Implementation of the National Academies' Program Recommendations: NIOSH Personal Protective Technology (PPT) Program

Presented to:
NIOSH Board of Scientific Counselors

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Table of Contents

Glossary

AAMI - Association of Medical Instrumentation
AAOHN - American Association of Occupational Health Nurses
ABMS - automatic breathing machine simulator
ABOHN - American Board of Occupational Health Nurses
AHOP - Association of Occupational Health Professionals in Healthcare
AIHA - American Industrial Hygiene Association
AIHce - American Industrial Hygiene Conference and Exposition
ANA - American Nurses Association
ANSI - American National Standards Institute
AORN - Association of periOperative Registered Nurses
APIC - American for Professionals in Infection Control and Epidemiology
ARI - acute respiratory illness
ASSE - American Society of Safety Engineers
BARDA - Biomedical Advanced Research and Development Authority
BLS - Bureau of Labor Statistics
BREATHE - Better Respiratory Equipment using Advanced Technologies for Healthcare Employees
BSC - Board of Scientific Counselor
CA - conformity assessment
Cal/OSHA - State of California Division of Occupational Safety and Health (DOSH)
CBRN - Chemical Biological Radiological Nuclear
CCER - Closed Circuit Escape Respirator
CCSCBA closed-circuit self-contained breathing apparatus
CDC - the Centers for Disease Control and Prevention
CEN - European Committee for Standardization
CFR - Code of Federal Regulations
CO_2 - carbon dioxide
COPPE - Committee on Personal Protective Equipment
CPWR - Center for Construction Research
CRADA - Cooperative Research and Development Agreement
CSA - Canadian Standards Association International
CSPC - Consumer Safety Products Commission
EMS - emergency medical services
EOSTI - end of service time indicator
ERC - Educational and Research Center
EU - European Union
FDA - US Food and Drug Administration
FFR - filtering facepiece respirator
GPRA - Government Performance and Results Act
HCSA - Health Care and Social Assistance

HCW - health-care worker
HPD - hearing protection device
IAFC - International Association of Fire Chiefs
IAFF - International Association of Firefighters
IDLH - immediately dangerous to life or health
IL - inward leakage
ILI - influenza-like illness
IOM - Institute of Medicine
ISEA - International Safety Equipment Association
ISO - International Organization for Standardization
ISRP - International Society for Respiratory Protection
LOA - letter of agreement
MOU - Memorandum of Understanding
MRE - mine rescue ensemble
MSHA - Mine Safety and Health Administration
MTA - Material Transfer Agreement
NA - National Academies
NFPA - National Fire Protection Association
NIOSH - National Institute for Occupational Safety and Health
NIST - National Institute of Standards and Technology
NPRM - Notice of Proposed Rule Making
NRC - National Research Council
NSS - National Strategic Stockpile
NTTAA - National Technology Transfer and Advancement Act
OHN - occupational health nurse
OMSHR - Office of Mine Safety and Health Research
OSHA - Occupational Safety and Health Administration
PAPR - powered air-purifying respirator
PCA - Principal Component Analysis
PCAWG - PPT Program Conformity Assessment Working Group
PPE - personal protective equipment
PPT - Personal Protective Technology
REACH - Respirator Evaluation in Acute Care Hospitals
REL - Recommended Exposure Limit
ResPECT - the Respiratory Protection Effectiveness Clinical Trial
RFI - request for information
RPP - respiratory protection program
SAR - supplied-air respirator
SC - standards committee
SCBA - self-contained breathing apparatus
SCSR - self-contained self-rescuer
SDO - standards development organization
SEI - Safety Equipment Institute
SM - surgical mask

SME - Society of Mining Engineers
STP - standard test procedure
TAG - Technical Advisory Group
TC - technical committee
THL - total heat loss
TIL - Total Inward Leakage
UL - Underwriter Laboratories
VA - Veterans Administration
VLE - vapor liquid extraction
VTU - Virginia Tech University
WG - working group
WHO - World Health Organization

IMPLEMENTATION OF THE NATIONAL ACADEMIES' NIOSH PROGRAM RECOMMENDATIONS:

Personal Protective Technology Program

June 20, 2014

INTRODUCTION

The National Academies (NA) completed and published a review of the NIOSH Personal Protective Technology Program (PPT Program) in 2008, one of eight NIOSH programs analyzed. It provided five broad recommendations for improving the Program based on an evaluation of the relevance and impact of the Program's activities. Those five recommendations included:

1. Implement and Sustain a Comprehensive National Personal Protective Technology Program

2. Establish PPT Research Centers of Excellence and Increase Extramural PPT Research

3. Enhance the Respirator Certification Process

4. Increase Research on the Use and Usability of PPT

5. Assess PPT Use and Effectiveness in the Workplace Using a Life-Cycle Approach

The PPT Program prepared a detailed Implementation Plan to address these recommendations, and began to implement the activities aligned with the PPT Program Strategy in January 2009. It developed a set of issues for each recommendation to define specific approaches to the major components of each recommendation. Eighteen issues were developed. The Implementation Plan was submitted to the NIOSH Board of Scientific Counselor (BSC) for comment and approval. The BSC found that:

> Overall, the Program Implementation Plan is complete. It is an ambitious plan that has the potential to transform the program. The plan addresses each of the NA recommendations in detail, is largely appropriate and, in some cases, commendably goes beyond what the NA recommended.

The final version of the Implementation Plan was published in May 2010, following its modification based on the BSC comments. The PPT Program began immediately to execute strategies to address the Program's highest priority issues.

Five of these issues were subsequently selected in 2011 for the purposes of the new Government Performance and Results Act (GPRA) measure assessing the progress made toward implementing select recommendations made by the NA. These were selected to provide: a mix of on-going and new initiatives; ambitious, but realizable targets; focus on stated stakeholder needs; and emphasis to each of the PPT Program's four strategic goals. The five sub-recommendations selected were:

1. Participate in policy development and standards-setting across all types of PPT
   NA Report Recommendation 1 (Issue 1.2)
   PPT Program Activity: Policy and Standards Development

2. Oversee certification of all PPT, including an assessment of certification mechanisms
   NA Report Recommendation 1 (Issue 1.3)
   PPT Program Activity: Technology Evaluation

3. Conduct outreach programs for optimal use and acceptance of PPT by workers
   NA Report Recommendation 1 (Issue 1.5)
   PPT Program Activity: Surveillance and Communications

4. Define barriers to and facilitators of PPT use
   NA Report Recommendation 4 (Issue 4.1)
   PPT Program Activity: Technology Research and Surveillance and Communications

5. Develop innovative PPT designs and test methods to improve comfort, fit and usability
   NA Report Recommendation 4 (Issue 4.2)
   PPT Program Activity: Technology Research

In 2011, the NIOSH Board of Scientific Counselors (BSC) reviewed these sub-recommendations for progress, and scored the PPT Program's progress on each recommendation in areas of Relevance, Sustainability, Progress and Potential for Impact. The score report for the 2011 review can be found in Appendix 1.

The narratives in this report cover two periods: 2008-September 2011 and October 2012-present. Efforts to maintain the activities completed in the first review are described, and for the second period the report addresses continuing, modified and new activities. These descriptions are presented below. Additionally, Appendix 2 contains the rationale for not selecting the following sub-recommendations:

Expand the extramural research program and increase its coordination with intramural activities

Enhance the respirator certification program

Assess PPT use and effectiveness in the workplace using a life-cycle approach

Recommendation #1 (Issue 1.2):

Participate in policy development and standards across all types of PPT

Background

Status: *In Progress*

External Factors: The regulatory authority for the NIOSH respirator certification program comes from the Mine Safety and Health Amendments Act of 1977 (30 U.S.C. 577a, 651 et seq., and 657(g)) and the Occupational Safety and Health Act of 1970 (30 U.S.C. 3, 5, 7, 811, 842(h), 844). The respirator approval regulations have as their basis the performance tests and criteria for approval of respirators used by workers such as healthcare workers, construction workers, miners, painters, asbestos removal workers, fabric mill workers, and fire fighters.

There are no NIOSH standards for non-respiratory PPT. NPPTL personnel participate on voluntary consensus standards for respirator and non-respiratory PPT standards, in the standards development activities of other federal agencies, and in private sector organizations to aid in the transfer of research findings to application to the design, performance and use of various PPT. PPT researchers may request Agency permission, in accordance with prescribed procedures, to become members of consensus standards committees as an official duty and may vote according to standards development organization (SDO) procedures. Approved activities are authorized under the Office of Management and Budget Circular No. A-119 – Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities and are consistent with the National Technology Transfer and Advancement Act (NTTAA) of 1995 (http://www.whitehouse.gov/omb/circulars_a119).

Implementation of Recommendation

Activity A: Regulatory Updates for Respiratory Protection

Description: NIOSH has a regulatory role to certify respiratory protective devices and to prevent worker related injury and illness through the development, certification, deployment and use of personal protective equipment (PPE). Standards for PPE are the primary means to introduce new technology that improves the protective performance of the equipment. The NIOSH role in developing respirator regulations for the current respirator certification standard, 42 Code of Federal Regulations (CFR), Part 84; consensus respirator standards; and other PPE consensus standards is to provide quality science to the standards process that will result in improvements in occupational safety and health.

Progress: The changes are being introduced in incremental rule-making steps and policy development, called modules. These modules represent a continuous improvement strategy for the respirator certification program. A process using public meetings, information dockets, and requests for information has been established to obtain informed viewpoints from all segments of the worker community and respirator manufacturers. NIOSH's regulatory agenda containing

the respiratory protection modules planned and being developed through this process can be viewed at http://www.cdc.gov/niosh/regulatory.html.

Since the publication of the NA PPT Program Evaluation Report, the following activities and research support proposed changes to the regulations:

- Amendments to Powered Air-Purifying and Supplied Air Respirator Requirements for Approval of Respiratory Protection Devices
- Total Inward Leakage (TIL) Requirements for Respirators
- Amendments to Closed-Circuit Self-Contained Breathing Apparatus Performance Requirements for Approval of Respiratory Protective Devices
- Approval Tests and Standards for Closed-Circuit Escape Respirators
- Amendments to Establish Wildland Firefighting Protection Performance Requirements for Approval of Respiratory Protective Devices

Impact: The PPT Program has succeeded in conducting the science and formulating several regulatory modules that have progressed to be published as notices of proposed rulemaking. Standards for PPE are the primary means to introduce new technology that improves the protective performance of the equipment. The purpose of this effort is to update the respirator certification standard to be consistent with contemporary technology. Technology and newly emerging hazards have out-paced the existing requirements that were last promulgated in 1972. The PPT Program goal is to revise the respirator standards under 42 CFR Part 84 to incorporate state-of-the-art performance levels, test methods and quality assurance requirements in incremental rule-making steps and policy development, called modules. For example, the TIL regulation is intended to quantify the ability of respirators to fit individuals, it is not intended to replace individual fit testing as mandated by the Occupational Safety and Health Administration (OSHA). The TIL requirements will have a margin of safety over currently certified respirators.

Future Plans: The PPT Program has substantial control over the development of the science to support updates, the development of technical criteria supported by this science, and the vetting of the science and basic technical approaches with outside experts and stakeholders. Its role in developing 42 CFR respirator regulations is to provide quality science to the standards process that will result in occupational safety and health improvements. The PPT Program will continue using the modular process to develop and promulgate improvements to respirator certification policies and regulations that allow respirator end-users to take advantage of new and emerging technologies in the area of respiratory protection. The upgrades will encompass the performance parameters for various respirator types, quality assurance provisions, and modernizing the certification process.

Activity B: Participation in voluntary consensus standards, in the standards development activities of other federal agencies, and in private sector organizations

Description: The NIOSH role in developing consensus standards for PPE other than respirators is to provide quality science to the standards process that will result in improvements in occupational safety and health. Performance and certification standards for protective clothing and equipment such as garments, ensembles, footwear, gloves, head protection and hand protection are primarily the responsibility of non-government SDOs. Some of these are the National Fire Protection Association (NFPA), American National Standards Institute (ANSI), ASTM International, International Safety Equipment Association (ISEA), and the International Organization for Standardization (ISO). NIOSH personnel serve on numerous consensus SDOs which serve as the conduit to the PPT Program.

Progress: Collaborative agreements have been established through Memorandums of Understanding (MOUs) and other working relationships with the ISO, ANSI, NFPA, ASTM International, Canadian Standards Association International (CSA) and the ISEA. These relationships have been established in the areas of protective clothing (i.e. ensembles, garments, footwear and gloves), hearing protection, eye and face protection, fall protection, industrial head protection, and respiratory protection. The standard writing activities address PPT performance, use, and maintenance. Program personnel participate as voting committee members and maintain visible, active leadership positions in these organizations. Examples include leading the US Technical Advisory Group to ISO for respiratory protection; holding the Vice-Chairmanship for the ANSI Z88 committee on respiratory protection, the Chair position for the overarching NFPA Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment, the Chair position for ASTM Committee F23 on Protective Clothing and Equipment, the Membership Secretary position for ASTM Committee E54 for Homeland Security Applications; and membership on many technical committees and subgroups.

Impact: NIOSH encourages employees with relevant expertise to participate as approved representatives in SDO activities of private sector, voluntary consensus standards committees to facilitate translation of NIOSH scientific research findings into improved occupational safety and health practices. The development and acceptance of contemporary standards for non-respiratory PPT will greatly enhance efforts to make the nation's workplaces safer and healthier. Specific examples where NIOSH personnel membership on SDOs and where supporting research directly impacted the development and release of revised or new PPT standards since 2008 are:

- ASTM F2704-10 Standard Specification for Air-Fed protective ensembles
- ASTM F2815-10 Standard Practice for Chemical Permeation through Protective Clothing Materials
- ASTM F2731-11 Standard Test Method for Measuring the Transmitted and Stored Energy of Firefighter Protective Clothing Systems
- NFPA 1999 Standard on Protective Clothing for Emergency Medical Operations, 2008 Edition

- NFPA 1984 Standard on Respirators for Wildland Fire Fighting Operations, 2011 Edition

Future Plans: The PPT program standards development activities will continue to emphasize involved membership on various SDO committees. These activities include conduct of supporting research, development of test methods and performance criteria, certification standards, and selection, care, and maintenance standards for PPT. The commitment to these activities is evidenced by: (1) conducting research projects addressing technology gaps and providing data used by SDOs in their standards development activities; (2) continued collaboration under MOUs with NFPA, ASTM and ISEA; (3) continued resources supporting participation of PPT Program scientists in SDO committee meetings and associated activities; and (4) establishing annual performance plans for NPPTL staff defining their SDO activities.

Several future activities include involvement on the ASTM F23 Protective Clothing and Equipment Subcommittee to develop a new specification for non-sterile isolation gowns intended for use in health care facilities and the recent NIOSH participation on the NFPA Technical Committee on Hazardous Materials Response Personnel. This committee has responsibility for standards on the requirements for the professional competence, training, procedures, and equipment for emergency responders to hazardous materials incidents. To complement this activity, NIOSH will complete a series of fast facts, fact sheets and booklets for Chemical Biological Radiological Nuclear (CBRN) respirators and a CBRN Handbook by FY13.

2014 Update Recommendation #1 (Issue 1.2):

Participate in policy development and standards across all types of PPT

Addition of or modifications to activities since last review

The PPT Program is committed to developing the science to support PPT standards' updates, developing technical criteria for standards supported by this science, and vetting the science and basic technical approaches with outside experts and stakeholders. Its role in developing 42 CFR 84 respirator regulations includes identifying the need, working with stakeholders in industry, labor, other government agencies, and academia to establish potential performance requirements, conducting scientific studies to validate potential performance requirement, and participating in the standards development process to incorporate quality science in the standards that will result in occupational safety and health improvements. The time intensive approach inherent in the traditional federal regulatory process led to the establishment of the 1995 NTTAA (https://standards.gov/nttaa/agency/index.cfm?fuseaction=home.main), directing federal agencies to incorporate consensus standards in the process when possible. The PPT Program is realigning resources to most effectively support the standards development approach defined in the NTTAA. NIOSH has engaged NIST to most effectively provide guidance to aligning activities to be in compliance with NTTAA. This approach will enhance the PPT Program's leadership in the standards development activities with the intent to develop PPT standards more expeditiously. The Program is continuing to invest considerable resources and commitment participating in voluntary consensus standard development and supporting the

PPT standards development activities of other federal agencies and private sector organizations. For example the PPT Program provide information on powered air-purifying respirators (PAPRs) to assist OSHA in responding to comments on the Notice of Proposed Rulemaking (NPRM) for Occupational Exposure to Respirable Crystalline Silica respirator table. The PPT Program has representatives on ANSI, NFPA, and ASTM standard setting committees (discussed below). The PPT Program also has expanded its collaboration with the Food and Drug Administration (FDA) to assess approaches to harmonize the overlapping authorities associated with NIOSH approval and FDA clearance of respirators. In another effort, the PPT Program is working with the Environmental Protection Agency (EPA) to address the content of pesticide labels and the PPE recommendations indicated on the label.

The Program has been supporting and leading the development of ISO standards for respiratory protection. Together with OSHA, NIOSH is assessing the most effective approach to incorporate the ISO standards in the United States. Internal NPPTL working groups are assessing the approach to incorporating the ISO respiratory protection standards in the NIOSH strategy for updating 42 CFR 84. The path forward for policy development and standards for other types of PPT, including protective clothing, hearing and fall protection, is included in the conformity assessment activities (Recommendation #1, Issue 1.3)

NPPTL carefully reviewed the BSC Review of Progress Report of January 10, 2012 recommendation to expand its involvement in non-respiratory PPE and assessed research efforts underway to support standards across multiple industry sectors. The Program is focusing research to support standards on respirators, protective clothing, interfaces between types of PPE, hearing protection, and fall protection. The PPT Program has activities in a number of sectors: Healthcare (new respirator for health care personnel and isolation gowns), Public Safety (fire fighters, emergency medical services (EMS), law enforcement), Mining (knee pads), Construction (fall-arrest harnesses and hard hats), Manufacturing (hearing protection) and Agricultural (pesticide handling). While the efforts for particular types of PPE may be focused on addressing gaps for a particular industry sector, these efforts could be applied to other sectors once implemented.

In addition to respiratory protection, the Program is also involved in research supporting standards development activities in hospital isolation gowns, protective clothing, hearing protection, anti-vibration gloves, and fall-arrest harnesses. In the area of hearing protection, the Program is a member of the ANSI S12 (noise) and S3 (bioacoustics) managed by the Acoustical Society of America. Through the Program's memberships on the ANSI S12 and S3 committees, it also has membership in the ISO Technical Committee (TC) 43 on Acoustics and TC 43/ Subcommittee 1 on bioacoustics. The PPT Program's representative is an appointed member of Working Group 17 on hearing protection devices (ISO TC43/SC1/WG17). The representative also serves as the chair for the ANSI S12 committee.

The following table lists the Program's hearing protection research projects contributing to standards.

Project Name	Start Date	End Date
Hearing Protector Testing Methods & Rating Schemes	10/01/96	09/30/15
Hearing Protector Performance for Impulse Noise	10/01/09	09/30/14
Compendium and Selection Tool for Hearing Protection Devices (PHP)	10/01/09	09/30/13
Testing Speech Intelligibility and Hearing Protection	04/01/10	09/30/14
Field Attenuation Measurement for Hearing Protection Devices	10/01/10	09/30/14

The Program has conducted research on harness design and sizing effectiveness. Fall-arrest harnesses provide the last line of defense to 6.3 million construction workers in areas where fall-from-height hazards cannot be completely eliminated. The Program's research provided updated harness sizing and cut-length information for harness design to reduce the risk of worker injury that results from poor fit or improper size selection. The Program has analyzed the effect of body and harness characteristics on suspension tolerance time and impact force on the neck after a successfully arrested fall. Fall victims may suffer suspension trauma (fatal reduction of return blood flow from the legs to the heart and brain) after a successfully arrested fall, if they are not rescued quickly or the harness does fit them well. Fall victims also are exposed to the risk of neck injuries during a forceful suspension; using an instrumented manikin, the PPT Program is addressing this issue. The Program is also a member of the ANSI Z359 Committee on Fall Protection Standard. The Program is working with the leading harness manufacturers to incorporate the results of the Program's research into the standard. In another effort to support the needs of construction workers, the Program recently received funding for a project to investigate the potential of hard hats to reduce brain injuries occurring from falls.

Since 2012, the program has engaged in research efforts to improve PPE for the fire service, Fire Apparatus Design and PPE Sizing: Knowledge & Technology Transfer. The Program is also working with the NFPA to modify their 1901 standard Automotive Fire Apparatus. The modification will incorporate fire apparatus seat belt and seat designs that accommodate a variety of fire fighters wearing their PPE safely.

The PPT Program has conducted research involving the assessment of the effects of anti-vibration gloves. Three publications have resulted from this research during the past two years. Beyond the glove assessment, the program is also engaged in a research study to further assess intervention methods: Hand-Arm Vibration Exposures: Development of Assessment and Intervention Methods and Technologies 10/01/2012-09/30/2017.

The Program is involved on ANSI Standard Committee S2 and the Vice Chair of the US TAG on human vibration exposure.

Progress made or maintenance efforts since last review

Since the previous report, NIOSH has successfully promulgated the following respirator standards:

Closed Circuit Escape Respirator (CCER) –This new regulation improved upon the previous standard by allowing the total capacity for oxygen supply and carbon dioxide removal to vary by respirator model to address different work and escape needs. It also addresses a number of issues encountered by the mining community with the design of these devices. For the first time in a respirator regulation, the CCER final rule contains provisions for a manufacturer registration program, addressing one of the recommendations provided in the NA review of the PPT Program (Recommendation 3: Enhance the Respirator Certification Process). To provide manufacturers an opportunity to have their equipment evaluated to the new standard prior to submitting the products for approval, the PPT Program initiated a correlation testing program.

End of Service Time Indicator (EOSTI) –This new standard institutes a requirement to provide emergency responders adequate time to enter a fire, respond to a fire, and exit the dangerous response scenario. The standard provides greater latitude in setting the indicator alarm to ensure that it more effectively meets the different worker protection needs for different occupations and work operations. This standard set a default service life at a minimum of 25 percent of the rated service time and allows the indicator to be adjusted higher by the manufacturer, at the request of the purchaser.

NIOSH initiated the following standards since the last update:

- Fee module – A Notice of Proposed Rule Making (NPRM) was published in 2013 to update the fees charged by NIOSH for the certification of respirators allowing the NIOSH respirator certification program to recover the costs associated with respirator certification. Two public meetings were held. All comments received are being reviewed and final rule is being developed. This standard addresses the BSC's concern in their review of the Progress Implementation Report for NIOSH Personal Protective Technology Program dated January 10, 2012, about the ability to maintain adequate resources for sustaining the update of the regulations. Increasing the respirator certification fees will allow NIOSH to direct its discretionary funding to respirator research, standards development, surveillance, and outreach activities.
- NFPA Standard for non-structural firefighting – Users in Law Enforcement and other emergency services desire CBRN protections, but do not want or need the firefighting features identified in the NFPA 1981 standard. Rulemaking concepts will be developed to change the existing NIOSH requirement that identifies NFPA 1981 as a performance requirement for CBRN Certification. Based on input from the user community, the concept may also include combination units, self-contained breathing apparatus (SCBA)/Air-purifying. NIOSH is working with the NFPA technical committee during this pre-rule phase.

Since the previous report to the BSC, the following activities and research to support proposed changes to the respirator regulations have occurred:

- Development of new, comprehensive standards for certifying multi- PAPRs, supplied-air respirators (SAR), and closed-circuit self-contained breathing apparatus (CCSCBA) is underway. As stated above, the PPT Program is assessing the approach to leveraging the consensus standards process, including an assessment of the ISO draft respiratory protective device standards, test methods, and performance requirements to determine the best path forward for these modules.
    - PAPR activities – To fully address stakeholder concerns regarding both financial impact and impact on small businesses, further input is being solicited through publication of a request for information (RFI). The PAPR standard is being updated to incorporate scientific findings regarding machine carbon dioxide (CO_2) testing, human breathing gas tests, challenge testing and inward leakage (IL). In compliance with the NTTAA directive to cite consensus standards rather than developing independent standards, current work is emphasizing an evaluation of the ISO 17420-2 Respiratory protective devices – Performance requirements – Part 2: Filtering device standard. Benchmark testing of technologies for low work rate PAPRs for health-care workers is underway.
    - Full facepiece positive pressure, pressure-demand Type C and Type CE SAR activities – This standard will allow these respirators to be used during entry into and escape from CBRN Immediately Dangerous to Life and Health (IDLH) atmospheres and improve the performance and reliability of SAR which will improve respirator user safety and health.
    - CCSCBA activities – the intent is to have a webinar and draft an RFI in 2014. During this process, further involvement of the NFPA will be sought.

- Revision of the minimum performance requirements to determine the effectiveness of Inward Leakage (IL) Requirements for Respirators.
    - Requirements for half-mask air-purifying particulate only respirators – In response to the NIOSH 2009 Notice of Proposed Rulemaking (NPRM) on IL, commenters expressed concerns that "the proposed procedure cannot discriminate between well- and poor-fitting respirators. This is primarily due to the large amount of panel-to-panel variability (noise) in the method. The substantial amount of test variability makes it impossible for a respirator manufacturer to use pre-submission testing to determine whether a respirator will pass at NIOSH" (inter-panel variability). In response to these stakeholder's comments, beginning in 2012, NIOSH completed a literature review of potential sources of inter-panel variability and authored a peer reviewed research protocol to complete an inter-panel variability study. Two scientific webinars and a Public Meeting were held in 2013. In response to stakeholders' comments, a contract was awarded to complete the economic impact analysis. The comments and economic impact analysis are being reviewed and a second NPRM is expected to be completed in FY2014.

  - Other classes of respirators – Research activity is underway to develop the scientific basis for addressing inward leakage for all other classes of respirators. The PPT Program is evaluating the potential alignment of NIOSH requirements with requirements developed by other SDO's including ISO, NFPA and ASTM. This research will benefit national efforts (NIOSH and OSHA) in understanding the proposed ISO definitions of protection level, the ISO classification scheme, and recommendations for selection and use.
  - Respirator panels – Work has been completed on determining the panel size (i.e., the number of subjects to test each respirator) and the passing criterion. This work was published in a peer-reviewed journal (Landsittel-D et al. Determining sample size and a passing criterion for respirator fit-test panels. Journal of Occupational and Environmental Hygiene. 2014 Feb; 11(2):77-84).

- Amendments to establish Wildland Firefighting Protection Performance Requirements for Approval of Respiratory Protective Devices – The NFPA 1984 Standard-Rev was issued by the Standards Council on December 14, 2010 and approved for an effective date of January 3rd, 2011 as an American National Standard. NIOSH developed new standard test procedures (STP) to evaluate respirators certified by NIOSH to the NFPA 1984 standard. To date, no manufacturers have submitted respirators for certification under this standard. The manufacturers stated that there have been no requests for this type of respiratory protection. The PPT Program initiated an assessment in 2013 to evaluate the barriers affecting the implementation of the NFPA 1984 standard. This process included specifying the objective of the standard, identifying the internal and external factors that were involved in the creation/adoption of the standard and barriers to achieving compliance. This assessment and the overall standards development process were on the February 2014 agenda for the Institute of Medicine (IOM) Committee on Personal Protective Equipment (COPPE) meeting. Three presentations on standard development were given at this COPPE meeting by non-COPPE members: (1) Jorge Contreras from the American University – Washington College of Law presented information on models of participation in technical standard settings; (2) Andrew Updergron from Gesmer Updegrove, a law firm for technology companies and emerging businesses, discussed strategies for successful standards development and adoption; and (3) Ben Favret of Vestagen Technical Textiles described the development process for ASTM WK38455 standard on healthcare protective uniforms breathable, antimicrobial barrier attire. The COPPE also provided informal comments which will assist the PPT Program in developing a standards development strategy. Standards development will be discussed at a future NFPA meeting as well.

- Healthcare worker respirator – The PPT Program is collaborating with the Department of Veterans Affairs (VA), universities, and manufacturers to develop performance requirements for a respirator with improved comfort and design features to address healthcare worker needs. The improved performance requirements have been developed and published. The next steps are to work with a consensus standard organization to transform the performance requirements into a standard with these

improved design features. These activities are discussed further under Recommendation 4, Issues 4.2 and 4.3. Through these efforts, the PPT Program has published a number of relevant papers with Texas Tech University researchers, who have conducted 3D modeling / computer simulations of comfort and fit. The PPT Program is also pursuing collaborations with the Georgia Institute of Technology on reusable facemask technology. The program collaborated with Georgia Tech to evaluate the filtration efficiency of the prototype devices designed to improve comfort and fit.

- Isolation gown standard – NIOSH is leading the research efforts and participating in the ASTM F23 Committee on Protective Clothing and Equipment working to develop a hospital isolation gown standard. This effort was initiated after recent feedback from stakeholders indicated a strong need to develop performance requirements for isolation gowns, and IOM recommended increased research on the gowns for healthcare workers (HCWs). The findings of the NIOSH research are being used as the scientific basis to develop an ASTM standard for the minimum performance and design criteria for isolation gowns. The results may also be used to update the Association of Medical Instrumentation (AAMI) PB70/Ed.2, Liquid barrier performance and classification of protective apparel and drapes intended for use in health care facilities.

- Total Heat Loss (THL) Standard – The consensus standards of the NFPA establish the THL criteria for the various first responders' categories. Manufacturers of first responder PPE and independent test labs such as Underwriters Laboratories (UL) test the heat loss characteristics of a sample of material used in a protective ensemble on a THL apparatus by placing a representative swatch of material onto the apparatus and measuring the heat flux across the fabric, in dry and wet conditions. After this test, the fabric is assigned a THL number. The relationship between that number and the heat loss from the body is not totally understood across all areas of first responders' PPE. NIOSH initiated research to addresses the actual physiological responses in terms of heat loss from the subjects while wearing commonly used first responder ensembles to provide a sound physiological basis for setting THL values in current and future PPE performance standards. ASTM initiated activity to develop a THL standard. Once approved as an ASTM standard, NFPA is expected to adopt the standard as well.

- Participation in SDOs – The Program has membership on over 30 technical committees and subgroups of various SDOs [ANSI, NFPA, and ISO] including leadership positions. PPT program researchers, OSHA and manufacturers participate on the USTAG. The PPT program ISO project officer acts as the administrator of the USTAG. The following table summarizes the leadership positions held by Program employees.

Standards Development Committee	Position
ISO Respiratory Protection Device Standard	Leading the US TAG
ANSI Z88 committee on respiratory protection	Vice-Chair
NFPA Technical Correlating Committee on	Chair

Fire and Emergency Services Protective Clothing and Equipment	
ASTM Committee F23 on Protective Clothing and Equipment	Chair
ASTM Committee E54 for Homeland Security Applications	Membership Secretary
ASTM E54.04 Subcommittee on PPE	Chair

- Comments on OSHA Proposed Silica Standard – The PPT program provided comments on the PPE requirements in the proposed revisions to the Occupational Safety and Health Administration's silica standards for general industry (29 CFR 1910.141) and construction (29 CFR 1926.51) in 2013.

- Completion and NIOSH website posting of a series of NIOSH Fast Facts for Chemical Biological Radiological Nuclear (CBRN) and PAPR respirators:
    - *What's special about Chemical, Biological, Radiological, and Nuclear (CBRN) air-purifying respirators (APR)?*
    - *What's special about Chemical, Biological, Radiological, and Nuclear (CBRN) powered air-purifying respirators (PAPR)?*
    - *Getting optimal performance from a powered air-purifying respirator (PAPR) depends on the condition of its battery!*

- Research on PPE for Mine Rescue Teams – Currently, there are no minimum requirements, best practice documents, or nationally recognized consensus standards for protective clothing used by mine rescue teams in the United States. In light of some of the more recent mine rescuer fatalities in the past years, the trend in the mining industry is toward non-exposure to potential hazards for rescue workers. The mining industry and regulatory agencies have been more restrictive in exposing rescue workers and others in the aftermath of a mine disaster. The PPT program is working with the NIOSH Office of Mine Safety and Health Research to determine the best approach to provide guidance and/or input to standard on mine rescue ensembles.

Impact(s) made since last review (process or outcome related)

The PPT Program has succeeded in conducting the science and formulating several regulatory modules that have been promulgated to final regulation, EOSTI and CCER. The impact of the CCER regulations is that five manufacturers participated in the correlation program. Several manufacturers have since indicated the intent to submit products for NIOSH certification under the CCER standard; however, as of May 2014 no product has been certified to this standard.

Several other standards development activities have progressed to be published as notices of proposed rulemaking and will be finalized in 2014. These include fees and IL for half facepiece, air-purifying particulate-only respirators.

The Program has provided leadership and input to over 30 ISO standards, draft standards and technical specifications relating to respiratory protection and human physiology (the Program authored six).

In an effort to achieve international harmonization of respiratory protective device standards, the PPT Program has evolved the ISO activity from a parallel effort within the program to an integrated standards development effort. This allows the Program to assess the most effective approach to integrating the ISO standards development activities with the standards development activities to update 42 CFR Part 84. A comparative assessment is in process to determine which ISO standards should be validated as the United States considers the most effective approach for harmonizing internationally. Two new projects were identified for 2015 to support these activities. One project will compare the test methods proposed in the ISO standard to the test methods currently used by NIOSH and another will look at the physiological issues associated with the performance requirements.

The development and acceptance of contemporary standards for non-respiratory PPT will greatly enhance efforts to make the nation's workplaces safer and healthier. Specific examples where NIOSH membership on SDOs and supporting research directly impacted the development and release of revised or new PPT standards since 2012 are:

- American National Standard for Respiratory Protection Z88.2 (out for ballot)
- AATCC Test Method 202-2013 Relative Hand Value of Textiles: Instrumental Method
- ANSI/AAMI PB70:2012 Liquid barrier performance and classification of protective apparel and drapes intended for use in health care facilities
- AATCC Test Method 127-2013 Water Resistance: Hydrostatic Pressure Test
- ASTM WK33313 - New Specification for non-sterile isolation gowns intended for use in health care facilities (in development)
- ASTM WK38455 - New Specification for Healthcare Worker Protective Uniforms (in development)
- ASTM WK27291 - New Practice for Ergonomic Performance Evaluation of First Responders Protective Ensembles

Future plans

The Program will continue to strategize on the most effective approach for applying the consensus standards process for PPE standards and identify approaches to incorporating consensus standards by reference in an effort to most effectively leverage the spirit of the NTTAA. Several future activities include continued involvement on the ASTM F23 Protective Clothing and Equipment Subcommittee to develop a new specification for non-sterile isolation gowns intended for use in health care facilities. Based on information gained from the development of the isolation gowns, the committee may begin to explore the needs to develop a standard for surgical gowns. Participation on the NFPA Technical Committee on Hazardous Materials Response Personnel will continue. This committee has responsibility for standards on the requirements for the professional competence, training, procedures, and equipment for

emergency responders to hazardous materials incidents. To complement this activity, the Program will initiate the development of a series of booklets, CBRN respirators, and a CBRN Handbook using the fact sheets described above during the next two years.

The PPT program will continue to investigate different means to reach wildland fire fighters who may request NIOSH certified respirators to protect them from the contaminants to which they are exposed. The Program intends to publish a technical report concerning vapor liquid extraction (VLE) devices that were designed and marketed as respirators for wildland firefighters. These devices are not NIOSH approved.

The Program is dedicating personnel resources to assessing the potential implementation of ISO respiratory protection standards. The study will outline a plan to assess potential future economic impacts and needs of a national strategy to understand/implement ISO respiratory performance requirements. The Program will lead a round table discussion at American Industrial Hygiene Conference and Exposition (AIHce) in May 2014. The PPT Program will also continue to provide testing support to the mining program in the development of new technologies for mine rescue and work to identify appropriate approaches for developing standards appropriate for the mining environment.

Recommendation #1 (Issue 1.3):

Oversee certification of all PPT including an assessment of certification mechanisms.

Background

Status: *In Progress*

External Factors: There is no nationally recognized central authority for certifying or overseeing the certification of non-respiratory personal protective technologies (PPT). The National Academies (NA) in its 2008 review of the NIOSH PPT Program defines this as one of the most significant weaknesses of the national efforts concerning worker health and safety protection. One of the report's primary recommendations specifically addressed this situation. It recommended that NIOSH oversee all PPT certification in order to ensure a minimum uniform standard of protection and wearability.

A standard for PPT conformity assessment does not exist. Several private organizations, such as the Safety Equipment Institute (SEI) and Underwriters Laboratory (UL) do provide third party certification services for PPE; however, in most cases testing and certification are voluntary so most users rely on declarations of conformity provided by equipment manufacturers.

As evident in comments received in the NIOSH docket, different views exist within the PPT Program's stakeholders as to the viability of NIOSH being responsible for the certification of all

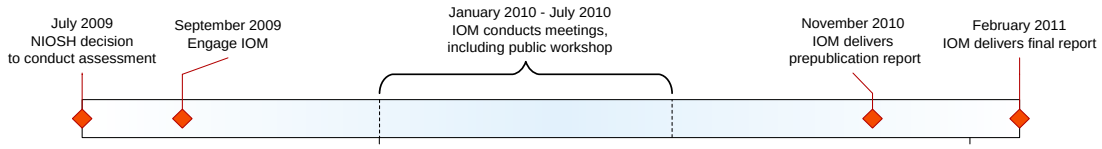
PPT. Some believe NIOSH's responsibility for certifying respirators should be expanded to cover all types of PPT (e.g., eye protection, hearing protection, protective clothing), while others believe the status quo is adequate. The 2008 NA report recognized that NIOSH's historical role in providing certification of respirators has had a significant positive impact on the quality of respirators available in the workplace with consequent reductions in deaths and serious injuries. The expansion of NIOSH's responsibilities to overseeing certification activities of non-respiratory PPT through development of a conformity assessment consensus standard and/or an audit/oversight function are logical and doable options that will result in safer and healthier workplaces across the nation.

Implementation of Recommendation

Activity A: Conduct an assessment of various certification mechanisms and their potential applicability to non-respiratory PPT

Description: The PPT Program engaged the IOM in September 2009 to conduct an assessment on non-respiratory PPT certification. The IOM was tasked to: 1) assess the certification mechanisms needed to ensure the efficacy of non-respiratory PPT; 2) examine various approaches to certification (e.g., federal laboratory certification, third-party certification, federal certification of nongovernmental laboratories); and 3) provide recommendations on certifying non-respiratory PPT.

Progress: This activity was completed on schedule in February 2011.



The IOM conducted a series of meetings between January and July 2010 as part of its assessment of the area. Two of these meetings involved open sessions with relevant stakeholders; one of these open meetings was in the form of a workshop to address the key issues of its task. The final report, *Certifying Personal Protective Technologies: Improving Worker Safety Report* was published in February 2011.

The IOM report provided three overarching recommendations. Recommendation 1 is the heart of the report and recommends the development and implementation of risk-based conformity assessment processes for non-respiratory PPT. This recommendation specifies the development of a framework to categorize products based on low, medium, or high risk to the health or safety of the worker that could result from failure of the product.

The second recommendation is to enhance research, standards development, and communications. This recommendation addresses the need for NIOSH participation in SDOs to address prioritized gaps, to develop a non-respiratory PPT clearinghouse site, and to address

PPE interface issues. Recommendation 3 concerns the establishment of a PPT and Occupational Safety and Health Surveillance System.

Impact: The IOM Certifying PPT Report provides the needed basis for moving forward with the 2008 NA recommendation for NIOSH to oversee non-respiratory certification.

Future Plans: NIOSH will work with its stakeholders to define the conformity assessment framework described in Recommendation 1 and initiate efforts to address implementation of Recommendations 2 and 3 using the IOM report as a guide.

Activity B: Develop a conformity assessment framework

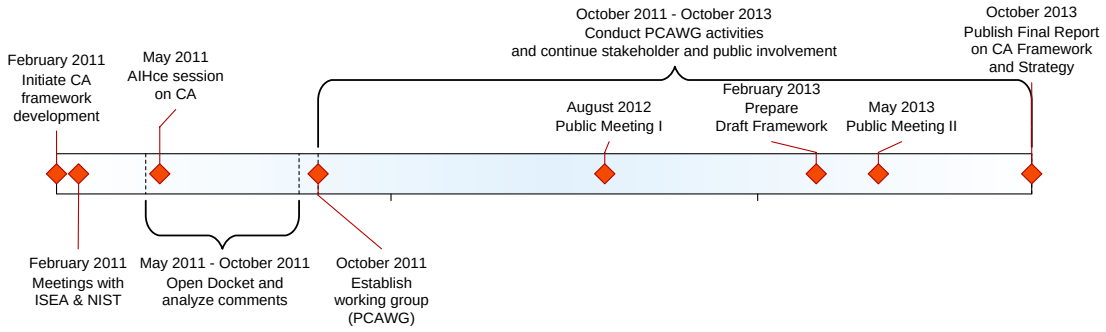
Description: NIOSH will continue to use various mechanisms to gather public and stakeholder input to define the specifics and broaden support for its approach to conformity assessment for non-respiratory PPT.

Progress: A docket soliciting comment on the NIOSH strategy was opened from May – July 2011. Seven comments were received. Comments are being assessed as an input to the NIOSH strategy for developing the conformity assessment framework.

In addition, NIOSH conducted a series of one-on-one discussions with specific major stakeholders. Several meetings were held in February 2011 with the ISEA, the United States largest trade organization involved in supporting safety equipment manufacturers. ISEA expressed interest in participating in NIOSH efforts to address the IOM recommendations. NIOSH also solicited National Institute of Standards and Technology (NIST) for input and participation as the development of the strategy moves forward. At NIOSH's request, NIST and ISEA as well as the Center for Construction Research (CPWR), Raytheon Corporation, and OSHA participated in an AIHce Emerging issues session on conformity assessment in May 2011. Stakeholder outreach will continue. NIOSH will initially conduct an assessment to identify current products available and certification processes employed for various types of PPE. It will also conduct a needs assessment to more thoroughly investigate the current processes involving standards and certification of PPE.

NIOSH is establishing a PPT Program Conformity Assessment Working Group (PCAWG) to address this matter. NIOSH's due diligence and strategy to develop the framework is being driven by the following questions:

- How is the interest in protecting the health and safety of the American worker shared by the private and public sectors maximized?
- What mechanisms must be developed or enhanced to ensure proper coordination among those federal agencies having authorities in this area?
- Using a cost/benefit approach, what will the marketplace, particularly PPE purchasers and end users, be realistically willing and able to support?
- Under what circumstances is a level of independence needed in a PPT conformity assessment system?



Impact: The completed conformity assessment framework will be the basis for NIOSH's decision to either develop a voluntary standard and/or establish an audit/oversight function.

Future Plans: Proceed to make a decision, as noted above.

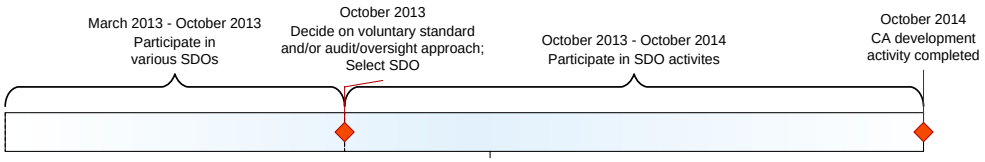
Activity C: Complete either the development of a voluntary standard and/or establish an audit/oversight function based on the developed framework.

Description: NIOSH recognizes the need to expand its participation in voluntary consensus SDOs. A key component of this participation will be to analyze each, and determine the one most appropriate for presenting the developed conformity assessment framework as a work item to help implement its decision.

Progress: This activity will be conducted from March 2013 – October 2014.

Impact: The development and acceptance of processes to oversee certification of non-respiratory PPT will greatly enhance efforts to make the nation's workplaces safer and healthier.

Future Plans: NIOSH will participate in consensus standard development activities to translate its conformity assessment framework into an effective conformity assessment tool.



2014 Update Recommendation #1 (Issue 1.3):

Oversee certification of all PPT including an assessment of certification mechanisms.

At the present time, U.S. PPT conformity assessment activities are very limited and primarily include conformity assessment certification activities for life saving technologies, or are applied

to technologies for market driven competitive advantage. We believe that NIOSH can foster improved and effective use of conformity assessment tools more broadly by providing U.S. coordination and guidance in expanding the application of conformity assessment activities to all PPE and PPT based additionally on personal health and safety requirements with uniform conformity assessment principles and practices.

The knowledge gained and experience acquired to date, suggest that NIOSH, in partnership with NIST, other Federal Agencies, and US conformity assessment accreditors and accredited bodies can be effective in providing needed coordination and guidance to improve the appropriate use of U.S. conformity assessment infrastructure in those PPT programs that currently exist and to new ones.

The following activities and progress underscore the potential national benefit that effective NIOSH leadership can provide without having regulatory authority.

Addition of or modifications to activities since last review

In 2011, the NIOSH BSC recommended UL and SEI participate in the PPT Conformity Assessment Working Group. NIOSH agreed with the BSC and invited both UL and SEI to participate. In addition, several other stakeholders (Scott Safety, Mine Safety and Health Administration (MSHA), and ICS Laboratories) expressed interest in the PCAWG activities and were invited to participate.

In 2012, the NIOSH BSC expressed concern that the PPT Program was not making any evident progress on the IOM recommendation to develop an online resource to provide information about all non-respiratory PPT products meeting third-party conformity assessment requirements and that NIOSH expand its role to become the primary clearinghouse for reliable information on non-respiratory PPT. In response, the Program dedicated additional resources to investigate possible content and platforms for developing a PPT clearinghouse. The Program is currently assessing opportunities to leverage and integrate current PPT systems into an available resource called the “PPEPro Database” and is identifying the potential stakeholder needs relative to product conformity assessment information needs (i.e. PPE standards, testing, inspection, certification, quality management system assessment and registration, surveillance, conformity declaration). The PPT Program is developing a database containing key information linking non-respiratory personal protective equipment (PPE) with national PPE standards, federal regulations, conformity assessment requirements, and standards development organizations. This database is serving as the foundation for Activity C (Complete either the development of a voluntary standard and/or establish an audit/oversight function based on the developed framework).

In its 2012 review, the NIOSH BSC indicated that a significant amount of jargon is associated with this activity. Early in the process of addressing this IOM recommendation it became clear that a glossary of conformity assessment terms was essential. A priority output of the PCAWG was the development of this glossary, which helps describe the conformity assessment jargon associated with this activity and responds to the concerns raised in the initial BSC review. It is

contained the draft Summary Report of the PCAWG (http://www.cdc.gov/niosh/docket/review/docket237A/pdfs/237-A_PPE_Conformity-DraftReport.pdf)

Progress and impacts made since last since last review

In September 2011, the PPT Program established the PPT PCAWG to address the recommendations provided by the IOM. The PCAWG is comprised of a national group of more than 30 experts including representatives of industry, manufacturers, labor, academia, government, standards development organizations, and accredited laboratory and certification bodies. The PCAWG met regularly over two years, producing key outputs in products and standards, surveillance, risk, and benchmarking national and international programs. An emphasis was placed on benchmarking the European Union (EU) PPE Directive, its conformity assessment system, and the role of the European Committee for Standardization (CEN) and ISO standards in meeting basic health and safety requirements. A second priority was to understand U.S. federal conformity assessment programs across the nation.

NIOSH completed an investigation and analysis of the European Union (EU) PPE Directive and Conformity Assessment (CA) program and documented the findings in a draft report, which was used as an input into an initial PPE CA National Framework. This framework contains key conformity elements needed to sustain public confidence in a comprehensive PPE CA program including basic health and safety requirements, PPE performance standards, conformity assessment standards, surveillance and auditing, etc. The proposed framework is based on existing CA programs in the U.S. as well as by the EU's CA system international standards and best practices which have been improved with decades of experience. U.S. programs reviewed include the National Institute for Justice's performance and conformity requirements for body armor; US Coast Guard requirements for personal flotation devices; NIOSH program for respiratory protective devices, and NFPA requirements for fire and emergency services PPT. NIOSH, jointly with NIST, expanded discussions with other US conformity assessment accredited bodies for certification, inspection, and laboratory testing.

NIOSH held a public meeting on September 17, 2013 to obtain stakeholder input on the draft PPT Conformity Assessment Framework. An overview of the PPT CA Framework was presented and four breakout sessions provided opportunities to obtain input from specific industry sector groups. Eighty two stakeholders participated in the meeting. Subsequently, a NIOSH docket soliciting public input to finalize NIOSH's initial concept for a framework scope including the roles and responsibilities of national involved parties was opened from August 14 to December 2, 2013. All completed PCAWG reports were placed on the docket for public review and comment. Twenty comments were received. Comments are being assessed as an input to revise and update the framework, which will undergo another public comment period.

NIOSH also expanded its review and understanding of the U.S. conformity assessment infrastructure by meeting with representatives of U.S. based certification and testing accredited bodies including SEI, UL, ICS Laboratories, the American Association for Laboratory Accreditation (A2LA), and ANSI. NIOSH has also examined governmental and private sector CA

programs of the National Institute for Justice, US Coast Guard, MSHA, and the NFPA CA requirements for Fire and Emergency Services Protective Clothing and Equipment. Review of these organizations and programs confirmed the diversity of U.S. PPE CA programs and requirements. NIOSH has worked jointly with the NIST to better understand national and international conformity assessment schemes and to define the most effective national role for NIOSH within the existing U.S. conformity assessment system.

NIOSH initiated the PPEPro database, which is the first step toward developing a PPE surveillance system for the nation, using national standards data gathered through the PCAWG activities. The PCAWG developed a database of PPT standards and associated PPT types by exploring current OSHA regulations, PPE performance standards and PPE testing standards. Resulting data were subsequently integrated into an interactive, searchable, prototype Microsoft Access database for non-respiratory PPE Standards. In 2012-2013, the Prototype Database was presented to stakeholders through the Institute of Medicine Committee on PPE, AIHce, and at the September 2013 Stakeholder Meeting. After receiving positive stakeholder feedback, NIOSH provided pilot funding to Vanderbilt University in 2014 to begin development of the web-based surveillance system.

Impact(s) made since last review (process or outcome related)

NIOSH investigation of US PPE conformity assessment programs, EU CA Program, and its use of consulting experts thru participation on the PCAWG influenced two standards development organizations (ASTM, ISEA/ANSI) to develop PPE conformity assessment standards. Both SDO's have made substantial progress in 2013 drafting and balloting their CA standards. The ISEA/ANSI standard was published in February 2014. Although these standards development activities underscore the importance of PPE CA and show national consensus organization response to IOM and NIOSH interests; the lack of national legislation and lack of a uniform framework for PPE CA likely will cause even greater diversity and inconsistencies in applying conformity assessment to PPE in the U.S. Because of this, the NIOSH PPT Program will continue to refine the framework into a nationally accepted structure.

Future Plans

Public input from the September 17, 2013 stakeholder meeting and the NIOSH docket, recommendations from PCAWG subcommittees, and benchmarking of current CA schemes will continue to inform NIOSH in finalizing a national PPE CA framework in 2014.

In developing a conformity assessment framework, NIOSH will continue to use various mechanisms to gather public and stakeholder input to define the specifics and broad support for its approach to conformity assessment for non-respiratory PPT. The PPT Program also is assessing how the respiratory protection activities should be incorporated in the overall framework.

Over the next few months, NIOSH will beta test the PPEPro database with a launch for public use planned for 2014. The Program is initiating a dialogue with standard development

organizations to explore the roles that they can play in advancing and maintaining the database.

Recommendation #1 (Issue 1.5):

Conduct outreach programs for optimal use and acceptance of PPT by workers

Background

Status: *In Progress*

External Factors: Every organization has a unique safety culture; however, there are some common characteristics that identify a safety culture. It is important to understand how to most effectively work with the various organizations across industry sectors to instill effective and lasting change to commit to adopting safety as a top priority, and provide compelling evidence to support sustaining a safety culture. Understanding how to most effectively educate and train leaders and users to select, use, and maintain the appropriate PPE is paramount.

The scope of the PPT Program outreach activities has been impacted by significant travel funding reductions across the Institute. These cuts began in FY12 and are expected to continue into the foreseeable future.

Implementation of Recommendation

Activity A: Develop an annual outreach strategy to encourage workers who rely on PPT to take responsibility for personal safety and encourage organizations to foster a culture of safety.

Description: A strong outreach program is the cornerstone for stakeholder/partnership building, and facilitates technology transfer. Workers, employers, PPE end-users, and trade associations are targeted as recipients of the PPT Program outreach activities.

Progress: This activity is on schedule in accordance with the Program's annual outreach plan. The outreach strategy includes 1) participating in industry sector events, 2) developing and implementing a public information campaign, and 3) conducting the PPT Stakeholder Meeting on an annual basis or at a frequency consistent with stakeholder needs. Table 1 shows targeted outreach activities since the development of the PPT Program Implementation Plan together with those planned in FY12.

Table 1. PPT Program Outreach Activities

Sector	FY 08	FY09	FY 10	FY 11	FY12 Planned
Healthcare & Social Services	2	2	4	5	3
Public Safety	4	5	4	6	3

Mining	3	3	1	2	2
Agriculture	-	1	6	6	0
Cross Cutting	7	10	3	5	4
Construction	-	-	-	-	1
TOTAL	16	21	18	24	13

The emphasis of the outreach effort for the past four years has been on the stakeholders most impacted by the PPT Program activities. These include firefighters, first responders, healthcare workers and miners. Partnerships with the International Association of Firefighters (IAFF) and the International Association of Fire Chiefs (IAFC) have been critical to the development of outreach products to address their needs. Partnerships have expanded in the healthcare community to organizations such as the American Nurses Association (ANA) and the Association of periOperative Registered Nurses (AORN) in response to pandemic preparedness and an emphasis placed on healthcare workers since the H1N1 influenza pandemic. Additionally, partnerships with safety generalists include the American Industrial Hygiene Association (AIHA), the American Society of Safety Engineers (ASSE), and the Society of Mining Engineers (SME).

Agriculture was added as a targeted sector in 2009, and has evolved to emphasize pesticide handlers throughout all industry sectors with over 800 stakeholders providing input. To reach out to this community, the PPT Program hosted eight telephonic stakeholder meetings to obtain the perspectives of experts and to identify the concerns and barriers to best PPE practices.

An activity was initiated in 2010 to develop and initiate a public information campaign for the PPT Program to expand its existing capabilities to a broader range of audiences with differing levels of understanding of the technical subject matter of the PPT Program's activities. The intent is to focus materials on the core PPT Program responsibilities that target workers who rely on PPE and technologies in the Health Care and Social Assistance (HCSA) sector (specifically health care subsectors including ambulatory services, hospitals, and residential care facilities) and also the Public Safety Sector, with an emphasis on fire fighters and emergency response personnel. One flyer has been developed in draft form to emphasize the importance of the NIOSH respirator approval.

The PPT Program has conducted the PPT Program Stakeholder Meeting annually for the past four years to facilitate research collaboration and stakeholder input to PPT Program activities. In 2009, the Program directly involved extramural partners by funding travel for grant recipients to participate in the PPT Stakeholder Meeting to share their research through poster or presentation and to identify potential areas of collaboration. In addition, other extramural researchers, PPE manufacturers, and external stakeholders from unions and labor participate in the meetings by providing input to intramural and extramural activities and by discussing their PPE needs. In 2011, over 200 stakeholders participated in the meeting.

Impact: Translation and dissemination of research results to health and safety professionals, employers, and employees increases the awareness of the impact and relevance of the PPT

Program and the role it plays in protecting workers. The targeted outreach activities have increased awareness of the importance of PPT in workplace safety and health. Most recently, NPPTL research led to updated guidance by the AORN and subsequent manufacturer action to no longer use a brand name on their product which could mislead purchasers. The manufacturer informed NPPTL that "in surgical staff safety, your efforts and communications were the convincing product we needed to help our teams understand the importance of protection over and above a surgical mask when performing laser surgery." This outcome and all public information campaign efforts provide critical information to workers to enhance workplace safety and health. In addition, the PPT stakeholder meeting provides updated PPT research and standards development information to stakeholders to keep workers safe.

Future Plans: FY12 outreach events are planned. The public information campaign includes continuing the development of a false advertising and replacement part awareness information product as well as initiating a website overhaul. The FY12 Stakeholder Meeting will be held on March 20-21, 2012 in Pittsburgh. The meeting will emphasize PPE selection, use, and expectations for workers involved in healthcare, mining, public safety, and pesticide handling. The meeting will include a combination of presentations, breakout sessions, poster presentations and workshops. Two breakout sessions, developed with stakeholders, will be held for each sector. FY13 and FY14 planning will be initiated during annual PPT Program strategic planning.

Activity B: Promote educational and professional training of PPT in occupational safety and health

Description: The results of research conducted and sponsored by the PPT Program are translated into prevention recommendations and then communicated to health and safety professionals, employers, and employees. State-of-the-art technologies and techniques are used to develop and improve training and education efforts. PPT information is disseminated to the appropriate user communities for the activities to be considered a success.

Progress: This activity is on schedule. Since 2010, Program emphasis has been to reach out to the NIOSH Educational and Research Centers (ERCs) and to other stakeholder groups through webinars and by supporting them through train-the-trainer activities, and by educating stakeholders on effectively navigating the PPT Program Trusted Source web page. The emphasis for the outreach activities has been in the following areas: public safety, healthcare, mining, and pesticide handlers.

In FY10, in partnership with MSHA, NIOSH provided an interactive training course on self-contained self-rescuer (SCSR) inspection, maintenance and use to address the issues associated with using mine escape devices. It contains unit-specific SCSR care, maintenance, and inspection training modules to ensure that SCSRs are kept in good condition and all units that fail inspection are removed from service. The training course also provides information to ensure that miners know how SCSRs work. Also in FY10, NIOSH developed and presented three CBRN respiratory protection training courses on CBRN respiratory protection selection, use, and maintenance guidance. Educational material was also developed and presented to address the

needs of end-user stakeholders who rely on NIOSH-approved respirators and have an interest in developing or improving respiratory protection programs (RPP) for their workforce.

In FY 10, NPPTL created the Trusted-Source web page as the one stop place to get reliable respirator information. The web page includes content to address three specific sections of information: (1) information on understanding the various types of respirators, how to identify approved models and outlets for purchase; (2) information on how to implement the use of respirators in the workplace and use them appropriately; and (3) ancillary respirator information, including, commonly asked questions and answers, respirator myths, the science of respirator function and performance, and respiratory protective devices not approved by NIOSH. In addition, several products have been developed and disseminated to support PPT training to targeted or all PPE users. For example, an update in 2010 to the Multivapor computer program to estimate breakthrough times and service life of air-purifying respirator cartridges was posted to the NPPTL web page to help industrial hygienists or other qualified persons to set cartridge change-out schedules.

Impact: The PPT Program used and will continue to use programmatic outputs to deliver appropriate health and safety training and educational material for the nation's workers to educate users and improve workplace safety and health. An example of impact is the NPPTL's Trusted-Source web page. This site is ranked in the top 100 web pages in the Centers for Disease Control and Prevention (CDC) and continues to receive about 275 visits per week.

Future Plans: The PPT program will continue to produce quality education and training materials and to evaluate and develop new materials as research produces knowledge to improve training products. The Program will continue to collaborate with the NIOSH ERCs to identify and implement PPT related training activities. In FY12, a new project began to improve proper respirator use by healthcare workers by developing a respiratory protection toolkit to provide updated training resources. In FY13 and FY14, the tools developed in this new project were adapted for use in nursing program respiratory protection training courses.

2014 Update Recommendation #1 (Issue 1.5)

Conduct outreach programs for optimal use and acceptance of PPT by workers

Addition of or modifications to activities since last review Due to new constraints on travel and participation in conferences, the PPT Program outreach strategy included a modification of the Program's stakeholders meeting. The Program hosted one large meeting covering all sectors annually through 2012. Starting in 2013, separate smaller meetings for the Healthcare, Agricultural and Public Safety Sectors were conducted. In addition, the use of social media and web-based meetings was increased to continue the outreach within the fiscal and travel constraints.

Progress made or maintenance efforts since last review

The Program's plans for outreach activities were adjusted to accommodate reduced travel to conferences and outreach venues. In March 2012, the PPT Program was able to host a large public stakeholder's meeting (with 350 participants). That included general presentations, sector (Healthcare, Mining, Public Safety Sectors and Pesticide Handler) breakout sessions and five workshops. The sector specific break-out sessions included the following topics:

- Healthcare
    - Respirator Evaluation in Acute Care Hospital (Reach II) Regional Results
    - Implementing Hospital Respiratory Protection Programs: Seeking Field Input for Educational Monograph

- Mining
    - Mining PPE Overview
    - SCSR Capacity
    - Physiological Aspects of Switching SCSRs in an IDLH Atmosphere
    - Cryogenic Life Support System
    - Drager SCSR/SCBA Mining System, Future Technologies for Breathing Air Systems
    - Novel Knee Protection for Miners

- Agriculture - Pesticide Handlers - Interactive sessions
    - Addressing PPE information sharing, PPE performance standards, pesticide label language, PPE label language and marketing
    - Possible contributing factors to three aspects of universal safety culture – industry, workplace and user-specific

- Public Safety
    - PPE used by emergency medical service (EMS) and medical first receivers
    - NIOSH Fire Fighter Fatality Investigations involving the performance of protective clothing and equipment and SCBA

- Workshops offered the second day of the meeting:
    - Understanding Respirator Fit Testing (cross-cutting)
    - Protect your Hearing: Understanding Hearing Loss (cross-cutting)
    - Protect Yourself from Heat Stress (cross-cutting)
    - Practical Use and Care Guidance for CBRN Respirators
    - Personal Protective Equipment Best Training Technique for Pesticide Workers

In 2013, the Program worked to provide concentrated efforts to meet the needs of the Healthcare, Public Safety, and Mining Sectors, and continued efforts to engage stakeholders concerned with pesticide handling by using smaller separate meetings involving face-to-face and remote participation through webinars and other electronic media connections. Highlights include:

- Healthcare -- The 2013 Stakeholder Meeting on Respiratory Protection for Healthcare Workers focused on a theme of improving healthcare worker compliance with respiratory protection. Stakeholder feedback was sought to (1) provide input to future updates of the NIOSH PPT Program research agenda and (2) assess progress toward better respirators for healthcare workers. One hundred twenty-five stakeholders attended in person while additional participants attended remotely via Envision at various facilities throughout the country.

- Public Safety -- The 2013 Public Safety Sector outreach activities were facilitated at two relevant meetings. The first activity was a workshop, Evaluation of Hazards and Operations in the Post-Fire Environment (overhaul), in conjunction with the InterAgency Board in February 2013. The second activity was a training opportunity at the IAFF John P. Redmond Symposium on the Occupational Health and Hazards of the Fire Service, "Practical Use and Care Guidance for Chemical, Biological, Radiologic, and Nuclear (CBRN) Respirators". The PPT Program worked with the IAFF and other Public Safety Stakeholders to develop a training seminar for firefighters regarding SCBA training and maintenance issues to provide SCBA users additional tools to keep them safe during times when SCBA use is necessary. PPT Program personnel worked collaboratively with IAFF, manufacturers, and fire departments to conduct the training for 85 participants completed the 90 minute training in two sessions.

- Mining -- The Program did not host a public meeting for the Mining Sector in 2013. The Mining Sector is engaged in research programs focused on mine escape, including novel respiratory protective devices. The certification activities of the PPT Program have focused on the processes needed to facilitate the approval of CCERs according to the requirements of the final rule (Recommendation #1, Activity A). The PPT Program is supporting the research efforts of the Mining Sector by providing technical expertise concerning current regulations and potential updates to the regulations needed to support the development of novel escape devices. The ISO consensus standards (Recommendation 1, Issue 1.2) for respiratory protection would include provisions for novel escape devices.

- Pesticide Handling -- The NIOSH 2013 Pesticide Handler PPT Stakeholder Meetings focused on motivating pesticide handlers and pesticide workers in all industries to use best pesticide PPE practices. Formal sessions focused on potential health effects of pesticide exposure, work safety culture, and the use and limitations of storytelling to motivate safer and healthier work practices. Pesticide handlers and pesticide workers shared their personal stories. Also, selected stakeholders showcased unique efforts to improve pesticide PPE practices. There were interactive sessions involving an expert panel, in which stakeholders brainstormed on ways to collaboratively promote wide-spread adoption of best pesticide PPE work practices. Thirty-six attended in person and as many as 200 attended via Live-meeting.

In addition to these types of stakeholder meetings, the PPT program is also using Webinars to reach stakeholders and conducted several manufacturer meetings. At the PPT Program Manufacturer's Meeting held on September 18, 2013, stakeholders engaged in the certification process indicated that the current PPT Program ListServe and website notifications are very effective in reporting timely and important updates to manufacturers and users of respiratory protective devices and other PPT. The need to better understand the science behind respirator shelf life and service life was emphasized at this meeting as an input to research activities planned to support respirator use for emergency response. The PPT Program shared the federal activities underway to most effectively educate the users on effective use scenarios during emergency response scenarios and solicited manufacturer support to increase worker safety during these scenarios.

Website updates tend to focus on the immediate needs of the certification program, providing information to stakeholders concerning approvals and reported or identified issues with the use of approved product (e.g. respirator user notices, letters to manufacturers, information regarding new respirator certifications). Efforts to update the website have been focused on complying with the required CDC templates and transforming the site to meet the updated CDC requirements. Additional efforts are expected to be a priority over the coming years. For example, one effort is underway to determine how the respirator certification list can be edited to serve as a useful tool for respirator users and purchasers. Furthermore, the PPEPro database (Recommendation 1, Issue 1.3) is expected to serve as the first step toward addressing the need for the PPT Program to serve as a PPE clearinghouse for the nation as recommended in the PPT Program NA review.

The PPT Program is partnering with the World Health Organization (WHO) Collaborating Center at the University of Pittsburgh to include PPT issues in its epidemiological global health project, the Supercourse (ttp://www.pitt.edu/~super1/). Supercourse is a repository of lectures on global health and prevention designed to improve the teaching of prevention. Supercourse has a network of over 56000 scientists in 174 countries who are sharing for free a library of 5350 lectures in 31 languages. A variety of web lessons has been and will continue to be posted featuring many of PPT Program's important projects and research. This research affects many industries that rely upon personal protective equipment to keep their workers safe and healthy. To date, the following lessons have been posted to Supercourse:

- Overview of the National Personal Protective Technology Laboratory – This initial lesson explains the organizational structure and mission of NPPTL.
- Overview of NIOSH-Approved Respiratory Protection Devices – This lecture presents an overview of respirators, their components, their protections, and guidelines for their use in industry.
- "Know it's NIOSH" Respirator Awareness – This lecture will explain how to verify that the N95 respirator you use is NIOSH-Approved.
- "Debunking the Myths of N95 Respirator Use" – This lecture will expose the fallacies behind common myths of N95 respirator use by presenting the science behind the facts.

The Program is also using LiveMeeting to share data and information with stakeholders. In 2012, the Program introduced an annual "N95" day on September 5th to promote awareness of proper use of N95 respirators. In 2012, the Program participated in the Webinar: "CDC Interagency Hospital Resource Utilization Meeting: Healthcare System Supply Chain". The Program collaborated with the University of Iowa Heartland Center for Occupational Health and Safety, hosting the webinar: "How to Best Protect Against Workplace Exposures!" In 2013, two scientific LiveMeeting events were held regarding sharing the procedures and results of the inter-panel variability study and the relevant data analysis. Another significant strategy initiated by the PPT Program is to increase the intramural and extramural research and intervention integration through increased interactions with extramural stakeholders with an emphasis on increased interactions with the NIOSH ERCs and extramural partners who are interested in collaborative approaches to addressing occupational safety and health needs across sectors.

The following table lists the PPT Program's outreach activities since the previous update. These outreach activities include outreach where the PPT Program is physically present at a conference, but does not include webinar presentations, dissemination to stakeholders through URL linkages, or postings to the web. These alternative outreach strategies have been increased to compensate for reduced travel budgets. The numbers provided in the estimates for FY14 include alternative outreach strategies such as webinar presentations as these activities are serving as our most prevalent means of information dissemination. Alternative dissemination strategies are being explored through a newly formed NIOSH Health Communications Team. The sectors of emphasis will continue to be Healthcare and Public Safety in FY14 with an increase in emphasis on cross-cutting activities. Our efforts to more effectively reach the mining community are being increased through enhanced collaborations with MSHA and the mining community.

Sector	**FY12 Planned**	**FY12 Actual**	**FY13 Planned**	**FY13 Actual**	**FY 14 Planned**
Healthcare	3	6	3	7	4
Public Safety	3	6	2	6	4
Mining	2	1	1	0	1
Agriculture	0	5	2	5	2
Cross Cutting	4	3	2	2	4
Construction	1	0	0	0	0
TOTAL	**13**	**21**	**10**	**20**	**12**

Other Sector-specific activities include:

Construction – The PPT Program has not expanded its efforts in the Construction Sector due to increased resources being dedicated to emergency preparedness planning (e.g., conserving respirators during an emergency was targeted as a focus area by the CDC Director in 2013) and the fact that PPE has

not been identified as a priority item for research and intervention in this sector. However, ongoing Program activities, including ongoing efforts to update 42 CFR Part 84, Subpart K, Non-powered Air-Purifying Particulate Respirators to include an assessment of respirator fit as a requirement for NIOSH approval, would positively impact construction workers who rely on N95 respirators. The research on fall arrest harnesses (discussed under Recommendation 1, Issue 1.2), conformity assessment activities (discussed in Recommendation #1, Issue 1.3), and research and surveillance on roadway construction (described under Recommendation #4, Issue 4.1) are also expected to have positive impacts on the Construction Sector.

Healthcare – NIOSH published a flyer in June 2013 (Respirator Awareness: Your Health May Depend On It, DHHS (NIOSH) Publication No. 2013-138) in English and Spanish to alert healthcare workers to the hazards associated with the airborne transmission of certain infectious diseases and the importance of respiratory protection in preventing adverse effects.

In addition, NIOSH led the development of intervention strategies through increased educational products, most notable of which is the *Respiratory Protection Program Toolkit*, a guide for respirator program administrators and related tools and resources created via contract by the California Department of Public Health and associated partners. The Toolkit is designed to assist hospital respirator program administrators, particularly those without formal education in workplace health and safety. The guide covers key requirements of the Cal/OSHA Respiratory Protection and Aerosol Transmissible Diseases standards, guidance on developing and evaluating a respiratory protection program, and information on the selection and use of respirators. The California toolkit has been modified for use nationwide, and will be co-branded with OSHA. It is currently under review and is expected to be published and available on the web in 2014.

In an effort to enhance the intramural and extramural research and intervention integration, the PPT Program has led the following activities in support of the Healthcare Sector:

- ERCs
    - University of Texas – American Association of Occupational Health Nurses (AAOHN) Educational Modules
    - University of Iowa (Heartland Center for Occupational Safety and Health), University of North Carolina, University of Kentucky, and University of Michigan – webinars
- University of California - AAOHN Survey Analysis
- California Dept. of Public Health – National RPP Toolkit Development
- The Joint Commission – Monograph Development
- AAOHN – Respiratory Protection Occupational Health Nurse (OHN) and Nurse Competencies
- Association of Occupational Health Professionals in Healthcare (AOHP) – Educational Module Development and OHN Respiratory Protection Competencies
- AORN – Surgical Smoke Recommended Practices
- ANA – Occupational Health Nurse Survey

- American Board of Occupational Health Nurse (ABOHN) – RP Nurse Competencies
- American for Professionals in Infection Control and Epidemiology (APIC) – Member APIC Research Committee

During the past two years, the Program has published the following NIOSH Numbered documents relevant to Healthcare:

- Loss of Start-Up Oxygen in CSE SR-100 Self-Contained Self-Rescuers
- Understanding the Breathing Gas Capacities (ratings) of Escape Respirators for Mineworker Use
- Respirator Awareness: Your Health May Depend On It (also in Spanish)
- Personal Protective Equipment for Healthcare Workers
- Getting Optimal Performance from a Powered Air-purifying Respirator (PAPR) Depends on the Condition of its Battery!
- What's special about Chemical, Biological, Radiological, and Nuclear (CBRN) powered air-purifying respirators (PAPR)?
- What's special about Chemical, Biological, Radiological, and Nuclear (CBRN) powered air-purifying respirators (PAPR)?

Pesticide Handlers -- To enhance training and educational activities for pesticide handlers, the Program has standardized the methodology and surveillance tools for assessing comprehensive PPE practices and barriers to best practices. It has improved the training curriculum for PPE use among agricultural pesticide handlers and other national training and intervention tools intended to supplement state and federal regulations, manufacturer instructions and required training. A widespread dissemination of informed interventions and archived recordings of the seminar series and the Best Pesticide PPE Training Techniques Workshop has been achieved. The Program has produced an Interactive Pesticide PPE Training Exhibit including pesticide label interpretation exercises, a chemical resistant materials glove display, and identifying PPE requirements on pesticide product labels.

Impact(s) made since last review (process or outcome related)

The PPT Program used and will continue to use programmatic outputs to deliver appropriate health and safety training and educational material for the nation’s workers to educate users and improve workplace safety and health. An example of impact is the NPPTL’s Trusted-Source web page. This site is ranked in the top 100 web pages in CDC and the number of visits per week has increased to 523 in the past year. The PPT program now has 868 page postings.

Another is the PPT Programs’ involvement in Respiratory Protection Training for OHN Students. The PPT Program collaborated with the University of Texas (Health Science Center at Houston), the Southwest Center for Occupational and Environmental Health and AAOHN in developing an online course on respiratory protection for OHNs. The PPT Program collaborated with leading nursing organizations (AAOHN, ANA, AOHP, and ABOHN) to develop educational competencies to help fill in the knowledge gaps OHNs expressed regarding respiratory protection.

In addition to the stakeholders meetings described in the previous section, the PPT Program had other outreach efforts. During 2012-2013, the Program facilitated the Pesticide Handler's Seminar series, four (4) seminars were conducted each year to address issues of concern and share occupational safety and health information. The Program interviewed 32 pesticide handlers in 22 different states to gather stories from pesticide handlers for incorporation in training videos. The interviews were recorded and the Program is working with SMEs to select the most appropriate stories to incorporate in videos to be used for training purposes for pesticide handler practices. By the end of 2014, the PPT Program plans to post the final video(s) on the website and distribute up to 1000 DVDs. Over the past two years, the Program's outreach activities to pesticide handlers throughout all industry sectors has increased from 800 to over 1500 stakeholder partners who provide input.

The following topics were included in the Pesticide Personal Protective Equipment Seminar Series:

- Use of Industry Exposure Databases for Personal Protective Equipment (PPE) Research
- Personal Protective Equipment (PPE) Training for Pesticide Handlers
- How Pesticide Personal Protective Equipment (PPE) Requirements are Determined for Workers Who Handle Pesticides
- Reducing the Risk of Heat-Related Illness in Agricultural Workers
- Creating a Pesticide PPE Informational Brochure and Making it Widely Available - "Dress for Success: Some Things to Know about Personal Protective Equipment BEFORE You Handle a Pesticide" was produced as a collaboration between the National Association of County Agricultural Agents, the National Pesticide PPE Training Solutions Committee (NTSC), and Syngenta
- Selecting Respirators for Pesticide Handling Exposures
- PPE Reductions for Enclosed Cabs and Closed Systems
- Dermal Route of Work-Related Exposure to Pesticides

The pesticide PPE activities have provided additional national guidance for pesticide handlers separate from what is on the pesticide labels and have provided additional tools for training pesticide handlers. Many agencies (e.g., Grimmway Enterprises, California County Agricultural Commissioner Offices, Virginia Department of Agriculture, Pennsylvania Office of Rural Health, and Minnesota Cooperative Extension) have used elements of the NIOSH Interactive Pesticide PPE Training Exhibit to enhance their training efforts or require their staff to participate in the NIOSH Pesticide PPE Seminar Series as part their training requirements. Recordings of the seminar series are used by safety professionals to train their educators and pesticide handlers (for example, Montana Department of Agriculture).

In order to expand its reach, the PPT Program has included social media, including Twitter and Facebook to potentially reach greater numbers of stakeholders. As of May 7, 2014, the PPT Program tweeted 4,515 times and had 6,457 followers. Tweets about NPPTL have reached 224,392 accounts The NPPTL Retweet rate is currently about 201,000. The NPPTL Facebook has 47 likes. In 2012, in addition to using these tools for Program outreach, the Program

successfully used both tools in an effort to recruit human subject volunteers for an inter-panel variability study. The PPT Program is making a deliberate effort to provide more effective tools to educate users on the PPT Program activities and encourage proper PPE use. As a step toward educating users on the NIOSH respirator certification activity, the PPT Program developed the first NIOSH Telestration video describing the respirator certification activity (see: https://www.youtube.com/watch?v=Pj9P-NNYgmw).

Future plans

The PPT program intends to leverage the NIOSH Total Worker Health (TWH)™ Program activities to plan and execute a workshop and workshop summary report to serve as the foundation for a consensus statement on the integration of occupational safety and health protection and health promotion. Future collaborations between the PPT and TWH™ programs will be considered to better define exemplary safety cultures in the workplace.

FY15 and FY16 outreach activities will continue to emphasize social media (e.g. webinars) and collaborative intramural and extramural initiatives. Formal planning was initiated during annual PPT Program strategic planning sessions in 2014. Preliminary planning for the 2015 Pesticide Handlers stakeholders' meeting is to seek stakeholder's feedback concerning the concept of creatively translating the testimonial DVD information into a training curriculum for pesticide handlers. The National Training Solutions Committee will be used to help develop the curriculum. Other plans include five outreach activities for Healthcare and two outreach activities for Public Safety. The activities will reflect current travel and budget restrictions by continuing to use collaborative resources, as successfully demonstrated in 2013.

The PPT Program will continue to produce quality education and training materials and to evaluate and develop new materials as research produces knowledge to improve training products. The Program will continue to collaborate with the NIOSH ERCs to identify and implement PPT related training activities. In FY14, the national toolkit developed will be published and adapted for use in nursing program curriculums.

The Pesticide Outreach Program is producing a NIOSH Training DVD which will be completed in the next year. The DVD will have personal narratives and expert commentaries that will raise awareness of the potential risk of pesticide exposure and the benefits to handling pesticide safely. It will address the need to motivate pesticide handlers to use safe pesticide handling practices as identified in its preliminary efforts to identify barriers**.**

The use of webinars will continue to be a priority for the Program's outreach activities for the foreseeable future. Researchers can share timely scientific data, updates concerning the development of consensus standards and PPE use and guidance information. In addition, these tools have been used to obtain feedback on Program activities from stakeholders. In order to reach Latino workers, the Program intends to explore methods to have webinars such as the "N95" day provided in Spanish either in 2014 or 2015. The Program is exploring other opportunities to incorporate the telestration concept to provide another user friendly approach to reaching stakeholders. Guidance for conserving respirators during emergency preparedness

scenarios is the next area of focus with an emphasis on extended use of filtering facepiece respirators.

Recommendation #4 (Issue 4.1):

Define barriers to and facilitators of PPT use

Background

Status: *In Progress*

External Factors: Users often do not like to wear PPE because of issues of comfort, fit, or job interference. The safety culture of each industry sector is unique and must be understood to effectively define the barriers to and facilitators of PPT use.

Implementation of Recommendation

Activity A: Prioritize activities necessary to support PPT research, surveillance, standard development, and PPT evaluation

Description: The barriers to proper PPT use are virtually unknown in certain industry sectors, while they vary significantly in others. These variations are the result of differing individual cultural perceptions about PPT use, human behavioral issues, and a lack of knowledge of what PPT is available, feasible, or how it is to be used properly. The facilitators to proper PPT use and care in the workplace must be defined for all industry sectors and used as tools to remedy the nation's inadequate and inappropriate use of PPT in the workplace.

Progress: This activity is on schedule. The PPT Program has taken several steps to prioritize the issues identified in response to the NA report's recommendations. These priorities are reviewed annually by the Program's management to assess the modification of listed priorities by addition or deletion.

The Program has developed a strategy to complete this activity by focusing efforts on the roadway construction, public safety, healthcare, and the pesticide handler workforces. These workforce groups were highlighted to identify the barriers which could then lead to targeted activities to address the outreach and training activities described under Recommendation 1. The roadway construction efforts have been in progress since FY04 and evolved from comprehensive surveillance activities to intervention and effectiveness approaches designed to address barriers to using PPE in roadway construction. These efforts were leveraged to develop strategies for pesticide handlers and healthcare workers. Pesticide handlers across all industry sectors have been targeted because of the significant deficiencies identified across this workforce and the significant involvement by stakeholders to partner with the PPT Program to identify approaches to address barriers to proper PPT use. The Healthcare sector was targeted during the H1N1 pandemic because of the historical dichotomy manifested in the public health

and infectious disease perspective toward PPE use, especially the use of respirators among this workforce. The H1N1 pandemic provided the opportunity to implement public health practice efforts to further explore the barriers to effective PPT use and identify strategies to feed into the outreach and training for this workforce.

Impact: A framework for PPT surveillance was developed and is used as a tool to integrate research and intervention activities in the PPT Program to address barriers to PPE use, including required behavioral changes of PPE users, employers, and worksite managers.

Future Plans: The roadway construction will be completed in FY12 and any generalized findings across this workforce will be developed into outreach products to support Recommendation 1. The effort to address pesticide handlers will continue and include pesticide handlers throughout all industry sectors. The findings in healthcare are being used to develop outreach initiatives and training described in Recommendation 1. The PPT program will continue to use its strategic planning and budget formulation processes to prioritize activities for FY13 and beyond.

Activity B: Apply barriers to use knowledge across industry sectors to improve PPE selection and use across industry sectors

Description: The knowledge gained from Activity A will be used to develop strategies to address the barriers to use issues and findings. The PPT Program will work with stakeholders and experts across NIOSH to address safety culture issues and identify the most appropriate outreach efforts to educate the stakeholders and work with stakeholders to implement successful intervention strategies. The efforts identified will be developed into project activities and linked to the outreach and training activities described under Recommendation 1.

Progress: This activity is in an early stage of development. The PPT Program is in the process of identifying the most appropriate partners to develop products and tools to address the knowledge gained under Activity 1.

Impact: Barriers to use knowledge will be incorporated in outreach and training activities to improve the products developed for the targeted industry sectors. There is significant synergy between these activities and the outreach and training activities (Recommendation 1 activities). This synergy and the proven success of the products and tools defined under this activity are expected to have significant impact on worker safety and health when incorporated in the outreach and training plans.

Future Plans: The PPT program is meeting with other NIOSH divisions in FY12 to identify potential collaborative partnerships to support these activities. Meetings are planned for the first quarter of FY12.

Activity C: Work with partners to develop training methods to enhance the workplace safety culture across industry sectors

Description: Methods to educate users on the information provided in the products described under Activity B will be explored during FY12-FY14. Training methods will be identified and approaches to implement the methods will be defined and applied to Recommendation 1. The first step is to establish one workforce on which to focus, and leverage the information learned to develop strategies for additional workforce components.

Progress: The PPT Program decided to focus innovative training methods on the nursing workforce because of the progress made in PPT Program healthcare activities since FY08. The PPT Program engaged the Institute of Medicine in FY11 to explore respiratory protection information content in nursing curricula in an effort to improve education and training for this workforce. The IOM letter report was delivered to the PPT Program in August 2011. The recommendations provided in the report are serving as the foundation for moving forward to identify strategies to address training topics for the nursing workforce. The objective is to leverage the information provided for nurses to address other healthcare sector workforce components prior to targeting additional sectors.

FY12 will be used to develop the strategy and identify potential partners with whom to collaborate to address the recommendations provided in the IOM letter report. The goal is to implement the strategy in FY13-FY14. An evaluation component will be incorporated in the strategy to assess progress.

From FY09-FY11 efforts were undertaken to identify barriers to PPE use among pesticide handlers in agriculture. There were three main barriers identified: lack of knowledge, limited access, and lack of acceptance. Several training interventions were developed with partners to most effectively train the pesticide handlers on PPE selection and use: chemical resistant glove materials, pesticide label, chemical resistant clothing, and PPE according to label. These efforts will continue to address pesticide handlers across all industry sectors during FY12.

Impact: Appropriate and innovative training approaches will provide valuable knowledge to help workers; employers and managers change behaviors on PPE use and usability. Through the pesticide handler outreach and stakeholder meeting efforts, pesticide PPE best training techniques have been identified. NIOSH is serving as the leader and facilitator to gather and provide these resources to interested parties across the nation. The FY12 PPT Stakeholder Meeting will provide several demonstrations and/or exercises to provide the PPE information needed to keep these workers safe. Also, pesticide PPE training resources will be on display. Agencies from across the country will showcase their resources. This will provide an opportunity for agencies to network with each other and to share resources.

2014 Update Recommendation #4 (Issue 4.1):

Define barriers to and facilitators of PPT use

Addition of or modifications to activities since last review

In its review of the PPT Program, the NA recommended an expansion of the extramural research program and an increase in its coordination with intramural activities. Significant progress has been made to most effectively leverage intramural and extramural expertise. Most notably, the Program is making a conscientious effort to identify opportunities to collaborate with the NIOSH ERCs and other extramural partners where the Program subject matter expertise can be leveraged to develop surveillance tools and information dissemination activities (e.g. webinars, best practice tools, and workplace solutions), and the extramural partners can utilize the tools and content to gather data from stakeholders and disseminate information to increase the Program's understanding of the barriers and facilitators of PPT use and increase the knowledge-base of users to improve PPE training and use. These activities are contributing to updating the research agenda and more effectively providing information to PPE users to facilitate guidance and training in these areas.

Progress made or maintenance efforts since last review

Since the 2012 report, the program has continued efforts to address pesticide handlers and will include pesticide handlers across industry sectors by working with the Commercial Pesticide Handlers in Lawn and Turf and Structural and USDA Forestry Service. The PPT Program continues to develop training methods with its partners, such as:

1. Best Pesticide PPE Training Practices Workshop (March 2012) and Video, which included three topics/ sessions and was a collaboration with five stakeholder partners.
2. Informational training DVD, "Putting Safety First", is under currently being produced and expected to be available in May 2015, and is a national collaboration of over 30 stakeholder partners. In the near future, we are working with Cooperative Extension and other partners to develop best training curriculum that incorporate this DVD for training pesticide handlers in all industry sectors.
3. Training curriculum, "Personal Protective Equipment Basics" aimed at pesticide handlers in all sectors was successfully implemented at the Professional Pest Managers School, Lancaster, PA in March 2014 to over 100 pesticide handlers working in a number of industries (almost exclusively Non-Ag) as part of their pesticide applicator credentialing programs in Maryland, Virginia and Pennsylvania.

In the spring of 2013, the Program was asked to serve a leadership role in several CDC activities concerning the H7N9 outbreak in China. The Program developed a NIOSH White Paper to describe options for balancing supply and demand for facial and respiratory PPE. Following the completion of this white paper, the Program was asked to lead the development of a Federal

White Paper focused on the same topic. The white paper was drafted in July 2013 and has been reviewed by numerous federal agencies including the Food and Drug Administration (FDA), the Veterans Administration (VA), OSHA, BARDA, and other parts of CDC to name some. A working group was formed in the Program to develop an implementation strategy to address recommendations identified in the H7N9 Preparedness white paper: *Options for balancing Supply and Demand for Facial and Respiratory PPE*. The Program was tasked with addressing the use of the respirators included in the 2006 National Strategic Stockpile (NSS), given explicit or implicit expiration of the products. Considerable resources were also engaged in addressing priority on extended use and potential reuse of respirators. The Program published an on-line guidance document in March 2014 that reduced approximately 40 recommendations concerning this issue down to a useable, limited number of paragraphs to provide healthcare organizations the information needed to reduce the number of supplies needed during emergency situations. The PPT Program continues to work to develop effective pandemic preparedness strategies including efforts for strategic respirator stockpile management.

The PPT Program has supported roadway construction research efforts to understand the barriers to using PPE, with an emphasis on respirators, in roadway construction. These efforts included comprehensive surveillance activities that evolved into intervention and effectiveness approaches designed to address barriers to using PPE in roadway construction. The Bureau of Labor Statistics (BLS)/NIOSH national respirator survey results for construction and focus groups with road and transportation building employees indicated a need for improved respiratory protection programs.

The research and surveillance activities, including road and bridge construction site visits, began in 2007 and ended in 2013. Worksite assessment for respiratory protection program procedures and practices were conducted. These assessments indicated that the most complete respiratory protection programs existed where OSHA had detailed requirements such as PPE requirements during removal of lead based paint. The surveillance also indicated air monitoring by the company or their representative(s) was not consistently completed.

At the majority of the sites visited, air monitoring was completed to assess the selection of and need for respiratory protection. Half of the companies sampled had exposures greater than the NIOSH Recommended Exposure Limit (REL) for a least one of the following: silica, xylene, arsenic, nickel, or lead. Assistance was offered to improve respiratory protection programs and included providing literature, training videos, air monitoring (to help determine need and adequacy of respiratory protection), and respirator fit testing demonstrations. Informal feedback from the sites was received and the results of the study published in numerous peer reviewed manuscripts and trade journals. The activities have ended and efforts are underway to determine whether additional intervention should be conducted or if other industry sectors should be explored to benefit from the knowledge gained from these activities. Two of the three personnel supporting these efforts have retired, and one has been directed to other research and surveillance initiatives; therefore, resources are not available to continue this work at the same level of effort as previously conducted. Over twenty publications and presentations were developed over the life of these activities and have significantly contributed to improving respiratory protection work practices in the roadway construction industry.

Assistance was offered to improve respiratory protection programs including literature, training videos, air monitoring to help determine need and adequacy of respiratory protection, and respirator fit testing demonstrations. The PPT Program obtained informal company feedback on information provided such as videos, brochures, fit-testing demonstrations and is currently evaluating the results of this pilot study. The American Road and Transportation Builders Association requested the PPT Program to present the results of this work at their conference around November 2014 and prepare a journal article for their trade magazine.

The Program's emphasis for pesticide handlers has involved identifying and overcoming the barriers to correct PPE use. The efforts outlined in the surveillance and outreach activities focused on the following:

- Using surveillance to determine the extent to which PPE practices are correct and to identify patterns of correct PPE practices over time,
- Determining barriers to correct PPE practices and factors that may motivate someone to improve their PPE practices when incorrect practices are identified,
- Using information obtained on practices, barriers and motivating factors to design, implement, and evaluate interventions aimed to reduce barriers and improve PPE practices (Stakeholder-Directed Interventions).

The Program has supported the NIOSH Office of Mine Safety and Health Research (OMSHR) in conducting research to develop performance requirements for the next generation of CCER for miners and research on other PPE used in the mining industry that should reduce the barriers to using these devices. Improved design concepts include research to enable connection of two breathing apparatus (either two SCSRs or a SCSR to a SCBA) to allow a seamless transfer to breathing from one device to the other. Also, the final rule for approval tests and standards for CCERs (42CFR84, Subpart O) requires registration of units upon purchase. The Program intends to collaborate with MSHA to best understand CCER distribution, training, and use to improve CCER surveillance activities and reduce barriers to use.

In the second half of 2013, the Program established a post-market surveillance working group. One of the objectives of the working group is to develop a strategy for collecting and combining post-market PPE data (internal and external to NPPTL) in a manner which makes it suitable for analysis (e.g. trending, etc.). A second objective includes the development of a website based post-market user interface. The working members are internal and external to the Program and include NIOSH-wide representatives and others from conformity concerned government agencies (NIST, FDA, Consumer Product Safety Commission (CPSC)) and UL.

The products and standards database (i.e. PPEPro data base) being developed (described under Recommendation #1, Issue 1.3) could be enhanced to address the issues of barriers to PPE use by incorporating post market surveillance information based on NIOSH investigations and surveillance data. This option will be explored as its utility is assessed. In addition, a research study was initiated to design the next generation permeation cell to be used in the testing of chemical protective clothing. This cell will lead to improved chemical PPE selection.

Efforts to understand the barriers affecting the implementation of the NFPA 1984 standard are ongoing (Recommendation #1, Issue 1.2). This process included specifying the objective of the standard, identifying the internal and external factors that were involved in the creation/adoption of the standard and barriers to achieving compliance. Understanding the barriers to compliance may also better define barriers to using proper respiratory PPE by wildland firefighters.

As mentioned under the progress section of Recommendation #1, Issue 1.2, the Program and the Veterans Administration chaired the Better Respiratory Equipment using Advanced Technologies for Healthcare Employees (Project BREATHE) WG. The purpose of the WG, which consists of representatives from nine Federal departments and agencies, is to develop a set of consensus recommendations that aim to improve respiratory protective equipment used by HCWs. The group discussed strategies to improving respirator compliance and developing a set of consensus recommendations that aim to improve respiratory protective equipment used by HCWs. From 2008-2013 the group identified 28 desirable characteristics needed to improve compliance. The 28 characteristics were grouped into four themes. A key component of Project BREATHE is the development and eventual promulgation of a voluntary respirator consensus standard to meet the needs of healthcare workers (currently called the "B95"). Three peer-reviewed manuscripts describing the 28 characteristics and the criteria necessary for widespread adoption of a voluntary consensus standard have resulted from this effort.

The Respiratory Protection Effectiveness Clinical Trial study is a collaborative effort between NIOSH, the CDC Office of Infectious Diseases (CDC/OID), VA, and Johns Hopkins University (JHU), the lead organization. The project aims to answer a key question about PPE use: How well do N95 filtering facepiece respirators (FFRs) protect HCWs in the outpatient setting against influenza, influenza-like illness (ILI), acute respiratory illness (ARI) and other respiratory illnesses, as compared to surgical masks (SMs)? This study is designed to provide additional research data needed to guide planning activities and policy makers to enable public health groups and healthcare delivery organizations to provide appropriate protection for HCWs in the event of an influenza pandemic or other infectious diseases epidemic.

A pilot study was conducted at Johns Hopkins Health System in Baltimore, Maryland during the 2010-2011 influenza season. Subjects enrolled at 4 locations (6 clusters) in the pilot study and were divided into two arms: filtering facepiece respirators (FFR) and surgical masks (SM). A total of 110 subjects completed the study, split evenly between the two arms. Weekly and symptomatic nasal swab samples are being analyzed for the presence of 17 respiratory viruses. The study was expanded to the VA-New York Harbor Healthcare System and Denver Health/University of Colorado for the 2011-2012 influenza season. Data collection began in January 2012, with 657 subjects enrolled in 53 clusters across the 3 sites. Additional sites in other regions of the country were conducted during the 2012-2013 influenza season.

While the PPT Program has focused on the priority sectors of Healthcare, Public Safety and Agriculture (pesticide handling) for these activities, other activities have a broader reach, such as the development and execution of training and research education seminars with the NIOSH

ERCs and professional society partners through webinars and posting content to the NIOSH website.

In 2013 alone, closer integration of intramural and extramural activities was evident through collaboration with five ERCs including six webinars and one educational module for developing content for nursing curriculum. Additionally, 5 NIOSH Science Blogs and 10 scientific webinars emphasizing these issues were completed in 2013. Also notable is the fact that the Program delivered 81 presentations to stakeholders and posted 110 information products to the web in 2013. In 2014, nine additional educational modules were developed for respiratory protection content for occupational health nursing curriculum. Integrating respiratory protection content in nursing curriculum represents a giant leap forward in providing increased guidance and training in health care to keep these workers safe.

The PPT Program has a project to identify appropriate hearing protection that maximizes the wearer's ability to communicate in a noisy environment. The results of this project will allow employers and workers to select hearing protectors that will not be rejected due to complaints of speech interference.

To aid in the acceptance of hearing protection, the PPT Program is investigating and developing a new test method and materials specifically tailored for use with hearing protection devices. During the first phase of the project (completed in FY2013), data were collected assessing the effect of ear canal occlusion, hearing protector attenuation, and background noise level on the intensity and frequency content of a talker's vocal output. Data collection using a professional voice talent to record word/sentence lists with and without earplugs in a quiet and pink noise environment has commenced.

In another effort to support the needs of construction workers, the PPT Program initiated a project to investigate the potential of hard hats to reduce brain injuries occurring from falls.

Impact(s) made since last review (process or outcome related)

Impacts have been made in the Healthcare, Public Safety, Agriculture (pesticide handling), Construction, and Mining Sectors as follows:

- In Healthcare, the major findings of the respirator evaluation studies, such as the fact that HCWs are infrequent N95 respirator users, ongoing training is not emphasized, and HCWs are improperly donning and doffing respirators, have been used to develop the OHN training described under Recommendation #1, Issue 1.5.
- In Public Safety, the Program has delivered multiple CBRN training seminars to partners to assist PPE users with most effectively using their CBRN respirators. Additional training seminars have focused on proper care and maintenance of CBRN self-contained breathing apparatus. The PPT Program has provided training seminars as three Professional Development Courses at American Industrial Hygiene Association conferences, twice at U.S. Army-U.S. Navy Joint Occupational Safety and Health Conferences, the IAFF Redmond Conference, the Pennsylvania State Homeland Security Conference, and two PPT stakeholder meetings. In addition, CBRN maintenance training

was provided on four separate occasions in conjunction with InterAgency Board meetings.

- In pesticide handling, thousands of pesticide handlers have been reached through the quarterly seminar series intended to share knowledge with users on understanding PPE use and research needs. The impact of these findings will be improved PPE, with an emphasis on respiratory protection, for these workers.
- In Construction, the results of PPT Program harness sizing research have been adopted by manufacturers for new lines of effective fall protection harnesses for diverse populations that facilitate user productivity and ensure user comfort. A recent white paper published by MSA Fall Protection, Inc. indicated that the company has used the research findings to develop next-generation fall-arrest harnesses. Another harness manufacturer and research partner, DBI-SALA, is also using our findings to formulate product designs
- In Mining, the study completed for assessment of kneepads used by miners (also referenced in Recommendation #4, Issue 4.1) also addressed the issues of improved fit and comfort. The usability and durability of commercially available kneepads was assessed and the research team is currently developing a Report of Investigation to describe the findings.

Over the past three years, the Program has reached out to NIOSH ERCs to offer opportunities to collaborate to leverage NIOSH and ERC expertise. NIOSH provides the ERCs the content for webinars and delivers the content, thereby improving communication to students and workers through increased dissemination and supporting the ERC requirements to provide training. In the past two years, the Program personnel have delivered at least seven webinars reaching thousands of students and users on PPT barriers to use issues.

As discussed under Recommendation 1, Issue 1.2, the impact of the hearing protection studies is use of the data to support new national and international standards.

Future plans

During FY2014, the Pesticide Outreach Activity will commence science-based interventions. These interventions involve the development, implementation, and evaluation of interventions based on the scientific study of PPE practices, barriers and motivating factors. Collaborations among diverse groups of stakeholder partners will be used to design creative effective interventions to address barriers and motivating factors in order to improve PPE practices. Stakeholder partners will be responsible for widely disseminating the interventions. Practices and barriers will then be reevaluated to determine whether barriers have been reduced and whether PPE practices have improved.

Future plans for the ResPECT project are to continue the study for several more years at multiple locations until enough data are collected to meet study objectives.

The Program will work to identify approaches to leverage existing activities within the current sectors of emphasis to incorporate similar approaches across other applicable industry sectors within the current personnel and fiscal constraints. One area of interest across sectors includes efforts to provide outreach to low literacy/low skilled workers, particularly those from immigrant communities. The PPT Program is supporting the International Society for Respiratory Protection (ISRP) to address international issues relative to low literacy/low skilled workers. The PPT Program had several meetings to discuss these efforts. Manufacturers within ISRP are leading the efforts and are focusing on outreach and education to these communities and product delivery and training. Due to the lack of webinar-based technology in the areas where the training is to be delivered, the ISRP sought support from NIOSH to support the development of the training packages, travel to these nations to deliver training, and serve as the warehouse to store the products intended to be delivered to the countries where training would be conducted. NIOSH provided input on the content of the first training modules
The third phase of the Testing Speech Intelligibility and Hearing Protection will continue. This phase involves listening tests where the pre-recorded talker as well as the listener is subjected to background noise and both are wearing hearing protection. At the conclusion of this study, the type of test that produces the widest distribution (i.e., greatest separation) of intelligibility scores across the different listening conditions will be identified. Recommendations regarding the use of a particular speech in testing will result from this research. Journal articles describing the effect of ear canal occlusion, hearing protector attenuation, and background noise level on the intensity and frequency content of a talker's vocal output, and a description of the type of test best-suited for assessing speech intelligibility in noise will be developed. The final product from this research would be the compilation of enough data to support the development of a new national standard for evaluating the ability of workers to communicate while wearing hearing protection. The primary audience for this project is the American National Standards Institute (ANSI S12 Committee on Noise).

The fall harness study demonstrated that both thigh strap angle and torso suspension angle were precursors to suspension trauma; thigh strap angle may be considered as a fit criterion to possibly minimize the need for a suspension test to predict angle of suspension and suspension tolerance, if so desired. As stated above (Impacts since last review, Recommendation 1, Issue 1.2) manufacturers and consensus SDO's can continue to incorporate NIOSH research findings to formulate product designs and update current fall protection standards.

Recommendation #4 (Issue 4.2)

Develop innovative PPT designs and test methods to improve comfort, fit, and usability

Background

Status: *In Progress, see Table 1*

External Factors: PPT that is uncomfortable (e.g., too hot, restricts movement) or fits poorly cause noncompliance and are a barrier to proper PPT use and effectiveness. The causes of poor

fit and comfort are complex, but the effects could be minimized by addressing the human factors affecting PPT use, leading to better test methods and ultimately improved PPT. To address this need, NIOSH is executing a research program focusing on three activity areas. Various external factors affect the ability of the PPT Program to fully implement the proposed research program. Anthropometric and human subject research projects are costly and labor-intensive; therefore, funds and staffing for these research projects must be evaluated in the context of other PPT certification, standards development, outreach, and research priorities.

Implementation of Recommendation

Activity A: Implement the NPPTL Facial Anthropometric Research Roadmap to update and improve respirator fit test panels.

Description: In 2007, the IOM, at the request of the PPT Program, reviewed NIOSH research conducted from 2001-2006 that led to the development of new respirator fit test panels. The report provided three overarching conclusions and a series of recommendations to incorporate the panel into respirator certification and future research opportunities. The PPT Program developed an action plan describing a 10-year research plan for facial anthropometric and respirator fit test research to address these issues. This activity is supported by research in the (1) respirator fit test research and (2) respirator performance and usability elements of the respiratory protection program area.

Progress: This activity is on schedule. Since 2008, this research has focused on developing state-of-the-art headforms for testing PPT and advanced mathematical/computational approaches to analyzing 2-D and 3-D facial anthropometric data. Collaborations with organizations in the US, Canada, China, and South Africa were established and continue. To better understand issues related to the frequency of fit testing, pilot data collection was initiated in 2008. The full study began in 2009 with an objective of collecting data from 220 subjects. Data collection monitoring 22 facial dimensions of the subjects over time is now ~50% completed. This study also addresses one of the objectives identified in the facial anthropometrics research roadmap related to developing standardized methods for 3-D head scanning and facial anthropometrics. Another component of this activity is to develop an advanced headform total inward leakage test system. To support this research, a literature search was completed in 2010 to identify optimal design criteria for test headforms (e.g., articulation, skin-like surfaces). A static headform with human-like skin was obtained in 2010; pilot fit tests demonstrated fit factors comparable to human subjects. A full proposal to validate these initial findings is being prepared. In 2011, three pilot studies on the user seal check steps in the FFR donning process, the application of an infrared camera for FFR leak detection, and the effect of multiple donnings on FFR fit were completed.

Impact: From 2008 through August 2011, 11 manuscripts were published in peer-reviewed journals related to this activity, with 4 more in press or submitted for internal approval. According to Science Citation Index, manuscripts in this activity have been cited 57 times (5 of these have been for the 11 manuscripts published since 2008). Several intermediate outcomes have been identified. NIOSH's respirator fit test panel and the new headforms have been used by several manufacturers (Draeger, MSA, and Honeywell) to design new respirator products.

Some of these are available in the market today; others are still in the design phase. In 2010, ISO published Technical Report #16976-2 which was based upon NIOSH facial anthropometrics research. Other ISO standards in development will incorporate NIOSH research on headforms. The frequency of fit test research will be available to serve as a scientific basis for current or future NIOSH and OSHA recommendations on the periodicity of respirator fit testing.

Future Plans: Remaining work on the first project and all of the manuscripts resulting from the pilot studies will be completed in FY12, while work on the other two projects continues. We anticipate publishing 2-4 manuscripts in quality journals and will continue to work with respirator manufacturers, ISO, and NPPTL staff developing 7 proposed revisions to 42 CFR Part 84 to assist them in using these outputs in the development of new products, test methods, and performance standards. The PPT Program will initiate new research (as needed) to complete the facial anthropometrics research roadmap.

Activity B: Conduct research to improve fit of body, hand, head, eye, and foot protective equipment, and protective ensembles.

Description: Previously male-dominated occupations, such as construction, firefighting, manufacturing, and waste management have seen increasing numbers of women and immigrant workers. These changing demographics can affect how well PPE fit the workforce. Respirators, for example, have historically been designed and sized based upon average US military personnel physiques. PPE designs should match the sizes and shapes of the workers that use them to maximize comfort and performance. For example, the fit of fire apparatus and equipment designs have been identified by the fire service as pressing issues to reduce exposures, injuries and fatalities. This research supports the (1) Ensembles/Integration research and (2) Firefighter PPE Elements of the Protective Clothing and Ensembles program area.

Progress: This activity is on schedule. One research initiative will establish a large-scale anthropometric database of U.S. firefighters. In Phase 1, completed in December 2010, 80 measurements were made including a 2-D hand scan, 3-D foot scans, and 3-D head scans (with and without a mask) on 950 firefighters in 4 US regions. Phase 2, to obtain 3-D whole body scanning of 195 representative subjects, is underway. A literature and web-based review has been completed for the 2nd project in this activity area listed in Table 1.

Impact: When completed, the firefighter sizing project will generate multiple guidelines for fire apparatus enhancement and manuscripts to be submitted to peer-reviewed journals. In addition to improving firefighter bunker gear, the outputs are expected to have significant impact on equipment design considerations in areas beyond PPE and PPT. The results will be applied to updating relevant NFPA standards on fire apparatus and the design of fire-engine cabs, seats, restraint systems, and egress. In addition to the two manuscripts being prepared, the PPE for a diverse workforce research will explore the possibility of incorporating information about PPT sizing issues into education and training materials for workers and supervisors in male-dominated industries.

Future Plans: As data collection for both projects supporting this activity will be completed in 2011, most of the remaining activities involve data reduction, analysis, and manuscript preparation. NIOSH staff will participate in NFPA meetings to help transition study findings into performance standards.

Activity C: Evaluate and develop test methods to quantitatively assess respirator/ensemble comfort.

Description: Few quantitative test methods exist to measure respirator/ensemble comfort and little is known about whether these methods can be used to "predict" human responses to PPE use. Underlying factors impacting the human perception of comfort are not well understood. This research uses test methods to measure comfort and physiological responses (e.g., core body temperature, skin temperature, deadspace temperature/humidity, CO_2, O_2, heart rate, etc.) to wearing various types of PPE or is focused on developing test methods and countermeasures. This research supports the (1) Heat Stress/Ergonomics of PPT Ensembles and (2) Respirator Physiology, Comfort, and Tolerability Elements of the Human Performance program area; and (3) Respirator performance & usability and (4) Influenza Pandemic elements of the Respiratory Protection program area.

Progress: This activity is on schedule. In 2011, NPPTL acquired a state of the art sweating thermal manikin to augment human subject studies in this activity area. Data collection for the first 4 projects listed in Table 1 under this activity as well as the Physiological Evaluation of Air Fed Ensembles project is completed. Project BREATHE (Better Respirator Equipment using Advanced Technology for Healthcare Employees) contains multiple tasks, but only one task (Comfort / Tolerability of FFRs and Surgical Masks) pertains to this activity area. That phase was completed in April 2011 and data analysis/manuscript preparation is nearly complete. Three of the studies (Total Heat Loss, Mine Rescue Ensembles, and the Forest Worker) have or will be initiating data collection in 2011, while the physiological evaluation of PAPRs will begin data collection in 2012.

Impact: From 2008 through August 2011, 15 manuscripts were published in peer-reviewed journals related to this activity, with 7 more in press or submitted. According to Science Citation Index, these papers have been cited 11 times. Since 2008, several national laboratories have reported using ASTM F2668-07 (Standard Practice for Determining the Physiological Responses of the Wearer to Protective Clothing Ensembles), which was developed by PPT Program researchers. A NIOSH study showing the negative effects of boot weight was influential in bringing new, lighter firefighter boot models to market. An ASTM work item (WK27291 - New Practice for Determining the Ergonomic Impact of Protective Clothing Ensembles) based upon PPT Program research was initiated in 2010. NIOSH staff developed an ISO Technical Report (16972) on O_2 and CO_2 in the breathing environment, which will be used within ISO to set performance requirements for the different types of respirators.

Future Plans: The PPT Program will work to complete these projects and to initiate new research to evaluate and develop test methods to quantitatively assess respirator/ensemble

comfort. Related to this activity area, we anticipate publishing 5-7 manuscripts per year and will continue to work with ASTM, ISO, and NPPTL staff developing proposed revisions to 42 CFR Part 84 to assist them in using these outputs in the development of test methods and performance standards. For example, we plan to initiate a new work item with ISO related to the psycho-physiology of respirator use and to update ASTM F2668.

The following table lists the projects supporting Issue 4.2. Those highlighted in gray have ended since the last BSC review; however, they remain tabulated because publications are being generated from the research completed. In addition, four new projects have begun to support these activities since the last BSC review.

Table 1. Projects supporting Recommendation 4.2

Activity Area	Project Name	Start Date	End Date
A	Development of Computer Aided Fit Methods	04/11/01	09/30/12
A	Frequency of Fit Testing	10/01/05	09/30/13
A	Advanced Headform Total Inward Leakage Test System	10/01/10	09/30/13
B	Sizing Firefighters and Fire Apparatus: Safe by Design	10/01/08	09/30/13
B	Personal Protective Equipment for a Diverse Workforce	10/01/09	09/30/11
C	Next Generation Structural Fire Fighting PPE Ensemble	10/01/04	09/30/13
C	Physiological Models and Countermeasures	10/01/04	09/30/12
C	Biomechanical and Physiological Study of Firefighter Boots	01/01/05	09/30/09
C	Metabolic Evaluation of N95 Respirator Use with Surgical Masks	10/01/06	09/30/12
C	Physiological Validation of the Total Heat Loss Test	10/01/07	09/30/14
C	Project BREATHE	10/01/08	10/30/15
C	Mine Rescue Ensembles	10/01/09	09/30/13
C	Physiological Evaluation of Air Fed Ensembles	10/01/09	09/30/12
C	Monitoring the Physiological Status of Forest Workers	10/01/10	09/30/11
C	Physiological Evaluation of Tight- and Loose-Fitting PAPRs	10/01/10	09/30/13

Notes: this list only contains projects identified in the NIOSH Program Portfolio Management (NPPM) system as > 50% PPT.

2014 Update Recommendation #4 (Issue 4.2)

Develop innovative PPT designs and test methods to improve comfort, fit, and usability

Addition of or modifications to activities since last review

While the use of safety helmets in construction is by now almost universal, this type of head protection does not currently provide sufficient head protection for falls. First of all, current

helmets do not use straps, and so the helmets are apt to drop off during the fall. Secondly, current helmets are designed primarily to protect a relatively stationary worker from a falling object, or to protect a slow-moving worker who strikes a head-level object. Designs to protect against falls where the head strikes the ground must address additional issues such as linear and angular acceleration. NIOSH is working to address this critical need with a new project in 2014 to optimize helmet design to reduce the severity of head injuries at construction worksites, based on the current state of knowledge of the mechanisms of head injury.

In response to 2007 data reported to MSHA regarding knee injuries in the Mining Sector (84 knee injuries averaging $13, 121 per injury), the Program completed a study to develop a novel kneepad for miners. The study used biomechanical data to develop an initial design concept and focus groups, yielding a kneepad prototype designed and evaluated to (1) reduce the stresses at the knee while in postures associated with low-seam mining (barrier to use); (2) be durable enough to withstand the mining environment; and (3) be well accepted by the mine workers (facilitator of use). The study also included evaluation of commercially available products according to the criteria identified by the focus groups. NIOSH is developing a Report of Investigation for dissemination and use by manufacturers to design better kneepads for mine workers and others in similar work environments.

Progress made or maintenance efforts since last review

In order for hearing protection to be effective in preventing Noise Induced Hearing Loss (NIHL), hearing protectors must be fit correctly. Unlike fit testing for respirator effectiveness, until very recently, hearing protector fit-testing methods were too time-consuming to be a practical reality in the workplace. Thus, workers have had no way to obtain feedback on the adequacy of the fit of their hearing protectors. The Program is investigating the effect of training on improving the attenuation that a person achieves when using insert ear plugs. The Program also had developed the NIOSH Hearing Protection Device (HPD) Well-Fit™ fit-testing system to be a rapid means to evaluate earplug attenuation. Recognizing the measurements for earplug attenuation involved measuring hearing thresholds with and without earplugs, this project was conceived to evaluate whether the fit-testing could be combined with the annual audiometric screening.

As mentioned under the progress section of Recommendation #4, Issue 4.1, the Project BREATHE WG discussed strategies to improve respirator compliance, including the need to develop more comfortable respirators. The WG identified ten factors related to comfort and is currently testing prototypes from two manufacturers that are designed to meet the Project BREATHE requirements. NIOSH is also working with Texas Tech University to measure face seal pressure.

In response to stakeholder comments, the Program initiated and completed (2012-2013) an inter-panel variability study which included a peer reviewed research protocol and the implementation of the NIOSH bivariate panel and the Principal Component Analysis (PCA)

panel. Panel implementation efforts are underway to include the NIOSH bivariate panel in certification test procedures in 2014.

This activity continued to make substantial progress toward program goals. Several international collaborations were completed including one with the National Research Council (NRC) of Canada titled "Head-and-Face Shape Variations of U.S. Civilian Workers" and another with Canada NRC and Tongji Medical College titled "Head-and-Face Shape Variations of U.S. Chinese Workers". A new international collaboration was also established with Chile for an anthropometric study on the Chilean respirator user population. Data collection on the "Frequency of Fit Testing" project, which began in 2009, was completed in 2013. The first articulated headform (characterized as the short/wide size, based on the PCA panel) was obtained in October 2012, the prototype was evaluated and further improvements were identified.

The large-scale anthropometric database of U.S. fire fighters was completed. Anthropometry data of 951 firefighters in four US regions were collected during 2009-2010, using a stratified sampling plan. They were measured in both seated and standing postures and with and without bunker gear. Their head, hand, and foot anthropometry data were also recorded. A subset of 210 firefighters was selected for 3-dimensional (3D) whole body scanning in multiple postures. The 3D scans were conducted at the same locations during 2011-2012. In 2013, NIOSH started a new project to expand NIOSH research to practice efforts. A key aspect of that study is focusing on firefighter structural glove configurations and sizing systems. Collaborators include the International Association of Women in Fire and Emergency Services and the NFPA. One manuscript was published on anthropometric procedures for protective equipment sizing and design in 2013. A partner meeting on firefighter glove sizing configuration and redesign was held in early 2013.

The Program is conducting a pilot project exploring the challenges of providing PPE designed for a diverse workforce in male-dominated industries. Because men are traditionally employed in these industries, PPE for workers is designed to fit only a variety of average US-born male physiques. As women and other workers of smaller-than-average statures are employed in male-dominated industries which require PPE, they are encountering PPE that fits poorly resulting in a possible safety liability. A review of the literature and web-based research was conducted to learn more about alternative PPE providers and access barriers to these products. This research also explored the possibility of incorporating information about alternative PPE into education and training materials for workers and supervisors in male-dominated industries. As the trend of women's and immigrants' increasing participation in male-dominated industries is not likely to diminish, the redesigning of PPE is a key element to the prevention of injuries and accidents in the workplace.

Several projects have ended which evaluated and developed test methods to quantitatively assess respirator/ensemble comfort and manuscripts from that work have been published. Data collection for some projects has been completed (FFR use on pregnant workers, forest workers). Most of the projects in this activity area consist of multiple phases; data collection is

still on-going. For example, data collection for Phase 1 of the mine rescue ensemble (MRE) project was completed. In this phase, performance and comfort of the MRE elements were evaluated. Meanwhile, in Phase II, sweating thermal manikin testing of three common mine rescue garments is currently in progress. In another project, NIOSH is working with ASTM to develop an isolation gown standard. A Federal Register Notice was published to solicit samples from isolation gown manufacturers to evaluate currently used products to determine existing performance, performance & design limitations, comfort, and interface issues. Samples with varying protection levels were received and data collection is in progress. On the THL project (described under Issue 1.2), Phase 1, which studied the effect of garments with different THL values on machine and human measurements and examined the importance of heat acclimatization, has been completed. While for the PAPR study, human subject data collection has just begun. In addition, the Program performed automatic breathing machine simulator (ABMS) evaluations on SCSR-nose-cup prototypes to support OMSHR Program extramural research being conducted under contract to develop the next generation escape breathing apparatus.

The PPT Program published a manuscript on the impact of harness fit on suspension tolerance. The study results provide a basis for harness designers, standards writers, and manufacturers to improve harness configurations and testing requirements for better worker protection against suspension trauma.

In October 2012, NIOSH signed a nonexclusive licensing agreement with Michael and Associates, Inc., (www.michaelassociates.com) to manufacture a hearing conservation system based on the NIOSH-developed HPD Well-Fit™ System. HPD Well-Fit™ allows a hearing conservation professional to quickly and accurately assess the attenuation of essentially any commercially available earplug and to use these data to estimate a worker's noise exposure.

The kneepad study for the coal mining industry was completed in 2013. The study evolved from the novel design for PPE for use in low-seam mining to the evaluation of commercially available products already in use in the industry. The project team evaluated the usability and durability of the PPE and completed efficacy testing and full-scale field evaluations. The research team is currently developing a Report of Investigations to present on its findings.

The following table lists the projects supporting Issue 4.2. Those highlighted in gray have ended since the last BSC review; however, they remain tabulated because publications are being generated from the research completed.

In addition to the projects identified in the table, there are approximately ten active NIOSH grants dedicated at least 50% to PPT. In FY12, NIOSH invited the grant recipients to participate in the PPT Program Stakeholder Meeting to facilitate intramural and extramural collaboration. These interactions resulted in the PPT Program collaborating with the extramural grant recipient to provide state-of-the art PPT Program facilities to evaluate designs for personal protective cooling systems for HAZMAT workers. The PPT Program is working to identify other opportunities to leverage personnel and facility resources to maximize the impact on workplace safety and health provided through the extramural grants.

Activity Area	Project Name	Start Date	End Date
A	Development of Computer Aided Fit Methods	04/11/01	09/30/15
A	Advanced Headform Total Inward Leakage Test System	10/01/10	09/30/16
A	Frequency of Fit Testing	10/01/05	09/30/15
A	Testing Speech Intelligibility and Hearing Protection	4/01/10	9/30/14
B	Sizing Firefighters and Fire Apparatus: Safe by Design (re-designated) Fire Apparatus Design and PPE Sizing: Knowledge and Technology Transfer	10/01/08 10/01/13	09/30/13 09/30/15
B	Hearing Protector Performance for Impulse Noise	10/01/09	09/30/14
B	Field Attenuation Measurement for Hearing Protection Devices	10/01/10	09/30/14
B	Evaluation of injury potential and usability of first receiver PPE	10/01/12	09/30/15
B	Development and Evaluation of Prototype Kneepads for the Low-Seam Mining Industry	10/01/09	09/30/13
C	Physiological Models and Countermeasures	10/01/04	09/30/12
C	Biomechanical and Physiological Study of Firefighter Boots	01/01/05	09/30/09
C	Metabolic Evaluation of N95 Respirator Use with Surgical Masks	10/01/06	09/30/12
C	Physiological Evaluation of Air Fed Ensembles	10/01/09	09/30/12
C	Monitoring the Physiological Status of Forest Workers	10/01/10	09/30/11
C	Next Generation Structural Fire Fighting PPE Ensemble	10/01/04	09/30/15
C	Physiological Validation of the Total Heat Loss Test	10/01/07	09/30/14
C	Project BREATHE	10/01/08	10/30/15
C	Mine Rescue Ensembles	10/01/09	09/30/15
	Hearing Protector Performance for Impulse Noise	10/01/2009	09/30/14
	Field Attenuation Measurement for Hearing Protection Devices	10/01/2010	09/30/14
C	Physiological Evaluation of Tight- and Loose-Fitting PAPRs	10/01/10	09/30/14
C	O2 Saturation & Trans. CO2 Level of Pregnant Workers Using a FFR	10/01/12	10/01/14
C	Development of Performance and Design Criteria for Isolation Gowns	10/01/12	10/01/14
C	Next Generation Permeation Cell Design	10/01/12	9/30/16
C	Penetration of Engineering Nanomaterial Through Protective Gloves	1/14/2013	9/30/2015

Impact(s) made since last review (process or outcome related)

Since the last update, four manuscripts have been published in peer-reviewed journals. From 2008 to the present, a total of 14 papers have been published in this activity area and they have been cited 63 times according to Science Citation Index. Information from this activity area is being used by the ISO standards committees to develop test method standards for respiratory protection. Outreach such as the development of NIOSH Headforms webpage (http://www.cdc.gov/niosh/npptl/topics/respirators/headforms/) and publication of a NIOSH Science Blog (http://blogs.cdc.gov/niosh-science-blog/2013/07/25/headforms/) resulted in significant interest from a diverse group of stakeholders including product design firms and

recreational, safety and medical equipment manufacturers. Over 20 intermediate outcomes have resulted from the development of these headforms. Some examples include:

1. Honeywell Safety Products used the 3D digital headforms to develop new hard hats. The headform dimensions were used to define the length, width and shape of the hard hat. Hard hats with different dimensions and shapes were designed and manufactured for U.S. and Chinese workers.
2. 12th Man Technologies is a medical design company that produces oxygen masks and N95 respirators. They used the 3D digital headforms to design new masks and choices of sizes they want to market.
3. GVS Filter Technology, a manufacturer of air purifying respirator products, used the 3D digital headform set to improve the face sealing of their masks They developed a new medium/large (M/L) size mask to expand the range and satisfy customers who want a choice. With the demand for a new M/L size mask, the digital headforms from NIOSH helped effectively refine the design.
4. Parallel Design designs and manufactures consumer and military sunglasses. The 3D digital headforms are used in the study of UV light leakage between frame and face from all directions, head force (how tightly they grip the cranium), fit, and curvature, as well as air flow, (especially for sky diving applications) and impact testing.

One manuscript has been published on the research to improve fit of body, hand, head, eye, and foot protective equipment, and protective ensemble to date and another is in print. Multiple partnership meetings have been conducted with key stakeholders. Results of this research will be applied to update relevant NFPA PPE standards.

Thirteen manuscripts in peer-reviewed journals have been published related to the development of methods to assess comfort since the last report with 7 more in press or submitted. According to Science Citation Index, these papers have been cited 13 times. Since 2008, NIOSH has published 28 papers in this area and according to Science Citation Index they have been cited 103 times.

Consensus SDOs continue to utilize the expertise of NIOSH researchers and cite NIOSH research. For example, a new ISO TC94 SC15 technical specification titled “The Psychophysiology of Respiratory Wear” and two new ASTM work items titled “WK27291 New Practice for Ergonomic Performance Evaluation of First Responders Protective Ensembles” and “WK33313 New Specification for non-sterile isolation gowns intended for use in health care facilities” have been drafted by working groups that include NIOSH researchers. Other government agencies and PPE manufacturers seek out NIOSH researchers for collaboration and consultation. For example, the Air Force Research Laboratory evaluated the effects of wearing proximity firefighting gear using test methods developed by NIOSH; while TDA Research consulted NIOSH in their development of a new cooling system. NIOSH will be supporting TDA Research grant efforts by evaluating their cooling system. This effort demonstrates the PPT Program efforts to effectively integrate intramural and extramural research to most effectively leverage NIOSH resources.

The impact of the NIOSH HPD Well-Fit hearing protection fit-testing system has been the transfer of technology with two entities. HPD Well-Fit has been licensed by Michael and Associates for use as a potential replacement for the FitCheck HPD fit-testing system. NIOSH and Virginia Tech University (VTU) have executed a Material Transfer Agreement (MTA) to allow VTU to develop a sound-field implementation of HPD Well-Fit. This system will be provided to the Naval Submarine Medical Research Laboratory, New London, CT. NIOSH has executed MTAs with the U.S. Navy (San Diego and New London) to support fit-testing efforts with the respective fleets and an MTA with the University of Connecticut to conduct research studies of HPD Well-Fit performance. These MTAs are public information.

In FY2012, several efforts were initiated to work with partners to field test HPD Well-Fit and integrate it with a hearing conservation program. The Department of Interior, Bureau of Safety and Environmental Engineering initiated a survey of workers in Louisiana to assess the attenuation of hearing protection that is used by drill-rig inspectors and engineers. The work conducted in this partnership demonstrated that workers who have poor attenuation can be identified and that they can be trained or refit to achieve adequate attenuation. The Bureau of Reclamation Grand Coulee Dam initiated a study of hearing protector attenuation for workers conducting high-level noise operations (e.g. sandblasting). The workers were tested before and after sandblasting operations. The attenuation measured with the protectors demonstrated a constant (within test limits) level of protection.

The fall-arrest harness research has helped to reduce the risk of worker injury resulting from poor fit, improper size selection, or the failure to don the harness properly. (Also included in Progress made, Recommendation 1, Issue 1.2.) The results of NIOSH harness sizing research have been adopted by manufacturers for new lines of effective fall protection harnesses for diverse populations that facilitate user productivity and ensure user comfort. The research results are currently used by leading harness manufacturers to develop the next-generation harnesses and to update current sizing systems which relied on body measurements of military personnel taken during 1970s and 1980s.

Future plans

The PPT Program plans to write 2-4 manuscripts per year in the Anthropometric Research Roadmap and respirator fit test panels' area. Data analyses with South African and Chilean collaborators should be completed in the next couple of years, resulting in additional publications. The Program is continuing to evaluate the anthropometric panels to identify appropriate updates and implementation strategies. The Program anticipates completing investigation of the correlation of human subject to the articulated headform. In addition, the procurement of additional static headforms and test for respirator fit is planned.

NIOSH plans to continue to work with partners to utilize the large-scale anthropometric database of U.S. fire fighters. Several additional publications are likely to be completed for updating the NFPA standards in the next few years. It is projected that the Fire Fighter PPE

Sizing study will have been completed by the end of FY2014. Expected outputs of this study include:

- A report on firefighter mask configuration and modification suggestions, based on NIOSH anthropometric database of firefighters across the U.S.
- A contract report on firefighter gloves configuration and redesign, based on NIOSH anthropometric database of firefighters across the U.S. using a multivariable approach - principle component analysis method.
- A report on firefighter respirator sizing methods, based on NIOSH anthropometric database of firefighters across the U.S.
- Two research-to-practice cases on firefighter personal protective equipment
- A media release on firefighter anthropometry study results and r2p application cases
- Recommendations to NFPA on anthropometric specifications for selected fire apparatus and PPEs for updating the current NFPA standards
- Peer-reviewed manuscripts.

It is anticipated that the Program will continue to publish 5-7 papers per year in the area of methods to assess comfort research and several ISO and ASTM standards which will cite NIOSH research will be finalized. All continuing projects are planning to complete data collection in the next 2-3 years. Project BREATHE should complete "B95" prototype testing in 2014 and discussions will be initiated with SDOs in 2015 to develop a consensus standard. Researchers on the THL study plan to complete Phase 2 and Phase 3 data collection. Phase 3 testing will evaluate the impact of protective clothing add-ons (e.g., pockets, reflective materials) on the THL value. An external collaboration is planned with South Florida University. As these projects are completed, new projects will be developed. For example, NIOSH plans to broaden research and SDO collaborations to include other types of protective clothing used in healthcare, to study cardiovascular effects of respirators in mild respiratory disease, develop advanced supplied air respirators thought improved breathing gas chemistry, and develop interventions for cardiovascular events among firefighters.

New research proposals for 2014 will emphasize correlation testing of ISO test methods for respiratory protective devices. Future research may include evaluating the use of the ABMS for other classes of respirators beyond our current evaluations of CCERs (CCER rule, Progress, Recommendation 1, Issue 1.2). Other test method development and research to provide manufacturers and consensus SDO's with improved methods for evaluating design and function of safety harnesses can be continued, especially efforts combining traditional anthropometry, 3-D body scanning technology and digital screen protractor with automated physiological recording systems.

The construction helmet research being initiated in FY14 will continue through FY17. Peer-reviewed manuscripts and presentations at national conferences will be developed. The recommendations from this project will be forwarded to SDO for consideration in revising the appropriate standards.

The results of the novel kneepad for mining study: Development and Evaluation of Prototype Kneepads for the Low-Seam Mining Industry (completed September 2013) will be published as a Report of Investigation.

The feasibility testing of the NIOSH HPD Well-Fit™ Audiometric system in a functioning hearing conservation program will be completed by the end of FY2014. Two lab-based studies are planned. The principle research to practice component of this research will be the NIOSH HPD Well-Fit Audiometric system developed in cooperation with a Cooperative Research and Development Agreement CRADA partner. The research will provide quantitative evidence supporting the choice of testing algorithms for measuring hearing thresholds and implementing fit testing. Data will be provided to the ANSI to develop an evidence-based standard field attenuation measurement standard (fit testing) for hearing protection devices. The data will provide employers quantitative estimates of the time needed to implement fit testing and to reinstruct workers in proper use of hearing protection. As well, such information will be useful to the OSHA to evaluate the cost of requiring fit testing as a part of hearing conservation programs. Finally, the authoritative guidance for fit testing HPDs will be developed for the next revision of NIOSH Criteria Document on Occupational Noise Exposure.

Appendix 1

Review of Progress Implementation Report for

NIOSH Personal Protective Technology Program

Submitted by Board of Scientific Counselors

January 10, 2012

BSC Working Group Members

Bill Kojola
Michael Kosnett
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Personal Protective Technology Progress Score Sheet

Directions: For each recommendation listed below, please circle a score for each scoring element and provide a brief justification for the assignment of that score. The work group may provide scores in .5 increments where they deem appropriate. If the group chooses to do that, please put a .5 next to the corresponding number and circle that number.

Recommendations In Progress:

Recommendation #1 (Issue 1.2): Participate in policy development and standards across all types of PPT.

Relevance: 1 2 3 4 5 **– SCORE: 4.5**

Brief Justification: Implementing this recommendation is highly relevant and of high priority. While there is some evidence that PPE other than respirators is addressed, it is unclear about the scope of and if this effort includes the full spectrum of PPE and all industry sectors where PPE is used.

Sustainability**:** 1 2 3 4 5 **– SCORE: 4.0**

Brief Justification: The program has demonstrated all relevant inputs for sustaining regulatory updates regarding respiratory protection and some of the relevant inputs for implementing its participation in the development of voluntary consensus standards. However, nothing was said in the document about resources and funding. We have concerns about the ability to maintain adequate resources for this work on standards development and the apparent lack of ties to academic institutions and other Federal agencies (such as Department of Defense chem/bio programs) that could assist NIOSH in achieving the objectives.

Progress: 1 2 3 4 5 **– SCORE: 4.0**

Brief Justification: Good progress has been achieved on this recommendation. More clarity is needed about the science and research that NIOSH performs on PPE that is aligned with the full spectrum of PPE encompassed in this work

Potential Impact: 1 2 3 4 5 **– SCORE: 5.0**

Brief Justification: The activities on this recommendation will have a substantial impact on worker safety and health. The NIOSH PPT program has come a long way over the recent years by expanding its efforts to include a broader range of PPE beyond that of respirators.

Recommendation #1 (Issue 1.3): Oversee certification of all PPT including an assessment of certification mechanisms.

Relevance: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: This is a massive undertaking by NIOSH that is highly relevant and the activities are directly responsive to the recommendation. Some of the jargon connected to this work is vague, however.

Sustainability: 1 2 3 4 5 – **SCORE: 4.0**

Brief Justification: The program appears to have identified a good number of the relevant inputs that are necessary to carry out its identified activities, particularly from the IOM report on certifying PPT and the formation of a conformity assessment workgroup. We have concerns about the long term adequacy of resources to carry out this recommendation for overseeing certification of all PPT.

Progress: 1 2 3 4 5 – **SCORE: 3.5**

Brief Justification: The program has achieved some progress in addressing the recommendation for assessing various certification mechanisms and initiating efforts to develop a conformity assessment framework. It does not appear that the full spectrum of stakeholders have been involved, such as the Safety Equipment Institute (SEI) and Underwriters Laboratory (UL), or that action on the clearing house recommended by IOM has been initiated.

Potential Impact: 1 2 3 4 5 – **SCORE: 4.0**

Brief Justification: The activities are reasonably likely to develop new partnerships and they have substantial potential to impact improvements in worker safety and health by

expanding the range of PPE that will fall within a new conformity assessment framework. We have concerns about the lack of NIOSH regulatory authority and audit/oversight function capability (including financial resources) that could hinder the impact of achieving the objective of this recommendation.

Recommendation #1 (Issue 1.5): Conduct outreach programs for optimal use and acceptance of PPT by workers.

Relevance: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: All of the activities being conducted directly respond to the recommendation and are highly relevant. It is unclear about the focus on construction workers, especially Latino construction workers, as well as low literacy/low skill workers, and recommended that this be addressed. We also note an apparent lack of outreach to OSHA.

Sustainability**:** 1 2 3 4 5 – **SCORE: 4.0**

Brief Justification: The PPT program has identified and engaged in outreach with many relevant organizations and stakeholder groups that have a high interest in PPE. We have concerns about future funding for the ERC's and its impact on sustainability of this recommendation. We also have concern about the lack of input from the construction industry on this recommendation.

Progress: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: The PPT program has shown substantial progress in achieving the objectives of this recommendation. The program has done an excellent job of expanding its outreach activities in recent years.

Potential Impact: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: The impact on worker health and safety resulting from the work on this recommendation will enhance existing and expand new partnerships. The activities will also have substantial impact on improving the health and safety or workers.

Recommendation #4 (Issue 4.1): Define barriers to and facilitators of PPT use.

Relevance: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: Barriers to the effective use of PPE are of substantial concern in the health and safety community. The activities being conducted by the PPT program are highly relevant to addressing and overcoming those barriers.

Sustainability**:** 1 2 3 4 5 – **SCORE: 4.5**

Brief Justification: Most of the relevant inputs necessary for achieving the goals of this recommendation have been identified and initiated for selected industry stakeholders, including roadway construction, healthcare, and pesticide handler workforces. The program should focus some effort on expanding the industries that are included in this work beyond that of pesticide handlers and the healthcare industry. In particular, outreach to low skilled construction workers, particularly those from immigrant communities, would be desirable.

Progress: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: The program has made significant progress in identifying and addressing barriers in the healthcare sector and among pesticide handlers. Progress in building on past accomplishments has been evidenced. Other work sectors should be included.

Potential Impact: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: The potential impact from the work on this recommendation is enormous in terms of improving worker safety and health and developing lasting

partnerships. We encourage the PPT program to reach out to as many industries and stakeholders as possible to help eliminate their barriers.

Recommendation #4 (Issue 4.2)*: *Develop innovative PPT designs and test methods to improve comfort, fit, and usability.

Relevance: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: Fit, comfort and usability are major issues that affect proper use and effectiveness of PPE. The activities of the PPT program are fully responsive to the objectives of the recommendation. All of the activities being conducted by the program are of high priority in carrying out the goals of the recommendation.

Sustainability: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: The PPT program has assembled all of the relevant inputs into implementing the identified activities. It has launched major research initiatives to address the fitting characteristics of respirator fit and comfort as well as established a research agenda for advancing improvements in the fit of other forms of PPE. The activities appear to be the most effective and efficient use of its resources devoted to this important endeavor.

Progress: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: Substantial progress has been achieved by the PPT program in addressing this recommendation. A range of research projects have been launched that have provided advances on this issue and future research initiatives are planned to further these advancements. Success in publishing results has been notable. NIOSH has done an excellent job responding to this recommendation and important need for workers.

Potential Impact: 1 2 3 4 5 – **SCORE: 5.0**

Brief Justification: The activities that have been carried out to date – and those that are planned for the future – have had and will continue to have major impact in advancing worker health and safety. Improving fit, comfort and usability of PPE is a critical concern and the NIOSH PPT program has done an outstanding job in conducting this work.

Appendix 2

2014 Update: *While the Program has many activities underway in support of the efforts described in Appendix 2, Appendix 2 was not updated for this review since the emphasis has been on the activities provided in the body of the document.*

Recommendation #2:

Expand the extramural research program and increase its coordination with intramural activities

Status

In progress; not selected for BSC tracking

Background

The second recommendation of the NA Report addresses the participation of external research organizations in the PPT Program. It refers to expanding this participation, as well as increasing the coordination between the extramural and intramural efforts. As there are limits on NIOSH's intramural resources, support for more extramural research may be necessary to meet the PPT research needs across all industry sectors.

The prioritization of PPT Program research occurs through a number of inputs, including that from stakeholders, and is frequently undertaken by the program. As the research needs are prioritized, NIOSH undergoes an internal process in which these needs are matched to NIOSH's available intramural expertise. The remaining unmet research needs can then become the focus for expanded extramural research efforts.

The NA report emphasizes the need for increased intramural/extramural research collaboration as a means of making the program more effective. This includes both external research sponsored by the PPT Program and that supported by the NIOSH Office of Extramural Programs.

NIOSH Decision

The PPT Program has made a deliberate effort to collaborate with the Office of Extramural Programs (OEP) by involving the extramural grant recipients in the PPT Stakeholder meeting, providing consultation to the extramural grant recipients, and providing contract opportunities to the extramural research community. A concerted effort has been made to maintain a number of existing external collaborations in order to provide continuity to long-term ongoing initiatives. Coordination between the intramural and extramural research efforts has increased by participating in NIOSH-wide meetings to strategize opportunities to increase collaboration. In addition, a strategic decision was made in FY11 to expand PPT Program operations to absorb nine Morgantown personnel and several laboratories to increase the PPT Program capacity. This expansion will enable the PPT Program to conduct several policy and standard development and research activities that had been put on hold pending facility improvements and personnel availability. Targeted outreach and invited participation in the PPT stakeholder meeting as described under Recommendation 1 will occur. Despite this progress, budget constraints are preventing NIOSH from effectively addressing the full intent of Recommendation 2.

Therefore, this recommendation was not selected for BSC tracking.

Recommendation #3:

Enhance the respirator certification program

Status

In progress; not selected for BSC tracking

Background

The third recommendation of the NA Report addresses enhancements to the long-standing NIOSH program for the certification of respiratory protection devices. This recommendation includes six identified issues that need to be addressed in order to translate the recommendation into operational practice:

3.1 Explore ways to expedite respirator certification regulation revisions
3.2 Assess the feasibility of updating certification fees
3.3 Examine the possibility of registering the purchase of NIOSH-certified respirators
3.4 Explore the expansion of the product audit program
3.5 Consider expanding the site audit program
3.6 Explore approaches for disseminating respirator certification test results data

NIOSH Decision

The six identified issues meet the criteria of being high priority issues, addressing a stakeholder need and providing a mix of ongoing and new initiatives. However, the PPT Program's experience in seeking resolution of these issues raises concern that realizable targets could be established and achieved within the timeframe of tracking by the BSC.

For example, issues 3.1 and 3.2 require successful promulgation of changes to the NIOSH regulation for the Approval of Respiratory Protective Devices (Title 42, CFR, Part 84). The PPT Program has substantial control over the development of the science to support updates, the development of technical criteria supported by this science, and the vetting of the science and basic technical approaches with outside experts and stakeholders. However, activities beyond the program's control include the time frames for review and comment periods and the development of the economic impact analysis and technical rationale of any proposed changes to the regulation. The Program has succeeded in conducting the science and formulating several regulatory modules that have progressed to be published as notices of proposed rulemaking, but has not been successful in processing the respirator certification regulations to conclusion. Further, the program anticipated a need for additional resources to fully implement these six issues. Additional resources are not anticipated over the next several years.

The issues defined in this recommendation are not new to the program, and activities have been put into place in an attempt to address most of them. However, resolution of these issues requires outputs and outcomes well beyond the influence and control of the PPT Program. Therefore, though this NA recommendation met the PPT Program's criteria for inclusion for BSC

tracking, it was decided that the inability to control key aspects of the processes makes them inappropriate for inclusion in the review activity.

Recommendation #5:

Assess PPT use and effectiveness in the workplace using a life-cycle approach

Status

In progress; not selected for BSC tracking

Background

The fifth recommendation of the NA Report addresses the need for a broad-based expansion of the PPT Program surveillance activities. The two issues identified for this recommendation are: (5.1) establish a comprehensive surveillance program and (5.2) conduct random periodic field testing of PPE.

The PPT Program realizes that surveillance data are a primary component necessary to understand the occupational safety and health issues and understand the PPT needs in the workplace. The two issues defined in this recommendation are not new to the program, and some limited project activities have previously been conducted. A PPT Program surveillance strategy was developed in FY09. Implementation of the plan was initiated in the healthcare and agriculture sectors; however, funding beyond the effort to support pilot initiatives has not been realized. Funding is not anticipated to support expansion of these efforts beyond the pilot level.

The PPT Program has also made a concerted effort to identify ongoing intramural and extramural surveillance activities with which the PPT Program could collaborate to move toward closing some of the knowledge gaps within the program. Where possible, the PPT Program has incorporated a PPT component in existing and ongoing intramural and extramural initiatives. Some examples include the Mining Intervention study through NIOSH Office of Mine Safety and Health Research (OMSHR), and NFPA's annual firefighter survey where several CBRN certified respirator use questions were added in an effort to understand this topic across the firefighter workforce. To date fiscal support required to incorporate a PPT component has been cost prohibitive in many cases.

NIOSH Decision

The PPT Program's experience in seeking to develop surveillance projects, "mine" surveillance databases of prior studies, or even collaborate on surveillance tools being implemented or used by others consume a disproportionate percentage of its discretionary budget. This experience raises concern that realizable targets could be established and achieved within the timeframe of tracking by the BSC. This is true for conducting significant periodic surveillance (Issue 5.2), and more so in establishing a comprehensive program (Issue 5.1).

Thus, though this NA recommendation meets the PPT Program's criteria for inclusion for BSC tracking, it was decided that the inability to apply significantly more resources to this effort will make it more difficult to demonstrate measurable progress in the defined timeframe relative to other NA recommendations. However, other specific issues (e.g., see the analysis for

Recommendation 4 concerning the definition of barriers to and facilitators of PPT use) are being addressed with increased emphasis on surveillance efforts.