CVB-CBRN-CUR-STP-0800

DETERMINATION OF LABORATORY RESPIRATOR PROTECTION LEVEL (LRPL) VALUES FOR COMBINATION UNIT RESPIRATORS (CUR), STANDARD TESTING PROCEDURE (STP)

1. PURPOSE

This document establishes the procedure for ensuring that the respirator is designed and constructed to fit persons with various facial shapes and sizes as specified by the National Institute for Occupational Safety and Health (NIOSH) Bivariate Panel (referred to as the NIOSH Panel). This is accomplished by determining the laboratory respirator protection level (LRPL) values provided by a CUR. This standard testing procedure (STP) was developed in coordination with the NFPA 1987 *Standard on Combination Unit Respirator Systems for Tactical and Technical Operations* subcommittee. To use this STP, refer to NFPA 1987, Section 7.1.2.

Disclaimer: Standard Testing Procedures (STPs) 800, 801, 802, 819 and 848 are referenced in the National Fire Protection Association (NFPA) Standard on Combination Unit Respirator Systems for Tactical and Technical Operations, NFPA 1987 (2023). These STPs were developed in concert with the NFPA 1987 standard. These STPs are not presently in effect; NIOSH is not currently using these STPs for the purpose of testing or approving combination unit respirators. Consequently, the STPs are being provided for ***informational purposes only*** *since each is referenced NFPA 1987.*

2. GENERAL

This STP describes the named procedure in sufficient detail that a person knowledgeable in the appropriate technical field can select equipment with the necessary resolution, conduct the test, determine whether or not the product passes the test, and create a record of those results, reporting the measurements obtained in a preestablished, standard format.

3. EQUIPMENT/MATERIAL

3.1. Rear Light Scattering Laser Photometer: TSI Inc., model 8587A, or equivalent. Concentration range is 1.0 micrograms per cubic meter ($\mu g/m^3$) to >200 milligrams per cubic meter (mg/m^3) with dynamic range LRPL values to 100,000.

3.2. NIOSH Dynamic Fit Software: Custom software developed in the LabVIEW environment, or equivalent. Software is available from NIOSH or Data Science Automation. The software is used to record the data collected by the laser photometer for each respirator and convert this data to LRPL value per exercise. The individual LRPL values are then converted to an overall LRPL value for each trial.

3.3. Aerosol Generator: MSP, model 2045 High Output Aerosol Generator, or equivalent. Capable of maintaining 5 to 100 mg/m^3 of corn oil challenge aerosol concentrations with a Mass Median Aerodynamic Diameter (MMAD) of 0.4 to 0.6 micrometers (µm). The geometric standard deviation must be less than 2.0.

3.4. Aerosol Monitor: TSI Inc., DustTrak II Aerosol Monitor model 8530, or equivalent. Detection range of 0.001 to 400 mg/m^3 with resolution of ± 0.1 percent (%) of reading or ± 0.001 mg/m^3, whichever is greater.

3.5. TSI Model 8038 PortaCount® Pro+ Respirator Fit Tester, or equivalent.

3.6. Corn Oil, 99% pure. CAS Number 8001-30-7. Commercial product names are Maise/Maize Oil, Maydol, and Mazola Oil, or equivalent.

3.7. Scanning Mobility Particle Sizer (SMPS): TSI Inc., with models 3082 Electrostatic Classifier (EC), 3081A Long Differential Mobility Analyzer (DMA), 3752 High-Concentration Condensation Particle Counter (CPC), and 3088 Advanced Aerosol Neutralizer, or equivalent.

3.8. Aerosol Test Chamber: The chamber shall be designed and constructed so that the test participants have ample space for unobstructed movement during the test and are visible at all times while in the chamber. The chamber shall have an air handling unit to provide a consistent and uniform aerosol concentration and fresh air, and may include mixing fans. The chamber design should include an entry vestibule designed to allow safe entry and exit from the chamber with minimal disturbance to both the aerosol concentration and the concentration uniformity. All tubing shall be conductive and tubing lengths and bends should be minimized.

3.9. Chamber Communications: Generic brand and model. Electronic audio communications (i.e., loudspeaker) for real-time voice communication from test administrator to test participants.

3.10. Face Size Sliding Measurement Caliper: Seritex, model GPM 104, or equivalent. With range of 0-200 millimeters (mm).

3.11. Face Size Spreading Measurement Caliper: Seritex, model GPM 106, or equivalent. With range of 0-300 mm.

3.12. Facepiece Direct Probe: Custom probe developed by NIOSH, or equivalent. The basis of design was first described by Liu [AIHAJ (45); 278-283, 1984]. The design shall not interfere with the fit or function of the PAPR. The probe is a bulkhead fitting and provides a tight seal using two rubber washers, one metal washer, and one nut. See Attachment H.

3.13. Test Participants

3.13.1. Test participants are required for this test. The number of participants needed is based on the respirator design described in the application. See Attachments C, D, and E. Manual caliper instruments are used to determine facial sizes for participant panel representation in the NIOSH Panel.

4. TESTING REQUIREMENTS AND CONDITIONS

4.1. Equipment shall be operated and calibrated in accordance with the testing laboratory's operation and calibration procedure(s) or the manufacturer's operation and maintenance manual(s). All measuring equipment utilized for this testing should have been calibrated using a method traceable to the National Institute of Standards and Technology (NIST), when available.

4.2. The pressure vessel which is part of the CUR shall meet all applicable Department of

Transportation Requirements for cylinder approval as well as for retesting/requalification.

4.3. Prior to participating in the test, test participants shall have familiarized themselves with the manufacturer's User Instructions (UI) for proper operation of the CUR. The test participants shall have been required to demonstrate their awareness of how to operate the CUR in accordance with the UI by operating the CUR. If the test participants need to do this just prior to running this test, they shall be provided with a CUR specimen other than those being used in testing.

4.4. Test units shall be new and can be reused after being cleaned, sanitized, and dried in accordance with the manufacturer's UI.

5. PROCEDURE

5.1. Respirator Set-up

5.1.1 Each facepiece shall be probed prior to the facepiece being issued to test participants. The test facility administrator or his staff destructively probes all submitted respirators uniformly.

5.1.2 The respirator sampling probe location shall terminate in the oral/nasal region. The optimum sampling probe position is approximately 1/4 inch from the skin at the point of quadrilateral symmetry of the mouth and nose, i.e., midway between the nose and upper lip. The exact final position of the sample probe will depend upon the design of the respirator being evaluated. Final position of the probe should have no to minimal impact on the designed function of the facepiece, nose cup, or faceblank area that the probe is penetrating. When probing submitted respirators, Test Administrator should not attach the probe through material seams since the seam penetration can cause leakage, potentially contributing to failing results.

5.1.3 Probes that do not clearly enter the oral nasal region, penetrate just the eye lens without penetrating the oral nasal nose cup, penetrate through a faceblank molded seam creating a possible seal leak or enter the nose cup but are blocked by internal respirator parts are considered inadequate test probes. If nosecup function is restricted by probe, testing laboratory may consider alternate equivalent probe locations.

5.1.4 In cases, where the respirator cannot be probed successfully by the test facility, kits with adapters for quantitative fit testing, from the manufacturers can be reviewed and considered for use, but only as a last resort.

5.1.5 Accessories shall be provided and attached to the CUR facepiece submitted for testing in order to obtain the heaviest facepiece configuration. NPPTL will determine the accessories to be added to the respirator for testing.

5.2. Test Participant and Respirator Selection

5.2.1 Manual caliper facial measurements shall be used to determine facial size and panel placement prior to each test participant donning a respirator. Anthropometric measurements are shown in Attachment A.

5.2.2 Test participants shall be selected to cover all the cells within the panels referenced in Attachment B. Each LRPL test shall consist of two trials. A minimum of 50, 68, or 76 pass/fail data points shall be collected from two trials by test participants of each facepiece size of each respirator submitted to NIOSH, as prescribed in Attachments C, D, and E.

5.2.3 If an approval holder or applicant submits a respirator design to fit a sub-population of users, the approval holder or applicant should provide NIOSH with information on the expected size distribution based on the NIOSH Panel. This information will be considered for the NIOSH LRPL testing.

5.3. Chamber Set-up

5.3.1. Turn on air handling unit with sufficient airflow to maintain the proper corn oil concentration.

5.3.2. Turn on vacuum pump for laser photometers.

5.3.3. Turn on mixing fans to produce an even concentration distribution throughout the chamber.

5.3.4. Turn on air compressor for corn oil generators to maintain the proper corn oil concentration. Corn Oil Challenge Concentration = 30 to 40 mg/m^3.

5.3.5. Turn on laser photometers.

5.3.6. Turn on SMPS and warm up for 15 minutes.

5.3.7. Turn on DustTrak.

5.3.8. Allow 30 minutes for the chamber concentration to stabilize.

5.3.9. Use the DustTrak to monitor the chamber concentration.

5.3.10. Use the SMPS according to the manual to determine the particle size. The correct size should be 0.4 to 0.6 µm with a geometric standard deviation of less than 2.0.

5.4. Conducting the LRPL Test

Sections 5.4.1. through 5.4.10. details the procedures to conduct an LRPL test for the CUR unit using only the facepiece in the air-purifying respirator (APR) mode with a chemical, biological, radiological, and nuclear (CBRN) canister. Section 5.4.11 details the procedure to conduct the Practical Performance Test, which is a Modified LRPL test to assess the CUR switchover mechanisms.

5.4.1. The manufacturer's UI provided with the test equipment shall be reviewed by all test facility personnel.

5.4.2. Test participant training will be conducted by test facility personnel based on the UI. The training shall address procedures for donning, doffing, troubleshooting, user seal checks, head harness tightening, and accessory interfacing.

5.4.2.1. Expert donning is not allowed in the conduct of this test.

5.4.2.2. Each test participant shall perform an unassisted donning of the respirator. Self-donning under supervision of the test administrator is permitted to make sure the appropriate adjustments to the facepiece are being performed until the test administrator is satisfied that the test participant is wearing the respirator in compliance with the manufacturer's UI.

5.4.2.3. Each test participant shall practice donning and doffing the respirator until they feel comfortable with the donning of the respirator.

5.4.2.4. After the practice donning and doffing is complete, the test participant shall don the respirator again and continue to wear it for five minutes before proceeding to the PortaCount fit testing.

5.4.2.5. Prior to LRPL testing, test participants are fit tested following OSHA 1910.134 App A – Fit Testing Procedures, using the PortaCount. The grimace exercise is omitted from this procedure. A fit factor of ≥2,000 for APR testing is required to commence testing. The test participant is permitted to adjust the facepiece following the successful fit test.

5.4.2.6. If three test participants within the same panel cell cannot achieve the minimum fit (as described above) using the PortaCount fit test, this is considered an overall LRPL test failure and can result in a denial.

5.4.3. Test participants enter the corn oil chamber and are instructed to attach their sample line tubing to their assigned photometer. Chamber concentration is monitored during the conduct of each individual LRPL test.

5.4.4. Information for each test participant shall be recorded in the NIOSH Dynamic Fit software program. The Test Administrator shall start the software program and relay the information of time to start the test, exercise, and timing of the exercise being performed.

5.4.5. The LRPL trial consists of a set of eleven one-minute standard exercises. During each trial of a LRPL test, each test participant will perform the following eleven exercises for one-minute each in the below listed sequence using the CUR facepiece in APR mode with a canister throughout the test. Participants should not touch any portion of the respirator during any part of the LRPL active test. Test Administrator will give verbal commands to stop and start each exercise.

5.4.5.1. Normal Breathing: In a normal standing position with hands to the sides or rear, without talking, the test participant shall breathe normally for one minute. A recommended procedure is to inhale through the nose and exhale through the nose at a normal pace.

5.4.5.2. Deep Breathing: In a normal standing position as above, the test participant shall breathe slowly and deeply for one minute, being careful not to hyperventilate. A recommended procedure is to inhale deeply through the nose and exhale through the mouth.

5.4.5.3. Turn Head Side to Side: Standing in place, with arms to side, the test participant shall slowly turn head from side to side for one minute between the extreme positions on each side. The head shall be held at each extreme momentarily so the participant can inhale at each side and return to the forward-facing position to exhale. Caution participants not to hit the shoulder with any part of the respirator during the conduct of the exercise.

5.4.5.4. Move Head Up and Down: Standing in place, the test participant shall slowly move head up and down, starting at level plane, move the head up slowly so the eyes are looking straight up at the ceiling, inhale and hold for one second. Return to the neutral, forward-facing position to exhale. Slowly move down past the horizontal level start point to the end point where the chin just touches the chest.

5.4.5.5. Recite the "Rainbow Reading Passage": The test participant shall talk out loud while reading a copy of the passage entitled Rainbow Passage. The test participant will keep reading the passage until told to stop.

5.4.5.6. Sight a Mock Rifle: While standing and normal breathing, the test participant shall pick up the mock rifle. The test participant shall shoulder the mock rifle in the favored shooting posture shoulder position. Bend the head while keeping the respirator fitted so as to allow a realistic sight picture to be attained by placing the cheek unhindered by respirator components (such as a canister) as close as possible to the rifle stock and rear sight aperture. Hold the cheek to stock position for one second. After attaining this posture, drop the arms, while still holding on to the mock rifle, to the side. Continue taking up realistic sight pictures with the mock rifle as described until told to stop or for one minute.

5.4.5.7. Reach for the Floor and Ceiling: While in normal breathing, standing, feet shoulder width apart and at arm's length from any other test participant, the test participant shall bend at the waist as if to touch toes/floor. After touching/reaching fully for the toes/floor, the test participant comes back up at a normal pace, exhales, and extends arms fully and reaching for the maximum length of arms to the ceiling direction. Keeping the arms locked, continue the procedure until told to stop or for one minute.

5.4.5.8. On Hands and Knees, Look Side to Side: Before starting, the test participant shall ensure that enough room is available between equipment, sample line and other test participants. Position on hands and knees and then extend the head looking straight out. Starting at the center, move the head to the right or left as far as possible and hold for one second. Inhale after that one second while holding the head at the extreme extension. Exhale once reaching the neutral, forward-facing position. Continue doing this exercise, not hitting the respirator aggressively, for one minute or when told to stop. At a normal pace, return to the standing position.

5.4.5.9. Facial Grimace: While in normal breathing and standing, the test participant shall grimace the face by smiling or frowning. Starting with the mouth closed, create a smile or frown that is physically felt by the test participant while wearing the tested respirator. It is recommended that smiling and frowning be alternated during the one-minute exercise.

5.4.5.10. Climb the Stairs at a Regular Pace: While breathing normally, the test participant climbs up the steps at a normal pace and back down at a normal pace. Upon the first participant completing one repetition of up and down, the second participant shall climb while the first participant waits. Continue the cycle until one minute expires or told to stop. A similar procedure is used even if one participant is testing—i.e., delay between each stair cycle. Return to the floor standing position. Ensure sample lines are not restricting movement during the climb.

5.4.5.11. Normal Breathing: In a normal standing position with hands to the sides or rear, without talking, the test participant shall breathe normally for one minute. A recommended procedure is to inhale through the nose and exhale through the nose at a normal pace.

5.4.6. Instruct the participants to disconnect the sample line from the photometer. Exit the chamber. Inform the participant(s) to return to the ready line and await further instructions for doffing the respirator or leaving the respirator donned. All those participants identified to doff the respirator will commence doing so and those participants that are being reviewed for test failure protocol will remain with respirator donned until instructed to doff.

5.4.7. The overall calculated LRPL value for each individual will be recorded by the NIOSH Dynamic Fit software and written on the test data sheet as shown in Attachment F.

5.4.8. All comments and observations by test participants, which are voluntary, shall be written on the test data sheet.

5.4.9. After a brief intermission (1-10 minutes), each test participant shall re-don the same respirator facepiece and repeat steps to complete the second trial for the test. Each test shall consist of two trials using the same respirator for each trial with the same test participant for each trial.

5.4.10. If a respirator is identified as a failure upon trial termination, the test administrator shall conduct a failure assessment protocol of the respirator in two phases. The first phase is to inspect the respirator while it is still donned on the test participant. Second is to inspect the respirator when it is doffed. Post-test failure analysis should consist of inspection of the test participant's eye-to-eye lens positioning; head harness positioning; head harness strap twists; nose cup distortion; hair in the facepiece seal area; canister not on securely; probe loose, missing or on a molded seal or surface causing a seal gap; or any other case-dependent situations. If noted deficiencies are confirmed with the respirator being improperly probed, reassign another like respirator to the test participant and retest for two complete trials.

5.4.11. Practical Performance (Modified LRPL Test to assess the CUR switchover mechanism): Eight participants will be selected out of the above described LRPL test panel. The eight selected Test participants must have passed the original LRPL with the assigned respirator. The modified LRPL CUR switchover trial shall consist of a set of eleven one-minute standard exercises. All trials will be performed in dedicated APR mode, unless there is no APR mode, then all trials will be performed in the powered air-purifying respirator (PAPR) mode, blower off. During each trial of a CUR test, each test participant shall perform the eleven exercises from 5.4.5.1 through 5.4.5.10 for one minute each. Test participants shall not touch any portion of the respirator during any part of the CUR active test. The Test Administrator shall give verbal commands to stop and start each exercise.

5.4.11.1. Activation of the switchover mechanism will happen after the last exercise of normal breathing, and the test participant shall switch between each CUR mode in 30 seconds or less. In a normal standing position, the test participant shall activate the CUR switchover mechanism to cycle through all the CUR modes of operation.

5.4.11.1.1 Where the CUR includes a PAPR mode and a self-contained breathing apparatus (SCBA) mode only, the activation sequence shall be current mode to: SCBA, then PAPR blower on, then PAPR blower off.

5.4.11.1.2 Where the CUR includes a dedicated APR mode and an SCBA mode only, the activation sequence shall be current mode to: SCBA mode, then APR.

5.4.11.1.3 Where the CUR includes a dedicated APR mode, a PAPR mode, and an SCBA mode, the activation sequence shall be current mode to: SCBA, then PAPR blower on, then PAPR blower off, then APR.

5.5. Data Analysis

5.5.1. The overall LRPL value will be collected for each trial run and written into the test data sheet.

5.5.2. The Test Administrator will record for each test participant the following:

5.5.2.1. Participant ID number; facepiece size worn; NIOSH Bivariate Panel Cell, any relevant comments noted during the trial.

6. PASS/FAIL CRITERIA

Refer to NFPA 1987 2023 Edition, Section 7.1.2: Laboratory Respiratory Protection Level.

6.1. The LRPL value for each CUR operating in the negative-pressure mode shall be equal to or greater than 2,000 for 95% or greater of the test participants tested.

6.2. During the activation of the CUR switchover element(s), the LRPL shall be greater than

1,000.

7. RECORDS\TEST SHEETS

7.1. All test data shall be recorded on the "Test Data Sheet; STP 0800, Laboratory Respirator Protection Level for CUR".

8. ATTACHMENTS

8.1 Attachment A: Anthropometric Measurements Reference

8.2 Attachment B: NIOSH Bivariate Panel

8.3 Attachment C: NIOSH Panel, One Size

8.4 Attachment D: NIOSH Panel, Two Size

8.5 Attachment E: NIOSH Panel, Three or more Sizes

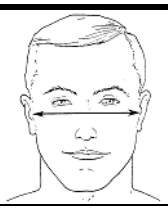
8.6 Attachment F: Example Test Data Sheet: STP 0800, Laboratory Respirator Protection Level for CUR

8.7 Attachment G: Laboratory Respirator Protection Level Calculations

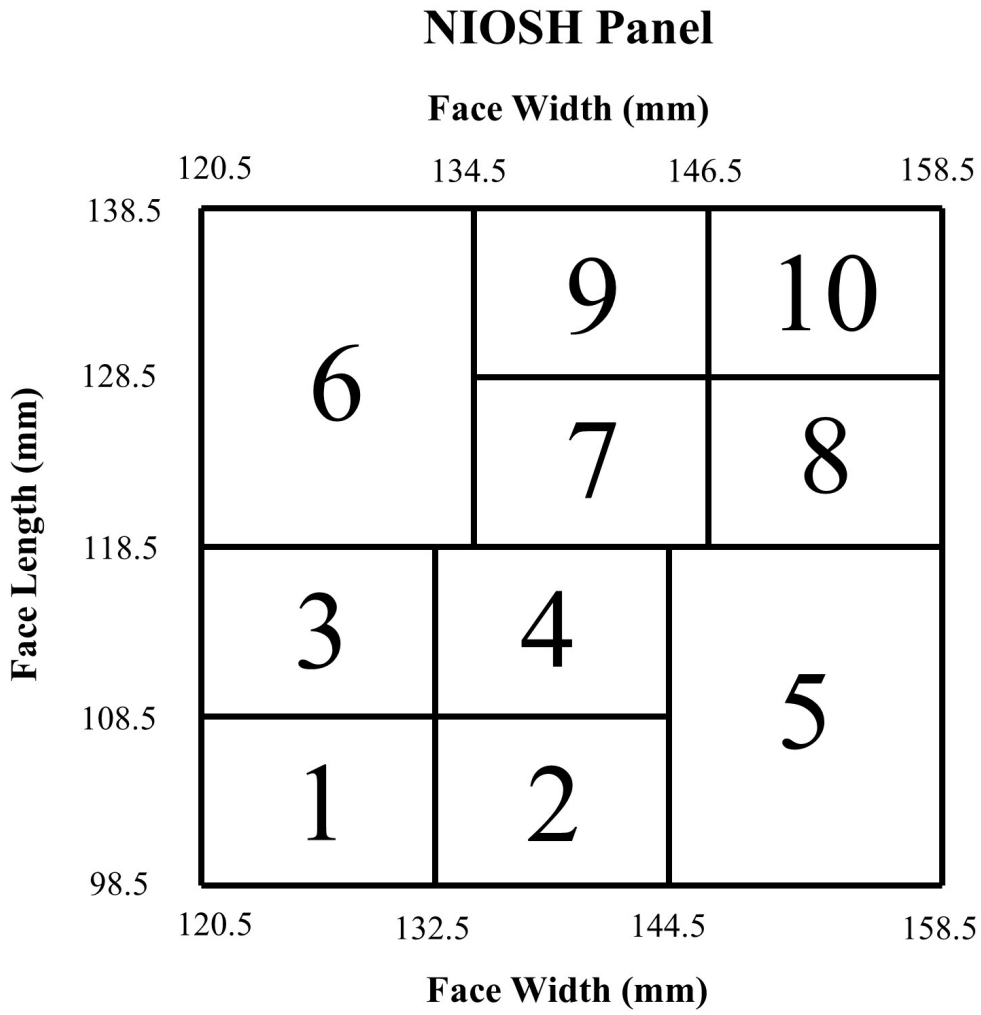
8.8 Attachment H: NIOSH Facepiece Direct Probe

8.9 Attachment I: List of Abbreviations and Acronyms

Attachment A: Anthropometric Measurements Reference

Description	Definition	Diagram
Bizygomatic Breadth	Maximum horizontal breadth of the face as measured with a spreading caliper between the zygomatic arches.	
Menton–Sellion Length	Distance as measured with a sliding caliper in the midsagittal plane between the menton landmark and the sellion landmark.	

Attachment B: NIOSH Bivariate Panel (NIOSH Panel)



Attachment C: NIOSH Panel test participant selection to be used for LRPL testing, One Size

CUR facepiece designed and manufactured in one unique size: 25 test participants, two replicates each, for a total 50 data points.

25-Member NIOSH Panel – Facepiece manufactured in one unique size		
NIOSH Panel Cell	Number of test participants	
1	2 participants	An additional **six** participants will be selected from Cells 2, 3, 4, 7, and 8. No more than four participants permitted from any one NIOSH Panel Cell.
2	2 participants	
3	2 participants	
4	2 participants	
5	2 participants	
6	2 participants	
7	2 participants	
8	2 participants	
9	2 participants	
10	1 participant	

Attachment D: NIOSH Panel test participant selection to be used for LRPL testing, Two Sizes

CUR facepiece designed and manufactured in two unique sizes: 29 test participants, two replicates each, for a total of 58 data points.

<table>
<tr><td colspan="3">29-Member NIOSH Panel - CUR facepiece manufactured in two unique sizes*</td></tr>
<tr><td>NIOSH Panel - cell number</td><td colspan="2">Number of test participants</td></tr>
<tr><td>1</td><td rowspan="6">14-15 participants from Cells 1-6 (at least one from each cell and no more than four from any one cell for a total of 14-15 participants)

Smaller Size</td><td rowspan="4"></td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td><td rowspan="5">14-15 participants from Cells 5-10 (at least one from each cell and no more than four from any one cell for a total of 14-15 participants)

Larger Size</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td><td rowspan="4"></td></tr>
<tr><td>8</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td></tr>
</table>

*For those panel cell sizes that overlap across two facepiece size distributions (i.e., panel cells 5 and 6), the test participants will be provided with either the smaller size or larger size respirator. If the minimum fit (as described above) is not achieved using the PortaCount fit test for the first size tested, the test participant can be tested in the alternate size offered at the discretion of the Test Administrator.

Attachment E: NIOSH Panel test participant selection to be used for LRPL testing, three sizes or more

CUR facepiece designed and manufactured in three unique sizes: 38-member panel, two replicates each, for a total of 76 data points.

<table>
<tr><td colspan="4">38-Member CUR facepiece manufactured in three (or more)* unique sizes</td></tr>
<tr><td>NIOSH Panel cell number</td><td colspan="3">Number of test participants</td></tr>
<tr><td>1</td><td rowspan="4">10 participants from Cells 1-4 (at least one from each cell and no more than four from any one cell for a total of 10 participants)

Smaller size</td><td></td><td rowspan="3"></td></tr>
<tr><td>2</td><td rowspan="5">17 participants from Cells 3-8 (at least one from each cell and no more than four from any one cell for a total of 17 participants)

Medium size</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td><td rowspan="6"></td><td rowspan="4">11 participants from Cells 7-10 (at least one from each cell and no more than four from any one cell for a total of 11 participants)

Larger size</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td><td rowspan="2"></td></tr>
<tr><td>10</td></tr>
</table>

*For those panel cell sizes that overlap across three facepiece size distributions (i.e., panel cells 3 - 8), the test participants will be provided with either the smaller size or larger size respirator. If the minimum fit (as described above) is not achieved using the PortaCount fit test for the first size tested, the test participant can be tested in one of the alternate sizes offered at the discretion of the Test Administrator.

Note: Three size distributions of small, medium, and large are annotated by smaller, medium, and larger sizes. For those submissions that contain extra small, use Cell 1 as an extra small (XSML) where the test participant must achieve a pass. For those submissions that contain extra–large, use Cell 10 as an extra-large (XL) where the test participant must achieve a pass.

Attachment F: Example Test Data Sheet: STP 0800, Laboratory Respirator Protection Level for CUR

Test Data Sheet; STP 0800, Laboratory Respirator Protection Level for CUR

Manufacturer: _____

Model Number or Name: _____

Facepiece / Part Number: _____

Date Started: _____ Date Ended: _____

Facepieces Sizes (circle one): 1 2 3 other _____

Laboratory Conditions				
Date	**Temperature**	**Humidity**	**Corn Oil MMAD**	**Geo Std Dev**

	Participant ID	Panel Cell	Facepiece Size	PortaCount Reading	Overall LRPL value Trial 1	Pass/ Fail	Overall LRPL value Trial 2	Pass/ Fail	Comments
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
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27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									

Total Pass / Fail Results	
LRPL	Practical Performance (Modified LRPL Test)

Passes		Passes	
Failures		Failures	
Overall results			

Comments

Was all equipment verified to be in calibration throughout the testing: €yes €no
Were all the part numbers verified against the hardware: €yes €no

Test Administrator Signature: _____Date: _____

Concurrence: _____ Date: _____

Attachment G: Laboratory Respirator Protection Level Calculations

The respirator system's performance is numerically quantified in terms of a LRPL value. The LRPL value is calculated by determining the ration of challenge aerosol concentration to the in-mask aerosol concentration as qualified by integrating the peak voltage output from the photometer over a time interval. A LRPL value is calculated for each individual exercise ($LRPL_i$):

$$LRPL_i = \frac{Challenge\ Concentration}{In\text{-}mask\ Concentration}$$

Each $LRPL_i$ for that trial are then used to calculate an overall LRPL value for the participant ($LRPL_0$) as follows where *n* is the number of exercises. The $LRPL_0$ is affected most by the smallest $LRPL_i$. Under the conditions of the test and the sensitivity of the photometers, the maximum $LRPL_0$ that can be reported is 100,000. The $LRPL_0$ values obtained are used to evaluate the system against the appropriate LRPL requirements.

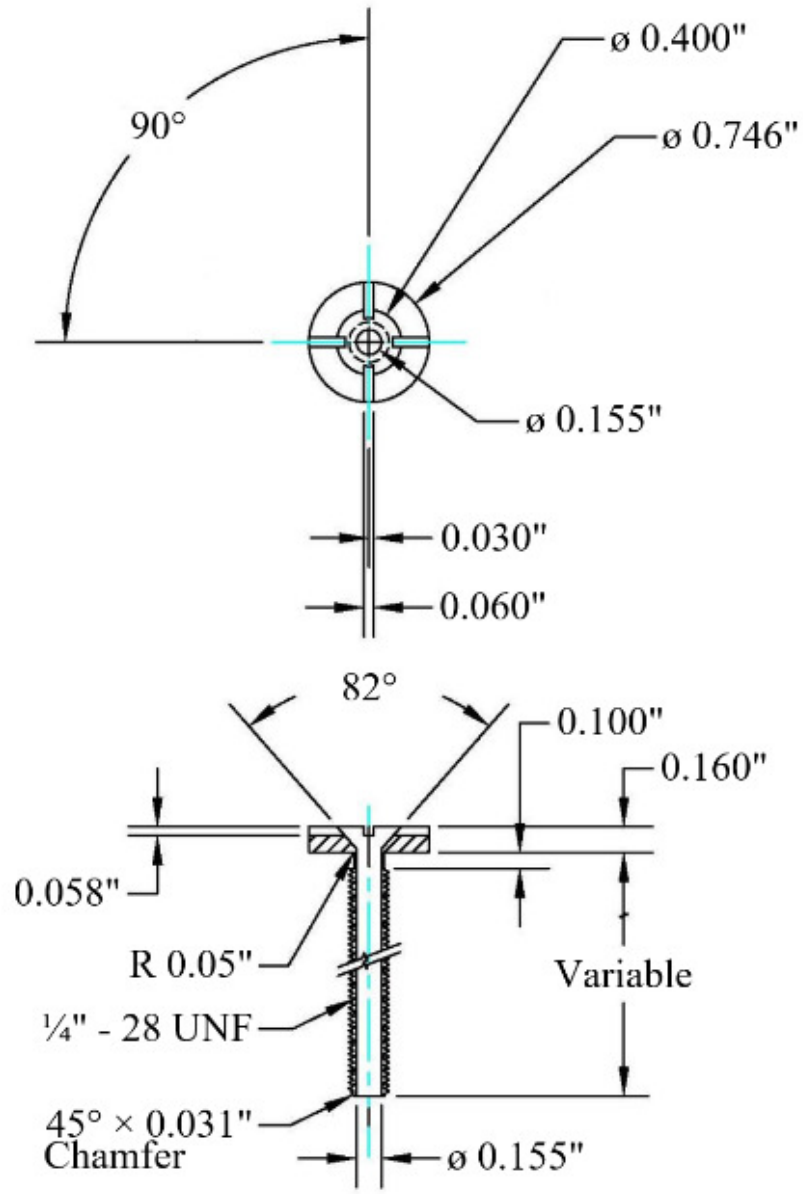
$$LRPL_0 = \frac{Number\ of\ Exercises}{\sum\left(\frac{1}{\text{Fit Factor e1}} + \frac{1}{\text{Fit Factor e2}} + \frac{1}{\text{Fit Factor e3}} + \cdots + \frac{1}{\text{Fit Factor e11}}\right)}$$

Example: A five exercise LRPL test has been conducted. Here are the calculations for the $LRPL_0$ based on the $LRPL_i$ values for each exercise. $LRPL_1$ = 100,000; $LRPL_2$ = 10,000; $LRPL_3$ = 25,000; $LRPL_4$ = 75,000; $LRPL_5$ = 100,000; n = 5.

$$LRPL_0 = \frac{5}{\sum\left(\frac{1}{100{,}000} + \frac{1}{10{,}000} + \frac{1}{25{,}000} + \frac{1}{75{,}000} + \frac{1}{100{,}000}\right)}$$

$LRPL_0$= 28,846

Attachment H: NIOSH Facepiece Direct Probe



Material:
Stainless steel (304)
Tolerance:
± 0.005"
± 0.5°

Attachment I: List of Abbreviations and Acronyms

Abbreviation or Acronym	Definition
µm	Microgram(s)
µg/m^3	Microgram(s) per cubic meter
APR	Air-purifying respirator
CBRN	Chemical, biological, radiological, nuclear
CUR	Combination Unit Respirator
LRPL	Laboratory Respirator Protection Level
mg/m^3	Milligram(s) per cubic meter
mm	Millimeter(s)
PAPR	Powered air-purifying respirator
SCBA	Self-contained breathing apparatus
SMPS	Scanning Mobility Particle Sizer
STP	Standard Testing Procedure
UI	User Instructions

Revision History

Revision	Date	Reason for Revision
0.0	26 February 2024	Establishment of the STP.