

SECTION 6 - TECHNOLOGY SAFETY DATA SHEET

TECHNOLOGY SAFETY DATA SHEET
OCEANEERING SPACE SYSTEMS
Advanced Worker Protection System

SECTION 1: TECHNOLOGY IDENTITY	
Manufacturer's Name and Address: Oceaneering Space Systems 16665 Space Systems Blvd. Houston, TX 77058-2268	Emergency Contact: Doris Hamill (281)228-5408 Information Contact: Doris Hamill (5281)228-5408 Date Prepared:
Other Names: AWPS	Signature of Preparer: Operating Engineers National Hazmat Program 1293 Airport Road, Beaver, WV 25813, phone 304-253-8674, fax 304-253-7758 Under cooperative agreement DE-FC21- 95 MC 32260

SECTION 2: PROCESS DESCRIPTION

The AWPS is a liquid-air based self-contained personal protection system that provides air to workers for both breathing and cooling. The system is rated for 2-hours. The system consists of a backpack, where the primary life-support components are mounted, protective garments, a liquid cooling garment (LCG), a SCBA Positive-Pressure respirator, and communication and support equipment.

The backpack consists of a dewar, heat exchangers, pressure control components, water circulation components, and electronics. The dewar holds the liquid air and provides for continuous withdrawal of liquid in all orientations. The dewar is insulated with a vacuum jacket where the liquid air/water heat exchanger which vaporizes the cryogen and cools the water is located. The pressure control system consists of a pressure closing valve, three relief valves, and several hand valves for filling, draining, and venting the dewar. The electronics are based on an 8-bit micro controller to monitor the functions and liquid air capacity of the backpack. The quantity of liquid air remaining in the dewar is displayed in eighths on an LED display. The display also shows low battery voltage and pump current. A red fault light indicates malfunctions.

The LCG is constructed of a stretchable material with tubing outside and patches attached to the inside. Heat is conducted away from the body by circulating chilled water from the vaporizer through the garment tubing-contact patches that lie against the surface of the skin.

A rechargeable station is required to fill the dewar on the AWPS with liquid air. The system uses liquid nitrogen to convert compressed breathing air into subcritical liquid air. The liquid air used is standard Grade "D" breathing air.

SECTION 3: PROCESS DIAGRAMS

Process diagrams are company proprietary. Contact Oceaneering Space Systems for additional information.

SECTION 4: CONTAMINANTS AND MEDIA

Liquid nitrogen is used to produce the liquid air used with the AWPS. Nitrogen vapors can build-up in the area where the AWPS is being filled or where the liquid nitrogen is stored. Monitoring for a decreased oxygen level may be indicated.

SECTION 5: ASSOCIATED SAFETY HAZARDS

Probability of Occurrence of Hazard:

- 1 Hazard may be present but not expected over background level
- 2 Some level of hazard above background level known to be present
- 3 High hazard potential
- 4 Potential for imminent danger to life and health

SECTION 5: ASSOCIATED SAFETY HAZARDS	
A. ELECTRICAL (LOCKOUT/TAGOUT)	RISK RATING: 3
<p>The AWPS filling station requires electricity for operation. Therefore, electrical hazards are present. Proper grounding, the use of ground fault circuit interrupters, and adherence to all applicable electrical codes and standards needs to be assured. Proper lockout/tagout procedures must be used when maintenance/repair activities are conducted on the filling station unit.</p>	
B. FIRE AND EXPLOSION	RISK RATING: 3
<p>There is the potential for explosion because of the compressed air used at the recharge station. Further pressurization occurs in the recharge station as a result of the compressed air and liquid nitrogen being used to fill the backpack. Cryogen dewars must have the proper pressure relief; accurate maintenance and calibration of pressure relief valves is essential. If the system is over-pressurized, there is the potential for rupture.</p> <p>The AWPS could not be used in a potentially flammable environment due to the open structure in the area of the electrical connections.</p>	
C. CONFINED SPACE ENTRY	RISK RATING: 1-4
<p>Confined space entry is not an inherent part of the AWPS but it may be utilized for such. The backpack adds several inches to the girth of the wearer, this needs to be taken into consideration before entry, otherwise there is the potential for the worker to get stuck either in the opening to the confined space or in the confined space itself.</p>	
D. MECHANICAL HAZARDS	RISK RATING: 1
<p>Assembling the cylinders and attaching hoses poses pinch points.</p>	
E. PRESSURE HAZARDS	RISK RATING: 4
<p>The compressed gas cylinder presents hazards which are discussed under K. of this section. The cryogen dewars must have the proper pressure relief; accurate maintenance and calibration of pressure relief valves is essential.</p>	

SECTION 5: ASSOCIATED SAFETY HAZARDS (CONTINUED)	
F. TRIPPING AND FALLING	RISK RATING: 2
Electric cords and hoses present potential hazards. Tripping and falling hazards are also present due to reduced visibility because of the hood of the outer suit or due to the visor on the hood being scratched or fogged. Workers need to take extra precautions.	
G. LADDERS AND PLATFORM	RISK RATING: N/A
Not part of this technology.	
H. MOVING VEHICLE	RISK RATING: 3
Not part of this technology but may be required for hazardous waste site activities. Due to decreased vision and hearing for the worker wearing the AWPS, moving vehicles in the area need to be aware of other workers and their positions. If the operator of the vehicle is wearing the AWPS, his/her vision may also be impaired, this will also increase hazards to other workers in the area. The ability to safely operate moving vehicles needs to be evaluated before the vehicle is moved. In addition, the backpack itself may restrict the movement of the operator or cause him/her to sit too far forward in the seat. These factors will also contribute to the safety concerns.	
I. BURIED UTILITIES, DRUMS, AND TANKS	RISK RATING: N/A
Not part of this technology.	
J. PROTRUDING OBJECTS	RISK RATING: N/A
Not part of this technology.	
K. GAS CYLINDERS	RISK RATING: 4
The compressed gas cylinder of breathing air accounts for one of the hazards associated with the filling of the AWPS. If compressed gas cylinders are damaged, gas can escape with great force and the cylinder itself can explode causing injury to workers and possibly damaging property. One example of this type of hazard is called "rocketing". The cylinder acts as a "rocket" if damaged or ruptured. The "rocket" (cylinder) can break through concrete walls or travel through open spaces.	
L. TRENCHING AND EXCAVATIONS	RISK RATING: N/A
Not part of this technology.	
M. OVERHEAD LIFTS	RISK RATING: N/A
Not part of this technology.	
N. OVERHEAD HAZARDS	RISK RATING: N/A
Not part of this technology.	

SECTION 6: ASSOCIATED HEALTH HAZARDS	
A. INHALATION HAZARD	RISK RATING: 3
The filling station has the potential to create a hazardous atmosphere. An increase in liquid nitrogen level can cause a decrease in the oxygen level. The area needs to be	

SECTION 6: ASSOCIATED HEALTH HAZARDS	
well ventilated and the need for monitoring should be considered.	
B. SKIN ABSORPTION	RISK RATING: 3
Although not an absorption concern, cold-contact skin burns can result from coming into contact with the liquid nitrogen or cold/frosted metal. Protective gloves and garments need to be utilized.	
C. HEAT STRESS	RISK RATING: 1-4
In the event of cooling system failure, the worker may be exposed to an increase in heat stress. This needs to be monitored in accordance with the heat stress plan in place at the site where the AWPS is being used.	
D. NOISE	RISK RATING: 2
The technology does not presents a potential noise hazard itself, but while utilizing the AWPS the workers ability to hear may be decreased. This has the potential to cause the worker to not hear warnings in the area where he/she is working or he/she may not hear the alarm on the AWPS.	
E. NON-IONIZING RADIATION	RISK RATING: N/A
Not part of this technology.	
F. IONIZING RADIATION	RISK RATING: N/A
Not part of this technology.	
G. COLD STRESS	RISK RATING: 1-4
If the purge valve (on the face piece) is accidentally opened during use of the AWPS, the potential exists for too much cooling because of the relationship between air utilization and cooling.	
H. ERGONOMIC HAZARDS	RISK RATING: 3
Lifting, bending, pulling, and carrying yield distinct ergonomic hazards for muscular/back injuries. The weight and placement of the backpack are critical to worker comfort and mobility as well as avoiding stress/strain injuries. With the addition of other PPE, worker muscle fatigue may be elevated. In addition, range of motion is limited by the outer suit. It will take greater strength to complete standard tasks and workers may have to assume awkward positions.	
I. OTHER	RISK RATING: 1-4
There may be claustrophobia associated with wearing the AWPS.	

SECTION 7: PHASE ANALYSIS**A. CONSTRUCTION/START-UP**

The set-up/start-up phase presents several hazards including pinch points, struck by hazards, slips/trips/falls, electrical hazards, muscular/back injury, cold-contact burn hazards, and exposure to cryogenics.

B. OPERATION

The operational phase presents several hazards including exposure to contaminant, muscular/back injury, pinch points, slips/trips/falls, struck by hazards, cold-contact burn hazards, heat stress, and exposure to contaminants.

C. MAINTENANCE

The maintenance phase presents several hazards including pinch points, electrical hazards, slips/trips/falls, muscular/back injury, and exposure to contaminants.

D. DECOMMISSIONING

The decommissioning phase presents several hazards, including exposure to the contaminant, pinch points, slips/trips/falls, and muscular/back injury.

SECTION 8: HEALTH AND SAFETY PLAN REQUIRED ELEMENTS**A. AIR MONITORING**

Nitrogen vapors may be present, especially during the filling process. Monitoring may be required for a low oxygen atmosphere.

B. WORKER TRAINING

Training that may apply in this case may include but not be limited to: HAZWOPER (Hazardous Waste Operations and Emergency Response), HAZCOM (Hazard Communication), Respiratory Protection, PPE (Personal Protective Equipment) Training, Electrical Safety, Heat Stress, Working with Cryogenics, Working with Compressed Gases, Ergonomics (proper lifting, bending, stooping, kneeling), specific training for equipment operation, CPR/First Aid/Emergency Response/Bloodborne Pathogens, Lockout/Tagout, Hand Signal Communication, and Construction Safety (OSHA 500) and/or General Industry Safety (OSHA 501).

C. EMERGENCY RESPONSE

Emergency response planning for a site needs to assure adequate coverage for hazards described in the TSDS. Having at least one person per shift trained in CPR and first aid is recommended. Due to a short shelf life, the AWPS may or may not be applicable for use when responding to an emergency situation.

SECTION 8: HEALTH AND SAFETY PLAN REQUIRED ELEMENTS (CONTINUED)
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D. MEDICAL SURVEILLANCE

Evaluation of personnel's general health with emphasis on the cardiovascular and respiratory system and the back. In addition, medical surveillance as required by OSHA standards must be conducted. Initial and annual audiograms may be required.

E. INFORMATIONAL PROGRAM

Workers must be trained in specific operation of equipment before use. In addition, workers should be trained to work with cryogenes.

SECTION 9: COMMENTS AND SPECIAL CONSIDERATIONS

Only personnel who have been adequately trained in the operation of this technology and associated hazards should be permitted to operate and/or work with the equipment.
