

**National Personal Protective
Technology Laboratory**

Concept Plan

**Total Inward Leakage Program
(for Respirators other than Filtering Facepieces
and Half-masks)**

Policy and Standards Development Branch

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Total Inward Leakage Program

(for Respirators other than Filtering Facepieces and Half-masks)

- **Current Project**
 - **Total Inward Leakage (TIL) characterization of other classes of respirators that are associated with standards presently in the rulemaking process or under development**
 - **Includes CC-SCBA, PAPR, SAR, and AFE**
- **Project Approach**
 - **Determine benchmark testing variables, perform benchmark testing, and set pass/fail requirements based on the results**

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- **Lessons learned during half-mask and filtering facepiece benchmark testing will provide valuable information for benchmark testing of other classes of respirators**
 - **Test protocol development**
 - **Test agent applicability**
 - **Test subject panel size selection**

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- **Sources of Inward Leakage**
 - **Particles passing through filter media of particulate respirators**
 - **Contaminants passing through respirator component connections that do not seal properly**
 - **Contaminants passing through the respirator-human interface when respirator internal pressure is negative**

Total Inward Leakage Program

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- **Sources of Inward Leakage (cont.)**
 - All of these inward leakage sources, via the means described, make up Total Inward Leakage
 - The TIL Test is intended to measure inward leakage from all sources combined

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- **Selection of Test Subjects**
 - **For tight-fitting facepiece assemblies, use NIOSH Bivariate Panel based on 2003 NIOSH anthropometric survey**
 - **Expected to cover >97% of U.S. civilian workforce**
 - **Los Alamos National Laboratory (LANL) panel excludes 15.3% of 2003 NIOSH survey subjects**
 - **For loose-fitting assemblies containing hoods and helmets and tight-fitting neck-dam assemblies, develop test panels based on 2003 NIOSH anthropometric database of head and neck circumference measurements**

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- **Selection of Test Subjects (cont.)**
 - **Test panel size to be specified through statistical analysis of benchmark test data**
 - **Determine the number of tests that are sufficient to yield statistically reliable data**

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- **Test Configurations**
 - The number of respirator configurations that will need to be tested will be determined on a case-by-case basis at the discretion of NIOSH
 - Respirator probe specification
 - Probe type
 - Probe location
 - Respirator class dependent
 - Available technology will be reviewed and implemented based on what makes sense and through benchmark testing
 - Draft ISO TIL Standard

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- **Test Agents**
 - **Corn oil aerosol**
 - Currently recognized and accepted test agent
 - Minimum measurable TIL level of 0.001%
 - **Salt (NaCl) aerosol**
 - Measurable TIL level of <0.0005% using flame photometry
 - **Ambient particulates**
 - Sufficient particle concentration
 - Minimum measurable TIL level is dependent on maximum ambient particle concentration

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- **Test Agents (cont.)**
 - **Isoamyl acetate (IAA) vapor**
 - Can IAA vapor be quantitatively evaluated or used for particulates
 - **Diethyl phthalate aerosol**
 - Health effects
 - Minimum measurable TIL level of 0.001%
 - **Sulfur hexafluoride gas**
 - Applicable to non-particulate filtering respirators containing materials that are porous to gases and vapors
 - Suitable detection systems include IR absorption and electron capture detection
 - Minimum measurable TIL level of < 0.0005%

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- **Test Protocols**
 - LRPL corn oil test protocol (NIOSH LRPL STP & Draft ISO TIL Standard)
 - NaCl test protocol (Draft ISO TIL Standard)
 - Sulfur hexafluoride test protocol (Draft ISO TIL & NFPA 1994 Standards)
 - OSHA quantitative fit test protocol for selection of test exercises
 - Industrial fit test isoamyl acetate vapor test protocol (measured quantitatively)

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- **Test Protocol Issues**
 - **Test Performance**
 - Test performance requirements to be established through benchmark testing
 - Test performance requirements will be determined for the respirator configuration submitted for approval

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- **Test Protocol Issues (cont.)**
 - **Test Exercises**
 - Follow OSHA fit test exercises with some additional criteria added to ensure that the exercise motions are performed more consistently by human test subjects
 - Represent typical movements where leakage could occur
 - Other exercises may be identified to add to this list or one or more of these exercises may be eliminated depending on benchmark test results
 - Respirator class-specific exercises may also be identified through benchmark testing

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$$TIL = 100 / FF$$

**Assume that the measured Fit Factor (FF) \approx Protection factor
(not Assigned Protection Factor [APF])**

A TIL of 0.001% \approx Protection factor of 100,000

A TIL of 1% \approx Protection factor of 100

A TIL of 10% \approx Protection factor of 10

A TIL of 20% \approx Protection factor of 5

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- **Test Protocol Issues (cont.)**
 - **Pass/Fail Criteria**
 - Anticipated that the pass/fail TIL values will approximate 100%/Fit Factor where Fit Factor is a minimum 10 fold multiple of current OSHA APF
 - Pass/fail criteria will be based on benchmark performance test results, not on current APF
 - Benchmark testing will be performed to gauge state-of-the-art technology capabilities and instrument sensitivities

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- **LRPL Focus**
 - **As the TIL project and development of the TIL module progresses, LRPL requirements will ultimately be replaced by the inward leakage requirements in the TIL program**

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Stakeholder Input can be submitted by

Mail:

NIOSH Docket Office

Robert A. Taft Laboratories, M/S C 34

Reference: Docket 168 – Total Inward Leakage (respirators
other than filter facepieces and half-masks)

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- **Questions for Consideration**
 - **Should TIL pass/fail criteria be based on the type of respiratory inlet covering, the intended use of the respirator, or other factors?**
 - **Are there any other test agents that can be used which will work for some or all types of respirators that are safe, environmentally friendly and can be accurately measured at the desired concentration?**
 - **Is there test equipment available that can reliably measure the concentration of the test agent(s) of choice that are not overly expensive to own, operate, or maintain?**

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- **Questions for Consideration (cont.)**
 - **Should NIOSH consider accepting TIL test results from independent laboratories?**
 - **Should the standard set of exercises employed by the fit testing process be used for all TIL testing, or should it be different for various types? Why?**
 - **Do the options for available respirators dictate what exercises can be done?**
 - **What will be the strategy for the placement of sample ports for other classes of respirators? Where will the sample point terminate with respect to the test subject for each class of respirator?**