a proposed "Manufacturer Compliance Plan," which shall consist of the compilation of all inspection results for West Virginia Approved Shelters, including the serial number(s) of the shelters, manufacture date of the shelter, the name and permit number of the mines in which each is located, the number of brass fittings inspected, the number of brass valves inspected, a listing of any visible signs of corrosion, stress-corrosion cracking or out of dimensional tolerance and the manufacturer's method and schedule for ensuring that sufficient quantities of all valves, fittings and other necessary parts will be available when necessary to complete the Refit process required by paragraph 2. The dates contained in approved Manufacturer Compliance Plans are enforceable as part of the manufacturers approval requirement.

2) In addition to the inspections required by paragraph 1, permit holders shall submit to the Director for approval by October 31, 2011, unless an alternative schedule is approved in writing by the Director, a written plan setting forth the manner and schedule by which each permit holder will replace all brass compressed gas cylinder valve and associated fittings utilized in underground mine shelters ("Refit Plan"). Such brass valves and fittings shall be replaced by December 31, 2013, with valves and fittings constructed of materials designed to withstand extended service in the underground mine environment without corrosion and stress-corrosion cracking (the "Refit"). Replacement valves and fittings shall also be subject to MSHA approval i.e., breathable air, harmful gas removal and monitoring components. The dates contained in approved Refit Plans are enforceable as part of the Emergency Shelter Plan.

West Virginia law requires that “[a]ny emergency shelter/chamber approved by the Director shall . . . [p]rovide proof of current approval for all items and materials subject to MSHA approval” W. Va. Code R. § 56-4-8.6(16). Accordingly, in order to comply with W. Va. Code R. § 56-4-8.6(16), permit holders must provide to the Director written documentation from the respective shelter manufacturers demonstrating that, at the time that each refitted shelter is returned to the applicable underground mine, all components thereof comply with current MSHA breathable air, harmful gas removal, and air monitoring component regulations and have necessary component approvals (see attached).

Upon completion of the Refit and the shelter being returned to the mine, an addendum to the mine’s Emergency Shelter Plan shall be filed with the appropriate OMHS&T regional office certifying the Refit.¹ Failure to comply shall result in the West Virginia approval for the unit being revoked and the operator being in violation of its Emergency Shelter Plan. West Virginia approved shelters refitted in accordance with this paragraph 2 and for which a properly completed addendum have been submitted to the appropriate OMHS&T regional office shall be deemed compliant with their West Virginia approval.

Note that under MSHA regulations 30 CFR §75.1506(a)(3), by December 31, 2018, prefabricated refuge alternative structures must also be MSHA-approved.

OMHS&T will provide future informational memoranda regarding the Refit process.

CONCLUSIONS

The demonstrated unpredictable service life of the brass valves and fittings is troublesome. The current situation left unchecked represents a safety hazard.

Identification of the exact compound or compounds responsible for facilitating the stress-corrosion cracking of the brass fittings and valves requires additional time and testing. However, corrective action does not require the exact identification of the corrosive agent as there are options that are capable of withstanding the underground mine environment without suffering zinc corrosion, which was identified as the root of the problem with the brass valves and fittings.

OMHS&T’s investigation strongly suggests delay may increase the number of failures and thus imposes an unacceptable safety risk. Therefore, all underground mine shelters must be inspected in accordance with paragraph 1 and the Refit of all brass compressed gas cylinder valves and fittings shall be completed in accordance with paragraph 2 and future OMSH&T instructions.

¹ After the Director has approved an operator’s emergency shelter/chamber plan, the operator shall submit revisions to the emergency shelter/chamber plan at any time that changes in operational conditions result in substantive modification. In addition, at any time after approval, the operator may submit proposed modifications or revisions to its plan along with reasons therefore to the Director. Within thirty (30) days after receipt by the Director of any proposed revisions or modifications to the emergency shelter/chamber plan, the Director shall either approve or reject the revisions, stating in detail the reasons for such rejection. W. Va. Code R. § 56-4-8.11.

PREVIOUS ACTIONS TAKEN

OMHS&T issued a safety notice on January 13, 2011, which notified the industry and instructed manufacturers to examine deployed units for similar issues (see attached).

MSHA published two hazard alert documents—Equipment Alert and a subsequent update memo concerning the hazard (see attached).

Manufacturers and the two agencies inspected units and examined valves and fittings suspected of potential failure.

A sample of the valves and fittings were submitted for metallurgical testing to Sherry Laboratories and to OSHA (see attached).

Consultations were held between the agencies and manufacturers of approved shelters and of the valves.

A joint OMHS&T and MSHA briefing was held on September 19, 2011, on the investigation and next steps.

ATTACHMENTS AVAILABLE FOR DOWNLOAD AT WWW.WVMINESAFETY.ORG.

Examination template

Summary of MSHA's Requirements for Breathable Air, Air Monitoring, and Harmful Gas Removal Components

West Virginia Equipment Failure Notice 13 January 2011

MSHA Refuge Chamber Alert 20 January 2011

Sherry Laboratory Metallurgy Report 27 January 2011

MSHA Refuge Chamber Alert Update 10 February 2011

Superior Products Letter 3 May 2011

OSHA Metallurgy Report 18 May 2011

Superior Products Letter 6 July 2011

Compress Gas Association Standard – Connection 701

Briefing Presentation September 19, 2011

References