

# **National Strategy for Personal Protective Technologies Research for the Services Sectors**

**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 Services Sectors

*“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; 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.<sup>1</sup> 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 mission of NPPTL 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

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<sup>1</sup> *Senate Rpt. 106-293 Departments of Labor, Health and Human Services, and Education and Related Agencies Appropriation Bill, 2001 Filed Under Authority of the Order of the Senate January 6, 1999,*

protective technology standards. NPPTL programs address PPE science and technology investigation, performance criteria, test methods, certification standards.

The services sectors include the subsectors shown in Table 1. A large portion of service workers are employed in office environments yet many others work with an array of recognized hazards. The services sectors comprise establishments that range from banks and other financial institutions to automotive repair and fast food service restaurants. In 2005, this sector employed less than one-half of the working population over 16 years of age in the United States

**Table 1. Sectors by NAICS Sectors That Make Up the NIOSH Services Sector.**

<b>NAICS</b>	<b>Sector</b>	<b>Industries within NAICS Group</b>
51	Information	Libraries, publishing, sound and movie recording, wired and wireless communications
52	Finance and Insurance	Depository and non-depository credit, insurance, brokerages
53	Real Estate, Rental, Leasing	Real estate brokerages, facility leasing and rental, real estate management, consumer products and equipment rental
54	Professional, Scientific and Technical	Drafting and design, law offices, accounting, direct mail, marketing and public relations, survey and mapping, veterinary medicine, engineering, laboratories, consulting
55	Management of Corporations and Entities	Corporate, subsidiary, and regional offices, bank holding companies
56	Administrative Support and Waste Management	Office, business and facility support, building services, travel reservations, investigation, waste collection, treatment and disposal, employment services
61	Education	Primary and secondary schools, technical and other colleges, universities, professional schools , educational support
71	Arts, Entertainment and Recreations	Performing arts, spectator sports, museums, zoos, botanical gardens, amusement parks, gambling industries, historic sites, and nature sites
72	Accommodations and Food Services	Hotels and motels, RV parks, boarding houses, restaurants, catering, drinking establishments
81	Other Services	Automobile and machine servicing and repair, giving organizations, religious organizations, social clubs, business, professional, labor, political and trade organizations, personal care, laundries, private households
92	Public Administration	Local, state, and federal governments excluding members of the military

Today's global economy requires businesses to be flexible in their responses to demands of consumers and producers, and to be prepared to respond 24 hours a day, 7 days a week. For workers, the "just-in-time" business model can mean increased stress, more shift work, and intense production demands that can compromise worker safety and health. More workers are choosing to stay employed due to financial needs such as health care insurance. Additional occupational health and safety needs may emerge for older workers. Increasingly, workers in the United States may not use English as their primary language, presenting challenges to safety and health programs, especially in training materials. Electronic technology is increasingly allowing work to be completed at locations away from employers' facilities, which may not provide adequate protection for the safety and health of the worker. The next several paragraphs describe each of the sectors in this NORA priority area; the number in parentheses in each heading is based upon the North American Industry Classification System. Descriptions of associated subsectors are described in Appendix 1.

## **Information (51)**

The information sector comprises establishments engaged in producing and distributing information and cultural products, providing the means to transmit or distribute these products as well as data or communications, and processing data. Unlike traditional goods, an "information or cultural product," such as a newspaper on-line or television program, does not necessarily have tangible qualities, nor is it necessarily associated with a particular form. A movie can be shown at a movie theater, on a television broadcast, through video-on-demand or rented at a local video store. A sound recording can be aired on radio, embedded in multimedia products, or sold at a record store. Unlike traditional services, the delivery of these products does not require direct contact between the supplier and the consumer. The intangible property aspect of information and cultural products makes the processes involved in their production and distribution very different from goods and services. They derive revenue not from sale of the distributed product to the final consumer, but from those who pay for the privilege of adding information to the original product.

## **Finance and Insurance (52)**

The finance and insurance sector comprises establishments primarily engaged in financial transactions. Establishments engaged in this activity use raised funds to acquire financial assets by making loans and/or purchasing securities, collect fees, insurance premiums, or annuity considerations; build up reserves; invest those reserves; and make contractual payments, or provide specialized services facilitating or supporting finance, insurance, and employee benefit programs. This sector encompasses transactions involving the creation, liquidation, change in ownership of financial assets; or in facilitating financial transactions.

## **Real Estate and Rental and Leasing (53)**

The real estate and rental and leasing sector comprises establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services. The major portion of this sector comprises establishments that rent, lease, or otherwise allow the use of their own assets by others. The assets may be tangible, as is the case of real estate and equipment, or intangible, as is the case with patents and trademarks. This sector also includes establishments primarily engaged in managing real estate for others, selling, renting and/or buying real estate for others, and appraising real estate. In addition, a substantial proportion of property management is self-performed by lessors.

## **Professional, Scientific, and Technical Services (54)**

The professional, scientific, and technical services sector comprises establishments that specialize in performing professional, scientific, and technical activities for others, specialize according to expertise, and provide these services to clients in a variety of industries and to households. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic

services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.

### **Management of Companies and Enterprises (55)**

The management of companies and enterprises sector comprises establishments that hold the securities of companies and enterprises for the purpose of owning a controlling interest or influencing management decisions or that administer, oversee, and manage establishments of the company or enterprise and that normally undertake the strategic or organizational planning and decision-making role of the company or enterprise.

### **Administrative, Support, Waste Management, and Remediation Services (56)**

The administrative and support and waste management and remediation services sector comprises establishments performing routine support activities for the day-to-day operations of other organizations. Activities performed include office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services. The administrative and management activities in this sector are typically on a contract or fee basis.

### **Educational Services (61)**

The educational services sector comprises establishments that provide instruction and training in a wide variety of subjects by specialized establishments, such as schools, colleges, universities, and training centers. These establishments may be privately owned and operated for profit or not for profit, or they may be publicly owned and operated. They may also offer food and accommodation services to their students. Educational services are usually delivered by teachers or instructors that explain, tell, demonstrate, supervise, and direct learning. Instruction is imparted in diverse settings, such as educational institutions, the workplace, or the home through correspondence, television, or other means. All industries in the sector share this commonality of labor inputs of instructors with the requisite subject matter expertise and teaching ability. The U.S. Labor Department predicts that education will be one of the fastest growing sectors over the next decade, with employment rising by more than 32% while average teacher age has increased over the past decade.

### **Arts, Entertainment, and Recreation (71)**

The arts, entertainment, and recreation sector includes a wide range of establishments that operate facilities or provide services to meet varied cultural, entertainment, and recreational interests of their patrons. This sector comprises establishments that are involved in producing, promoting, or participating in live performances, events, or exhibits intended for public viewing; that preserve and exhibit objects and sites of historical, cultural, or educational interest; and that operate facilities or provide services that enable patrons to participate in recreational activities or pursue amusement, hobby, and leisure-time interests. This industry group can be characterized by low income, part-time, seasonal, and comparatively younger workers. Many jobs require outdoor activity exposing workers to inclement weather conditions that may result in poor health

outcomes. Large audience events are subject to unique challenges, including mob frenzy and more recently terrorist threats.

## **Accommodation and Food Services (72)**

The accommodation and food services sector comprises establishments providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption. The sector includes both accommodation and food services establishments because the two activities are often combined at the same establishment. As in other services industries, hotels employ many young, part-time, seasonal workers and have average earnings that are lower than many other industries. Unlike many other industries, the hotels and other accommodations industry employ very young workers-nearly 1/5 were under the age of 25 with this being their first job. Food service workers tend to be young; more than 20% were between 16 and 19 years of age-contributing to high rates of turnover. Part-time workers, representing approximately 40% of the workforce, also contribute to high rates of turnover.

## **Other Services except Public Administration (81)**

The other services (except public administration) sector comprises establishments engaged in providing services not specifically provided for elsewhere in the classification system. Establishments in this sector are primarily engaged in activities, such as equipment and machinery repairing, promoting or administering religious activities, grant making, advocacy, and providing dry-cleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services. Private households that engage in employing workers on or about the premises in activities primarily concerned with the operation of the household are included in this sector.

## **Public Administration (92)**

The public administration sector consists of establishments of federal, state, and local government agencies that administer, oversee, and manage public programs and have executive, legislative, or judicial authority over other institutions within a given area. These agencies also set policy, create laws, adjudicate civil and criminal legal cases, provide for public safety and for national defense. This industry group encompasses occupations with minimal risk to those occupations with some of the highest risks. Public safety workers, including fire fighters and law enforcement, currently face heightened occupational safety and health risks. The conditions of work, such as the threat of terrorism, around the clock protection, and apprehending suspected criminals, present unique challenges to reduce the risk of injury and illness.

## **Assessment**

### **1. Who is most at risk?**

The services industry is comprised of 11 sectors as shown in Table 1 and described above. More than 65 million workers were employed in the 11 NAICS service industries. Occupations within these industries account for 50.5% of U.S. workers, 29% of workplace fatalities, and 23% of nonfatal injuries, according to 2004 BLS data.

**Table 1. List of Services Sectors, Employment, and Injury and Illness Rates**

Code*	Services Sector	Employment Jan. 2005	Rates, 2004‡	
			injury	Illness
51	Information	3,062,000	1.9	15.4
52	Finance and Insurance	8,114,000	0.8	12.0
53	Real Estate and Rental and Leasing	2,124,600	3.6	12.0
54	Professional and Technical Services	16,844,000	1.2	10.5
55	Management of Companies and Enterprises	1,755,600	2.5	16.4
56	Administrative and Support and Waste Management	8,087,900	3.6	17.7
61	Educational Services	2,820,600	2.4	11.5
71	Arts, Entertainment, and Recreation	1,890,900	<b>5.6</b>	<b>43.3</b>
72	Accommodation and Food Services	10,911,300	4.4	12.8
81	Other Services (except Public Administration)	5,394,000	3.1	12.1
92	Public Administration (government)	21,786,000	N/A	N/A
	Total Services Sectors	82,790,900		
	All Sectors (non-farm, no self-employed)	133,376,000	4.5	27.9

\*North American Industry Classification System (NAICS)

N/A not available

‡ injury rates per 100 employees/yr; illness rates per 10,000 employees/yr (excludes public employees)

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 research to intervene to improve the safety and health of these workers. Using 2004 data, Table 1 shows the average injury and illness rate for those sectors of the services industry. Rate calculations are available only for the private sector.

### ***Injuries***

The arts, entertainment, and recreation sector listed in Table 1 exceeded the injury rate for all industries with a rate of 5.6 injuries per 100 fulltime employees as compared to 4.5 injuries per 100 employees for all industries. The total number of injuries in the services sectors represents 23% of all injuries in the private sector as shown in Table 2 for the year, 2004. Within the services sectors, the highest percentage of injuries occurred in the accommodation and food services (33.8) and the administrative support and waste management (16.4%) sectors.

**Table 2. List of Services Sectors and Associated Injuries**

Code*	Services Sector	Number, 2004
51	Information	53,300 (5.8%)
52	Finance and Insurance	42,700 (4.6%)
53	Real Estate and Rental and Leasing	62,100 (6.7%)
54	Professional and Technical Services	72,700 (7.9%)
55	Management of Companies and Enterprises	39,400 (4.3%)
56	Administrative Support and Waste Management	151,800 (16.4%)
61	Educational Services	34,900 (3.8%)
71	Arts, Entertainment, and Recreation	64,300 (7.0%)
72	Accommodation and Food Services	312,100 (33.8%)
81	Other Services (except Public Administration)	91,100 (9.9%)
	Total Services Sectors (private only)	924,400
	All Sectors (non-farm, no self-employed, no government)	4,008,300

\*North American Industry Classification System (NAICS)

N/A not available

## Illnesses

One sector among the services industries listed in Table 1 exceeded the illness rate for all industries. That sector was arts, entertainment, and recreation at a rate of 43.3 illnesses per 10,000 fulltime employees as compared to 27.9 illnesses per 10,000 employees for all industries. Condition that contribute to this higher rate include skin disorders (9.7 v. 4.4), respiratory conditions (2.7 v. 2.0), poisoning (0.7 v. 0.4), and all other illness cases (21.1 v. 18.0).

**Table 3. List of Services Sectors and Associated Illnesses**

Code*	Services Sector	Number, 2004
51	Information	4,300 (9.0%)
52	Finance and Insurance	6,400 (13.4%)
53	Real Estate and Rental and Leasing	2,100 (4.4%)
54	Professional and Technical Services	6,400 (13.4%)
55	Management of Companies and Enterprises	2,600 (5.5%)
56	Administrative Support and Waste Management	7,500 (15.7%)
61	Educational Services	1,700 (3.6%)
71	Arts, Entertainment, and Recreation	4,000 (8.4%)
72	Accommodation and Food Services	9,200 (19.3%)
81	Other Services (except Public Administration)	3,500 (7.3%)
	Total Services Sectors (private only)	47,700
	All Sectors (non-farm, no self-employed, no government)	249,000

\*North American Industry Classification System (NAICS)

N/A not available

The total number of illnesses in the services sectors represents 19.2% of all illnesses in the private sector as shown in Table 3 for the year, 2004. As with the percentage of injuries, the highest proportion of illnesses within the services sectors occurred in the accommodation and food services (19.3%) and administrative support and waste management (15.7%) sectors followed by the financial and insurance and the professional and technical services sector at 13.4% each. BLS uses industry surveys to estimate injuries and illnesses among U.S. workers. Illness categories are limited and are likely to underestimate chronic conditions associated with occupational exposures.

Adults with asthma who had been enrolled in an HMO for at least a year were requested to complete a questionnaire about their health status. Percentages with workplace exacerbation of asthma for services sectors were 33% for public administration, 22% for educational services, and 22% for finance, insurance, and real estate.<sup>2</sup>

## 2. How serious is the issue?

### Fatalities

Table 4 shows the number of fatalities in the services sectors in the year, 2004. These sectors represent 26.6% of all occupational fatalities. The highest percentage of fatalities in these sectors occurred in the administrative support and waste management (24.4), public administration—government employees (21.3%), and other services except public administration (13.5%).

<sup>2</sup> Henneberger PK, Hoffman CD, Magid DJ, Lyons EE. Work-related exacerbation of asthma. *Int J Occup Environ Health*. 2002 Oct-Dec;8(4):291-6.

**Table 4. List of Services Sectors and Associated Fatalities**

Code*	Services Sector	Number, 2004
51	Information	58 (3.8%)
52	Finance and Insurance	46 (3.0%)
53	Real Estate and Rental and Leasing	72 (4.7%)
54	Professional and Technical Services	81 (5.3%)
55	Management of Companies and Enterprises	N/A
56	Administrative Support and Waste Management	389 (24.4%)
61	Educational Services	101 (6.6%)
71	Arts, Entertainment, and Recreation	105 (6.8%)
72	Accommodation and Food Services	148 (9.6%)
81	Other Services (except Public Administration)	207 (13.5%)
92	Public Administration (government)	327 (21.3%)
	Total Services Sectors	1,534
	All Sectors	5,764

\*North American Industry Classification System (NAICS)

N/A not available

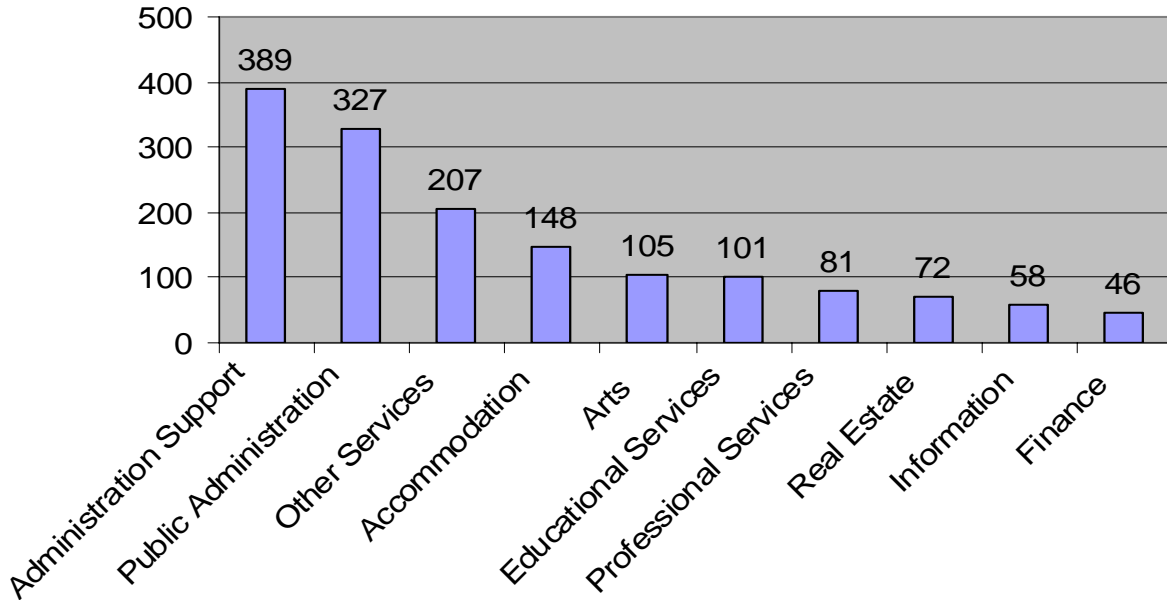
The two leading causes of fatalities in most service industries, according to BLS, are transportation incidents and violence as shown in Table 5. The types of hazards across industries in the NIOSH Services sector vary substantially. Workers in real estate, rental, and leasing and in administrative and waste management have the highest risks from falls. The latter group is joined with "other services" in having the greatest risks from contact with objects.

**Table 5. Occupational Fatalities and Leading Causes among the NORA Services Sectors Workers, 2004**

Services Sector	Fatalities		Percentage of Total Sector Fatalities			
	Number	Percentage of Total	Transportation	Violence	Falls	Contact Object
Information (51)	54	1 %	48	9	6	-
Finance & Insurance (52)	46	1 %	33	39	9	-
Real Estate, Rental and Leasing (53)	69	1 %	20	26	16	6
Professional, Scientific & Technical ((54)	76	1 %	30	4	11	-
Management of Corporations & Entities (55)	2	- **	-	-	-	-
Administrative & Waste Management (56)	370	6 %	22	7	18	13
Education (61)	44	1 %	11	9	11	-
Arts, Entertainment & Recreation (71)	99	2 %	11	11	11	6
Accommodations & Food Services (72)	146	3 %	14	52	8	3
Other Services (81)	204	4 %	10	19	11	14
Public Administration (91)	526	9 %	31	13	7	5

In 2004, the greatest number of fatalities among workers in the Services sector were employed in landscape maintenance (169), public safety (143), national security (69), restaurants (67), automotive repair (51), investigation and security services (47), waste collection (40), fire protection (37), drinking establishments (33), elementary and secondary schools (32), and religious organizations (32). These subsectors account for more than 40% of the 1,636 total deaths in the NORA services sectors. Similar fatality risks were noted in the 2003 BLS Census of Fatal Occupational Injuries data.

**Figure 1. Number of Occupational Fatalities in Services Sectors, 2004, n=1534**



**Table 6. List of Services Subsectors and Associated Fatalities in Rank Order, 2004**

Code	Subsector	Number
561	Administrative and Support Services	301
922	Justice, Public Order, and Safety Activities	190
722	Food Services and Drinking Places	118
811	Repair and Maintenance	115
611	Educational Services	101
562	Waste Management and Remediation Services	88
541	Professional, Scientific, and Technical Services	81
928	National Security and International Affairs	80
711	Performing Arts, Spectator Sports, and Related Industries	51
531	Real Estate	48
713	Amusement, Gambling, and Recreation Industries	46
813	Religious, Grant-making, Civic, Professional, and Similar Organizations	42
812	Personal and Laundry Services	39
511	Publishing Industries (except Internet)	34
721	Accommodation	30
522	Credit Intermediation and Related Activities	26
532	Rental and Leasing Services	24
921	Executive, Legislative, and Other General Government Support	22
524	Insurance Carriers and Related Activities	14
926	Administration of Economic Programs	14
517	Telecommunications	13
814	Private Households	11
924	Administration of Environmental Quality Programs	11
712	Museums, Historical Sites, and Similar Institutions	8

512	Motion Picture and Sound Recording Industries	5
523	Securities, Commodity Contracts, and Other Financial Investments and Related Activities	5
923	Administration of Human Resource Programs	5
515	Broadcasting (except Internet)	3
518	Internet Service Providers, Web Search Portals, and Data Processing Services	0
927	Space Research and Technology	0
	TOTAL	1,525

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Fifty-three percent of U.S. firefighters who died while on duty during 1994-2004 were volunteers, and 32% (368) were career firefighters. The remaining 15% (163) of deaths were among other firefighters (e.g., wildland, paid on-call, and part-time paid firefighters). Among volunteer firefighters, motor vehicle (MV) crashes during emergency response was a leading cause of fatality. Among career firefighters, asphyxiation was a leading cause of death. Cardiovascular failure was a leading cause of death for both voluntary and career firefighters.<sup>3</sup>

### ***Days Off Work***

More serious injury and illness cases result in more days away from work for the worker. Within the NORA services sector, the highest rates for days away from work cases were observed in leisure and hospitality and in "other services." In general, the injury and illness rates for 2003 were slightly higher than the rates for 2004.

In 2004, BLS reported that the overall average rate of injuries and illnesses among the service sector workers that resulted in days away from work was 1.3 cases per 100 employees versus 1.4 in 2003. Within the NORA services sectors, the risk for lost workday injuries are greater than 2 times the overall service sector average for workers in solid waste collection (3.6), spectator sports (2.8), landscape maintenance (2.6), and consumer electronics and appliance rental (2.6). Amputations that result in lost workdays are essentially 50 times the average rate for BLS service workers in commercial and industrial machine repair and maintenance (20.3 per 10,000 workers versus the average of 0.4). However, the number of reported cases is fewer than 50. Carpal tunnel injuries that resulted in days away from work averaged 1.6 per 10,000 workers across the BLS service sectors. The highest rates within the NORA services sectors were observed in credit card issuing businesses (4.4), legal services (4.0), janitorial services (3.9), other insurance activities (3.8), and newspaper publishers (3.4). Multiple traumatic injuries with days away from work were greatest for truck, trailer, and RV rental businesses (18.4 per 10,000 workers), landscape maintenance (17.6), heavy equipment rental and leasing (15.2), waste remediation (14.8), and real estate property management (13.0). In comparison, the average multiple traumatic injury rate with days away from work for the BLS Services sector is 5.1 per 10,000 workers.

Of the 14 private sector industries that reported 100,000 or more cases of nonfatal injuries or illnesses in 2004, two of these were in the accommodation and food services sector: full service restaurants with 113,300 cases and limited-service eating places with 104,200 cases. Waste management and remediation services (562) experienced injuries and illnesses at a rate higher

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<sup>3</sup> CDC. Fatalities among volunteer and career firefighters--United States, 1994-2004. [MMWR Morb Mortal Wkly Rep.](#) 2006 Apr 28;55(16):453-5.

than that of the sector as a whole, with 7.6 cases per 100 fulltime workers. The rate of total recordable cases in leisure and hospitality declined in 2004 to 4.7 cases per 100 full-time workers, down from 5.1 cases in 2003. This change was driven by a decline in the rate for accommodation and food services, which fell from 5.0 cases per 100 full-time workers in 2003 to 4.5 cases in 2004, while the rate for arts, entertainment, and recreation remained unchanged in 2004 at 5.9 cases per 100 workers. Table 7 shows that the waste management and remediation services subsector experienced the most server injuries when measure by more than 30 days away from work. Both the rental and leasing services and the performing arts, spectator sports, and related industries experienced higher than average rates of more than 30 days was from work as a result of an injury or illness as well.

**Table 7. Injury and Illness Rates\* by of Days Away from Work in High Risk Subsectors**

Number of days away from work	Private industry	Above Average Subsector					
		Rental & Leasing Services (532)	Waste Management & Remediation Services (562)	Performing Arts, Spectator Sports & Related Industries (711)	Museums, Historical Sites & Similar Institutions (712)	Amusement Gambling & Recreation Industries (713)	Accommodation (721)
1 day	20.3	<b>23.5</b>	<b>41.4</b>	<b>24.6</b>	<b>39.5</b>	<b>26.2</b>	<b>21.1</b>
2 days	16.2	<b>19.0</b>	<b>38.2</b>	13.4	15.6	<b>24.7</b>	<b>22.1</b>
3-5 days	26	23.9	<b>47.1</b>	<b>28</b>	<b>56.7</b>	<b>26.9</b>	<b>32.0</b>
6-10 days	17.9	16.5	<b>37.5</b>	<b>26.9</b>	<b>21.8</b>	17.9	<b>20.4</b>
11-20 days	16.1	<b>20.6</b>	<b>27.9</b>	<b>30.4</b>	8.2	15.1	15.3
21-30 days	9.6	<b>12.4</b>	<b>12.6</b>	<b>13.3</b>	2.4	9.3	<b>10.5</b>
>30 days	35.3	<b>36.8</b>	<b>84.7</b>	<b>43.3</b>	14.1	26.1	34.9
Total	141.3	152.7	289.4	179.9	158.3	146.2	156.2

\*injuries and illnesses per 10,000 employees, 2004

Bold red indicates rates above the average for the services industries

### ***Nature of Injury and Illness***

Sprains and strains were the prominent injury experience by the high risk subsectors as shown in Table 8. Fractures were above the average in three subsectors, whereas cuts, lacerations, and punctures were higher than the average for all private industry in four of the subsectors as shown in Table 8. Both the waste management and remediation services and the accommodation subsectors have injuries and ill nesses associated with most of the types of injury or illnesses. The other subsectors exhibited less variability by type of injury or illness.

**Table 8. Injury and Illness Rates\* by Nature of Injury or Illness in High Risk Subsectors**

Nature of injury, illness	Private industry	Above Average Subsector					
		Rental & Leasing Services (532)	Waste Management & Remediation Services (562)	Performing Arts, Spectator Sports, & Related Industries (711)	Museums, Historical Sites, & Similar Institutions (712)	Amusement, Gambling, & Recreation Industries (713)	Accommodation (721)
Sprains, strains	59	<b>67.4</b>	<b>130.5</b>	<b>69.9</b>	57.8	57.6	<b>63.3</b>
Fractures	10.6	<b>18.2</b>	<b>26.6</b>	<b>28.1</b>	5.1	10.4	8.5
Cuts, lacerations, punctures	12.8	8.5	<b>23.1</b>	7.6	<b>19.5</b>	<b>13.5</b>	<b>15.8</b>
Bruises, contusions	12.9	<b>14.1</b>	<b>26.6</b>	10.3	<b>16</b>	<b>19</b>	<b>18</b>
Heat burns	2.1	0.8	<b>2.8</b>	0.7	<b>3.5</b>	<b>3.8</b>	<b>3.9</b>

**Table 8. Injury and Illness Rates\* by Nature of Injury or Illness in High Risk Subsectors**

Nature of injury, illness	Private industry	Above Average Subsector					
		Rental & Leasing Services (532)	Waste Management & Remediation Services (562)	Performing Arts, Spectator Sports, & Related Industries (711)	Museums, Historical Sites, & Similar Institutions (712)	Amusement, Gambling, & Recreation Industries (713)	Accommodation (721)
Chemical burns	0.8	<b>0.9</b>	-	-	-	<b>1.1</b>	<b>1.4</b>
Tendonitis	0.8	-	-	<b>1.7</b>	-	0.6	0.4
Multiple injuries	5.7	<b>9.5</b>	<b>12.1</b>	5.1	<b>6.7</b>	4.2	4.7
with fractures	1.1	<b>2.7</b>	<b>3.4</b>	0.9	-	0.4	<b>0.4</b>
with sprains	2.2	<b>4.2</b>	<b>3.1</b>	1.8	<b>4.5</b>	<b>3.0</b>	<b>2.8</b>
Soreness, Pain	11.7	11	<b>14.6</b>	<b>15.8</b>	10.3	8.2	<b>14.2</b>
back pain	4.3	3.0	<b>5.7</b>	<b>4.4</b>	-	3.1	<b>4.4</b>
All other	22	20.8	<b>50.4</b>	<b>39.8</b>	<b>37.1</b>	<b>24.6</b>	<b>25.2</b>
Total:	141.3	152.7	289.4	179.9	158.3	146.2	156.2

\*injuries and illnesses per 10,000 employees, 2004

Bold red indicates rates above the average for the services industries

In a study of adolescent work-related injuries in Minnesota during 1986-1987, 1,607 injuries were reported in adolescents ages 12 through 17. Of the injuries, 24.1% occurred in services. Common injuries were sprains, lacerations, heat burns, and contusions.<sup>4</sup> Musculoskeletal disorders occur in many service industries including janitorial, room cleaning, waste collection, and spectator sports. Clerical staff in financial, legal, insurance, and publishing have experienced elevated rates for musculoskeletal disorders as well.

### **Part of Body Affected**

The part of body affected by injury or illness was high in both the waste management and remediation services and rental and leasing services subsectors regarding the trunk and more part particularly the back. These same subsectors had high rates of injuries for most parts of the body affected, whereas the other high risk subsectors shown in Table 9 were more particular in above average injuries or illnesses as observed by part of body affected.

**Table 9. Injury and Illness Rates\* by of Part of Body Affected in High Risk Subsectors**

Part of body affected	Private industry	Above Average Subsector					
		Rental & Leasing Services (532)	Waste Management & Remediation Services (562)	Performing Arts, Spectator Sports, & Related Industries (711)	Museums, Historical Sites, & Similar Institutions (712)	Amusement, Gambling & Recreation Industries (713)	Accommodation (721)
Head	9.1	<b>9.8</b>	<b>20.1</b>	8.2	<b>27.0</b>	<b>9.8</b>	<b>10.2</b>
eye	4.1	<b>4.4</b>	<b>7.6</b>	2.4	<b>6.8</b>	3.8	<b>4.3</b>
Neck	2.4	<b>3.1</b>	<b>3.1</b>	2.1	-	2.0	1.5
Trunk	50.2	<b>57.2</b>	<b>114.8</b>	46.3	42.7	44.0	<b>51.6</b>
back	31.7	<b>41.0</b>	<b>64.6</b>	26.5	23.2	25.3	31.3
shoulder	9.2	6.4	<b>31.6</b>	<b>10.9</b>	7.6	9.1	<b>11.1</b>
Upper extremities	32.6	25.2	<b>59.5</b>	<b>36.7</b>	<b>37.8</b>	<b>33.4</b>	<b>34.5</b>

<sup>4</sup> Parker DL, Clay RL, Mandel JH, Gunderson P, Salkowicz L. Adolescent occupational injuries in Minnesota. A descriptive study. Minn Med. 1991 Jun;74(6):25-8.

**Table 9. Injury and Illness Rates\* by of Part of Body Affected in High Risk Subsectors**

Part of body affected	Private industry	Above Average Subsector					
		Rental & Leasing Services (532)	Waste Management & Remediation Services (562)	Performing Arts, Spectator Sports, & Related Industries (711)	Museums, Historical Sites, & Similar Institutions (712)	Amusement, Gambling & Recreation Industries (713)	Accommodation (721)
finger	12.1	10.9	<b>12.6</b>	<b>13.1</b>	<b>22.7</b>	<b>12.5</b>	<b>12.5</b>
hand, except finger	5.6	2.7	<b>23.6</b>	4.4	<b>6.2</b>	3.6	<b>7.7</b>
wrist	6.6	4.0	<b>10.8</b>	6.1	4.3	<b>9.9</b>	5.1
Lower extremities	30.2	<b>35.6</b>	<b>57.4</b>	<b>71.7</b>	29.8	<b>36.2</b>	<b>40.4</b>
knee	11.2	<b>14.0</b>	<b>17.3</b>	<b>22.1</b>	8.6	<b>13.4</b>	<b>15.8</b>
foot, toe	6.5	<b>8.0</b>	<b>9.9</b>	<b>19.8</b>	5.3	<b>7.2</b>	<b>6.9</b>
Body systems	1.6	<b>2.0</b>	<b>2.3</b>	1.1	<b>5.8</b>	<b>3.0</b>	<b>2.8</b>
Multiple	14.2	<b>19.2</b>	<b>31.1</b>	13.4	14.2	<b>16.9</b>	13.3
Total:	141.3	152.7	289.4	179.9	158.3	146.2	156.2

\*injuries and illnesses per 10,000 employees, 2004

Bold red indicates rates above the average for the services industries

### Source of Injury and Illness

As shown in Table 10, the highest risk regarding source of injury from containers, vehicles, and ground surfaces or floors in the waste management and remediation services subsector. Indeed, the risk was elevated regarding the source of injury as ground surfaces or floor across all of the high risk subsectors as was worker motion or position.

**Table 10. Injury and Illness Rates\* by Source of Injury or Illness in High Risk Subsectors**

Source of injury, illness	Private industry	Above Average Subsector					
		Rental & Leasing Services (532)	Waste Management & Remediation Services (562)	Performing Arts, Spectator Sports & Related Industries (711)	Museums, Historical Sites & Similar Institutions (712)	Amusement, Gambling & Recreation Industries (713)	Accommodation (721)
Chemicals	2.0	1.7	<b>6.0</b>	-	-	<b>2.9</b>	<b>3.3</b>
Containers	18.1	15.2	<b>57.5</b>	6.8	14.0	14.8	<b>22.5</b>
Furniture	5.0	<b>12.1</b>	2.5	4.9	<b>14.9</b>	<b>6.7</b>	<b>15.5</b>
Machinery	9.2	8.4	<b>11.1</b>	4.0	3.1	<b>9.3</b>	7.7
Materials	14.3	10.4	<b>28.3</b>	5.7	9.1	8.2	3.5
Worker motion	20.5	18.0	<b>31.2</b>	<b>42.7</b>	<b>29.0</b>	<b>27.7</b>	<b>22.1</b>
Ground surface	26.3	<b>31.9</b>	<b>46.5</b>	<b>54.2</b>	<b>26.8</b>	<b>29.4</b>	<b>39.7</b>
Handtools	6.6	5.4	<b>8.0</b>	2.8	6.1	<b>6.8</b>	5.9
Vehicles	12.5	<b>28.7</b>	<b>56.7</b>	12.2	<b>19.2</b>	12.2	7.3
All other	20.4	<b>20.7</b>	<b>41.6</b>	<b>46.1</b>	<b>34.6</b>	<b>28.1</b>	<b>28.6</b>
Total:	141.3	152.7	289.4	179.9	158.3	146.2	156.2

\*injuries and illnesses per 10,000 employees, 2004

Bold red indicates rates above the average for the services industries

### Event or Exposure

As shown in Table 11, High rates of injury occurred in the waste management and remediation services as a result of contact with object or equipment principally as a result of being struck by

an object. This sector also experienced several above average injuries across several events or exposure. The high risk subsectors varied between each other as to the type of event or exposure that was experienced. Incidents involving transportation were experienced as above average event in all of the subsectors shown in Table 11.

**Table 11. Injury and Illness Rates\* by Event or Exposure in High Risk Subsectors**

Event or exposure	Private industry	Above Average Subsector					
		Rental & Leasing Services (532)	Waste Management & Remediation Services (562)	Performing Arts, Spectator Sports & Related Industries (711)	Museums, Historical Sites & Similar Institutions (712)	Amusement, Gambling, & Recreation Industries (713)	Accommodation (721)
Contact with object	37.6	35.5	<b>74.9</b>	<b>38.8</b>	31.4	35.6	<b>39.9</b>
Struck by	19.1	<b>21.7</b>	<b>31.1</b>	18.7	15.7	19	<b>20.4</b>
Struck against	9.4	7.9	<b>16.8</b>	<b>12.1</b>	<b>11.5</b>	<b>10.2</b>	<b>12.7</b>
Caught in object	6.2	3.6	<b>18.4</b>	4.3	2.4	4.3	4.4
Fall to lower level	9	<b>14</b>	<b>20.3</b>	<b>19.4</b>	<b>12.2</b>	7.1	<b>9.2</b>
Fall on same level	18.7	18.7	<b>31.6</b>	<b>31.3</b>	17.8	<b>23.1</b>	<b>34</b>
Slips, trips	4.2	<b>5.8</b>	<b>10.7</b>	<b>4.9</b>	3.4	<b>7.5</b>	<b>7.3</b>
Overexertion	35.5	<b>36.6</b>	<b>69.5</b>	24.3	23.9	27.6	32.3
Lifting	19.5	<b>23</b>	<b>40.3</b>	8.4	12.3	17	16.6
Repetitive motion	5.5	2.9	3.6	<b>6.6</b>	2.6	<b>6.1</b>	2.2
Harmful substance	5.9	4	<b>12.0</b>	2.2	<b>13.7</b>	<b>10.1</b>	<b>8.3</b>
Transportation	7.1	<b>19.8</b>	<b>31.3</b>	<b>8.8</b>	<b>17.7</b>	<b>8.4</b>	2.2
Fires, explosions	0.3	-	-	-	-	<b>1.2</b>	0.3
Assault, violent act	2.8	0.9	2.7	<b>5.0</b>	<b>7.2</b>	<b>3.3</b>	1.6
by person	2	0.8	-	0.7	-	<b>2.3</b>	1.1
by other	0.8	-	<b>2.6</b>	<b>4.3</b>	<b>6.6</b>	<b>1.0</b>	0.6
All other	14.8	14.3	<b>32.5</b>	<b>38.5</b>	<b>28.4</b>	<b>16.2</b>	<b>18.7</b>
Total:	141.3	152.7	289.4	179.9	158.3	146.2	156.2

\*injuries and illnesses per 10,000 employees, 2004

Bold red indicates rates above the average for the services industries

### 3. What research is needed?

#### *Incident Response*

The Congress outlined the need for PPE research; "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." NIOSH initiated a program to approve self-contained breathing apparatus for use by firefighters and other first responders after terrorist attacks. A self-contained breathing apparatus is a type of respirator commonly used by firefighters that provides air to users from a pressurized supply cylinder or tank carried on the back.

A primary focus is PPE for emergency responders, which is defined under the classification, Public Administration. The responder missions include law enforcement, fire department,

emergency medical services, follow-on responders, and special operations areas. Protection is needed from inhalation and dermal hazards in the forms of vapors, gases, aerosols, liquids, and particulates. The primary hazards to responders include chemical, biological, radiological, thermal, explosive, and ballistic. Terrorism is a threat to the safety and security of nearly all workers in public administration. Emergency preparedness specialists at all levels of government are being trained to protect the public and to respond to chemical, biological, radiological, and nuclear threats. Schools and other facilities that are open to the public have increased security and reduced access. Persistent dyspnea and deterioration of pulmonary function may occur in emergency response personnel including police officers as a result of exposure at the World Trade Center, "ground zero," early on September 11, 2001.<sup>5</sup>

There is a need to incorporate the safety and health of emergency responders into existing disaster preparedness plans and to provide periodic responder training and education in tasks unique to disaster situations. Upper respiratory and skin rash symptoms were the most common physical symptoms reported by police officers and firefighters and lacerations in New Orleans and sprains were the most common injuries after Hurricane Katrina struck the U.S. Gulf Coast.<sup>6</sup> Working close to sources of high frequency electromagnetic fields (EMF), such as transmitter antennas for mobile phones, pagers and police, fire, and other emergency services, can result in high EMF exposure.<sup>7</sup>

## **Surveillance**

More detailed investigations through surveillance methods are needed to identify and prioritize the services sectors' technologies for research. These investigations include disaggregating the high risk areas in the services sectors by nature of injury and exposure further to gain better detail regarding the population at risk. 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.

OSHA provides a rich source of recorded injuries that could be prevented with the use of PPE. As an example, according to OSHA inspection no. 106092331 an employee was assembling Class B fireworks and cut a piece of thermalite, which sparked a flash fire. The employee died from burns and smoke inhalation.

An example of an HHE is an evaluation the customized hearing protectors used by a SWAT team during training exercises. Changes in hearing following weapons firing on the indoor and outdoor ranges was used as an estimate of noise overexposure. Measurements were made of the

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<sup>5</sup> [Mann JM, Sha KK, Kline G, Breuer FU, Miller A](#). World Trade Center dyspnea: bronchiolitis obliterans with functional improvement: a case report. [Am J Ind Med](#). 2005 Sep;48(3):225-9.

<sup>6</sup> CDC. Health hazard evaluation of police officers and firefighters after Hurricane Katrina--New Orleans, Louisiana, October 17-28 and November 30-December 5, 2005. [MMWR Morb Mortal Wkly Rep](#). 2006 Apr 28;55(16):456-8

<sup>7</sup> [Gajsek P, Simunic D](#). Occupational exposure to base stations--compliance with EU directive 2004/40/EC. [Int J Occup Saf Ergon](#). 2006;12(2):187-94.

noise from the weapons used by the police department and of the noise reduction from all the hearing protectors worn by the officers.<sup>8</sup>

The NIOSH FACE program investigates occupational fatalities, many of which could be prevented by the use of functional PPE. Each year an average of 105 fire fighters die in the line of duty. The NIOSH Fire Fighter Fatality Investigation and Prevention Program conducts investigations of fire fighter line-of-duty deaths to formulate recommendations for preventing future deaths and injuries. The program does not seek to determine fault or place blame on fire departments or individual fire fighters, but to learn from these tragic events and prevent future similar events.

Surveillance is needed for understanding the exposures of service workers in their particular environments such as public school employees in large urban areas. Crumbling school infrastructure and crowded classrooms are associated with inadequate indoor air quality, asbestos exposure, noisy environments, and enhanced transmission of communicable and infectious diseases. Poor ventilation in vocational education classrooms, duplicator rooms, kitchens, and science laboratories may also contribute to hazardous exposures. Ergonomic hazards may be responsible for increasing rates of musculoskeletal disorders. Other work-related illnesses and injuries now documented among school employees include asthma, mesothelioma, asbestos-related lung cancer, violent assault, voice disorders, and depression. Such a diverse industry with many potentially hazardous activities and conditions calls for a comprehensive research and intervention agenda.<sup>9</sup>

### ***Technology Assessments***

There is a need to analyze technologies so that critical PPE needs with a standards perspective can be filled via research agendas for specific new technologies. Textile-based wearable electronics that can be integrated into military protective clothing are being developed, and these systems may be adaptable to the services sectors environments for monitoring human presence in complex operations.<sup>10</sup> Substantial research is underway regarding PPE to protect workers involved in removing mines in previous war-torn areas. These new technologies can have a broader benefit for other workers potentially exposed to explosions.

Respiratory protective equipment products and technologies for industrial worker and emergency responders could be considered mature. Refinements to current air-supplied and air-purifying respirator technologies are being explored. Protective ensemble (garments, hand wear, and footwear) materials and technologies include non-permeable barrier materials and new materials technologies such as semi-permeable and selectively permeable materials. New technologies that enhance ensemble “breathability” to minimize the negative physiological effects of heat stress are being investigated. Performance criteria for multi-hazard ensemble are being explored but with contradicting results. Considerable thermal and maximal cardiovascular strain and intense

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<sup>8</sup> NIOSH Health Hazard Evaluation Report. HETA #2002-0131-2898. Fort Collins Police Services, Fort Collins, Colorado, March 2003.

<sup>9</sup> Alexander DL. School employees: the forgotten municipal workers. *Occup Med.* 2001 Jan-Mar;16(1):65-78.

<sup>10</sup> Winterhalter CA, et al. 2005. Development of electronic textiles to support networks, communications, and medical applications in future U.S. military protective clothing systems. *IEEE Trans Inf Technol Biomed.* 9(3):402-6.

subjective discomfort measured in the firefighters emphasize the need to limit working time in hot conditions to only 10-12 min while wearing impermeable chemical protective suit systems.<sup>11</sup> In another study, incidence ratios for nasal cancer for teachers were significantly elevated.<sup>12</sup>

### **Waste Workers**

Remediation workers at a hazardous waste site loaded and transported low-level radioactive wastes for offsite disposal. Primary radionuclides present at the facility were <sup>137</sup>Cs, <sup>60</sup>Co, and <sup>241</sup>Am.<sup>13</sup> The results of another study confirm previous studies on the presence of airways and intestinal inflammation among workers in sewage treatment plants. The most likely causative agent was endotoxin.<sup>14</sup> The use of municipal wastewater treatment plants for the disposal of industrial wastes creates the potential for the exposure of treatment plant workers to hazardous chemical compounds that may be present in these wastes.<sup>15</sup> Results of a study of workers collecting waste suggested that acute work-related nose irritation is associated with exposure to bacteria as was unusual tiredness. Cough may have been associated to fungal spore exposure.<sup>16</sup> Municipal solid waste is collected manually, and this collection has recently been found to be among the highest-risk occupations in the United States with an annual injury rate of approximately 80 per 100 workers especially among garbage collectors. Injuries in another study showed a rate of 54 injuries per 100 workers per year.<sup>17</sup>

### **Intervention Research**

There is a need to develop interventions to address knowledge gaps and develop efforts for broad adoption of successful PPE interventions in targeted services sector technologies. As mentioned above, there is a need to design respiratory and dermal protection for very small particles. A study to describe the perceptions of a group of hazardous waste workers to understand their beliefs and attitudes about the use of respiratory protective equipment resulted in reports of the most negative perceptions related to communication, personal comfort, obstructed vision, structural environment, and fatigue.<sup>18</sup>

Sprains and strains receive scant attention from the PPE industry because of their association with overexertion. Nonetheless, PPE may have an important role to serve in reducing the severity of these injuries with creative applications of personal protective strategies to reduce

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<sup>11</sup> [Ilmarinen R](#), [Lindholm H](#), [Koivistoinen K](#), [Helisten P](#). Physiological evaluation of chemical protective suit systems (CPSS) in hot conditions. [Int J Occup Saf Ergon](#). 2004;10(3):215-26.

<sup>12</sup> Hemelt M, Granstrom C, Hemminki K. Occupational risks for nasal cancer in Sweden. [J Occup Environ Med](#). 2004 Oct;46(10):1033-40

<sup>13</sup> Hoffman DE. Worker and environmental protection issues in the remediation of an abandoned source manufacturing facility. [Health Phys](#). 2003 Feb;84(2 Suppl):S30-6.

<sup>14</sup> Rylander R. Health effects among workers in sewage treatment plants. [Occup Environ Med](#). 1999 May;56(5):354-357.

<sup>15</sup> Elia VJ, Clark CS, Majeti VA, Gartside PS, MacDonald T, Richdale N, Meyer CR, Van Meer GL, Hunninen K. Hazardous chemical exposure at a municipal wastewater treatment plant. [Environ Res](#). 1983 Dec;32(2):360-71

<sup>16</sup> [Heldal KK](#), [Eduard W](#). Associations between acute symptoms and bioaerosol exposure during the collection of household waste. [Am J Ind Med](#). 2004 Sep;46(3):253-60.

<sup>17</sup> [Englehardt JD](#), [An H](#), [Fleming LE](#), [Bean JA](#). Analytical predictive Bayesian assessment of occupational injury risk: municipal solid waste collectors. [Risk Anal](#). 2003 Oct;23(5):917-27.

<sup>18</sup> [Salazar MK](#), [Connon C](#), [Takaro TK](#), [Beaudet N](#), [Barnhart S](#). An evaluation of factors affecting hazardous waste workers' use of respiratory protective equipment. [AIHAJ](#). 2001 Mar-Apr;62(2):236-45.

overexertion—e.g., the contentious area of extra-skeletal bracing<sup>19</sup>—as well as other causes of sprains and stains, e.g., slips and falls.<sup>20</sup> Glove design can provide for more grip with less force upon the musculoskeletal system.<sup>21</sup> A sitting/kneeling support device makes hip support available where the work requires kneeling, which reduces tension in the thigh muscles, by widening the angle of the knees, reduces compression on the knees, ankles and lumbar region (middle to lower back), and improves blood circulation.<sup>22</sup> Anthropometric information such as body size or body segment measurements of some occupational groups differs significantly.<sup>23</sup> Products that enter the market need to be evaluated for their efficacy and effectiveness, e.g., back or limb supports. In addition, personal protection devices for disabled workers also need to be evaluated. Body shields such as hard hats have been used to reduce fractures and other injuries.<sup>24</sup>

Dermal exposures are another area requiring PPE research. Protection against the effects of heat and flame is available in the form of special clothing, but this clothing has to be matched carefully to the working environment, the job being done, and the individual wearer. Intervention research is essential to determine whether specific interventions work to prevent work-related injury and illness. In a study of printers' skin care policy, the implementation of interventions were evaluated that included gloves of the correct type and size, and use of an after-work cream.<sup>25</sup> A study of dermal exposures to commercial petroleum-based liquid used for cleaning, lubricating, and protecting firearms that is used in the United States by military personnel, police, and individual gun owners for maintaining a wide variety of firearms suggest that persons handling or using the liquid should protect the skin from exposure.<sup>26</sup> Police officers may have repeated exposure to CS spray during their training and in their work, and designated police officers carry CS spray canisters daily in the line of duty, which have been associated with a range of unpredictable cutaneous reactions including contact allergy, leukoderma, initiation or exacerbation of seborrheic dermatitis, and aggravation of rosacea.<sup>27</sup>

## **Emerging Problems**

Infectious disease such as Avian influenza and SARS may place workers in the hospitality industry at risk as they make contact with travelers and their discarded materials. Needle stick injuries are increasing outside medical clinics and hospitals. More and more patients are injecting medications for diabetes, arthritis, and other common ailments at home. Needles from illicit drug use also get placed in domestic solid waste. Workers in waste handling, hospitality, and

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19 Kraus, J., K. Brown, D. McArthur, C. Peek-Asa, L. Zhou, Reduction of Acute Low Back Injuries by Use of Back Supports. *International Journal of Occupational and Environmental Health*, 1996, pp. 264-273.

20 Manning, D.P. *Spine*, Volume 9, November 7, 1984.

21 Wing AM. 2006. More Grip, Less Force. *Occupational Health & Safety*. 75(4):64, 66, 68-71.

22 Canadian Centre for Occupational Health and Safety,

[http://www.ccohs.ca/oshanswers/ergonomics/sitting/sitting\\_alternative.html#\\_1\\_9](http://www.ccohs.ca/oshanswers/ergonomics/sitting/sitting_alternative.html#_1_9)

23 Hsiao H, Long D, Snyder K. 2002. Anthropometric differences among occupational groups. *Ergonomics*. 45(2):136-152.

24 Makris A. Nerenberg J, "Full Scale Evaluation of Lightweight Personal Protective Ensembles for Demining in Providing Protection Against Blast-Type Anti-Personnel Mines," *Journal of Mine Action*, James Madison University, Harrisonburg, Va., Version 4.2, June 2000.

25 Brown TP, Rushton L, Williams HC, English JS. Intervention development in occupational research: an example from the printing industry. *Occup Environ Med*. 2006 Apr;63(4):261-6.

26 [Arfsten DP](#), [Garrett CM](#), [Jederberg WW](#), [Wilfong ER](#), [McDougal JN](#). Characterization of the skin penetration of a hydrocarbon-based weapons maintenance oil. *J Occup Environ Hyg*. 2006 Sep;3(9):457-64.

27 [Watson K](#), [Rycroft R](#). Unintended cutaneous reactions to CS spray. *Contact Dermatitis*. 2005 Jul;53(1):9-13.

housekeeping experience increased injury and infection risks as they handle contaminated discarded needles.

Wireless technology is changing the locations where work can be completed especially for information industries. Miniaturization of some electronic devices may result in increased musculoskeletal disorders and in hearing loss with long-term use. In an effort to better serve customers, the use of wireless communication (headsets) may increase the number of hearing loss incidents. In addition, noise exposure in the kitchens may be problematic. Wait and kitchen staffs are under time pressure to accommodate customers with "fast food" putting them at increased risk of falls, burns, cuts, and muscle strains.

Ergonomic interventions have reduced muscle strain from lifting but have increased the loads that are pushed or pulled by workers. These new job demands may have long-term health risks that have yet to be recognized. Violence is an increasing risk for many in the service sector, especially those in public safety and food and alcohol service. Increased reliance on electronic measures has created productivity pressures on workers in the information sector.

Ceramic artists can be exposed to many hazards including metals (such as lead), fibrogenic dusts (such as silica), heat, repetitive motion, radiation, and toxic emissions from kilns.<sup>28</sup> Theatrical fogs are commonly used in the entertainment industry to create special atmospheric effects during filming and live productions. Higher exposures were associated with movie and television productions for those employed as "grips," who were exposed to mineral oil-and glycol-based theatrical fogs.<sup>29</sup> There is a high occurrence of non-Hodgkin's lymphoma, particularly among typesetters.<sup>30</sup>

## **Violence**

Based on Ohio's workers' compensation claims from 1983 through 1985, police officers, employees of the real estate industry, and hotel/motel employees were found to be at high risk for occupational violent crime injury and death.<sup>31</sup> Subclasses of handguns differ substantially in their risk for use in fatal shootings of law enforcement officers.<sup>32</sup>

## **PPE Program Effectiveness**

A PPE program must be comprehensive to be effective. It requires commitment and active participation at the planning, development, and implementation stages from all levels: senior management, supervisors, and workers. A good PPE program consists of several essential elements: workplace survey, selection of appropriate controls, selection of appropriate PPE, fitting, training, management support, and PPE storage, maintenance and care as well as auditing

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<sup>28</sup> Dorevitch S, Babin A. Health hazards of ceramic artists. *Occup Med.* 2001 Oct-Dec;16(4):563-75, iii.

<sup>29</sup> Teschke K, Chow Y, van Netten C, Varughese S, Kennedy SM, Brauer M. Exposures to atmospheric effects in the entertainment industry. *J Occup Environ Hyg.* 2005 May;2(5):277-84.

<sup>30</sup> Rafnsson V. Incidence of cancer among bookbinders, printers, photoengravers, and typesetters. *Occup Environ Med.* 2001 Aug;58(8):523-527.

<sup>31</sup> Hales T, Seligman PJ, Newman SC, Timbrook CL. Occupational injuries due to violence. *J Occup Med.* 1988 Jun;30(6):483-7.

<sup>32</sup> Wintemute GJ. Homicide, handguns, and the crime gun hypothesis: firearms used in fatal shootings of law enforcement officers, 1980 to 1989. *Am J Public Health.* 1994 Apr;84(4):561-4.

of the program. Research is needed to remove barriers to an effective program and develop methods to simplify the program.

### ***Improve Existing PPE***

Hazard reduction with the use of PPE to protect the services sector workers needs continuous attention, not only to improve the protective technologies but also to improve the proper use and care for these technologies. Known hazards and PPE include the following (Also see Appendix 2):

- Lung and respiratory protection (inhalation) – dust, chemicals, fumes, aerosols
- Whole body protection – air supplied suit, encapsulating suit
- Skin and dermal protection – protective clothing and garments around toxic and irritating chemicals, heat, hot metal, flame-retardant clothing, cold
- Ionizing radiation protection – protective clothing, air supplied respirators, personal detection devices
- Electromagnetic radiation – electromagnetic radiation suit
- Hand protection – gloves, barrier creams, hand leathers, and arm protectors
- Foot protection – safety shoes and boots with non-slip soles and heels
- Head and hair protection – hard hats, hair nets, cold protection
- Eye and vision protection – protective eyewear, welding helmets, laser protection (with caution)
- Hearing protection – acoustic earmuffs and plugs
- Electrical protection – insulated gloves, clothing, tools
- Body loads or impacts – shoulder pads, padded aprons, shin guards, knee pads, gloves
- Fall protection – lifelines, body support
- Occupant restraints – seatbelts
- Bullet-proof gear – bullet proof vests
- Musculoskeletal protection – low force grip gloves, attached knee and sitting support, (back belts?)

## **4. Who are our partners?**

### ***PPE Industry***

A significant partner in PPE research is the PPE manufacturing and marketing industry. As an example, NIOSH held a meeting for all respirator manufacturers on December 12, 2005, at the NIOSH site in Pittsburgh, Pennsylvania. The meeting addressed replacement rates, and alternatives to the silica dust tests for powered, air-purifying respirators, labeling for filtering face piece respirators, and other topics and included a Standard Application Procedures Workshop. Manufacturer representatives attended. One organization representing this industry is the International Safety Equipment Association.

NIOSH approval under its program will signify that a self-contained breathing apparatus is expected to provide needed protection to first responders in situations where an act of terror has released harmful chemicals, pathogens, or radioactive materials into the air. Approvals will be based on positive results from rigorous tests on sample units submitted to NIOSH by manufacturers, and from stringent evaluation of manufacturers' quality-control practices,

technical specifications, and other documentation. These positive results will demonstrate that the device provides the required level of protection against chemical, biological, radiological, and nuclear agents.<sup>33</sup>

### **Professional and Standard-setting Organizations**

Professional organizations also provide viable partners in PPE research. These include the National Safety Council, 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 standards that apply to the services sector industry workers are listed in Appendix 2. Other organizations that affect standard setting include the following.

- International Association of Chiefs of Police
- International Association of Fire Chiefs
- National Emergency Managers Association
- Interagency Board for Equipment Standardization and Interoperability
- Council of State and Territorial Epidemiology
- Association of Occupational and Environmental Clinics
- Network of Employers for Traffic Safety National Truck Equipment Association, Ambulance Manufacturers Division
- Risk Management and Decision Processes Center (The Risk Center), Wharton School, University of Pennsylvania

### **Governmental Agencies**

Another partner is the Occupational Safety and Health Administration (OSHA)<sup>34</sup> with its agreements with industrial entities such as through its Alliances Program. The National Science Foundation is another potential partner as it funds collaborative university-business programs. Important research regarding PPE is also performed by the Defense Advanced Research Projects Agency of the Department of Defense, the Department of Energy, and the Department of Homeland Security. European Union Directives development also provides opportunities for collaboration.

PPE used in the outer space environment should help in designing PPE ensembles. A detailed CAD model of the U.S. Space Shuttle Spacesuit, developed by the National Aeronautics and Space Administration (NASA) is used to represent the directional shielding of an astronaut; it has detailed helmet and backpack structures, hard upper torso, and multilayer space suit fabric material. The NASA Computerized Anatomical Male and Female models are used in conjunction with the space suit CAD model for dose evaluation within the human body.<sup>35</sup> Other government agencies with a potential for partnerships include the following:

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<sup>33</sup> <http://www.cdc.gov/niosh/npptl/scbacert.html>

<sup>34</sup> Wallace WJ. Performing the PPE Hazard Analysis. *Occupational Safety and Health*. 2005;74(12):60, 62.

<sup>35</sup> De Angelis G, Anderson BM, Atwell W, Nealy JE, Qualls GD, Wilson JW. Astronaut EVA exposure estimates from CAD model spacesuit geometry. *J Radiat Res (Tokyo)*. 2004 Mar;45(1):1-9.

- National Institute of Justice, U.S. Department of Justice.
- U.S. Bureau of Labor Statistics (BLS).
- U.S. Departments of Defense and Justice's Interagency Board for Equipment Standardization and Interoperability
- U.S. Army Soldier and Biological Chemical Command
- USDA Forest Service
- National Interagency Fire Center
- Uniformed Services University of the Health Sciences
- U.S. Fire Administration
- National Institute of Standards and Technology, Department of Commerce
- Inter-Agency Board for Equipment Standardization and InterOperability

## **Unions**

Unions that represent workers in the wholesale and retail trade industries include the following:

- American Federation of Labor-Congress of Industrial Unions
  - Center to Protect Workers' Rights
  - Industry Coordinating Committee Covering the Arts, Entertainment, Media and Telecommunications Industries
- Service Employees International Union
- Laborers' International Union of North America
- Communications Workers of America
- International Association of Fire Fighters
- American Federation of State, County and Municipal Employees
- American Federation of Government Employees
- National Fire Protection Association
- Screen Actors Guild
- Actors' Equity Association
- American Federation of Musicians
- American Federation of Television and Radio Artists
- International Alliance of Theatrical Stage Employees
- International Brotherhood of Electrical Workers
- National Association of Broadcast Employees and Technicians
- The Newspaper Guild
- Writers Guild of America

## **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.<sup>36</sup> Communications are an important adjunct to the PPE ensemble as well.

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36 Groves WA, Ramani RV, Radomsky MC, Flick JP. Protecting First Responders: Analysis of PPE Guidelines Distributed at the World Trade Center and Pentagon Disaster Sites. *Professional Safety*. 2004;49(11):31-41.

## **First Decade NORA Priorities**

An original NORA priority addressed PPE. That 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.

## **Training**

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.<sup>37</sup> Safety signs have been found to be ineffective in encouraging the donning of PPE.<sup>38</sup> An example of a need is to understand the differences between primary and secondary clothing. Primary clothing is used when the exposure is significant, e.g., molten substance splashes, radiant heat and flame. Secondary protective clothing is designed for continuous wear.<sup>39</sup> Failures or deficiencies in hearing conservation programs can often be traced

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37 Schroll RC. Emergency Response Training: How to Plan, Conduct, and Evaluate for Success. *Professional Success*. 2002;47(12):16-21.

38 Young SL, Franz JP, Rhoades TP, Darnell KR. Safety Signs and Labels. *Professional Safety*. 2002;47(9):18-23.

39 Gojdics R. Personal protective clothing: purchasing flame-resistant secondary clothing. *Professional Safety*. 2002;47(10):56-57.

to inadequacies in the training and education of noise-exposed employees and those who conduct elements 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 unfeasible.
- 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 the national deployment of PPE technologies.
- Partnerships will be leveraged to address the threat of uncontrolled hazards, especially the threat of terrorist attacks.
- 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 services sector workplaces from small fabrication shops to large factories, mills, or processing plants in America. 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 the tracking of 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 inspection reports regarding the services sector to identify 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 also involves international collaboration in PPE standards as well as with partners from government and industry.

***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 in the workplace. PPE must be designed and made available to properly fit and protect the growing numbers of adolescent, female, minority, and disabled workers. 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, 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., barrier creams, extra-skeletal braces, personal detection monitors, armor, personal restraints.*

■ *Investigation of test methods for PPE effectiveness for different anthropomorphic characteristics.*

■ *Investigation of the potential of PPE interdiction to protect service workers from injury that results from violent acts.*

#### **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.***

***Goal: To learn about training and education needs to through meetings, conferences, and symposia.***

***Goal: To design training programs specific to special populations such as youth.***

## **Appendix 1: Services' Subsectors Descriptions**

### **511 Publishing Industries (except Internet)**

Industries in the Publishing Industries (except Internet) subsector group establishments engaged in the publishing of newspapers, magazines, other periodicals, and books, as well as directory and mailing list and software publishing. Works may be in one or more formats including traditional print form, CD-ROM, or proprietary electronic networks. Software publishing is included here because the activity, creation of a copyrighted product and bringing it to market, is equivalent to the creation process for other types of intellectual products. Publishing the reporting, writing, editing, and other processes that are required to create an edition of a newspaper is treated as a major economic activity, rather than as a subsidiary activity to a manufacturing activity, printing.

### **512 Motion Picture and Sound Recording Industries**

Industries in the Motion Picture and Sound Recording Industries subsector group establishments involved in the production and distribution of motion pictures and sound recordings. While producers and distributors of motion pictures and sound recordings issue works for sale as traditional publishers do, the processes are sufficiently different to warrant placing establishments engaged in these activities in a separate subsector. Production is typically a complex process that involves several distinct types of establishments that are engaged in activities, such as contracting with performers, creating the film or sound content, and providing technical postproduction services. Film distribution is often to exhibitors, such as theaters and broadcasters, rather than through the wholesale and retail distribution chain.

### **515 Broadcasting (except Internet)**

Industries in the Broadcasting (except Internet) subsector include establishments that create content or acquire the right to distribute content and subsequently broadcast the content. The industry groups (Radio and Television Broadcasting and Cable and Other Subscription Programming) are based on differences in the methods of communication and the nature of services provided. The Radio and Television Broadcasting industry group includes establishments that operate broadcasting studios and facilities for over the air or satellite delivery of radio and television programs of entertainment, news, talk, and the like. These establishments are often engaged in the production and purchase of programs and generating revenues from the sale of air time to advertisers and from donations, subsidies, and/or the sale of programs. The Cable and Other Subscription Programming industry group includes establishments operating studios and facilities for the broadcasting of programs that are typically narrowcast in nature.

### **516 Internet Publishing and Broadcasting**

Industries in the Internet Publishing and Broadcasting subsector group establishments that publish and/or broadcast content exclusively for the Internet. The unique combination of text,

audio, video, and interactive features present in informational or cultural products on the Internet justifies the separation of Internet publishers and broadcasters from more traditional publishers.

### **517 Telecommunications**

Industries in the Telecommunications subsector include establishments providing telecommunications and the services related to that activity. The Telecommunications subsector is primarily engaged in operating, maintaining, and/or providing access to facilities for the transmission of voice, data, text, sound, and video. A transmission facility may be based on a single technology or a combination of technologies.

### **518 Internet Service Providers, Web Search Portals, and Data Processing Services**

Industries in the Internet Service Providers, Web Search Portals, and Data Processing Services subsector group establishments that provide: (1) access to the Internet; (2) search facilities for the Internet; and (3) data processing, hosting, and related services. The industry groups (Internet Service Providers and Web Search Portals, Data Processing Hosting, and Related Services) are based on differences in the processes used to access information and process information. The Internet Service Providers and Web Search Portals industry group includes establishments that are providing access to the Internet or aiding in navigation on the Internet. The Data Processing, Hosting, and Related Services industry group includes establishments that process data. These establishments can transform data, prepare data for dissemination, or place data or content on the Internet for others.

### **519 Other Information Services**

Industries in the Other Information Services subsector group establishments supplying information, storing information, providing access to information, and searching and retrieving information. The main components of the subsector are news syndicates, libraries, and archives.

### **521 Monetary Authorities-Central Bank**

The Monetary Authorities-Central Bank subsector groups establishments that engage in performing central banking functions, such as issuing currency, managing the Nation's money supply and international reserves, holding deposits that represent the reserves of other banks and other central banks, and acting as a fiscal agent for the central government.

### **522 Credit Intermediation and Related Activities**

Industries in the Credit Intermediation and Related Activities subsector group establishments that (1) lend funds raised from depositors; (2) lend funds raised from credit market borrowing; or (3) facilitate the lending of funds or issuance of credit by engaging in such activities as mortgage and loan brokerage, clearinghouse and reserve services, and check cashing services.

## **523 Securities, Commodity Contracts, and Other Financial Investments and Related Activities**

Industries in the Securities, Commodity Contracts, and Other Financial Investments and Related Activities subsector group establishments that are primarily engaged in one of the following: (1) underwriting securities issues and/or making markets for securities and commodities; (2) acting as agents (i.e., brokers) between buyers and sellers of securities and commodities; (3) providing securities and commodity exchange services; and (4) providing other services, such as managing portfolios of assets; providing investment advice; and trust, fiduciary, and custody services.

## **524 Insurance Carriers and Related Activities**

Industries in the Insurance Carriers and Related Activities subsector group establishments that are primarily engaged in one of the following: (1) underwriting (assuming the risk, assigning premiums, and so forth) annuities and insurance policies or (2) facilitating such underwriting by selling insurance policies, and by providing other insurance and employee-benefit related services.

## **525 Funds, Trusts, and Other Financial Vehicles**

Industries in the Funds, Trusts, and Other Financial Vehicles subsector are comprised of legal entities (i.e., funds, plans, and/or programs) organized to pool securities or other assets on behalf of shareholders or beneficiaries of employee benefit or other trust funds. The portfolios are customized to achieve specific investment characteristics, such as diversification, risk, rate of return, and price volatility. These entities earn interest, dividends, and other property income, but have little or no employment and no revenue from the sale of services.

## **531 Real Estate**

Industries in the Real Estate subsector group establishments that are primarily engaged in renting or leasing real estate to others; managing real estate for others; selling, buying, or renting real estate for others; and providing other real estate related services, such as appraisal services.

## **532 Rental and Leasing Services**

Industries in the Rental and Leasing Services subsector include establishments that provide a wide array of tangible goods, such as automobiles, computers, consumer goods, and industrial machinery and equipment, to customers in return for a periodic rental or lease payment. The subsector includes two main types of establishments: (1) those that are engaged in renting consumer goods and equipment and (2) those that are engaged in leasing machinery and equipment often used for business operations. The first type typically operates from a retail-like or store-front facility and maintains inventories of goods that are rented for short periods of time. The latter type typically does not operate from retail-like locations or maintain inventories, and offers longer term leases. These establishments work directly with clients to enable them to acquire the use of equipment on a lease basis, or they work with equipment vendors or dealers to support the marketing of equipment to their customers under lease arrangements. Equipment

lessors generally structure lease contracts to meet the specialized needs of their clients and use their remarketing expertise to find other users for previously leased equipment. Establishments that provide operating and capital (i.e., finance) leases are included in this subsector.

### **533 Lessors of Nonfinancial Intangible Assets (except Copyrighted Works)**

Industries in the Lessors of Nonfinancial Intangible Assets (except Copyrighted Works) subsector include establishments that are primarily engaged in assigning rights to assets, such as patents, trademarks, brand names, and/or franchise agreements for which a royalty payment or licensing fee is paid to the asset holder. Establishments in this subsector own the patents, trademarks, and/or franchise agreements that they allow others to use or reproduce for a fee and may or may not have created those assets. Establishments that allow franchisees the use of the franchise name, contingent on the franchisee buying products or services from the franchisor, are classified elsewhere.

### **541 Professional, Scientific, and Technical Services**

Industries in the Professional, Scientific, and Technical Services subsector group establishments engaged in processes where human capital is the major input. These establishments make available the knowledge and skills of their employees, often on an assignment basis, where an individual or team is responsible for the delivery of services to the client. The individual industries of this subsector are defined on the basis of the particular expertise and training of the services provider. The distinguishing feature of the Professional, Scientific, and Technical Services subsector is that most of the industries grouped in it have production processes that are almost wholly dependent on worker skills. In most of these industries, equipment and materials are not of major importance, unlike health care, for example, where "high tech" machines and materials are important collaborating inputs to labor skills in the production of health care. Thus, the establishments classified in this subsector sell expertise.

### **551 Management of Companies and Enterprises**

Industries in the Management of Companies and Enterprises subsector include three main types of establishments: (1) those that hold the securities of (or other equity interests in) companies and enterprises; (2) those (except government establishments) that administer, oversee, and manage other establishments of the company or enterprise but do not hold the securities of these establishments; and (3) those that both administer, oversee, and manage other establishments of the company or enterprise and hold the securities of (or other equity interests in) these establishments. Those establishments that administer, oversee, and manage normally undertake the strategic or organizational planning and decision-making role of the company or enterprise.

### **561 Administrative and Support Services**

Industries in the Administrative and Support Services subsector group establishments engaged in activities that support the day-to-day operations of other organizations. The processes employed in this sector (e.g., general management, personnel administration, clerical activities, cleaning activities) are often integral parts of the activities of establishments found in all sectors of the

economy. The establishments classified in this subsector have specialized in one or more of these activities and can, therefore, provide services to clients in a variety of industries and, in some cases, to households. The individual industries of this subsector are defined on the basis of the particular process that they are engaged in and the particular services they provide. Many of the activities performed in this subsector are ongoing routine support functions that all businesses and organizations must do and that they have traditionally done for themselves. Recent trends, however, are to contract or purchase such services from businesses that specialize in such activities and can, therefore, provide the services more efficiently. The industries in this subsector cannot be viewed as strictly "support." The Travel Arrangement and Reservation Services industry group, includes travel agents, tour operators, and providers of other travel arrangement services, such as hotel and restaurant reservations and arranging the purchase of tickets, serves many types of clients, including individual consumers. This group was placed in this subsector because the services are often of the "support" nature (e.g., travel arrangement) and businesses and other organizations are increasingly the ones purchasing such services. The administrative and management activities performed by establishments in this sector are typically on a contract or fee basis. These activities may also be performed by establishments that are part of the company or enterprise.

## **562 Waste Management and Remediation Services**

Industries in the Waste Management and Remediation Services subsector group establishments engaged in the collection, treatment, and disposal of waste materials. This includes establishments engaged in local hauling of waste materials; operating materials recovery facilities (i.e., those that sort recyclable materials from the trash stream); providing remediation services (i.e., those that provide for the cleanup of contaminated buildings, mine sites, soil, or ground water); and providing septic pumping and other miscellaneous waste management services.

## **611 Educational Services**

Industries in the Educational Services subsector provide instruction and training in a wide variety of subjects. The instruction and training is provided by specialized establishments, such as schools, colleges, universities, and training centers. The subsector is structured according to level and type of educational services. Elementary and secondary schools, junior colleges and colleges, universities, and professional schools correspond to a recognized series of formal levels of education designated by diplomas, associate degrees (including equivalent certificates), and degrees. The remaining industry groups are based more on the type of instruction or training offered and the levels are not always as formally defined. The establishments are often highly specialized, many offering instruction in a very limited subject matter, for example ski lessons or one specific computer software package. Within the sector, the level and types of training that are required of the instructors and teachers vary depending on the industry. Establishments that manage schools and other educational establishments on a contractual basis are classified in this subsector if they both manage the operation and provide the operating staff. Such establishments are classified in the educational services subsector based on the type of facility managed and operated.

## **711 Performing Arts, Spectator Sports, and Related Industries**

Industries in the Performing Arts, Spectator Sports, and Related Industries subsector group establishments that produce or organize and promote live presentations involving the performances of actors and actresses, singers, dancers, musical groups and artists, athletes, and other entertainers, including independent (i.e., freelance) entertainers and the establishments that manage their careers. The classification recognizes four basic processes: (1) producing (i.e., presenting) events; (2) organizing, managing, and/or promoting events; (3) managing and representing entertainers; and (4) providing the artistic, creative and technical skills necessary to the production of these live events. Also, this subsector contains four industries for performing arts companies. Each is defined on the basis of the particular skills of the entertainers involved in the presentations. The industry structure for this subsector makes a clear distinction between performing arts companies and performing artists (i.e., independent or freelance). Although not unique to arts and entertainment, freelancing is a particularly important phenomenon in this Performing Arts, Spectator Sports, and Related Industries subsector. Distinguishing this activity from the production activity is a meaningful process differentiation. This approach, however, is difficult to implement in the case of musical groups (i.e., companies) and artists, especially pop groups. These establishments tend to be more loosely organized, and it can be difficult to distinguish companies from freelancers.

## **712 Museums, Historical Sites, and Similar Institutions**

Industries in the Museums, Historical Sites, and Similar Institutions subsector engage in the preservation and exhibition of objects, sites, and natural wonders of historical, cultural, and/or educational value.

## **713 Amusement, Gambling, and Recreation Industries**

Industries in the Amusement, Gambling, and Recreation Industries subsector (1) operate facilities where patrons can primarily engage in sports, recreation, amusement, or gambling activities and/or (2) provide other amusement and recreation services, such as supplying and servicing amusement devices in places of business operated by others; operating sports teams, clubs, or leagues engaged in playing games for recreational purposes; and guiding tours without using transportation equipment. This subsector does not cover all establishments providing recreational services.

## **721 Accommodation**

Industries in the Accommodation subsector provide lodging or short-term accommodations for travelers, vacationers, and others. There is a wide range of establishments in these industries. Some provide lodging only; while others provide meals, laundry services, and recreational facilities, as well as lodging. Lodging establishments are classified in this subsector even if the provision of complementary services generates more revenue. The types of complementary services provided vary from establishment to establishment. The subsector is organized into three industry groups: (1) traveler accommodation, (2) recreational accommodation, and (3) rooming and boarding houses. The Traveler Accommodation industry group includes

establishments that primarily provide traditional types of lodging services. This group includes hotels, motels, and bed and breakfast inns. In addition to lodging, these establishments may provide a range of other services to their guests. The RV (Recreational Vehicle) Parks and Recreational Camps industry group includes establishments that operate lodging facilities primarily designed to accommodate outdoor enthusiasts. Included are travel trailer campsites, recreational vehicle parks, and outdoor adventure retreats. The Rooming and Boarding Houses industry group includes establishments providing temporary or longer-term accommodations, which for the period of occupancy, may serve as a principal residence. Board (i.e., meals) may be provided but is not essential. Establishments that manage short-stay accommodation establishments (e.g., hotels and motels) on a contractual basis are classified in this subsector if they both manage the operation and provide the operating staff. Such establishments are classified based on the type of facility managed and operated.

## **722 Food Services and Drinking Places**

Industries in the Food Services and Drinking Places subsector prepare meals, snacks, and beverages to customer order for immediate on-premises and off-premises consumption. There is a wide range of establishments in these industries. Some provide food and drink only; while others provide various combinations of seating space, waiter/waitress services and incidental amenities, such as limited entertainment. The industries in the subsector are grouped based on the type and level of services provided. The industry groups are full-service restaurants; limited-service eating places; special food services, such as food service contractors, caterers, and mobile food services; and drinking places. Food services and drink activities at hotels and motels; amusement parks, theaters, casinos, country clubs, and similar recreational facilities; and civic and social organizations are included in this subsector only if these services are provided by a separate establishment primarily engaged in providing food and beverage services.

## **811 Repair and Maintenance**

Industries in the Repair and Maintenance subsector restore machinery, equipment, and other products to working order. These establishments also typically provide general or routine maintenance (i.e., servicing) on such products to ensure they work efficiently and to prevent breakdown and unnecessary repairs.

## **812 Personal and Laundry Services**

Industries in the Personal and Laundry Services subsector group establishments that provide personal and laundry services to individuals, households, and businesses. Services performed include: personal care services; death care services; laundry and dry cleaning services; and a wide range of other personal services, such as pet care (except veterinary) services, photofinishing services, temporary parking services, and dating services. The Personal and Laundry Services subsector is not all-inclusive of the services that could be termed personal services (i.e., those provided to individuals rather than businesses).

## **813 Religious, Grant-making, Civic, Professional, and Similar Organizations**

Industries in the Religious, Grant-making, Civic, Professional, and Similar Organizations subsector group establishments that organize and promote religious activities; support various causes through grant-making; advocate various social and political causes; and promote and defend the interests of their members. The industry groups within the subsector are defined in terms of their activities, such as establishments that provide funding for specific causes or for a variety of charitable causes; establishments that advocate and actively promote causes and beliefs for the public good; and establishments that have an active membership structure to promote causes and represent the interests of their members. Establishments in this subsector may publish newsletters, books, and periodicals, for distribution to their membership.

### **814 Private Households**

Industries in the Private Households subsector include private households that engage in employing workers on or about the premises in activities primarily concerned with the operation of the household. These private households may employ individuals, such as cooks, maids, and butlers, and outside workers, such as gardeners, caretakers, and other maintenance workers.

### **921 Executive, Legislative, and Other General Government Support**

The Executive, Legislative, and Other General Government Support subsector groups offices of government executives, legislative bodies, public finance and general government support.

### **922 Justice, Public Order, and Safety Activities**

The Justice, Public Order, and Safety Activities subsector groups government establishments engaged in the administration of justice, public order, and safety programs.

### **923 Administration of Human Resource Programs**

The Administration of Human Resource Programs subsector groups government establishments primarily engaged in the administration of human resource programs.

### **924 Administration of Environmental Quality Programs**

The Administration of Environmental Quality Programs subsector groups government establishments primarily engaged in the administration of environmental quality.

### **925 Administration of Housing Programs, Urban Planning, and Community Development**

The Administration of Housing Programs, Urban Planning, and Community Development subsector groups government establishments primarily engaged in the administration of housing, urban planning, and community development.

### **926 Administration of Economic Programs**

This subsector comprises government establishments primarily engaged in the administration of economic programs.

### **927 Space Research and Technology**

This subsector group comprises government establishments that conduct space research.

### **928 National Security and International Affairs**

This subsector comprises government establishments primarily engaged in national security and international affairs.

## **Appendix 2: Applicable Standards and Standards Setting Organizations**

### *U.S. Department of Human Services*

NIOSH

42 CFR PART 84, Approval of respiratory protective devices

### *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

1910.136 – Foot protection

1910.138 – Hand protection

1910.137, 335 – Electrical workers' clothing and equipment

1910.146 – Permit-required confined spaces

1910.156 – Fire brigades

1910.1001 – Asbestos

1910.1018 -- Inorganic arsenic

1910.1025 – Lead

1910.1027 – Cadmium

1910.1028 – Benzene

1910.1030 – Bloodborne pathogens

1910.1044 – 1,2-Dibromo-3-chloropropane

1910.1045 – Acrylonitrile

1910.1047 – Ethylene oxide

1910.1048 – Formaldehyde

1910.1050 – Methylenedianiline

1910.1051 – 1,3-Butadiene

1910.1052 – Methylene chloride

29 CFR 1920.120 – Hazardous Waste Operations and Emergency Response (HAZWOPER)

### *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 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 Z49.1:2005, Safety in Welding and Cutting

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 Z136.1, Laser Safety Standards

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  
ASTM F1959 Standard Test Method for Determining the Arc Thermal Performance Value of Material for Clothing  
ASTM 1930 Standard Test Method for Evaluation of Flam-Resistant Clothing for Flash Fire Simulations Using Instrumented Manikins  
ASTM F955 Standard Test Method for Evaluating Heat Transfer through Materials for Protective Clothing Upon Contact with Molten Substances  
International Organization for Standardization  
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 mitts  
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 13.340.99 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 6161:1981 Personal eye-protectors, Filters and eye-protectors against laser radiation  
ISO 8194:1987 Radiation protection, Clothing for protection against radioactive contamination, Design, selection, testing and use  
American Conference of Governmental Industrial Hygienists  
Guidelines for Selection of Chemical Protective Clothing, 1987  
A Guide for Control of Laser Hazards, 1990  
National Fire Protection Association  
NFPA 1951 Standard on Protective Ensemble for USAR Operations  
NFPA 1971 Standard on Protective Ensemble for Structural/Proximity Fire Fighting  
NFPA 1975 Standard on Station/Work Uniforms for Fire and Emergency Services  
NFPA 1977 Standard on Protective Clothing and Equipment for Wildland Fire Fighting

NFPA 1981 Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services

NFPA 1982 Standard on Personal Alert Safety Systems (PASS)

NFPA 1983 Standard on Fire Service Life Safety Rope and System Components

NFPA 1991 Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies

NFPA 1992 Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies

NFPA 1994 Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents

NFPA 1999 Standard on Protective Clothing for Emergency Medical Operations

NFPA 2112 Standard on Flame Resistant Garments for Protection of Industrial Personnel against Flash Fire

Underwriters Laboratory

UL Standard 752, bulletproof vests

U.S. National Institute of Justice

Bulletproof vests