

## Development Plan for Air-Fed Suit Respirator Standard

Goal: Develop a NIOSH respirator certification standard for air-fed suits where the suit acts as the respirator. The air-fed suit respirator may include: an inclusive, one piece, positive pressure inflated chemical protection suit, or multiple component personal protection technologies utilizing a supplied air respirator (SAR), or an air purifying respirator, (APR).

NIOSH has considered the option of including the NIOSH certification of Air-Fed Suit Respirators (AFSR) in the existing subparts (SAR, APR) as determined by the type of respirator used in the suit. However, in order to be more responsive to future technological evolutions in the workplace that may impact the use of these suits; NIOSH is considering the use of a new subpart to address the certification requirements for air-fed suit respirators. Creating a subpart to 42 CFR Part 84 to address air-fed suit respirators will facilitate the ability to address potential uses, such as in IDLH (immediately dangerous to life and health) environments, which the existing subparts for supplied air respirators or air purifying respirators do not address.

Since these suits are used to provide both dermal and respiratory protection, NIOSH is collaborating with ASTM, through an existing Memorandum of Understanding (MOU), where ASTM is developing a specification for the design and performance criteria for Air-Fed Protective Ensembles. NIOSH conceptualizes the certification of the air-fed suit respirator may require documentation that the non-respiratory component technologies including materials, design, parts (gloves, boots) and construction have met or exceeded the requirements of the ASTM standard under draft by Committee F23 Protective Clothing (Subcommittee on Chemical Hazards F23.30). NIOSH is currently participating in the development of this performance standard.

The Department of Energy (DOE), the National Aeronautics and Space Association (NASA), the International Standards Organization (ISO), the European Committee for Standardization (CEN), and the American National Standards Institute (ANSI), have written specifications or drafts of specification for air-fed suits. NIOSH is considering the methods included in these standards or drafts of standards for the conceptualization of NIOSH certification requirements for air-fed suit respirators.

The following tables briefly outline the test methods included in the DOE, NASA, ISO, CEN, and ANSI standards or drafts of standards. Tables I and II include test procedures that may be included in the conceptualization of NIOSH certification requirements for air-fed suit respirators. Table III includes test procedures that may be included in the ASTM standard for Air-Fed Protective Ensembles.

Table I

The following test descriptions outline requirements, most relating to respiratory protection, that are included in a majority of the air-fed protective suit specification standards or drafts of standards.					
Test description	ISO	NASA	DOE	ANSI	CEN
Inward leakage, aerosol penetration*	▲	▲	▲	▲	▲
Couplings	▲	▲	▲	▲	▲
Air flow rate (general)*	▲	▲	▲	▲	▲
Air-supply lines	▲	▲	▲	▲	▲
Air-supply source	▲	▲		▲	▲
Breathing resistance	▲	▲		▲	▲
Breathing tube/hose	▲	▲		▲	▲
Carbon dioxide content of inhalation air	▲	▲	▲	▲	▲
Compressed air supply tube	▲	▲		▲	▲
Conditioning by temperature and/or wearing	▲	▲		▲	▲
Connections (general, for cleaning)	▲	▲		▲	▲
Connection strength	▲	▲	▲		▲
Continuous flow valve	▲	▲		▲	▲
Exhaust assemblage	▲	▲		▲	▲
External breathing hose strength	▲	▲	▲	▲	▲
External breathing hose (resistance to collapse)	▲	▲	▲	▲	▲
Internal breathing hose (strength)	▲	▲		▲	▲
Internal breathing hose (resistance to collapse)	▲	▲		▲	▲
Noise	▲	▲	▲	▲	▲
Pressure in suit	▲	▲		▲	▲
Resistance to ignition				▲	▲
Resistance to flame	▲	▲	▲	▲	
Vision/visor	▲	▲		▲	▲
Warning and measuring means	▲	▲		▲	▲

Table II

The following test descriptions outline requirements may not be included in a majority of the standards or drafts of standards reviewed, however, they are considered important to include due to proposed updates to SAR and PAPR subparts and the intended use of the suits.					
Test description	ISO	NASA	DOE	ANSI	CEN
Air-supply harness		▲		▲	
Air-supply system pressure				▲	
Escape test, doffing		▲	▲		
Remaining service life indicator		▲			
Test temperature	▲	▲		▲	
Unmanned CO <sub>2</sub> in respired gas		▲			
Weight requirement		▲			

Table III

The following test requirements address the dermal protection and the material properties of the suits and may be included in the ASTM draft standard, Specification for Air-Fed Protective Ensembles.					
Test description or criteria	ISO	NASA	DOE	ANSI	CEN
Abrasion resistance	▲	▲		▲	▲
Burst strength	▲			▲	▲
Conditioning by wearing	▲			▲	
Flex cracking resistance	▲	▲		▲	▲
Glove and footwear strength	▲			▲	▲
Integral gloves	▲			▲	
Integral footwear	▲			▲	
Integral visor impact resistance	▲	▲		▲	
Integral visor mechanical strength					▲
Integral visor permeation resistance	▲	▲		▲	
Integral visor resistance to ignition	▲				
Inward leakage, aerosol penetration*	▲		▲	▲	▲
Leak tightness*	▲	▲		▲	▲
Manned physiological testing		▲			
Permeation resistance	▲	▲		▲	▲
Practical performance	▲	▲		▲	
Preconditioning (cleaned and reused)	▲	▲		▲	▲
Puncture resistance	▲			▲	▲
Seam penetration resistance	▲				
Seam permeation resistance	▲			▲	
Seam strength	▲	▲		▲	▲
Tear resistance	▲	▲		▲	▲
Tensile strength	▲	▲			

(\*) The specification is dependent upon the classification of the suit tested; the test does not necessarily apply to all classes.

The Inward Leakage Test is being considered as a NIOSH requirement and is included in the ASTM standard draft. The inclusion of the Inward Leakage Test in the conceptualization of the certification requirements for air-fed suit respirators will be considered following the public comment period.

In addition to the requirements determined from the review of current standards, the respiratory protection of the suit must meet the following requirements:

**Title 42 Code of Federal Regulations (CFR), Part 84, Subparts A, B, D, E, and G:**

Subpart A: General Provisions  
Subpart B: Application for Approval  
Subpart D: Approval and Disapproval  
Subpart E: Classification of Approved Respirators  
Subpart G: General Construction and Performance

Optional requirements may include:

- Service time requirement, testing, and certification.
- Service temperature requirements, testing and certification.
- Environmental Control Unit minimum requirements, testing and certification.
- Hand-operated valve requirements, testing and certification.
- Self donning and contaminated suit removal tests. Contaminated suit removal (UV fluorescent powder) and the escape test (head outside the suit) are significant to the nuclear industry.
- ASTM Committee F23 draft for specification for Air-Fed Protective Ensembles does not currently contain flammability or flame resistance testing. The NASA includes a fabric electrostatic charge dissipation requirement.