National Strategy for Personal Protective Technologies Research for the Transportation, Warehousing and Utilities Sector

A DRAFT Prepared for NIOSH

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This draft is formatted into four parts: an overview, assessment, research plan, and appendixes. The assessment is structured using the five questions that NIOSH is using for its NORA town hall meetings, and the research plan is structured similar to the White House strategy for preventing a pandemic.

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National Strategy for Personal Protective Technologies Research for the Transportation, Warehousing and Utilities Sector

"Providing National and World Leadership to Prevent Illnesses and Injuries"

Overview

Every day, in nearly every type of U.S. work setting, personal protective technologies are used to reduce workers' risk of job-related injury, illness, and death. These technologies include personal protective devices such as respirators, chemical-resistant clothing, hearing protectors, and safety goggles and glasses that provide a barrier between the worker and an occupational safety or health risk. In particular, respirators are a required component of many occupational safety and health programs, and may represent a worker's last line of defense against exposure to toxic fumes, vapors, or dust. More generally, personal protective equipment (PPE) is a last line defense after engineering controls.

PPE are tools that ensure the basic health protection and safety of users. PPE is any device designed to be worn by an individual when exposed to one or more safety and health hazards. PPE includes all clothing and other work accessories designed to create a barrier against or restraints from workplace hazards, and using PPE requires hazard awareness and training on the part of the user. Employees must be aware that the equipment does not eliminate the hazard; and if the equipment fails, exposure will occur. To reduce the possibility of failure, equipment must be properly fitted and maintained in a clean and serviceable condition. Personal protective technologies also include devices that provide a worker with early warning of a hazard or otherwise help keep the worker safe from harm, such as sensors that detect toxic atmospheres and communication devices used for safe deployment of emergency workers.

At the request of the Congress, the National Institute for Occupational Safety and Health (NIOSH) established the National Personal Protective Technology Laboratory (NPPTL) in Pittsburgh, PA in 1999.[1] NPPTL focuses expertise from many scientific disciplines to advance federal research on respirators and other personal protective technologies for workers. NPPTL's efforts are essential for applying state-of-the-art science to meet the increasingly complex occupational safety and health challenges of the 21st Century. NPPTL's strategic research program ensures that the development of new PPE keeps pace with employer and worker needs as work settings and worker populations change and new technologies emerge. NPPTL research also responds to the need for effective protective technologies for first responders in terrorist events and other disasters. NPPTL incorporates NIOSH's longstanding program for testing and approving respirators for use in traditional work settings.

The NPPTL mission is to prevent work-related illness and injury by ensuring the development, certification, deployment, and use of PPE and fully integrated, intelligent ensembles. This will be accomplished through the advancement and application of personal protective technology standards.

Assessment

1. Who is most at risk?

A distinguishing characteristic of the transportation, warehousing, and utilities sectors is the operation of physical facilities, labor forces, and equipment spread across geographic areas ranging from city-wide to global. The transportation and warehousing sector includes industries that provide transportation of passengers and cargo (by air, rail, water, road, and pipeline), warehousing and storage for goods, scenic and sightseeing transportation, and transportation-related support activities transportation (inherently multimodal), which includes postal and courier services. One support activity is the repair and maintenance of transportation equipment such as aircraft at an airport, railroad rolling stock at a railroad terminal, or ships at a harbor or port facility.

The utilities sector provides electric power, natural gas, steam supply, water supply, and sewage removal. Electric power includes generation, transmission, and distribution; natural gas includes distribution; steam supply includes provision and/or distribution; water supply includes treatment and distribution; and sewage removal includes collection, treatment, and disposal of waste through sewer systems and sewage treatment facilities.

Table 1. List of Transportation, Warehousing and Utilities Subsectors

Code*	Transportation, Warehousing, and Utilities Subsector	Employment Dec. 2005		Rates, 2004‡	
		Private	Public	Injury	illness
481	Air Transportation	487,600		9.7	47.3
482	Rail Transportation	227,400		2.6	9.9
483	Water Transportation	64,000		4.2	19.2
484	Truck Transportation	1,404,200		6.0	9.2
485	Transit & Ground Passenger Transportation	391,200		5.9	19.1
486	Pipeline Transportation	37,000		2.4	10.4
487	Scenic & Sightseeing Transportation	32,300		4.6	10.7
488	Support Activities for Transportation	554,600		5.2	15.7
491	Postal Service		772,200		
492	Couriers & Messengers	576,400		11.7	78.1
493	Warehousing & Storage	594,100		8.9	37.7
221	Utilities	559,800		4.6	59.6
	Industry-wide	4,368,800		7.0	26.3
	Grand Total	5,700,800			

* North American Industry Classification System (NAICS)
‡ [**above average in Red**] injury rates per 100 employees/yr; illness rates per 10,000 employees/yr
Yellow indicates the transportation and warehousing average rate
Red indicates those rates that exceed the industrywide average

Injury and illness rates provide a measure of the success of worker protection strategies. Those portions of industry with the highest rates indicate failures in protection and opportunities for intervention research to improve the safety and health of these workers. Using 2004 data, Table 1 shows the transportation, warehousing, and utilities industry injury rates.

Injuries

The air transportation subsector has the highest rate of injury in the transportation, warehousing, and utilities subsectors at 9.7 injuries per 100 employees per year. The couriers and messenger and warehousing and storage subsectors have the second and third highest rates of injuries, respectively, at 11.7 and 8.9 injuries per 100 employees per year. All three of these subsectors exceed the average injury rate for the transportation and warehousing sector, which has a rate of 7.0 injuries per 100 employees per year.

Illnesses

Like injuries, the air transportation subsector has the highest rate of illnesses in the transportation, warehousing, and utilities subsectors at 47 illnesses per 10,000 employees per year. The couriers and messenger, utilities, and warehousing and storage subsectors have the second, third, and fourth highest rates, respectively, at 78.1, 59.6 and 37.7 illnesses per 10,000 employees per year. All four of these subsectors exceed the average illness rate for the transportation and warehousing sector at 26.3 illnesses per 10,000 employees per year.

Sectors

Transportation and warehousing

While the incidence rate of injuries and illnesses in the transportation and warehousing sector declined in 2004 from 7.8 to 7.3 cases per 100 full-time workers, the rate was significantly higher than the rate of 4.8 cases in all of private industry. Of the ten three-digit NAICS industries within this industry sector, only truck transportation experienced a significant decline in the rate of injuries and illnesses, falling from 6.8 cases per 100 full-time employees in 2003 to 6.1 cases in 2004. This decline can be attributed to decreases in the numbers and rates for both cases involving days away from work, job transfer or restriction, and cases involving days away from work. [2]

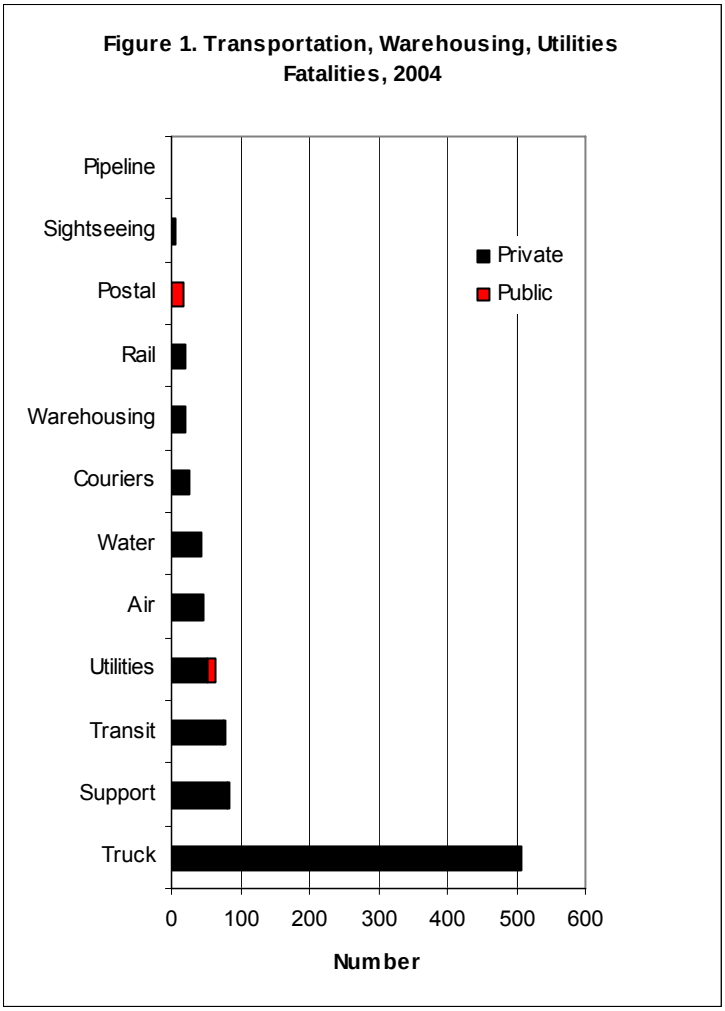
Utilities

Utilities was the only industry sector in 2004 to experience a statistically significant increase in the incidence rate of total recordable injury and illness cases, rising from 4.4 cases per 100 full-time workers in 2003 to 5.2 cases in 2004. This rise was the result of a jump of 19 percent in the number of cases reported in the industry sector, while the total number of hours worked rose by only 1 percent. Approximately 60 percent of the increase in cases in this sector can be attributed to natural gas distribution, where the rate of injuries and illnesses increased from 4.8 to 7.3 cases per 100 full-time employees in 2004. This industry accounted for about 20 percent of total employment in the utilities industry sector, but contributed nearly 27 percent of the reported cases.[3]

Postal Service

Data for public employees are excluded from the private industry statistics. Nonetheless, fatality rates for the U.S. Postal Service Rates were calculated in a study for the period, 1983-1989. Over this period, 169 occupational injury deaths among Postal Service workers occurred in which the average annual rate of occupational injury death was 2.1 per 100,000 workers, less than half the rate of 5.4 per 100,000 workers for all industries combined. Motor-vehicle-related events (n=72) were the leading cause of fatal occupational injury, followed by homicide (n=40). Cause-specific

rates for Postal Service employees were consistently lower than rates for all industries. Collisions between motor vehicles caused 43 (60%) of the motor-vehicle-related deaths among Postal Service workers. Three (4%) deaths occurred to pedestrians on the job who were struck by motor vehicles. Fifty-one (71%) deaths occurred among mail carriers and eight (11%) among drivers. Among homicide victims, 26 (65%) were men. The homicide rate for men was 0.5 per 100,000, compared to 0.6 for women. Firearms were used in 34 (85%) of the homicides. Seventeen (43%) of the victims were mail carriers; nine (23%), postal clerks; five (13%), postmasters and mail superintendents; and three (8%), other specified occupations.[4]



2. How serious is the issue?

Fatalities

In 2004, the transportation, warehousing, and utility sectors recorded 916 work-related fatalities. Figure 1 shows the frequency of occupational fatalities for each of the transportation, warehousing, and utilities subsectors. The subsector with the most fatalities was truck transportation totaling 508 cases. Another 226 fatalities were recorded in the next three highest frequency sectors: support activities for transportation (80 private and 4 public employees), transit and ground passenger transportation (75 private and 3 public employees), and utilities (51 private and 13 public employees).

Days Off Work

Figure 2 shows the ranking of severity of injuries (total days off work per 10,000 employees) by subsector in the transportation, warehousing, and utility sectors in the United States. The average across all industries is 150 days off work per 10,000 employees. All the subsectors shown in Figure 2 except utilities and pipeline transportation exceed this nationwide average. Air transportation leads the industry with the 592 days off work per 10,000 employees, but the couriers and messengers may have the most severe injuries with 212 cases per 10,000 workers off work for more than 30 days out of a total of 548 days off-of-work per 10,000 employees as a result of an injury.

Conditions

The seriousness of occupational injuries and illnesses can also be shown by the conditions associated with these injuries and illnesses. Those subsectors that are above average for the

transportation, warehousing, and utility industry provide a measure of seriousness of the injury or illness. The Postal Service is not included because the data covers only private and not public employment, and likewise, public employment in the utilities sector is also excluded.

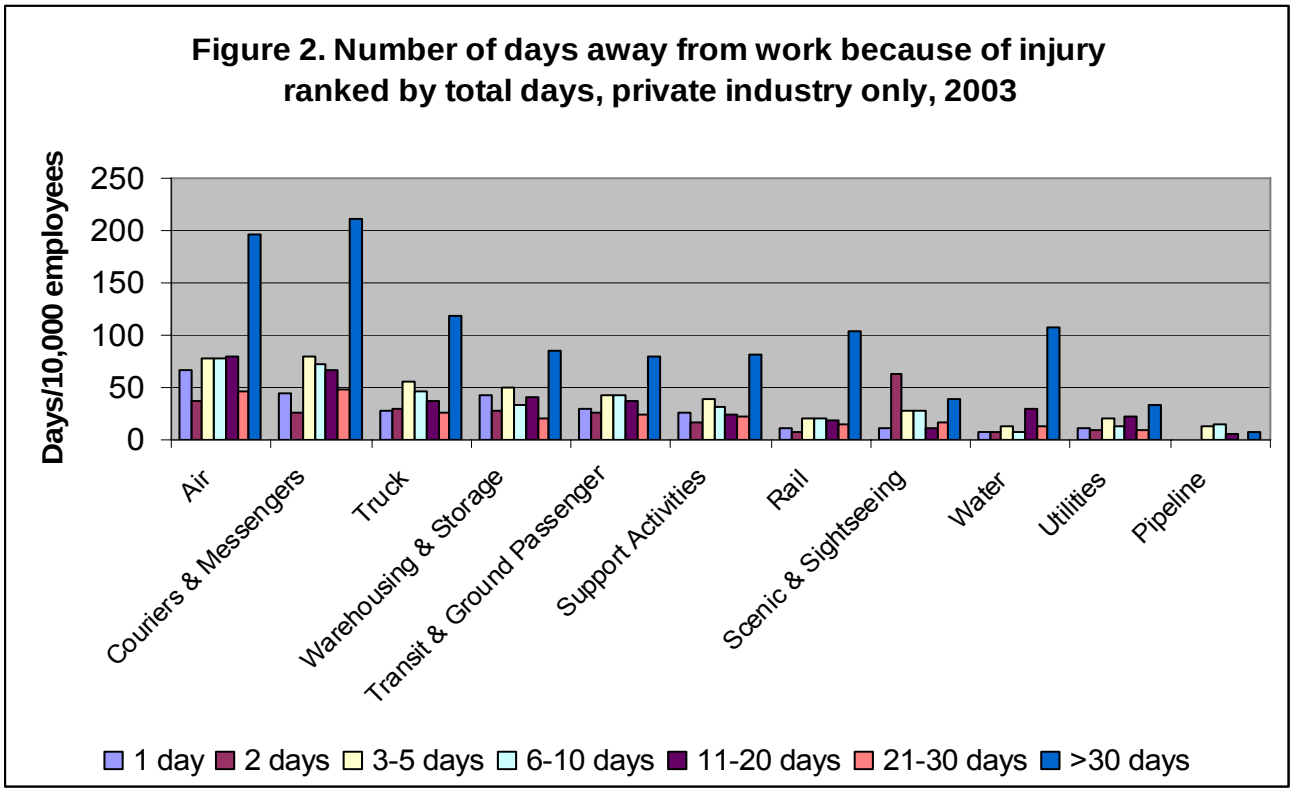


Table 2. Injury Rates (per 10,000 employees) by Nature of Injury, 2003

Private Subsector	Sprains, strains	Fractures	Cuts	Heat burns	Chemical burns	Amputations	Multiple injuries
Air	371.2	15.5	17.3	-	1.8	1.8	11.6
Couriers & messengers	234.2	23.5	16.7	-	-	0.5	19.3
Industrywide	173.2	24	15.2	2.2	2.1	1.6	13.0
Truck	157.0	34.7	14.3	3.4	4.5	2.8	13.7
Warehousing & storage	139.3	21.2	20.4	-	-	0.8	12.2
Ground passenger	138.0	12.8	6.4	1.4	-	-	14.6
Rail	108.6	18.7	12.9	-	-	1.3	-
Support activities	97.4	16.7	15.9	4.8	1.0	0.8	12.1
Scenic & sightseeing	67.9	-	56.6	-	-	-	-
Utilities	63.2	8.6	4.3	1.1	-	-	4.3
Pipeline	25.3	-	-	5.1	-	-	-

Yellow indicates the transportation and warehousing average rate
Red indicates those rates that exceed the industrywide average

Nature of Injury

The seven conditions by nature of injury are shown in Table 2 for 2003. Both air transportation and couriers and messenger subsectors have above average rates of sprains and strains.

Regarding fractures, truck transportation exceed the average for the industry while every other subsector is below the average. Five subsectors have above average rates of cuts and lacerations: scenic and sightseeing transportation (three times the average), warehousing and storage, air transportation, couriers and messengers, and support activities for transportation. Burns are a costly injury to treat.[5] Both pipeline transportation and scenic and sightseeing transportation had more than twice the rate of heat burns in the industry with truck transportation also above the industry average. Truck transportation also had more than twice the rate of chemical burns in the industry. Truck and air transportation had above average rates of amputation cases. Courier and messenger, rail transportation, and truck transportation had above average rates of multiple injuries.

Table 3. Injury Rates (per 10,000 employees) by Source of Injury or Illness in Order of Total Injuries and Illnesses, 2003

Subsector, private	Chemicals	Containers	Furniture	Machinery	Materials	Worker motion	Surfaces	Hand tools	Vehicles
Couriers & Messengers	1.4	210.7	4.2	10.2	20.7	119.2	72.5	2.6	77.8
Air	4.6	207.8	10.9	11.3	20.1	88.3	64.5	2.5	114.9
Industrywide	3.7	81.4	7.5	10.1	27.7	52.4	58.4	6.6	72
Truck	6.3	42.5	9.2	10.8	41.3	45.2	73	6.8	79.1
Warehousing & Storage	2.9	101.3	15.8	16.2	13.4	40.3	38.2	9.0	38
Ground Passenger	1.1	15.7	1.1	2.1	11.8	34.2	57.1	2.5	113.4
Support Activities	2.1	34.8	2.1	10.9	34.5	33.5	36.4	8.2	53.6
Utilities	1.1	4.1	1.6	8.8	15.1	26.9	22.8	10.6	9.5
Pipeline	-	-	-	5.1	-	10.1	-	12.7	-
Rail	-	4.9	0.9	1.8	8.9	1.8	45	11.1	19.6
Scenic & Sightseeing	-	-	-	-	11.3	-	-	-	-

Yellow indicates the transportation and warehousing average rate (excludes the utilities sector)
Red indicates those rates that exceed the industywide average
Postal Service not included because of public and not private employment
Water transportation not included because the rates were to too small

Source of Injury or Illness

Table 3 shows nine sources of injury or illness. Both truck and air transportation exceed the average injury rate resulting from chemical exposure for the transportation and warehousing sector. Containers are among the highest source of injury in this industry. Both couriers and messengers and air transportation exceed twice the injury rate associated with exposure to containers, and another subsector, warehousing and storage also has an above average rate of injury associated with exposure to containers. Both truck and air transportation had above average injury rates related to chemical exposures, and these two subsectors plus warehousing and storage (more than twice the average rate) had above average rates of injury associated with exposures to furniture. Machinery was responsible for above average rates of injury in five subsectors: warehousing and storage, air transportation, support activities, truck transportation, and couriers and messengers. Exposure to materials was responsible for above average rates of injuries in truck transportation and support activities. Worker motion contributed to above average rates of injury for couriers and messengers (more than twice the average rate) and air transportation. Surfaces contributed to above average rates for these same two subsectors as well

as for truck transportation, and vehicles were responsible for above average rates of injury for these three subsectors plus the ground passenger subsector. Handtools were associated with above average rates of injuries in six subsectors: pipeline, rail, truck, and pipeline transportation; utilities; and warehousing and storage.

Table 4. Injury Rates (per 10,000 employees) by Part of body affected:, 2003

Subsector, private	Total:	Head	Eye	Neck	Trunk	Back	Shoulder	Upper	Lower
Air	581.6	46	11.3	20.3	254.5	160.7	67.5	96.9	116.7
Couriers & Messengers	548.5	21.8	4.2	7.9	226.5	145.7	39.7	72.2	159.4
Industrywide	354.6	20.5	6.3	8.4	139.3	85.1	29.8	61.9	82.3
Truck	340.2	17.0	4.0	7.2	131.6	75.0	28.9	63.6	77.5
Warehousing & Storage	298.2	17.2	12.2	4.8	119.6	76.3	21.6	64.5	63.2
Transit	281.7	15.3	4.3	16.0	92.7	62.8	17.5	35.7	49.2
Support Activities	242.2	18.8	6.9	3.3	78.3	44.0	16.3	48.4	58.4
Rail	195.8	13.4	4.0	7.6	74.8	43.6	18.7	33.8	57.4
Scenic & Sightseeing	192.5	11.3	-	-	56.6	-	-	84.9	-
Water	183.2	-	-	-	-	-	-	-	-
Utilities	118.5	6.3	2.5	2.5	40.8	26.0	7.4	23.5	31.2
Pipeline	45.5	-	-	-	22.8	20.2	-	10.1	10.1

Yellow indicates the transportation and warehousing average rate (excludes the utilities sector)
Red indicates those rates that exceed the industywide average
Postal Service not included because of public and not private employment

Part of Body Affected

As shown in Table 4, air transportation represented above average rates of injury to all parts of the body, with couriers and messengers affected with above average rates of injury on all parts of the body except for eye and neck. However, along with air transportation, warehousing and storage and support activities had above average rates of injury to the eye, and the transit subsector experienced above average injuries to the neck. In addition to air transportation and couriers and messengers, truck transportation exceeded the average rate of injuries to the shoulder, and scenic and sightseeing, warehousing and storage, and truck transportation exceeded the average rate of injury to the upper extremities.

Illness Rates

As shown in Table 5, four subsectors–couriers and messengers (three times the average), utilities (two times the average), air transportation, and warehousing and storage–exceeded the average rate of illness for the transportation and warehousing sector. Utilities has a near order of magnitude higher rate of skin illnesses than the transportation and warehousing sector with warehousing and storage and support activities subsectors experiencing above average rates of this illness. Both water and transit and ground transportation have four time the average rate of respiratory illness with utilities and support activities also experiencing more than the average rate of this illness. Above average rates of poisoning were experienced in the air and truck transportation sectors. Above average levels of hearing loss were experienced in five subsectors: utilities, air and rail transportation, couriers and messengers, and support activities.

Table 5. Illness Rates per 10,000 Employees in the Transportation, Warehousing, and Utility Sectors, 2004

Private Subsector	Total	skin	respiratory	poisonings	hearing loss	other
Couriers & Messengers	78.1	0.5	0.7		5.5	71.3
Utilities	59.6	22.6	2.2		18.1	16.6
Air	47.3	0.8	1.9	0.6	11.4	32.6
Warehousing & Storage	37.7	2.4	0.5	0.4	0.9	33.4
Industry-wide	*26.3*	*1.2*	*1.8*	*0.4*	*2.8*	*20.1*
Pipeline	25					6.9
Water	19.2		8.8			6.5
Transit & Ground Passenger	19.1	0.6	7.7			10.2
Support Activities	15.7	1.9	3.1		3.5	6.9
Scenic & Sightseeing	10.7					6.2
Rail	9.9				6.2	3.2
Truck	9.2	1	0.9	0.5		6.8

Yellow indicates the transportation and warehousing average rate (excludes the utilities sector)
Red indicates those rates that exceed the industywide average
Postal Service not included because of public and not private employment

3. What research is needed?

Incident Response

An imperative for PPE research is a mandate from the Congress, which stated, "It has been brought to the Committee's attention the need for design, testing and state-of-the-art equipment for this nation's... miners, firefighters, health care, agricultural and industrial workers... (Also) the Committee encourages NIOSH to carry out research, testing and related activities aimed at protecting workers who respond to public health needs in the event of a terrorist incident. The Committee encourages CDC to organize and implement a national personal protective equipment laboratory."

Acts of Violence

PPE needs to be considered as the last line of defense against injury resulting from acts of violence. The second leading cause of death among U.S. Postal Service workers is homicide. In addition, attacks with anthrax through the mail presented a new and deadly health threat to postal workers, government employees, and news media offices in October 2001.[6] Moreover, aircraft workers were victims of homicide as the terrorists commandeered four aircraft in the September 11, 2001 attack. Taxi cab drivers are among the highest rates and major victims of violence, which is associated with several risk factors for workplace violence:[7]

- Contact with the public
- Exchange of money
- Delivery of passengers, goods, or services
- Having a mobile workplace
- Working alone or in small numbers
- Working late at night or during early morning hours
- Working in high-crime areas

Surveillance

There is a need to identify and prioritize transportation, warehousing, and utilities technologies for PPE research. More detailed investigations through surveillance methods are needed to identify and prioritize manufacturing technologies for research. These investigations include disaggregating the high risk areas in transportation, warehousing, and utilities by the various conditions indicated in Tables 2-5 further to gain better detail regarding the population at risk. The high rates of sprains and strains as shown in Table 2 presents a unique challenge for PPE research. Also, of particular interest is understanding further the high rates of "other" illnesses as shown in Table 5.

PPE interventions can be identified by conducting case studies of investigation reports by OSHA and by NIOSH in their Health Hazard Evaluations (HHE's) and Fatality Assessment and Control Evaluation (FACE) Programs. In addition, National Transportation Safety Board and U.S. Coast Guard investigation reports are resources available for identifying PPE needs. OSHA provides a rich source of recorded injuries that could be prevented with the use of PPE. As an example, an truck driver from an export/import consolidation center trucking company arrived at an intermodal yard to pick up a container transport chassis. While loading, he was pinned by the chassis and killed.[8]

An example of an HHE is an investigation of sanitation workers exposed to noise. An investigation of 160 exposed employees potentially exposed to noise from pumps, compressors, vacuum trucks used to clear sewer lines, and construction equipment used to maintain and install sewer lines found excessive noise exposure.[9] The NIOSH FACE program investigates occupational fatalities, many of which could be prevented by the use of functional PPE. A summary of these reports related to electrical contact injuries found the need to insulate and isolate workers from electrical energy and ensure that proper PPE is available and worn by workers (including fall protection equipment).[10]

National Transportation Safety Board investigation reports and studies provide potential sources for identifying PPE needs related to transportation. The reports and studies fall into one of five categories: aviation, highway, marine, pipeline, hazardous chemicals, and railroad.[11] One recent report indicated the Board's need for better surveillance systems to identify risk factors related to transportation incidents.[12] U.S. Coast Guard produces investigation reports of marine casualties. In one small passenger vessel sinking, the Coast Guard reported on the hazard of PPE in protecting the operator and passengers. When the sinking incident was discovered, the donning of life preservers would have prevented escape from under a canopy and resulted in more deaths.[13]

Technology Assessments

A need exists to identify research gaps while iteratively analyzing technologies so that critical PPE needs with a standards perspective can be filled via research agendas for existing as well as specific new technologies. The scientific literature indicates a need to examine needs related to spills and fire regarding natural gas,[14, 15] transportation,[16] and radioactive materials.[17] Furthermore, sewer and water supply work present unique exposures such as to leptospirosis contamination,[18] hepatitis A[19] and C,[20] chlorinated products,[21] and toxic gases.[22] Confined

spaces are also a hazard in utility work including exposures related to septic tanks, sewage digesters, boilers, pumping/lift stations, pipelines, sewage distributions, and utility vaults.[23, 24]

Literature also indicates an array of problems in electric utility work that could be addressed with PPE. These problems include injuries,[25] magnetic fields,[26] solar radiation,[27] electrical contact,[28] ionizing radiation,[29] and benzene exposure.[30]

In addition problems have also been reported regarding transport and warehouse work. These include noise,[31, 32] diesel exhaust,[33] assault,[34] sleep deprivation,[35] asbestos,[36] injuries,[37, 38, 39, 40] cold,[41] and respiratory symptoms/cancer.[42, 43] Moreover, marine transport work has been associated with the problems of drowning, injuries, poisonings, and violence. [44] Not only protection from the initial hazard of aircraft crashes such as non-restraints is important, but survival after a crash is of concern regarding postcrash fire and cold.[45, 46]

Intervention Research

A need also exists for developing PPE interventions to address the gaps and develop efforts for broad adoption of successful PPE interventions in targeted transportation, warehousing, and utilities technologies. Injuries and illnesses in the air transportation subsector are prominent by their across-the-board high rates, and a special study of this industry appears warranted. In addition, high rates of injuries in the couriers and messengers subsector also indicate the need for more detailed investigation into the application of PPE. Table 6 shows the principle needs for intervention research for the four subsectors that have the highest rates of private employment injury and illness. It also includes truck transportation, which has a high frequency of occupational fatalities.

Table 6. Leading Subsectors Regarding Injuries and Illnesses

Subsector	Injury and Illness Problems
Air Transportation	► Highest rate of days away from work because of injury ► High injury rate to all body parts: head (eyes, neck), trunk, back shoulder, upper and lower extremities ► High illness rate for poisoning, hearing loss, and “other”
Couriers and Messengers	► Second highest rate of days away from work because of injury ► High injury rate to head, trunk, back shoulder, upper and lower extremities ► High illness rate for hearing loss and “other”
Warehousing and Storage	► Fourth highest rate of days away from work because of injury ► High injury rate to the eye and upper extremities ► High illness rate to the skin and “other”
Utilities	► Only sector to increase in injury frequency in 2004; attributed to natural gas distribution, which increased from 4.8 to 7.3 injuries per 100 workers ► High illness rate to the skin, respiratory tract, and hearing
Truck Transportation	► Third highest rate of days away from work because of injury ► Highest frequency of fatalities ► High injury rate to the shoulder and upper extremities ► High illness rate for poisoning

PPE Program Effectiveness

Many of the injuries and illnesses in the transportation, warehousing, and utility sectors could be prevented through an effective PPE program. Thus, not only the improvement of PPE is

important, but the use and maintenance of PPE is also important. PPE programs need to be improved including appropriate training of workers in PPE use and maintenance.

4. Who are our partners?

PPE Manufacturing Industry

The International Safety Equipment Association represents the safety equipment manufacturing industry and promotes and the increased use and awareness of PPE. Members of the association include companies that design, manufacture and supply safety equipment that is used in hazardous work environments. It also drafts national and international safety equipment performance standards, provides a forum for discussing industry issues such as non-proprietary technologies and e-commerce, and represents the industry's interests before governmental agencies. The Best's Safety & Security Directory also provides a large compilation of PPE manufacturing and distribution companies,[47] which is a source for potential collaboration in specialty areas.

Professional and Standard-setting Organizations

Professional organizations also provide viable partners in PPE research. These include the, American Conference of Governmental Industrial Hygienists, American Industrial Hygiene Association, and American Society of Safety Engineers. Standard-setting organizations include the American National Standards Institute, American Society of Testing Materials, European Committee for Standardization, International Organization for Standardization, National Fire Protection Association, and Standards Council of Canada. Several PPE–including those adopted by governmental organizations–standards that apply to transportation, warehousing, and utility industry workers are listed in Appendix 2.

Table 7. List of Unions that Represent Transportation, Warehousing, and Utility Workers

Air Line Pilots Association
American Federation of Government Employees
American Federation of State, County and Municipal Employees
American Postal Workers Union
American Train Dispatchers Department
Brotherhood of Locomotive Engineers
Brotherhood of Railroad Signalmen
Communication Workers of America
Flight Attendants Association
International Association of Machinists
International Brotherhood of Teamsters
International Longshore and Warehouse Union
International Longshoremen's Association
Marine Engineers' Beneficial Association
National Air Traffic Controllers Association
National Association of Letter Carriers
National Postal Mail Handlers Union
National Rural Letter Carriers Association
Professional Airways Systems Specialists
Sailors' Union of the Pacific
Seafarers International Union of North America
Transport Workers Union of America
Transportation Communications International Union
United Transportation Union
Utility Workers Union of America

Transportation Trade Organizations and Unions

A plethora of unions represent workers in the transportation, warehousing, and utility sectors, as shown in Table 7. Opportunities exist to work with the unions in training their members and apprentices through their programs. An example of a specialty training organization is the Alaska Marine Safety Education Association that supports a cold water safety information and training

network on all four U.S. coastlines.[48] Its education and training is based on practical information involving PPE survival equipment.

Industry associations include the International Transportation Management Association that addresses shipping logistics and international shipping transportation, and the Air Transport Association that convenes an annual conference on Human Factors, Maintenance, and Ramp Safety. The North American Transportation Association provides occupational accident insurance and programs for the trucking and transportation fleets including independent owner operators. Some other associations among many include the American Bus Association, Association of American Railroads, International Air Transport Association, the International Warehouse Logistics Association, American Gas Association, and the National Rural Water Association.

Governmental Agencies

OSHA has jurisdiction over off-highway loading and unloading, such as warehouses, plants, grain handling facilities, retail locations, marine terminals, wharves, piers, and shipyards, whereas the Department of Transportation (DOT) regulates driving over public highways and the health and safety of drivers. DOT has jurisdiction over interstate commerce while OSHA has jurisdiction over intrastate commerce except when handling hazardous materials. The Federal Aviation Administration (FAA) regulates flight crews and some other aspects of the safety of ground crews. If there is a clause that covers a working condition in an operational plan negotiated between the carrier and the FAA, the FAA has jurisdiction over that working condition. Otherwise, OSHA covers most of the working conditions of ground crews and baggage handlers. The FAA's Civil Aerospace Medical Institute carries out medical certification, research, and education. Its principal concern is the human element in flight: pilots, passengers, air traffic controllers, and the entire human support system that embraces civil aviation. The Federal Railroad Administration (FRA) within DOT promulgates and enforces rail safety regulations and conducts research and development in support of improved railroad safety. OSHA maintains a partnership with the International Warehouse Logistics Association, which could be built upon.

The National Transportation Safety Board (NTSB) and, within DOT, the FAA, Federal Highway Administration**,** Federal Motor Carrier Safety Administration, FRA, Federal Transit Administration, Maritime Administration, Pipeline and Hazardous Materials Safety Administration, and National Highway Traffic Safety Administration are all potential partners in the PPE strategy. Indeed, many of these agencies depend upon PPE to protect workers in the transportation industry.

U.S. Department of Homeland Security's Transportation Security Administration protects the nation's transportation systems to ensure freedom of movement for people and commerce. The U.S. Coast Guard–located in the Department of Homeland Security–is a maritime service, and its mission is to protect the public, including the workforce, in the nation's ports and waterways, along the coast, and on international waters. The U.S. Postal Service is another potential partner in PPE research.

5. How can we make a difference?

Emergency Preparedness

The attacks of September 11, 2001 have demonstrated the need for improved PPE. improvements are needed in PPE ensembles, guidelines, and effective delivery systems of equipment. There is also a need for quick access to expert information regarding complex emergencies.[49] Communications are an important adjunct to the PPE ensemble as well.

First Decade NORA Priorities

An original NORA priority addressed chemical protective clothing, noise, respirators, and eye safety. NIOSH's Protective Clothing Program is aimed at protecting the skin from various health hazards that may be encountered in the workplace or during a terrorist attack. The program has evolved over the years to incorporate a broad range of studies of how chemicals seep through barrier materials, leak through small holes, or change the barrier material to reduce its protection.

Noise-induced hearing loss is 100 percent preventable but once acquired, hearing loss is permanent and irreversible. Non-linear hearing protectors (NLHPs) have been developed to provide improved communication and ability to hear warning signals while protecting workers from hazardous noise. However, the existing American and international standards for testing linear hearing protectors cannot address the performance and effectiveness of nonlinear (level dependent and active noise cancellation) devices. NIOSH is developing standardized laboratory test methods for acoustic and psycho-acoustic assessment of NLHPs, which addresses the shortcomings of current ANSI and ISO standards.

Respirators protect the user in two basic ways. The first is by the removal of contaminants from the air. Respirators of this type include particulate respirators, which filter out airborne particles; and "gas masks" which filter out chemicals and gases. Other respirators protect by supplying clean respirable air from another source. Respirators that fall into this category include airline respirators, which use compressed air from a remote source; and self-contained breathing apparatus, which include their own air supply

Personal protective eyewear, such as goggles, face shields, safety glasses, or full face respirators must also be used when an eye hazard exists. The eye protection chosen for specific work situations depends upon the nature and extent of the hazard, the circumstances of exposure, other protective equipment used, and personal vision needs. Eye protection should be fit to an individual or adjustable to provide appropriate coverage. It should be comfortable and allow for sufficient peripheral vision. Selection of protective eyewear appropriate for a given task should be made based on a hazard assessment of each activity, including regulatory requirements when applicable.

PPE Program Design

A PPE program must be comprehensive. Training to respond to emergencies requires planning and evaluation. PPE is critical is part of this response. Common emergencies include fires, medical emergencies, HazMat releases, special rescues (e.g., confined space), workplace violence, bomb threats, external emergencies, weather and power failure.[50] Safety signs have

been found to be ineffective in encouraging the donning of PPE.[51] Failures or deficiencies in hearing conservation programs can often be traced to inadequacies in the training and education of noise-exposed employees and those who conduct elements of the program. A good PPE program consists of several elements:

- workplace survey
- selection of appropriate controls
- selection of appropriate PPE
- consider new applications, e.g., restraint systems, protection from violence, sleep monitors with wake-up feedback, musculoskeletal protection (sprains and strains)
- new or improved PPE and ensemble designs
- fitting
- training
- management support
- maintenance
- auditing of the program

Research Plan

In addition to the above assessment, an important aspect of this *Research Plan* is to provide a framework for future U.S. Government planning efforts that is consistent with *The National Security Strategy* and the *National Strategy for Homeland Security*. It recognizes that preparing for and responding to emergencies cannot be viewed as a purely federal responsibility, and that the nation must have a system of plans at all levels of government and in all sectors outside of government that can be integrated to address the threat of emergencies whether small or catastrophic. It is guided by the following principles:

● Engineering control or inherently safer systems should be used to negate the need for PPE. PPE should only be used as a "last line of defense" when engineering control systems or hazard elimination are not feasible.
● Employers should have credible preparedness plans to respond to PPE needs within their workplaces. Individual workers should be prepared for the use of PPE and be trained in the use of PPE for their particular working conditions.
● The private sector should play an integral role in PPE research and development and should be part of national deployment of PPE technologies.
● Partnerships will be leveraged to address the threat of uncontrolled hazards, especially the threat of terrorist attacks or natural disasters.
● Three criteria are important in assessing the need for PPE research:
  ► Frequency of the occupational safety and health problem.
  ► Severity of the occupational safety and health problem.
  ► The preventability of the problem with PPE.

The *Research Plan* addresses the full spectrum of the transportation, warehousing, and utilities sectors with physical facilities, labor forces, and equipment spread across large geographical areas ranging from city to world-wide. While the circumstances of these environments are very different, our strategic principles remain relevant. Four pillars of the *Research Plan* are described below:

Pillar 1. Surveillance

Occupational health surveillance can be viewed as tracking occupational injuries, illnesses, hazards, and exposures. Occupational surveillance data are used to guide efforts to improve worker safety and health, and to monitor trends and progress over time. This effort will analyze and interpret existing data, undertakes data collection efforts to fill gaps in surveillance data, provides support to state agencies to conduct occupational surveillance and associated prevention efforts, and works with Federal, State, and private sector partners to improve occupational health surveillance.

Goal: To set priorities for further surveillance and research.

Priorities under this goal include:

■ ***Investigate high risk subsectors and populations for injuries and illnesses that can be prevented with PPE.***

■ ***This surveillance effort involves the review and monitoring of HHEs, FACE, and OSHA as well as NTSB inspection reports regarding transportation, warehousing, and utilities to identify the circumstances of severe injuries and illnesses that PPE could prevent; and PPE failures to protect workers.***

■ ***The emergence of new technologies need to be evaluated for both potential hazards as well as use in PPE.***

Pillar 2. Standardization and Certification

NIOSH is developing appropriate standards and test procedures for PPE used to protect workers in hazardous environments. This development work includes the validation of performance-based PPE specifications including shelf life. Concepts, standards (when fully developed), and other documents will be posted when they become available. This development work involves international collaboration in PPE standards as well as with partners from government and industry.

Goal: To develop and validate performance-based specifications and standards for PPE.

Goal: To establish voluntary standards or 42 CFR certification programs for PPE.

One priority under this goal includes:

■ ***NIOSH issues recommendations for respirator use. Industrial type approvals are in accordance to the NIOSH federal respiratory regulations 42 CFR Part 84.***

Pillar 3. Product Development and Evaluation

PPE such as respirators and protective clothing can be used to isolate workers from the hazard. PPE must not only be effective, but also practical for use. Microsensing devices assess workers' exposure to environmental contaminants, notify workers before chemicals break through protective clothing, and identify failures in containment systems for hazardous materials. New materials in clothing would improve the protection of workers from burns, explosions, and hazardous chemicals. In addition to field surveys of chemical protective clothing (CPC) performance, studies need to examine ways to detect when chemicals have gotten inside CPC, and how to effectively remove chemicals from protective clothing after it has been contaminated. PPE research includes literature searches and data gathering, laboratory and field studies, and materials, filter/cartridge, shelf-life and design evaluations.

Goal: To incorporate advanced protective technologies into fully-integrated, intelligent, and reliable ensembles.

Goal: To collaborate with partners in the development of PPE to protect workers from high risk, frequency, and/or severity hazards.

Priorities under this goal include:

■ ***Continuation of ongoing research, e.g., hearing protectors, respirators, protective clothing, eye protection.***

■ ***Investigation and evaluation of PPE emerging into the marketplace, e.g., personal detection monitors, EM radiation protection, crash survival, fall-dampening devices, personal restraints.***

Pillar 4. Education, Training, and Feedback

The purpose of training and training-related research is to understand and act on the multiple factors influencing occupational education and training effectiveness. NIOSH evaluates the impact of training programs and their components by investigating theoretical models gleaned from health promotion, psychology, learning and educational perspectives, the role of attitudes, beliefs, behavioral intentions, and other characteristics of the individual that affect learning and transfer of learning into action, barriers affecting adoption of health and safety behaviors promoted by training, and environmental influences on occupational safety and health training.

Goal: To improve and implement PPE training programs, guidelines, and products for optimum use and acceptance by workers.

Appendix 1: Transportation Subsector Descriptions

481 Air Transportation: The air transportation subsector transports passengers and/or cargo using aircraft, such as airplanes and helicopters, which includes scheduled and nonscheduled transportation. Scheduled air carriers fly regular routes on regular schedules and operate even if flights are only partially loaded. Nonscheduled carriers often operate during nonpeak time slots at busy airports. These establishments have more flexibility with respect to choice of airport, hours of operation, load factors, and similar operational characteristics. Nonscheduled carriers provide chartered air transportation of passengers, cargo, or specialty flying services. Specialty flying services establishments use general-purpose aircraft to provide a variety of specialized flying services.

482 Rail Transportation: The rail transportation subsector transports passengers and/or cargo using railroad rolling stock. Railroads either operate on networks, with physical facilities, labor force, and equipment spread over an extensive geographic area, or operate over a short distance on a local rail line.

483 Water Transportation: The water transportation subsector transports passengers and cargo using water craft, such as ships, barges, and boats. It is composed of two industry groups: (1) one for deep sea, coastal, and Great Lakes; and (2) one for inland water transportation. This split typically reflects the difference in equipment used.

484 Truck Transportation: The truck transportation subsector provides over-the-road transport of cargo using motor vehicles, such as trucks and tractor trailers. The subsector is subdivided into general and specialized freight trucking. This distinction reflects differences in equipment used, type of load carried, scheduling, terminal, and other networking services. General freight transportation establishments handle a wide variety of general commodities, generally palletized, and transported in a container or van trailer. Specialized freight transportation is the transportation of cargo that, because of size, weight, shape, or other inherent characteristics require specialized equipment for transportation. Each of these industry groups is further subdivided based on distance traveled. Local trucking establishments primarily carry goods within a single metropolitan area and its adjacent nonurban areas. Long distance trucking establishments carry goods between metropolitan areas.

485 Transit and Ground Passenger Transportation: The transit and ground passenger transportation subsector includes a variety of passenger transportation activities, such as urban transit systems; chartered bus, school bus, and interurban bus transportation; and taxis. These activities are distinguished based primarily on such production process factors as vehicle types, routes, and schedules. In this subsector, the principal splits identify scheduled transportation as separate from nonscheduled transportation. The scheduled transportation industry groups are urban transit systems, interurban and rural bus transportation, and school and employee bus transportation. The nonscheduled industry groups are the charter bus industry and taxi and limousine service. The other transit and ground passenger transportation industry group includes both scheduled and nonscheduled transportation.

486 Pipeline Transportation: The pipeline transportation subsector uses transmission pipelines to transport products such as crude oil, natural gas, refined petroleum products, and slurry. This subsector includes the storage of natural gas because the storage is usually done by the pipeline establishment and because a pipeline is inherently a network in which all the nodes are interdependent.

487 Scenic and Sightseeing Transportation: The scenic and sightseeing transportation subsector utilizes transportation equipment to provide recreation and entertainment. These activities have a production process distinct from passenger transportation carried out for the purpose of other types of for-hire transportation. This process does not emphasize efficient transportation; in fact, such activities often use obsolete vehicles like steam trains, to provide some extra ambience. The activity is local in nature, usually involving a same-day return to the point of departure. The scenic and sightseeing transportation subsector is separated into three industries based on the mode: land, water, and other.

488 Support Activities for Transportation: The support activities for the transportation subsector provides services in support of transportation and may be provided to transportation carrier establishments or to the general public. This subsector includes a wide array of establishments, including air traffic control services, marine cargo handling, and motor vehicle towing. It includes services to transportation but is separated by type of mode serviced. The Support Activities for Rail Transportation industry includes services to the rail industry (e.g., railroad switching and terminal establishments). Ship repair and maintenance not done in a shipyard are included in other support activities for water transportation. An example would be floating drydock services in a harbor.

491 Postal Service: The postal service subsector includes the activities of the National Postal Service and its subcontractors in delivering letters and small parcels, normally without pick-up at the sender's location. Sorting and transportation activities, where necessary, are generally mechanized. The restriction to small parcels distinguishes these establishments from those in the transportation industries. Subcontractors include rural Post Offices on contract to the Postal Service. Bulk transportation of mail on contract to the Postal Service is not included here, because it is usually done by transportation establishments that carry other customers' cargo as well.

492 Couriers and Messengers: The couriers and messengers subsector provides intercity and/or local delivery of parcels. These articles can be described as those that may be handled by one person without using special equipment. This allows the collection, pick-up, and delivery operations to be done with limited labor costs and minimal equipment. Sorting and transportation activities, where necessary, are generally mechanized. The restriction to small parcels partly distinguishes these establishments from those in the transportation industries. This subsector includes both complete networks of courier services establishments also distinguishes these transportation services—which includes intercity transportation as well as establishments that, under contract to them—perform local pick-up and delivery and messengers that usually deliver within a metropolitan or single urban area, may use bicycle, foot, small truck, or van.

493 Warehousing and Storage: The warehousing and storage subsector is engaged in operating warehousing and storage facilities—including bonded warehousing in free trade zones—for general merchandise, refrigerated goods, and other warehouse products. These establishments take responsibility for storing and securing the goods. They do not sell the goods they handle. They may also provide a range of logistics services related to the distribution of goods, which includes labeling, breaking bulk, inventory control and management, light assembly, order entry and fulfillment, packaging, pick and pack, price marking and ticketing, and transportation arrangement.

221 Utilities: The utilities sector comprises establishments engaged in the provision of the following utility services: electric power, natural gas, steam supply, water supply, and sewage removal. Within this sector, the specific activities associated with the utility services provided vary by utility: electric power includes generation, transmission, and distribution; natural gas includes distribution; steam supply includes provision and/or distribution; water supply includes treatment and distribution; and sewage removal includes collection, treatment, and disposal of waste through sewer systems and sewage treatment facilities.

Appendix 2: Applicable Standards and Standards Setting Organizations

U.S. Department of Human Services

NIOSH

42 CFR Part 84, Approval of respiratory protective devices

Outer Continental Shelf Lands Act, Section 208(e) "conduct studies of underwater diving techniques and equipment"

NIEHS

42 CFR Part 65, National Institute of Environmental Health Sciences Hazardous Waste Worker Training

U.S. Department of Labor (DOL)

Occupational Safety and Health Administration

29 CFR 1910 – Occupational Safety and Health Standards

- 1910.95 – Hearing Protection
- Subpart I – Personal Protective Equipment
- 1910.132 – General requirements
- 1910.133 – Eye and face protection
- 1910.134 – Respiratory protection
- 1910.135 – Head protection
- 1919.137 – Electrical protective devices
- 1910.136 – Foot protection
- 1910.138 – Hand protection
- 1910.137, 335 – Electrical workers' clothing and equipment
- 1910.146 App D – Confined Space Pre-Entry Check List
- 1910.146 App E – Sewer System Entry
- 1910.146 App F – Rescue Team or Rescue Service Evaluation Criteria

29 CFR 1917 Marine Terminals, Personal Protection

- 1917.91 – Eye and face protection
- 1917.92 – Respiratory protection
- 1917.93 – Head protection
- 1917.94 – Foot protection
- 1917.95 – Other protective measures

29 CFR 1918 Subpart J Safety and Health Regulations for Longshoring, Personal Protection

- 1918.91 – Eye and face protection
- 1918.92 – Respiratory protection
- 1918.93 – Head protection
- 1918.94 – Foot protection
- 1918.95 – Other protective measures

U.S. Coast Guard

- Vessel Safety Manual

46 CFR Shipping

- 25.25 – Life Preservers and Other Lifesaving Equipment
- 25.26 – Emergency Position Indicating Radio Beacons (EPIRB)
- 35.30-20 – Emergency equipment
- 35.40-20 – Emergency equipment
- 78.36 – Work Vests

78.47-27 – Self-contained breathing apparatus
77.30 – Emergency Equipment
77.35 – Fireman's Outfit
97.34 – Work Vests
97.37-20 – Self-contained breathing apparatus
154.1400 – Safety equipment: All vessels
154.1405 – Respiratory protection
154.1840 – Protective clothing
154.1852 – Air breathing equipment
160 – Lifesaving Equipment
185.728 – Testing and servicing of Emergency Position Indicating Radiobeacons (EPIRB).
185.730 – Servicing of inflatable liferafts, inflatable buoyant apparatus, inflatable life jackets, and inflated rescue boats
196.34 – Work Vests
196.37-20 – Self-contained breathing apparatus and gas masks
197.1 – Subpart B—Commercial Diving Operations
197.550 – Respiratory protection (benzene)
197.555 – Personal protective clothing and equipment (benzene)
Appendix E to Subpart C of Part 197—Respirator Fit Tests (benzene)

U.S. Department of Transportation

49 CFR 172 Research and Special Programs Administration
172.702 Applicability and responsibility for training and testing
193 Liquefied Natural Gas Facilities: Federal Safety Standards
193.2511 Personnel safety
193.2717 Training: fire protection
214 Railway Workplace Safety
214.103 Fall protection, generally
214.105 Fall protection systems standards and practices
214.107 Working over or adjacent to water
214.111 Personal protective equipment, generally
214.113 Head protection
214.115 Foot protection
214.117 Eye and face protection

49 CFR 399 Motor Carrier Safety, Employee Safety and Health Standards
49 CFR 571.218 Motorcycle helmets
399.207 Truck and truck tractor access requirements

U.S. Environmental Protection Agency

40 CFR 211 Hearing protector label requirements

American National Standards Institute

ANSI Z88.7-2001, Color Coding of Air-Purifying Respirator Canisters, Cartridges, and Filters
ANSI Z88.10-2001, Respirator Fit Testing Methods
ANSI Z 88.2-1969, Standard Practice for Respirator Protection
ANSI Z90.1-1971, Helmets
ANSI Z41.1-1991, Protective Footwear
ANSI S12.6-1997, Methods for Measuring the Real-Ear Attenuation of Hearing Protectors

ANSI Z87.1-2003, Standard for Occupational and Educational Eye and Face Protection Devices
ANSI Z359.1-1992, Safety Requirements for Personal Fall Arrest Systems, Sub-Systems and Components
ANSI Z89.1, Safety Requirements for Industrial Head Protection
ANSI Z89.2, Safety Requirements for Industrial Protective Helmets for Electrical Workers
ANSI J6.6-1971, Rubber Insulating Gloves
ANSI/ASSE Z359.1 Safety Requirements for Personal Fall Arrest Systems

American Society for Testing Materials

ASTM F23 Protective Clothing

International Organization for Standardization

ISO 13.260 Protection against electric shock. Live working Including tools for working with voltages
ISO 13.280 Radiation protection Including protection against radio-frequency radiation
ISO 13.340.01 Protective equipment in general
ISO 13.340.10 Protective clothing, including flameproof clothing
ISO 13.340.20 Head protective equipment, including helmets, eye-protectors, hearing protectors, ear muffs, teeth protectors and hoods.
ISO 13.340.30 Respiratory protective devices
ISO 13.340.40 Hand and arm protection, Including protective gloves, sleeves and mits
ISO 13.340.50 Leg and foot protection, Including safety boots and shoes
ISO 13.340.60 Protection against falling and slipping, including safety ropes, harnesses and fall arrestors
ISO 13.340.70 Lifejackets, buoyancy aids and flotation devices
ISO 13.340.99 Other protective equipment
ISO 3873:1977 Industrial safety helmets
ISO 4007:1977 Personal eye-protectors, Vocabulary
ISO 4849:1981 Personal eye-protectors, Specifications
ISO 4850:1979 Personal eye-protectors for welding and related techniques, Filters, Utilization and transmittance requirements
ISO 4851:1979 Personal eye-protectors, Ultra-violet filters, Utilization and transmittance requirements
ISO 4852:1978 Personal eye-protectors, Infra-red filters, Utilization and transmittance requirements
ISO 4854:1981 Personal eye-protectors, Optical test methods
ISO 4855:1981 Personal eye-protectors, Non-optical test methods
ISO 4856:1982 Personal eye-protectors, Synoptic tables of requirements for oculars and eye-protectors
ISO 4869-1:1990 Acoustics, Hearing protectors, Part 1: Subjective method for the measurement of sound attenuation
ISO 4869-2:1994 Acoustics, Hearing protectors, Part 2: Estimation of effective A-weighted sound pressure levels when hearing protectors are worn
ISO/TR 4869-3:1989 Acoustics, Hearing protectors, Part 3: Simplified method for the measurement of insertion loss of ear-muff type protectors for quality inspection purposes
ISO/TR 4869-4:1998 Acoustics, Hearing protectors, Part 4: Measurement of effective sound pressure levels for level-dependent sound-restoration ear-muffs
ISO 6161:1981Personal eye-protectors, Filters and eye-protectors against laser radiation

ISO 8194:1987Radiation protection, Clothing for protection against radioactive contamination, Design, selection, testing and use

ISO/CD 2801 Clothing for protection against heat and flame -- General recommendations for selection, care and use of protective clothing

ISO/FDIS 11611 Protective clothing for use in welding and allied processes

ISO/FDIS 11612 Protective clothing -- Clothing to protect against heat and flame

ISO/DIS 13506.3 Protective clothing against heat and flame -- Test method for complete garments -- Prediction of burn injury using an instrumented manikin

ISO/FDIS 14116 Protective clothing -- Protection against heat and flame -- Limited flame spread materials, material assemblies and clothing

ISO/DIS 16602.3 Protective clothing for protection against chemicals -- Classification, labeling and performance requirements

ISO/CD 17491-1 Protective clothing -- Test methods for clothing providing protection against chemicals -- Part 1: Determination of resistance to outward leakage of gases (internal pressure test)

ISO/CD 17491-2 Protective clothing -- Test methods for clothing providing protection against chemicals -- Part 2: Determination of resistance to inward leakage of aerosols and gases (inward leakage test)

ISO/AWI 17491-3 Protective clothing -- Test methods for clothing providing protection against chemicals -- Part 3: Determination of resistance to penetration by a jet of liquid (jet test)

ISO/AWI 17491-4 Protective clothing -- Test methods for clothing providing protection against chemicals -- Part 4: Determination of resistance to penetration by a spray of liquid (spray test)

ISO/AWI TR 26061 Guidelines on the selection, use, care and maintenance of protective clothing

American Conference of Governmental Industrial Hygienists

Guidelines for Selection of Chemical Protective Clothing, 1987

National Fire Protection Association

NFPA 70E: Electrical Safety in the Workplace

Institute of Electrical and Electronic Engineers

National Electrical Safety Code[52]

Snell Memorial Foundation

B-90A 1998 Augmentation to the 1990 Standard for Protective Headgear

B-90 1995 Standard for Protective Headgear for Use with Bicycles

B-95a 1998 Addendum to the 1995 Standard for Protective Headgear for Use with Bicycles

M200 2000 Standard For Protective Headgear for Use with Motorcycles and Other Motorized Vehicles

M2005 2005 Standard for Protective Headgear for Use with Motorcycles and Other Motorized Vehicles

U.S. Department of the Interior

Aviation management aircraft rental agreement provisions: supplement no. 1 special use - helicopter class a, b and c external load including long line

B8.1.3.3 Personal Protective Equipment (PPE)

B8.1.3.3.1 An aviator's flight helmet

B8.1.3.3.2 A long-sleeved shirt and trousers (or long-sleeved flight suit) made of fire-resistant polyamide or aramid material or equal

B8.1.3.3.3 Boots made of all-leather uppers which extend above the ankles
B8.1.3.3.4 Gloves made of leather, fire-resistant polyamide or aramid material
B8.1.3.3.5 Shirt with sleeves overlapping gloves and pants with legs overlapping boots

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