State of West Virginia
Joe Manchin III, Governor

WV Office of Miners' Health, Safety & Training
Ronald L. Wooten, Director
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March 9, 2007

Draeger Safety, Inc.
101 Technology Drive
Pittsburgh PA 15275

Subject: Approval of Draeger Emergency Shelter™ under WV Legislative Rule Title 56, Series 4 Emergency Rules Governing Protective Clothing and Equipment

Sirs,

After the evaluation of the documentation submitted and with the recommendation of our technical reviewers the Office of Miner's Health Safety and Training approves Draeger Safety, Inc.'s the Draeger Emergency Shelter™ for use in meeting the Emergency Shelters/Chambers requirements outlined in the West Virginia Emergency Rule Governing Protective Clothing And Equipment, §56-4-8.

The Draeger Emergency Shelter™ is approved for application in underground mines for use by 10 and 16 miners when built and provisioned as designed and providing a minimum of 96 hours life support.

Draeger Safety, Inc. shall, upon request, provide this office with verification of valid orders, delivery dates, and status of delivery as required for this office to enforce §56-4-8.

Any changes required or enhancements to the approved design affecting the ability to meet any provision of §56-4-8 shall require approval of this Office prior to any affected Draeger Emergency Shelter™ being placed into operation.

Ronald Wooten
Director
Office of Miners' Health and Safety

Review of the Draeger Emergency Shelter™ Manufactured by Draeger Safety, Inc. for Adherence to WV Legislative Rule Title 56, Series 4 Emergency Rules Governing Protective Clothing and Equipment

March 8, 2007

WV Requirement	Consensus	Justification
§8.4.1. Provide a minimum of 48 hours life support (air, water, emergency medical supplies, and food) for the maximum number of miners reasonably expected on the working section; --- In addition shelters were reviewed against the recent MSHA PIB 07-03 that makes a federal standard for refuge chambers that has different assumptions than used for the WV standard. The major items are -- • 96 hours breathable air • 25 ppm instead of 50 ppm on the maximum CO; • 4 gasses to be detected in the chamber (O2, CO2, CO, and CH4); • 0.62297 LPM oxygen per man, not 0.5; • 0.5097 LPM CO2 scrubbing capability, not 0.4; • 3 fold chamber volume purge air requirement. http://www.msha.gov/regs/complian/PIB/2007/pib07-03.aspSome.	Meets Requirement	The independent professional engineer, Lloyd English, PhD, PE (10347 WV), and the manufacturer presented reviewers with documentation and addressed inquiries such as to demonstrate that the LifeShelter™ meets individual elements contained in §8.4.2. through §8.4.15. Meeting these requirements satisfies §8.4.1. The Draeger Emergency Shelter™ design reviewed were for 10 and 16 person units with life support for at least 96 hours. The independent professional engineer and manufacturer presented detailed computational analysis and evidence from testing supporting their claims that the Draeger Emergency Shelter™ meets or exceeds all applicable Title 56, Series 4 requirements and those applicable from MSHA PIB 07-03. It is the consensus judgment of the reviewers that the Draeger Emergency Shelter™ meets applicable requirements in Title 56, Series 4, §8.4.1. through §8.4.15
§8.4.2. Be capable of surviving an initial event with a peak overpressure of 15 psi for 3 seconds and a flash fire as defined by National Fire Protection Association standard NFPA-2113 of 300 degrees Fahrenheit for 3 seconds;	Meets Requirement	The independent professional engineer and the manufacturer presented reviewers documentation and addressed inquiries regarding the results of detailed computational modeling of the Draeger Emergency Shelter™ that demonstrated its ability to sustain a 15 psi overpressure for 3 seconds without failure of structural components or deformation that would affect the operation of the unit. The computational analysis was done by Yury Demidov and Stefan Reul of PreTech, Hamburg, Germany The demonstration of survivability of flash fire requirement was accomplished through review of detailed construction drawings and the material specification of all external components.

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§8.4.3. Be constructed such that it will be protected under normal handling and pre-event mine conditions;	Meets Requirement	The independent professional engineer and the manufacturer presented reviewers documentation and addressed inquiries concerning the detailed construction drawings and material specifications for the Draeger Emergency Shelter™ that demonstrated to the reviewers the ability of the Draeger Emergency Shelter™ to survive normal handling conditions in an underground mine and the ability of the manufacturer to address mine-specific operational capacity.
§8.4.4. Provide for rapidly establishing and maintaining an internal shelter atmosphere of oxygen above 19.5%, carbon dioxide below 0.5%, carbon monoxide below 50 ppm, and an apparent-temperature of 95 degrees Fahrenheit; --- In addition shelters were reviewed against the recent MSHA PIB 07-03 that makes a federal standard for refuge chambers that has different assumptions used for the WV standard. The major items are -- • 96 hours breathable air • 25 ppm instead of 50 ppm on the maximum CO; • 4 gasses to be detected in the chamber (O2, CO2, CO, and CH4); • 0.62297 LPM oxygen per man, not 0.5; • 0.5097 LPM CO2 scrubbing capability, not 0.4; • 3 fold chamber volume purge air requirement. http://www.msha.gov/regs/complian/PIB/2007/pib07-03.aspSome.	Meets Requirement	The independent professional engineer and the manufacturer presented reviewers with documentation and addressed inquiries that demonstrated the ability of the Draeger Emergency Shelter™ to comply with applicable requirements in WV 56-4 and the MSHA PIB 07-03. The 96 hour supply of oxygen and removal of CO2 were demonstrated both computationally and through experimentation. The maintenance of CO was addressed through the design of the airlock for which experimental and computational data were provided and through the use of purge air for which computational analysis were supplied. The maintenance of an apparent temperature below 95 F was demonstrated through computation and experimentation.

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§8.4.5. Provide the ability to monitor carbon monoxide and oxygen inside and outside the shelter/chamber; --- In addition shelters were reviewed against the recent MSHA PIB 07-03 that requires monitors for 4 gasses to be detected in the chamber (O2, CO2, CO, and CH4); http://www.msha.gov/regs/complian/PIB/2007/pib07-03.aspSome.	Meets Requirement	The independent professional engineer and the manufacturer presented documentation and addressed inquiries demonstrating the ability of monitoring applicable gases inside and outside the Draeger Emergency Shelter™.
§8.4.6. Provide a means for entry and exit that maintains the integrity of the internal atmosphere;	Meets Requirement	The independent professional engineer and the manufacturer presented documentation and addressed inquiries that demonstrated the ability to enter and exit the Draeger Emergency Shelter™ without violating the integrity of the internal atmosphere through computational and experimental means.
§8.4.7. Provide a means for MSHA certified intrinsically safe power if power required;	Meets Requirement	The independent professional engineer and the manufacturer verified that no electrically powered systems were required for the operation of the Draeger Emergency Shelter™.
§8.4.8. Provide a minimum eight quarts of water per miner;	Meets Requirement	The independent professional engineer and the manufacturer presented documentation that sufficient water would be provided for 96 hours – sixteen quarts per miner.

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§8.4.9. Provide a minimum of 4,000 calories of food per miner;	Meets Requirement	The independent professional engineer and the manufacturer presented reviewers with documentation that 96 hours of food would be provided – 8000 calories per miner.
§8.4.10. Provide a means for disposal of human waste to the outside of the shelter/chamber;	Meets Requirement	The independent professional engineer and the manufacturer presented reviewers with documentation and addressed inquiries demonstrating that a means would be provided to meet this requirement.
§8.4.11. Provide a first aid kit as defined at W. Va. Code Chapter 22A Article 2-59(3)(b) independent of the section first aid kit required by W. Va. Code Chapter 22A Article 2-59(3) and 2-60(f);	Meets Requirement	The independent professional engineer and the manufacturer presented reviewers with documentation that required first aid materials would be provided.
§8.4.12. Have provisions for inspection of the shelter/chamber and contents;	Meets Requirement	The independent professional engineer and the manufacturer presented reviewers with documentation and addressed inquiries that demonstrated that sufficient provisions had been made for inspecting the Draeger Emergency Shelter™.
§8.4.14. Provide a battery-powered occupant-activated strobe light of a model approved by the Director that is visible from the outside indicating occupancy;	Meets Requirement	The independent professional engineer and the manufacturer presented reviewers with documentation and addressed inquiries that demonstrated that once MSHA approved strobes are available they will be provided for the Draeger Emergency Shelter™.
§8.4.15. Provide provisions for communications to the surface; and	Meets Requirement	The independent professional engineer and the manufacturer presented reviewers with documentation and addressed inquires that demonstrated the ability to of the Draeger Emergency Shelter™ to support existing and

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WV Requirement	Consensus	Justification
		emerging communication options and that each would be equipped to support the mine's communication system.

Reviewers:

Randall Harris, Engineering Advisor to Director OMHS&T

Felicia Peng, Ph.D., Associate Professor, Department of Mining Engineering, West Virginia University

Keith Heasley, Ph.D., Associate Professor, Department of Mining Engineering, West Virginia University