Concept: Proposed Industrial Powered, Air-Purifying Respirator (PAPR) Standard

Draft: November 4, 2005

84.300 Scope: Powered, air-purifying Respirators (PAPRs) shall be approved under this subpart

The purpose of Subpart P is to establish procedures and minimum requirements for issuing approvals and extensions of approval specifically to PAPRs. PAPRs shall meet the applicable requirements of subparts A through G of Part 84 plus this subpart.

84.301 Definitions

(a) Powered, Air-Purifying Respirator (PAPR) - an air-purifying respirator that uses a powered mechanism (blower) to pass ambient air through an air-purifying element to a respiratory inlet covering and which maintains an air pressure above ambient during operation and testing at all times in the area of the nose and mouth

(b) Tight-fitting PAPR - a PAPR which contains a respiratory inlet covering that seals to the face or neck

(c) Loose-fitting PAPR- a non-tight-fitting PAPR which contains a respiratory inlet covering that may contact but does not seal completely to the face or neck. It may consist of a hood, helmet, non-tight sealing facepiece, or neck dam.

(1) Hood - a loose-fitting respiratory inlet covering that covers the head and neck. It may cover portions of the shoulders.

(2) Helmet - a loose-fitting non-flexible respiratory inlet covering that is designed to offer some degree of impact and penetration protection of the head

(3) Loose-fitting facepiece - a loose-fitting respiratory inlet covering which makes contact with but does not seal to the face. It does not cover the neck or shoulders.

(4) Loose-fitting neck dam - a loose-fitting respiratory inlet covering which makes contact with but does not seal to the neck

(d) Gas Mask PAPR (Canister PAPR) - A tight-fitting PAPR which contains an appropriate canister and may contain a PAPR100 filter suitable for its intended use and which is designed to operate in a silent mode as defined herein.

(e) Chemical cartridge and/or filter PAPR - A tight-fitting PAPR which contains an appropriate cartridge and/or PAPR filter suitable for its intended use and which may optionally be designed to operate in a silent mode as defined herein

(f) Breath-response PAPR - a tight-fitting PAPR which continuously monitors the user's air demand rate and adjusts air flow accordingly

(g) Respiratory inlet covering - A facepiece, hood, helmet, or some combination of these which serves as a respiratory protective covering to the nose and mouth area

(h) End-of-Service-Life Indicator (ESLI) - An indicator which indicates to the user that the chemical cartridge, canister, or filter has reached the end of its service life. It may be active or passive. An active ESLI is defined as an indicator which invokes a spontaneous warning signal such as a flashing light or ringing bell which is automatic. A passive indicator requires monitoring by the wearer, such as a band which changes color to indicate cartridge or canister exhaustion.

(i) Intrinsically safe - A PAPR which is intrinsically safe as determined by 30 CFR Part 18, Subpart D ¶18.82 or by a recognized independent laboratory

(j) Silent mode - A use mode of a tight-fitting PAPR where the PAPR is designed to offer respiratory protection when the blower is not operating

(k) Flow rating- A PAPR air flow rating of Low, Moderate, or High designated by the manufacturer and determined in ¶84.313

84.302 Description

(a) A PAPR utilizes a powered mechanism to draw ambient air through an air-purifying element(s) to remove contaminants from the ambient air. It is designed for use as respiratory protection against atmospheres with solid and liquid contaminants (e.g., dusts, fumes and/or mists), gases, and/or vapors where the concentrations during entry and use are not immediately dangerous to life or health (IDLH) and the atmosphere contains adequate oxygen to support life. All are considered as positive pressure.

(b) Gas Mask PAPRs are equipped with appropriate canisters and may also contain PAPR100 filters. They are designed to operate in a silent mode as defined herein. They may be used for escape from hazardous atmospheres containing a minimum of 19.5% oxygen to support life.

84.303 Required components

(a) PAPRs shall, where its design requires, contain the following component parts:

(1) Respiratory inlet covering

(2) Cartridge, canister and/or filter unit(s)

(3) Harness assembly

(4) Blower

(5) Breathing tube

(6) Battery and/or power cord

(7) Low flow/pressure indicator

(8) Low and full battery charge indicator

(9) Operation switch

84.304 General construction

In addition to Subpart G:

(a) Each PAPR shall have an indicator to indicate when the battery is fully charged and at low charge. It shall be readily detectable to the wearer during use without manipulation of the respirator.

(b) Each PAPR shall have an active indicator which alarms the user, via a readily visible light or other means, when the air pressure inside the respiratory inlet covering is not above ambient. It shall be readily detectable to the wearer during use without manipulation of the respirator

(c) Each PAPR shall have readily accessible switches and controls designed to prevent accidental shutoff

(d) Each tight-fitting PAPR shall be designed to prevent unpurified air from entering the system if the blower function stops

(e) Color coding of cartridges and canisters shall be per the ANSI Z88.7 -2003 (or most recent version) where applicable

(f) Where two or more cartridges, canisters or filters are used in parallel, their resistance to air flow shall be within ± 10% when measured at 85 lpm

(g) Where two or more cartridges, canisters or filters are used in parallel, the manifold system shall be designed for essentially equal air flow through each cartridge, canister, or filter

84.305 Breathing tubes

Flexible breathing tubes shall be designed and constructed to prevent:

(a) Restriction of free head movement

(b) Disturbance of the fit of the respiratory inlet covering

(c) Interference with the wearer's activities; and

(d) Shutoff of airflow due to kinking, or from chin or arm pressure

84.306 Body harnesses

(a) Each respirator shall, where necessary, be equipped with a suitable harness designed and constructed to hold the components of the respirator in position against the wearer's body

(b) Where applicable, harnesses shall be designed and constructed to provide for holding a respiratory inlet covering in the ready position when not in use

84.307 Head harnesses

(a) All respiratory inlet coverings shall be equipped with a head harness designed and constructed to hold the unit properly in place, provide adequate tension during use, and provide even distribution of pressure over the entire area in contact with the head or face

(b) Respiratory inlet covering head harnesses shall be adjustable and replaceable where necessary

84.308 Respiratory inlet coverings

(a) Half-mask facepieces and full facepieces shall be designed and constructed to fit persons with various facial shapes and sizes either:

(1) By providing more than one facepiece size; or

(2) By providing one facepiece size which will fit varying facial shapes and sizes

(b) Half-mask facepieces shall not interfere with the fit of common safety and/or corrective eyeglasses

(c) Full facepieces shall provide for optional use of eyeglasses or lenses, which shall not interfere with the sealing surface or reduce the respiratory protective qualities of the respirator

(d) Hoods, helmets, and loose-fitting facepieces shall be designed and constructed to fit persons with various head sizes, provide for the optional use of corrective eyeglasses or lenses, and

insure against any restriction of movement or vision by the wearer

(e) Helmets shall meet the requirements of ANSI Z89.1-2003 Class A (or latest version) or the helmet shall be prominently and permanently labeled to indicate that it is not impact and penetration resistant

(f) Neck seal designs shall provide a seal around the neck without causing discomfort to the user and permit easy donning and doffing

84.309 Lenses of respiratory inlet coverings

(a) Respiratory inlet coverings shall be designed and constructed to provide adequate vision

(b) Lenses of respiratory inlet coverings shall not distort vision

(c) Lenses, including visors and shields, shall not fog as a result of normal operation

(d) Lenses shall meet the requirements of ANSI Z87.1- 2003 (or latest version) or the lenses shall be prominently and permanently labeled to indicate that they are not impact resistant

84.310 Inhalation and exhalation valves

(a) Inhalation and exhalation valves shall be

(1) Protected against damage or distortion

(2) Designed, constructed, and provided where necessary to prevent exhaled air from adversely affecting cartridges, canisters, and/or filters

(b) Exhalation valves shall be:

(1) Protected against damage, distortion, and external influence; and

(2) Designed and constructed to prevent inward leakage of contaminated air

84.311 Exhalation valve leakage

(a) Dry exhalation valves and valve seats shall be subjected to a suction of 25 mm water column height while in a normal operating position

(b) Leakage between the valve and valve seat shall not exceed 30 milliliters per minute

84.312 Breathing resistance

(a) For all PAPRs, exhalation breathing resistance shall be measured in the nose/mouth area of

the respiratory inlet covering with the blower operating

(b) Exhalation breathing resistance may not exceed 25.4 mm (1") water gauge above static at any flow rate with the respirator operating on a headform and the static reference point being between inhalation and exhalation breaths

(c) Gas Mask PAPRs shall meet and tight-fitting chemical cartridge and/or filter PAPRs may optionally meet and be granted approval for use in silent (non-powered) as well as normal (powered) mode:

(1) For approval in a silent mode, initial resistance to airflow shall additionally be measured inside the respiratory inlet covering of a completely assembled PAPR with the blower not operating and with the highest resistance cartridges, canisters, and/or filters

(2) For approval in a silent mode, the maximum allowable resistance requirements with the blower not operating, mounted on a test fixture, and air flowing at a continuous rate of 85 liters per minute, are as follows:

Type of Protection	**Initial Inhalation Resistance**	**Initial Exhalation Resistance**
Particulate only	35 mm H_20	20 mm H_20
Gas/vapor cartridge only	40 mm H_20	20 mm H_20
Gas/vapor cartridge/ particulate	50 mm H_20	20 mm H_20
Gas/vapor canister only	40 mm H_20	20 mm H_20
Gas/vapor canister/ particulate	65 mm H_20	20 mm H_20

84.313 Air pressure determination for maintaining positive pressure

(a) All PAPRs shall maintain a positive pressure above ambient inside the facepiece during operation

(b) Air pressure shall be measured in the area of the nose and mouth, inside the respiratory inlet covering of the completely assembled PAPR on a headform

(c) Units shall meet the minimum requirements with the most restrictive (highest resistance) filter/cartridge/canister combination for which approval is sought at the highest flow rating specified by the manufacturer

(d) A breathing machine shall be used with breathing rates as follows:

Low flow rating

14.5 res./min @ 10.5 lpm

Moderate flow rating

24 res./min @ 40 lpm

High flow rating

30 res./min @ 86 lpm + 37 res./min @ 103 lpm for the last five minutes of rated operational time (see note)

(e) Pressure shall remain above ambient at all times during testing

(f) Static pressure relative to external pressure may not exceed 2" of water column height for any PAPR during testing

Note: High flow rating units shall remain above ambient when tested at 30 res./min. @ 86 lpm up until the last five minutes of the rated operational service time. During the last five minutes of rated operational service time, the unit will be tested at 37 res./min. @ 103 lpm. Then, the unit shall continue to perform at 30 res./min. @ 86 lpm for 15 minutes beyond the rated operational service time.

84.314 Air flow determination for testing cartridges, canisters, and/or filters at a constant flow and for machine breathing gas testing

(a) The manufacturer shall specify a maximum and minimum average constant flow rate of the PAPR system on which the cartridges, canister or filters will be used

(b) Average constant air flow shall be determined on a headform by testing three PAPR systems equipped with cartridges, canisters, and/or filters which will provide the least resistance and by testing three PAPR systems equipped with cartridges, canisters, and/or filters which provide the greatest resistance

(c) A breathing machine shall be used with breathing rates as follows:

Low flow rating

14.5 res./min @ 10.5 lpm

Moderate flow rating

24 res./min.@ 40 lpm

High flow rating

30 res./min. @ 86 lpm + 37 res./min @ 103 lpm for the last five minutes of rated operational time (see note)

(d) The determined average constant air flow values shall fall within the specified maximum and minimum values provided by the manufacturer

(e) The maximum specified air flow rate shall be used for cartridge, canister, and/or filter testing

(f) The minimum specified air flow rate shall be used for the breathing gas: carbon dioxide (CO_2) machine test

84.315 PAPR-100 and PAPR-95 particulate filter efficiency level determination

(a) Twenty filters or filter assemblies of each powered, air-purifying particulate respirator model shall be tested for filter efficiency against a dioctyl phthalate (DOP) or equivalent liquid particle aerosol deemed to meet the requirements of this section

(b) Filters including holders and gaskets; when separable shall be tested for filter efficiency level, as mounted on a test fixture in a manner as used on the respirator

(c) When the filters do not have separable holders and gaskets, the exhalation valves shall be blocked so as to ensure that leakage, if present, is not included in the filter efficiency level evaluation

(d) Particulate filters shall be tested at the maximum average constant flow rate specified by the manufacturer

(e) Filter efficiency test aerosols shall be as follows:

(1) A neat, cold-nebulized dioctyl phthalate or equivalent aerosol at 25±5 degrees C that has been neutralized to the Boltzmann equilibrium state shall be used. Each PAPR100 and PAPR95 filter shall be challenged with a concentration not exceeding 200 mg/m^3

(2) The PAPR100 test shall continue until minimum efficiency is achieved or until an aerosol mass of 200±50 mg has contacted each filter

(3) Each PAPR-95 filter shall be challenged with a concentration not exceeding 200 mg/m^3 to determine initial penetration only

(f) The DOP aerosol shall have a particle size distribution with a count median diameter of 0.185±0.020 micrometer and a standard geometric deviation not exceeding 1.60 at the specified test conditions as determined with a scanning mobility particle sizer or equivalent

(g) The efficiency of the filter shall be monitored and recorded throughout the test period by a suitable forward-light-scattering photometer or equivalent instrumentation

(h) The minimum filter efficiency for each of the twenty tested filters shall be determined and recorded and be equal to or greater than the filter efficiency criterion listed for each level as follows:

PAPR100, Efficiency >= 99.97%
PAPR95, Efficiency >= 95%

84.316 Chemical cartridge/canister gas/vapor removing effectiveness

(a) PAPR cartridges and canisters shall be tested as received and shall meet the minimum requirements set forth in Tables 1 and 2 of this subpart

(b) Cartridges and canisters shall be tested at the maximum average constant flow rate specified by the manufacturer

(c) Chemical cartridges and canisters may listed as effective against additional gases and vapors that are not specifically listed in Table 1 or 2 , as determined by NIOSH, where

(1) the cartridges or canister have been approved for gases or vapors in the same class or family as those listed in Table 1 or 2 and

(2) the cartridge or canister has been demonstrated to be effective against removing these additional gases or vapors

(d) Manufacturers may further request approval for chemical cartridges and canisters for gases or vapors that are not listed in Table 1 or 2 and, as determined by NIOSH, are not effective at removing the gas or vapor in the same class or family as those listed in Table 1 or 2 (i.e. do not fall in (a) or (c) above)

(1) NIOSH may accept or reject the request after a review of the effects on the wearer's safety and health and with consideration of field experience and resources

(2) For gases under this paragraph (d), cartridge test concentration calculations shall be determined as the permissible exposure limit (PEL) multiplied by the highest assigned protection factor (APF) of the system on which it will be used multiplied by a safety factor of 10. Where this is not achievable or can not be done safely in the laboratory, time and concentrations may be proportionally adjusted.

(3) For gases under this paragraph (d), canister test concentration calculation shall generally be set at IDLH times 100. Where this is not achievable or can not be done safely in the laboratory, time and concentrations may be proportionally adjusted.

(4) Test time for cartridges for which approval is sought under this paragraph (d) shall generally be set at 50 minutes. Where this is not achievable or can not be done safely in the laboratory, time and concentrations may be proportionally adjusted.

(5) Test time for canisters for which approval is sought under this paragraph (d) shall generally be set at 60 minutes. Where this is not achievable or can not be done safely in the laboratory, time and concentrations may be proportionally adjusted.

(e) Allowable breakthrough concentrations for all testing for which approval is sought shall be less than or equal to the NIOSH REL (respirable exposure limit) or OSHA PEL (permissible exposure limit) in effect at the time of testing, whichever is lower

(f) Three PAPR cartridges or canisters shall be tested at 25±2.5^{0}C and 25% RH, and three PAPR cartridges or canisters shall be tested at 25±2.5^{0}C and 80% RH for each gas and vapor for which approval is sought

TABLE 1 - PAPR **CARTRIDGE** GAS/VAPOR BENCH TESTS AND REQUIREMENTS

Gas/vapor life	Test Concentration (parts per million)	Maximum Break Through (parts per million)	Minimum allowable service (minutes)
Ammonia	1000	12.5	50
Chlorine	500	5	35
Chlorine Dioxide	500	0.1	30
Cyclohexane	1000	5	50
Formaldehyde	100	1	50
Hydrogen Chloride	500	5	50
Hydrogen Fluoride	70	3	30
Hydrogen Sulfide	1000	10	30
Methylamine	1000	10	25
Sulfur dioxide	500	5	30

TABLE 2 - PAPR **CANISTER** GAS/VAPOR BENCH TESTS AND REQUIREMENTS

Gas/vapor life	Test Concentration (parts per million)	Maximum Break Through (parts per million)	Minimum allowable service (minutes)
Ammonia*	2,500	12.5	24

Carbon Monoxide	20,000	35	60
Chlorine	2,500	5	24
Chlorine Dioxide	1,000	0.1	60
Cyanogen Chloride*	300	2	60
Cyclohexane *	2,600	10	60
Ethylene Oxide	5,000	1	60
Formaldehyde*	500	1	60
Hydrogen Cyanide *	940	4.7	60
Hydrogen Sulfide *	5,000	5	60
Methylamine	1,000	10	12
Nitrogen Dioxide*	200	1NO2, 25 NO	60
Phosgene *	250	1.25	60
Phosphine *	300	0.3	60
Sulfur Dioxide *	1,500	5	60

* Denotes gases/vapors which are also used as CBRN test agents

Canisters and cartridges meeting Cyclohexane and PAPR-100 requirements may be approved for tear gases Chloroacetophenone and o-Chlorobenzylidene Malonitrile if desired by the applicant without additional testing when used on tight-fitting respirators offering purified air to the eyes

84.317 Laboratory Respiratory Protection Level (LRPL)

(a) The LRPL will be determined for each PAPR design and shall be >= 2,000 for > 95% trials with the blower operating and, for silent mode PAPRs, with the blower not operating

(b) Sampling shall be performed in the breathing zone of the respirator

(c) The test atmosphere shall contain 20–40 mg/m^3corn oil aerosol of a mass median aerodynamic diameter of 0.4–0.6 μm

(d) The test atmosphere shall be maintained at normal operating conditions of 70^o ±5 F and 50 ±10 % RH)

(e) The LRPL shall be calculated using eleven exercises: Normal Breathing, Deep Breathing, Turn Head Side to Side, Move Head Up and Down, Recite the Rainbow Reading Passage or equivalent, Reach for the Floor and Ceiling, On Hands and Knees – Look Side to Side, Facial Grimace, Climb Stairs at a Regular Pace, and Normal Breathing

(f) Practical performance will also be evaluated in this test. The practical performance of the respirator shall evaluate human interface issues associated with the use of the respirator. As a minimum, factors which shall be evaluated (if applicable based upon the respirator design) are: the likelihood for the user to accidentally turn the power switch off, the likelihood for hoses and electrical wires to tangle causing the respirator position on the wearer to move to an improper position, continued clear and unobstructed visibility with turning of the head or looking up or down, and ease of use. Test subjects shall be trained on proper use of the respirator in accordance with the applicant's user instructions.

84.318 Field of view

PAPR respiratory inlet coverings shall obtain an average Visual Field Score (VFS) of 90 or greater following the VFS method described by the American Medical Association. Where multiple sizes are offered, the determination shall be made using a head form that is best sized to the respiratory inlet covering.

84.319 Low temperature fogging

The respiratory inlet covering shall demonstrate an average Visual Acuity Score (VAS) of greater than or equal to 75 points following the VFS method described by the American Medical Association for all measurements of acuity with the blower operating, and for silent mode PAPRs, with the blower not operating. The respirator shall be cold soaked for four hours and then worn in an environmental chamber maintained at the minimum operating temperature specified by the applicant.

84.320 Noise levels

Noise levels generated by any PAPR shall be measured at each ear location, at the maximum average constant airflow specified by the manufacturer, and shall not exceed 80 dBA

84.321 Breathing gas: Carbon dioxide (CO_2), machine-generated

(a) The concentration of carbon dioxide in inspired gas in a PAPR shall be measured at the mouth of a headform while the respiratory inlet covering is mounted on a headform which is connected to a breathing machine

(b) This test shall be conducted with the PAPR blower operating at the minimum air flow rate specified by the manufacturer and, for silent mode PAPRs, with the blower not operating.

(c) A sedentary breathing machine cam shall be used;

(d) The breathing rate shall be 14.5 respirations per minute with a minute volume of 10.5 liters. Note: If a nose cup is specified as being an optional component by the manufacturer, this test shall be conducted with and without it. The nose cup is not to be sealed to the headform.

(e) A concentration of 5% carbon dioxide in air shall be exhaled into the respiratory inlet covering through the mouth/nose port of the headform

(e) The respirator shall be tested at a temperature of 25±5 degrees C

(f) During testing, the concentration of carbon dioxide in the inspired gas at the mouth shall be continuously recorded and the maximum average concentration during the inhalation portion of the breathing cycle shall be recorded. The test shall be performed until the carbon dioxide concentration stabilizes.

(g) A minimum of three respiratory inlet coverings, or one of each size, whichever number is greater, shall be tested. For example - three of a single size device or one each of a three-size device

(h) The maximum allowable average carbon dioxide concentration, during the inhalation cycle, shall not exceed 1.0 %

84.322 Breathing gas: Oxygen (O_2) and Carbon dioxide (CO_2), human subject-generated

(a) The concentration of carbon dioxide and oxygen in inspired gas in a PAPR shall be measured at the mouth of a test subject

(b) This test shall be conducted with the PAPR blower operating and, for silent mode PAPRs, with the blower not operating

(c) Twelve human subjects (equally distributed for each respiratory inlet covering size) shall perform the test at the following work rates:

(1) Standing and

(2) Walking at 3.5 miles per hour

(d) Each exercise shall be performed for ten minutes

(e) Carbon dioxide and oxygen data shall be considered for the last five minutes of each exercise

(f) For each of these last five minutes, a minimum of the last five breaths shall be considered

(g) The calculated maximum range concentration for carbon dioxide during the inhalation portion of the breathing cycle shall not exceed 0.02 (or 2.0%)

(h) The inhaled fractional oxygen concentration shall be no less than 0.195 (or 19.5%)

(i) The respirator shall be tested at a temperature of 25±5 degrees C

(j) The respirator shall meet these criteria for 11 of 12 subjects

84.323 Low pressure indicator

(a) For all PAPRs, a low pressure indicator shall be present, and actively and readily indicate when pressure inside the respiratory inlet covering falls to ambient pressure during blower operation

(b) Low pressure indicators shall be readily visible or detectable (via sound or vibration) to the user without manipulation of the respirator

(c) Low pressure indicators shall be configured so that they may not be de-energized when the blower is energized

84.324 Full and low battery power indicator

(a) Each PAPR equipped with a battery shall contain an indicator to show when the battery is fully charged

(b) Each PAPR equipped with a battery shall contain a low battery indicator and shall indicate that the battery is low when (or before) the battery can no longer provide the unit with 15 minutes of additional adequate power to properly power the unit at the lowest recommended operating temperature and at the highest flow with the highest resistance combination of cartridges/canisters/filters

(c) Low battery indicators shall be readily visible or detectable (via sound or vibration) to the user without manipulation of the respirator

(d) Low battery indicators shall be configured so that they may not be de-energized when the blower is energized

84.325 Battery life

(a) The battery shall be tested in a fully charged state per the manufacturer's instructions

(b) The PAPR system shall be operated fully assembled on a headform with no filtering elements

(c) For breath-response PAPRs, a breathing machine as described in this part shall be used

(d) The PAPR system shall operate for the stated battery life + 15 minutes at the lowest recommended operating temperature specified by the applicant

(e) At no time shall the pressure, when measured in the nose/mouth area drop to ambient during testing when connected to a breathing machine

84.326 End-of-Service-Life (ESLI) criteria

Manufacturers seeking approval for PAPRs which utilize cartridges or canisters with an ESLI shall provide the following:

(a) Data:

(1) Demonstrating that the ESLI is a reliable indicator of sorbent depletion (the ESLI fully indicates cartridge or canister end-of-service-life at less than or equal to 90% of the service life)

(2) on adsorption of any impregnating agents used in the indicator

(3) on the effects of industrial interferences which are commonly found in workplaces where it is anticipated that a given respirator will be used

(4) on any reaction products produced in the reaction between the sorbent and the contaminant gases and a vapor against which it is designed to protect

(5) the shelf (storage) life of the indicator

The data shall include flow-temperature results at minimum and maximum recommended flows and temperatures of the PAPR system, at 25% and 80% RH, and at two contaminant levels.

(b) Passive ESLI additional requirements

In addition to the foregoing, all passive ESLI shall meet the following criteria:

(1) A passive ESLI shall be situated on the respirator so that it is readily visible by the wearer without manipulation of either the respirator or the indicator

(2) If the passive ESLI utilizes color change, the change shall be detectable to people with physical impairments such as color blindness (Example- light color to dark color)

(3) If the passive indicator utilizes color change, reference colors for the initial color of the indicator and the final (end point) color of the indicator shall be placed adjacent to the indicator

(c) General ESLI requirements

All ESLI shall meet the following requirements:

(1) The ESLI shall not interfere with the effectiveness of the face seal
(2) The ESLI shall not change the weight distribution of the respirator to the detriment of fit

(3) The ESLI shall not interfere with required lines of sight

(4) Any ESLI that is permanently installed shall withstand cleaning and a drop from a six-foot height onto concrete

(5) Replaceable ESLI shall be designed to be easily removed and replaced

(6) PAPRs with an ESLI shall be labeled appropriately to adequately inform the user of use conditions and of any situations that could cause false positive and negative ESLI

responses

(7) PAPRs with an ESLI shall contain adequate information in the user instructions to fully explain the operation, use conditions, and of any situations that could cause false positive and negative ESLI response

(8) The ESLI shall not create any hazard to the wearer's health or safety

84.327 Service time limitations

(a) Service time recommendations for batteries and any other applicable components shall be listed in the user instructions

(b) Battery service life time increments for which batteries shall be approved shall be in one hour increments (example - 1- hour, 2-hours, 3-hours, etc.) with a minimum rating of one hour

(c) Battery service times shall be such that batteries will perform properly and meet testing requirements for the entire stated battery operational service time + 15 minutes at the lowest recommended operating temperature specified by the applicant and with the highest resistance combination of cartridges, canisters, and or filters

84.328 Shelf life limitations

(a) Special shelf (storage) life requirements for filters, cartridges, canisters, batteries, and any other applicable components shall be addressed in the user instructions if applicable

84.329 Intrinsic safety, optional

To be approved as intrinsically safe, the PAPR shall meet the requirements for permissibility and intrinsic safety set forth in 30 CFR Part 18, Subpart D ¶18.82 or it may be approved as intrinsically safe by a recognized independent laboratory per standards accepted by NIOSH

84.330 Hydration device (drink tube), optional

To be approved, dry drinking tube valves, valve seats, or seals shall be subjected to a suction of 75 mm of water column height while in a ready for use position (not in a hose retainer) and with any manual or automatic flow valve in a non-drinking position. Leakage of air through the tube shall not exceed 30 ml/min

84.331 Additional container requirements specific to PAPRs

(a) All containers shall be designed and constructed to permit easy donning of the unit

(b) All containers shall bear markings which show the applicant's name and appropriate approval

information deemed necessary by NIOSH

(c) Containers shall prominently list the battery duration(s) and battery part number(s) of the unit when the unit may be equipped with a battery and the designated flow rating of the unit

84.332 Additional label requirements specific to PAPRs

(a) The flow rating(s) shall be clearly displayed on the respirator unit

(b) The battery service life and part number shall be prominently displayed on the respirator battery pack, and if not readily visible on the battery pack, on another visible location on the unit. If the unit is to be powered by an external source, the unit must me labeled as such.

(c) The protections for which approval is being sought shall be clearly and legibly displayed on the cartridge/canister/filter

(d) Additional cautions and limitations appropriate to PAPRs shall be added as deemed necessary by NIOSH