National Strategy for Personal Protective Technologies Research for the Wholesale and Retail Trade 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 Wholesale and Retail Trade 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.[1] NPPTL focuses expertise from many scientific disciplines to advance federal research on respirators and other personal protective technologies for workers. NPPTL's efforts are essential for applying state-of-the-art science to meet the increasingly complex occupational safety and health challenges of the 21st Century. NPPTL's strategic research program ensures that the development of new PPE keeps pace with employer and worker needs as work settings and worker populations change and new technologies emerge. NPPTL research also responds to the need for effective protective technologies for first responders in terrorist events and other disasters. NPPTL incorporates NIOSH's longstanding program for testing and approving respirators for use in traditional work settings.

The 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 protective technology standards.

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[1] *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*,

The wholesale and retail trade sectors are made up of two parts: the wholesale trade sector, and the retail trade sector. The wholesale and retail trade sectors are particularly sensitive to changes in technology, global trade, business practices, and consumer tastes. Stresses of jobs include unplanned overtime, long workdays, and shift work, all of which can adversely impact the well being of the 21 million workers in these sectors.

Wholesale Trade

The Wholesale Trade sector comprises establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The merchandise described in this sector includes the outputs of agriculture, mining, manufacturing, and certain information industries, such as publishing. The wholesaling process is an intermediate step in the distribution of merchandise. Wholesalers sell merchandise to other businesses and normally operate from a warehouse or office. This sector comprises two main types of wholesalers: merchant wholesalers that sell goods on their own account and business to business electronic markets, agents, and brokers that arrange sales and purchases for others generally for a commission or fee. Some wholesale establishments may be connected with a single manufacturer and promote and sell the particular manufacturers' products to a wide range of other wholesalers or retailers. Other wholesalers may be connected to a retail chain, or limited number of retail chains, and only provides a variety of products needed by that particular retail operation(s). Still other wholesalers may not take title to the goods, but act as agents and brokers for a commission.

In 2004, wholesale trade accounted for 5.7 million jobs. More than 193,000 wholesale trade workers were self-employed, while approximately 90% of wholesale trade establishments employ less than 20 workers. Approximately 36% of all wholesale trade workers work in establishments that employ less than 20 workers. Consolidation also is expected to create fewer and larger companies.

Retail Trade

The Retail Trade sector comprises establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The retailing process is the final step in the distribution of merchandise; retailers are, therefore, organized to sell merchandise in small quantities to the general public. This sector comprises two main types of retailers: store and nonstore retailers. Store retailers operate fixed point-of-sale locations, located and designed to attract a high volume of walk-in customers. Nonstore retailers are organized to serve the general public, but they reach customers and market merchandise with methods, such as the broadcasting of "infomercials," the broadcasting and publishing of direct-response advertising, the publishing of paper and electronic catalogs, door-to-door solicitation, in-home demonstration, selling from portable stalls (street vendors, except food), and distribution through vending machines. Establishments engaged in the direct sale (nonstore) of products, such as home heating oil dealers and home delivery newspaper routes are included.

In 2005, retail trade accounted for 1.4 million retail establishments, more than 23 million workers, and $4.4 trillion in sales. The Retail Trade sector has a diverse mix of jobs, ranging from cashier to stock handler. The most common occupation in retail trade is retail salespersons. There were 3,937,540 retail salespersons in retail trade; their average annual wages were

$22,720. Workers in retail trade are increasingly contract, temporary, and part-time workers. Their education level is low and their turnover rate is high. In 2004, average weekly earnings were $371 for retail workers compared with $529 for the entire workforce. In 2004, 31% of retail workers were under 24 years of age compared with 14% for all industries. In retail industry, 3,637 homicides (46% of all homicides) took place from 1992 to 2001. Increasing competition from large discount stores and supercenters will either force smaller stores to sell out to larger ones, or encourage them to become more efficient by adopting new technologies and procedures.

Assessment

1. Who is most at risk?

The wholesale trade industry is comprised of three subsectors as shown in Table 1, and the retail trade sector is comprised of 12 subsectors. Of these twelve subsectors, the first 11 comprise store-based operations whereas the twelfth one includes nonstore retailers. All of the subsectors in these two sectors are described in Appendix 1.

Table 1. List of Wholesale and Retail Trade Sectors

Code*	Wholesale and Retail Trade Sectors	Employment June 2005	Rates, 2004‡ injury	illness
423	Merchant Wholesalers, Durable Goods	2,990,800	4.0	**14.7**
424	Merchant Wholesalers, Nondurable Goods	2,022,100	**5.5**	12.9
425	Wholesale Electronic Markets and Agents and Brokers	735,000	2.8	7.6
42	**WHOLESALE TRADE**	**5,747,900**	4.4	13.2
441	Motor Vehicle and Parts Dealers	1,918,800	5.0	13.4
442	Furniture and Home Furnishings Stores	575,800	**5.6**	9.3
443	Electronics and Appliance Stores	531,100	3.1	4.8
444	Building Material and Garden Equipment & Supplies Dealers	1,271,700	**8.0**	12.8
445	Food and Beverage Stores	2,822,100	**6.2**	**16.3**
446	Health and Personal Care Stores	955,100	2.2	8.1
447	Gasoline Stations	869,000	3.4	5.5
448	Clothing and Clothing Accessories Stores	1,410,900	2.5	3.1
451	Sporting Goods, Hobby, Book, and Music Stores	644,100	3.8	8.3
452	General Merchandise Stores	2,920,600	**6.7**	**28.7**
453	Miscellaneous Store Retailers	905,200	3.1	12.0
454	Nonstore Retailers	431,900	4.6	**23.0**
44-45	**RETAIL TRADE**	**15,256,300**	5.1	14.5

* North American Industry Classification System (NAICS)
‡ injury rates per 100 employees/yr; illness rates per 10,000 employees/yr

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 those subsectors of the wholesale and retail trade industry that exceed average injury and illness rates for their respective sectors.

Injuries

More than 21 million workers in wholesale and retail trade are at risk for fatal and nonfatal injuries. In 2004, approximately 843,000 workers were injured at work in performing their jobs. Approximately 60% were severe enough to require days away from work, job transfer, or restriction. The U.S. Bureau of Labor Statistics (BLS) data also suggests that the overall number

of injuries and fatalities may be attributed to a subset or subsector of high risk workplaces, such as mail order, home stores, or gasoline stations, etc. Young workers make up a significant part of the workforce in the wholesale and retail trade sectors. Overall, workers aged 16-19 have twice the injury rate of workers of all ages.

Merchant wholesalers of nondurable goods exceed the injury rate for the wholesale trade sector as sown in Table 1. Four subsectors of the retail trade sector exceeded the sector average: furniture and home furnishings stores, building material and garden equipment and supplies dealers, food and beverage stores, and general merchandise stores.

Illnesses

In the wholesale trade sector, the merchant wholesalers of durable goods exceeded the sector average for occupational illnesses. Three subsectors of the retail trade sectors exceeded the average illness rate of the sector: food and beverage stores, general merchandise stores, and nonstore retailers.

In a study, 33% of adults who had been enrolled in an HMO with workplace exacerbation of asthma were high for wholesale and retail trade.[2] Perchloroethylene (PERC), a potential human carcinogen, is the most commonly used dry cleaning solvent. Symptoms associated with exposure include: depression of the central nervous system; damage to the liver and kidneys; impaired memory; confusion; dizziness; headache; drowsiness; and eye, nose, and throat irritation. Repeated dermal exposure may result in dermatitis.[3]

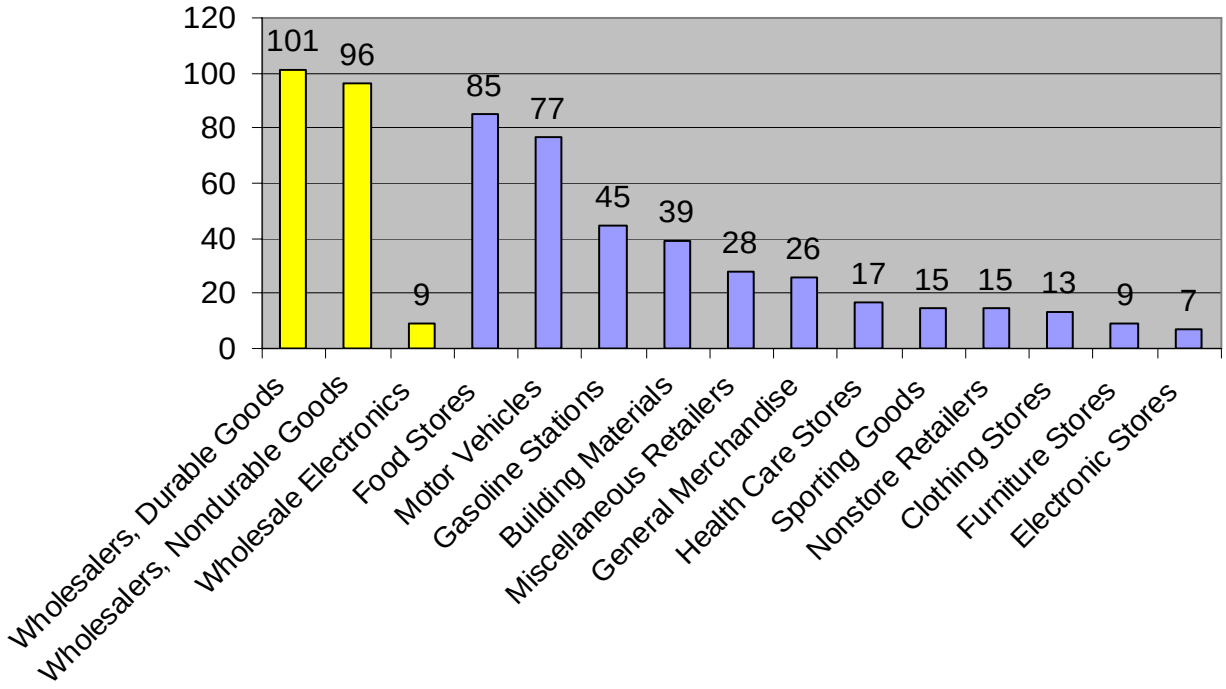
2. How serious is the issue?

Fatalities

The wholesale and retail trade sectors reported, respectively, 206 and 377 fatalities in 2004. The total of 583 fatalities in these two sectors represented 10% of all 5,764 occupational fatalities in the United States in 2004. The number of fatalities by three wholesale (by yellow bars) and twelve retail (by blue bars) subsectors are shown in Figure 1. In 2004, there were 575 fatalities in the wholesale and retail trade sector, more than any other BLS sector. A large number of the fatalities occurred in retail gas stations and convenience stores, jobs that employ young and often inexperienced workers.

[2] 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.
[3] http://www.osha.gov/SLTC/drycleaning/index.html

Figure 1. Fatalties by Wholesale and Retail Trade Subsector, 2004



Liquor stores had the highest work-related fatality rates in the retail industry. The two leading causes of death in the retail industry were violence (69.5%) and motor vehicle crashes (19.3%). Females, younger, minority, and foreign-born workers were more likely to be killed in retail than other industries. Deaths in the retail industry were more likely to be in small businesses, after normal business hours, and in urban settings.[4]

Days Off Work

A measure of the seriousness of an injury or illness is the number of days away from work. As shown in Table 2 and 3, the rate of injury and illness for both the wholesale and retail sectors nearly mirror the rate for all private industry across the spectrum of number of days away from work. The subsector, merchant wholesalers for nondurable goods, was above average for the wholesale trade sector across this spectrum of days away from work as shown in Table 2.

Table 2. Injury Rates* by Number of Days Away from Work for Wholesale Trade, 2004

Number of days away from work	Private industry	Wholesale Trade	Merchant Wholesalers, Durable Goods (423)	Merchant Wholesalers, Nondurable Goods (424)	Wholesale Electronic Markets & Agents & Brokers (425)
1 day	20.3	23.0	21.4	**28.6**	13.7
2 days	16.2	17.8	15.7	**23.2**	11.5
3-5 days	26.0	31.7	26.7	**40.8**	27.1
6-10 days	17.9	20.2	16.6	**29.2**	9.8

[4] Peek-Asa C, Erickson R, Kraus JF. Traumatic occupational fatalities in the retail industry, United States 1992-1996. Am J Ind Med. 1999 Feb;35(2):186-91.

11-20 days	16.1	16.1	14.2	**20.8**	10.9
21-30 days	9.6	9.3	8.6	**11.7**	5.5
> 30 days	35.3	33.5	28.4	**46.3**	18.3
Total:	141.3	151.7	131.7	**200.6**	96.9

*injuries and illnesses per 10,000 employees, 2004

Four subsectors in retail trade had above average totals of mean days away from work because of an injury or illness as shown in Table 3. Two of the subsectors had above average rates of the most severe cases as indicated by more than 30 days away from work: building material and garden equipment and supplies dealers, and food and beverage stores.

Table 3. Injury and Illness Rates* by Average Number of Days Off of Work in Retail Trade and Subsectors with Above Average Rates, 2004

Number of days away from work	Retail Trade	Above Average Injury and Illness Rate Subsectors			
		Furniture & Home Furnishings Stores (442)	Building Material & Garden Equipment & Supplies Dealers (444)	Food & Beverage Stores (445)	Nonstore Retailers (454)
1 day	22.8	**27.7**	**35.3**	23.0	**31.4**
2 days	18.9	13.8	**27.3**	**19.6**	**25.2**
3-5 days	29.1	**38.7**	**41.2**	**40.6**	**29.8**
6-10 days	19.2	**38.4**	**32.4**	**26.5**	18.5
11-20 days	15.2	**24.3**	**23.6**	**22.0**	13.0
21-30 days	10.7	**13.6**	**12.2**	**12.7**	7.7
> 30 days	35.1	34.6	**54.0**	**50.5**	34.2
Total:	150.9	**191.2**	**225.9**	**194.9**	**159.9**

*injuries and illnesses per 10,000 employees, 2004

While the incidence rates for both of these industry sectors remained relatively unchanged in 2004, the rate for retail trade (5.3 cases per 100 full- time workers) was significantly higher than the rate of 4.5 cases for wholesale trade and the rate of 4.8 cases for private industry as a whole. Within retail trade, the rate in only one of the subsectors, building material and garden supply stores, changed significantly in 2004, where the total recordable case rate rose from 6.4 to 8.1 cases per 100 full-time workers. Nearly all of this change was accounted for by an increase in the number of cases among home centers. The rate of injuries and illnesses for home centers rose from 7.2 cases per 100 full-time workers in 2003 to 10.4 cases in 2004. More than 99% of the reported increase in cases was injuries, and nearly 6 in 10 of these were cases that involved days away from work, job transfer, or restriction.

Nature of Injury and Illness

Table 4, shows the subsectors that had above average rates of injury and illness by the characteristic of nature of injury or illness. In wholesale trade, one subsector was above average, merchant wholesalers for nondurable goods. In retail trade, five subsectors were above average in these rates: 1. furniture and home furnishings stores; 2. building material and garden equipment and supplies dealers; 3. building material and garden equipment and supplies dealers; 4. food and beverage stores; and 5. nonstore retailers. Across these subsectors, sprains and strains represented the largest contribution to the higher rates. Moreover, fractures were high in three of

these subsectors, and cuts, lacerations, and punctures were high in another three subsectors as shown in Table 4.

Table 4. Injury Rates* by Nature of Injury and Illness for Wholesale and Retail Trade, 2004

Nature of injury, illness	Wholesale Trade	‡ Merchant Wholesalers, Nondurable Goods (424)	Retail Trade	Above Average Injury and Illness Rate Subsectors (‡) Furniture & Home Furnishings Stores (442)	Building Material & Garden Equipment & Supplies Dealers (444)	Food & Beverage Stores (445)	General Merchandise Stores (452)	Nonstore Retailers (454)
Sprains, strains	66.7	**95.6**	67.3	**89.5**	**109.9**	**84.1**	**83.3**	**70.4**
Fractures	11.8	**12.5**	10.0	9.5	**17.4**	**11.2**	**10.9**	9.4
Cuts, lacerations, punctures	11.8	8.5	14.9	**28.3**	**21.9**	**30.4**	13.7	4.9
Bruises, contusions	13.3	**18.5**	15.1	**20.9**	**20.6**	**21.0**	**21.8**	11.5
Heat burns	0.9	0.5	1.4	-	-	**3.0**	1.2	1.3
Chemical burns	0.6	**1.0**	0.9	-	0.9	0.7	**1.0**	**7.9**
Amputations	0.9	0.5	0.8	-	**2.5**	**2.3**	-	-
Carpal tunnel syndrome	1.5	1.1	1.8	1.4	1.0	**3.8**	1.3	**2.1**
Tendonitis	0.7	**1.2**	0.8	-	-	**1.6**	**0.9**	-
Multiple injuries	5.5	**8.2**	5.3	4.2	**8.1**	**7.2**	**6.0**	**9.0**
with fractures	0.9	0.8	0.7	-	**1.3**	**1.1**	0.7	-
with sprains	1.7	**2.1**	2.6	2.6	**2.7**	**4.5**	2.5	**7.1**
Soreness, Pain	15.1	**24.7**	12.2	**14.2**	**14.3**	11.5	**24.2**	10.0
back pain	6.2	**10.6**	4.2	**5.3**	**5.3**	3.7	**7.5**	**5.1**
All other	22.9	**28.4**	20.3	**22.6**	**28.5**	18.1	**26.9**	**32.5**
Total:	151.7	**200.6**	150.9	**191.2**	**225.9**	**194.9**	**191.2**	**159.9**

*injuries and illnesses per 10,000 employees, 2004

Part of Body Affected

The same subsectors as discussed above were also above average for injuries and illnesses regarding part of body affected—an important characteristic for PPE determination. The trunk was prominent as a part of the body injured, and within it, the back was prominent. Lower extremities were also a frequent location for injury. The head was an above average injury rate location for four of the subsectors.

Table 5. Injury Rates* by Part of Body Affected for Wholesale and Retail Trade, 2004

Part of Body Affected	Wholesale Trade	‡ Merchant Wholesalers, Nondurable Goods (424)	Retail Trade	Above Average Injury and Illness Rate Subsectors (‡) Furniture & Home Furnishings Stores (442)	Building Material & Garden Equipment & Supplies Dealers (444)	Food & Beverage Stores (445)	General Merchandise Stores (452)	Nonstore Retailers (454)
Head	8.6	**9.2**	9.1	**12.4**	**12.5**	7.7	**13.2**	5.0
eye	3.4	3.4	3.4	1.6	**5.0**	2.7	**3.8**	2.7
Neck	2.5	**2.8**	2.8	**2.9**	**3.7**	2.1	**4.9**	1.0
Trunk	60.5	**83.9**	56.5	**82.9**	**86.0**	**68.0**	**71.6**	**69.0**
back	41.6	**56.9**	36.1	**56.2**	**55.7**	**42.2**	**46.9**	**39.0**
shoulder	8.5	**12.7**	10.1	**11.0**	**13.9**	**15.4**	**11.2**	9.0
Upper extremities	26.7	26.5	32.9	**35.4**	**43.2**	**58.2**	**36.7**	23.2
finger	10.3	8.1	12.9	**16.6**	**17.0**	**29.8**	11.2	6.9
hand	5.3	**5.5**	5.3	5.2	**8.9**	**7.1**	**6.4**	**5.4**
wrist	5.1	**5.5**	6.5	**7.4**	**6.7**	**12.4**	**7.5**	4.9
Lower extremities	38.1	**55.3**	33.5	**38.7**	**59.7**	**41.2**	**43.6**	**36.5**
knee	11.8	**17.9**	11.9	11.7	**18.5**	**15.5**	**15.6**	**17.3**
foot, toe	10.6	**14.1**	9.3	**9.9**	**19.7**	**12.4**	**12.3**	7.0
Body systems	0.9	0.9	1.6	**2.9**	**2.8**	1.0	**2.2**	**1.9**
Multiple	13.5	**20.7**	13.5	**15.4**	**17.7**	**15.6**	**17.2**	**21.5**

All other	0.8	1.4	1.0	-	-	1.1	1.9	1.8
Total:	151.7	200.6	150.9	191.2	225.9	194.9	191.2	159.9

*injuries and illnesses per 10,000 employees, 2004

Occupational eye injuries have been recognized as a serious health risk to workers and are in need of further investigation to develop effective interventions. Rhode Island workers' compensation claims of ocular injury between 1998 through 2002 were examined. The highest risk of injury resulting in disability indemnification was the wholesale trade sector.[5]

Source of Injury and Illness

As shown in Table 6, the source of injury follows a pattern that would be expected, e.g., furniture as the source of injury for the subsector, furniture and home furnishings stores. Containers are a significant source of injury in the nondurable goods wholesalers and general merchandise stores. Other elevated rates of injuries and illnesses occurred as a result of worker motion, floor or ground surfaces, handtools, and vehicles.

Table 6. Injury Rates* by Source of injury, illness for Wholesale and Retail Trade, 2004

		‡		Above Average Injury and Illness Rate Subsectors (‡)				
Source of injury, illness	**Wholesale Trade**	**Merchant Wholesalers, Nondurable Goods (424)**	**Retail Trade**	**Furniture & Home Furnishings Stores (442)**	**Building Material & Garden Equipment & Supplies Dealers (444)**	**Food & Beverage Stores (445)**	**General Merchandise Stores (452)**	**Nonstore Retailers (454)**
Chemicals	1.3	2.1	1.9	2.1	1.5	1.3	2.4	9.1
Containers	28.5	52.2	32.7	30.5	37.7	54.1	53.6	32.9
Furniture, fixtures	3.7	4.8	9.6	54.2	11.7	5.0	20.4	2.4
Machinery	9.5	10.4	10.5	7.3	12.4	25.0	10.1	6.3
Parts & materials	18.2	6.4	12.7	6.3	43.2	3.4	6.9	7.8
Worker motion	24.2	32.7	19.6	22.3	25.9	27.4	22.4	20.9
Ground surfaces	24.5	36.1	27.6	24.6	31.6	35.4	34.6	39.9
Handtools	4.8	3.8	7.0	13.5	8.6	13.1	5.5	11.5
Vehicles	22.5	33.3	12.4	13.5	21.5	11.2	10.9	14.2
All other	14.4	19.1	17.0	17.0	31.8	18.9	24.4	14.9
Total:	151.7	200.6	150.9	191.2	225.9	194.9	191.2	159.9

*injuries and illnesses per 10,000 employees, 2004

Event or Exposure

The most important events or exposures in the subsectors with above average rates of injury or illness occurred as a result of contact with an object or equipment overexertion, especially related to lifting. Other events or exposures of importance included struck by or against an object, caught in an object or equipment, and slips and trips.

Table 7. Injury Rates* by Event or Exposure for Wholesale and Retail Trade, 2004

		‡		Above Average Injury and Illness Rate Subsectors (‡)				
Event or Exposure	**Wholesale Trade**	**Merchant Wholesalers, Nondurable Goods (424)**	**Retail Trade**	**Furniture & Home Furnishings Stores (442)**	**Building Material & Garden Equipment & Supplies Dealers (444)**	**Food & Beverage Stores (445)**	**General Merchandise Stores (452)**	**Nonstore Retailers (454)**
Contact with object, equipment	41.4	44.7	42.9	59.5	69.8	61.1	55.1	27.2

[5] McCall BP, Horwitz IB. Assessment of occupational eye injury risk and severity: an analysis of Rhode Island workers' compensation data 1998-2002. Am J Ind Med. 2006 Jan;49(1):45-53.

Struck by object	22.0	21.5	25.0	**34.2**	**41.7**	**31.9**	**33.6**	13.1
Struck against object	9.5	**11.7**	10.2	**17.0**	**13.3**	**15.1**	**13.8**	9.2
Caught in object, equipment, material	7.7	**9.3**	4.9	**6.0**	**10.4**	**9.6**	4.9	4.0
Fall to lower level	10.8	**16.0**	8.1	6.8	**13.9**	7.8	8.4	**22.6**
Fall on same level	14.4	**21.6**	20.9	17.6	18.9	**29.1**	**29.6**	18.1
Slips, trips	6.1	**9.2**	4.1	**5.6**	3.5	**6.3**	**4.7**	3.8
Overexertion	39.9	**57.8**	43.9	**69.1**	**75.9**	**52.6**	**61.0**	39.6
lifting	24.8	**36.7**	27.7	**39.8**	**41.5**	**35.1**	**39.0**	21.7
Repetitive motion	4.1	**4.3**	4.4	**5.6**	4.4	**8.5**	4.0	**5.2**
Exposed to harmful substance	3.6	3.6	4.7	4.3	3.8	**6.3**	**5.3**	**12.6**
Transportation accidents	11.7	**14.7**	5.0	3.8	**11.4**	3.5	2.1	**6.7**
Fires, explosions	0.3	0.3	0.2	-	-	-	-	-
Assault, violent act	0.7	**1.7**	1.7	-	1.2	1.4	**2.9**	**2.5**
by person	0.3	**0.8**	1.2	-	-	1.2	**1.9**	**1.3**
by other	0.4	**0.9**	0.4	-	-	-	**1.0**	**1.2**
All other	18.6	**26.8**	15.1	**18.8**	**23.1**	**18.3**	**18.0**	**21.6**
Total:	151.7	**200.6**	150.9	**191.2**	**225.9**	**194.9**	**191.2**	**159.9**

*injuries and illnesses per 10,000 employees, 2004

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." Food retailers face increased challenges to consistently meet requirements during emergency incidents. A food security and safety emergency resource was developed by food retailers for food retailers with two goals: to improve store-level responses to some of the more common emergencies, and to improve coordination between store employees and government emergency responders. Related to emergency responses and preparedness the American Red Cross and home improvement retailers have formed partnerships designed to educate people on hurricane and disaster preparedness. The workers delivering needed food and shelter supplies require protection from hazards that may be present following an emerging event.

Surveillance

More detailed investigations through surveillance methods are needed to identify and prioritize wholesale and retail trade technologies for research. These investigations include disaggregating the high risk areas in wholesale and retail trade 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, OSHA (inspection no. 306677246) investigated employees exposed to hazardous chemicals in a hardware store when an unprotected employee was severely burned with a liquid drain cleaner.

An example of an HHE is an investigation of potential hearing damage from recently installed scanner/scale units in a store's checkout lanes.[6] HHE's serve to identify needs for PPE where other controls are lacking.

The NIOSH FACE program investigates occupational fatalities, many of which could be prevented by the use of functional PPE. A FACE investigation at a building supply store regarded a 16-year-old male part-time laborer who was killed as a result of crushing injuries when the forklift he had been operating tipped over. He was not wearing a restraint device such as a seat belt.[7]

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.[8]

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 overexertion—e.g., the contentious area of extra-skeletal bracing[9]—as well as other causes of sprains and stains, e.g., slips and falls.[10] Anthropometric information such as body size or body segment measurements of some occupational groups differs significantly.[11] Products that enter the market need to be evaluated for their efficacy and effectiveness, e.g., back or limb supports.[12] In addition, personal protection devices for disabled workers also need to be evaluated. Glove design can provide for more grip with less force upon the musculoskeletal system.[13]

Body shields such as hard hats have been used to reduce fractures and other injuries.[14] Personal detection system innovations may offer solutions to amputations when other controls fail, such as saws equipped with a safety system that detects when someone accidentally contacts the spinning saw blade, and then stops the blade in milliseconds.[15]

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[6] HETA-2004-0415-2963. Health hazard evaluation report: HETA-2004-0415-2963, Meijer, East Lansing, Michigan.

[7] FACE Report 2000-09. Sixteen-Year-Old Laborer At a Building Supply Center Crushed by Forklift That Tipped Over – Ohio.

8 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.

9 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.

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

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

[12] Canadian Centre for Occupational Health and Safety, http://www.ccohs.ca/oshanswers/ergonomics/sitting/sitting_alternative.html#_1_9

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

14 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.

15 http://www.sawstop.com/how-it-works-overview.htm

Dermal exposures are another area requiring PPE research. Toxic hepatitis from dimethylacetamide occurred among employees on a new acrylic-fiber production line at a U.S. wholesale and retail trade plant in which inadequate personal protective equipment for dermal exposures was provided.[16] NIOSH found that approximately 60% of workers monitored were exposed to uncured epoxy resins, mostly to the arms, hands, and torso, as a result of deficient PPE in a windblade wholesale and retail trade firm.[17] A study at munitions and pharmaceutical wholesale and retail trade sites found that the use of PPE was ineffective in preventing dermal absorption of nitroglycerin.[18] Alpha-methylene-gamma-butyrolactone is known as the cause of both dermatitis in retail florists and tulip finger in wholesale floral workers who handle the bulbs.[19]

The retail trades industry had a significantly higher than expected proportion of fatalities attributable to forklift rollovers. The majority of the fatalities in the retail trades industry occurred in the building materials, garden supply, and hardware retail trades.[20] A study examined the circumstances of the forklift-related deaths. The proportion of the fatalities occurred to workers in wholesale trade was 8%. Many of the fatalities resulting from forklift "overturns" might have been prevented if the operator had been restrained with a lap/shoulder belt.[21]

Emerging Issues

The trade sector has a continuing need for workers, turnover is high, many of the jobs are entry level, skill levels may be low, and as a result the sector attracts a diverse workforce of both very young and older workers. Some of the emerging issues include long work hours, shift work, and work stress from serving the public, either in direct or telemarketing sales. Musculoskeletal disorders continue to be a burden to workers, but the stress loads are shifting from the low back and legs to the upper extremities and shoulders/neck. This is occurring as a consequence of materials handling equipment reducing the lifting burdens but increasing the need to use keyboards and monitoring systems. Nonstandard shift schedules were found in a study to have a higher risk for occupational injuries and illnesses than conventional day shifts. The calculated hazard ratios were 1.43 for evening shifts, 1.36 for rotating shifts, 1.30 for night shifts, 1.15 for irregular shifts, and 1.06 for split shifts.[22]

Changes in the business climate, consumer demands, and new technologies lead to changes in job conditions and job turnover that eventually impacts overall productivity and safety and health

16 Baum SL, Suruda AJ. 1997. Toxic Hepatitis from Dimethylacetamide. *Int J Occup Environ Health*. 3(1):1-4.
17 Mattorano DA, Dowell CH. 2005. Assessing dermal exposures to epoxy resins in the windblade **wholesale and retail trade** industry. Occupational and Environmental Exposures of Skin to Chemicals, Stockholm, Sweden, June 12-15, 2005. Morgantown, WV: National Institute for Occupational Safety and Health, 2005.
18 Akrill P, et al. 2002. Biological monitoring of nitroglycerin exposure by urine analysis. *Toxicol Lett*. 134(1-3):271-6.
19 Guin JD, Franks H. Fingertip dermatitis in a retail florist. Cutis. 2001 Apr;67(4):328-30.
20 Janicak CA, Deal GA. Occupational fatalities involving forklifts. J Trauma. 1999 Dec;47(6):1084-7.
21 Collins JW, Landen DD, Kisner SM, Johnston JJ, Chin SF, Kennedy RD. Fatal occupational injuries associated with forklifts, United States, 1980-1994. Am J Ind Med. 1999 Nov;36(5):504-12.
22 Dembe AE, Erickson JB, Delbos RG, Banks SM. Nonstandard shift schedules and the risk of job-related injuries. Scand J Work Environ Health. 2006 Jun;32(3):232-40.

issues. To accommodate the 24-7 expectations of consumers, retail businesses that once closed each day, now remain open, often permanently. Consolidation also is occurring as small retail companies become big companies; conversely large companies are downsizing, divesting, or outsourcing non critical functions. The distinctions between wholesale and retail trade are blurring. The introduction of new technology into an industry can have multiple impacts from increased productivity to increased unintended consequences leading to new types of work-related safety and health conditions.

Young Workers

The National Research Council's report "Protecting Youth at Work" found that as much as 80% of youth will have worked during their high school years. The majority of adolescents is employed in the retail and service sectors. Working youth appear to have injury rates almost twice that of adult workers. There is evidence that each year more than 200,000 youth experience work injuries and at least 70 die.[23] Youth workers suffer fatal and nonfatal occupational injuries with most occurring in the retail industry.[24] During the period between 1992 through 1998, the BLS identified an annual average of 67 work related deaths of individuals younger than 18 years of age.[25] Work injuries to adolescents are prevalent in the retail trades sector, with a large portion occurring in eating and drinking establishments. A study identified the fast food industry as the source of a large proportion of occupational injuries to adolescents, and indicated that task-specific risk factors seem to be strongly related to gender.[26] Survey findings indicated one-fifth of teens used equipment they thought dangerous; nearly 40% always or often felt rushed at work; and about half received training on how to avoid injury.[27] Employment in retail trades, equipment use, lack of training, and burn injuries were associated with increased limitation of normal activities.[28] Sprains and strains, followed by lacerations, were the most frequent type of injury among Massachusetts teens. Grocery stores, restaurants, health services, and department stores accounted for more than half of all injuries.[29] In Minnesota, 61.2% of reported injuries in adolescents occurred in wholesale and retail trade, and common injuries were sprains, lacerations, heat burns, and contusions.[30] In a Minnesota study, the highest number of work-related injuries to youth occurred in eating and drinking establishments and food stores accounting for 44% of all young worker injuries.[31]

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[23] Wegman DH, Davis LK. Protecting youth at work. Am J Ind Med. 1999 Nov;36(5):579-83.
[24] West C, de Castro AB, Fitzgerald ST. 2005. The youth work force: unique occupational health considerations and challenges. AAOHN J. 2005 Jul;53(7):297-305.
[25] Higgins DN, Tierney J, Hanrahan L. Preventing young worker fatalities. The Fatality Assessment and Control Evaluation (FACE) Program. AAOHN J. 2002 Nov;50(11):508-14.
[26] Hendricks KJ, Layne LA. Adolescent occupational injuries in fast food restaurants: an examination of the problem from a national perspective. J Occup Environ Med. 1999 Dec;41(12):1146-53.
[27] Zakocs RC, Runyan CW, Schulman MD, Dunn KA, Evensen CT. Improving safety for teens working in the retail trade sector: opportunities and obstacles. Am J Ind Med. 1998 Oct;34(4):342-50.
[28] Knight EB, Castillo DN, Layne LA. A detailed analysis of work-related injury among youth treated in emergency departments. Am J Ind Med. 1995 Jun;27(6):793-805.
[29] Brooks DR, Davis LK. Work-related injuries to Massachusetts teens, 1987-1990. Am J Ind Med. 1996 Feb;29(2):153-60.
[30] 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.
[31] Mardis AL, Pratt SG. Nonfatal injuries to young workers in the retail trades and services industries in 1998. J Occup Environ Med. 2003 Mar;45(3):316-23.

Workplace Violence

Workers in retail and service industries are at high risk for workplace violence. More than half of the injury events in a study were robbery-related, and nearly 13% were fatal. Businesses open 24 hours and those having a history of violent events were found to be at increased risk for employee injury.[32] Violence in the workplace accounts for 1,000 fatalities and over 20,000 nonfatal events annually in the United States. One of occupations with the most fatalities is employees in retail establishments.[33] Studies indicate that persons employed in various retail occupations such as convenience stores and restaurants experience an increased risk for being a victim of an occupational homicide. A large proportion of workers aged 19 and under was employed in these types of occupations.[34] The occupational toxic exposures reported in general retail stores involved cleaning agents, solvents, paints, caustics, and bleach used with exposures to entry-level jobs most frequently by adolescents.[35]

Women Workers

Over the decade, 3,821 females died as a result of injuries sustained at work, with an average annual fatality rate of 0.82/100,000 female workers. Among industries, retail trade and services accounted for nearly half of all occupational injury deaths to females.[36] Women workers dominate the labor market of part-time and casual jobs, particularly in the retail trade and consumer services sector.[37] The Census of Fatal Occupational Injuries (CFOI) reported 8,672 workplace homicide victims between 1992 and 2001. The retail trade industry division had the highest number of homicides.[38] The leading cause of death for all workers is motor vehicle incidents, while the leading cause of occupational injury death of females is homicide. Homicide is currently the leading cause of traumatic workplace death among women in the United States.[39]

Self-employed Workers

Research suggests that rates of occupational injury and death may be higher among self-employed workers than in the wage and salaried population. High fatal injury rates among the self-employed occurred in the retail industry, and homicide deaths occurred more frequently among self-employed workers. [40] Workplace homicide rates are highest for men, older and self-

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[32] Schaffer KB, Casteel C, Kraus JF. A case-site/control-site study of workplace violent injury. J Occup Environ Med. 2002 Nov;44(11):1018-26.
[33] Runyan CW, Zakocs RC, Zwerling C. Administrative and behavioral interventions for workplace violence prevention. Am J Prev Med. 2000 May;18(4 Suppl):116-27.
[34] Janicak CA. An analysis of occupational homicides involving workers 19 years old and younger. J Occup Environ Med. 1999 Dec;41(12):1140-5.
[35] Woolf AD, Flynn E. Workplace toxic exposures involving adolescents aged 14 to 19 years: one poison center's experience. Arch Pediatr Adolesc Med. 2000 Mar;154(3):234-9.
[36] Jenkins EL. Occupational injury deaths among females. The US experience for the decade 1980 to 1989. Ann Epidemiol. 1994 Mar;4(2):146-51.
[37] Zeytinogla IU, Seaton MB, Lillevik W, Moruz J. Working in the margins women's experiences of stress and occupational health problems in part-time and casual retail jobs. Women Health. 2005;41(1):87-107.
[38] Hartley D, Biddle EA, Jenkins EL. 2005. Societal cost of workplace homicides in the United States, 1992-2001. Am J Ind Med. 47(6):518-27.
[39] Bell CA. Female homicides in United States workplaces, 1980-1985. Am J Public Health. 1991 Jun;81(6):729-32.
[40] Mirabelli MC, Loomis D, Richardson DB. Fatal occupational injuries among self-employed workers in North Carolina. Am J Ind Med. 2003 Aug;44(2):182-90.

employed workers, and minorities, and robberies, mostly in retail settings, accounted for half of the homicides.[41]

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

There is a need to develop interventions to address knowledge gaps and develop efforts for broad adoption of successful PPE interventions in targeted wholesale and retail trade technologies.

Improve Existing PPE

Hazard reduction with the use of PPE to protect wholesale and retail trade 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
- Skin and dermal protection – protective clothing and garments around toxic or irritating chemicals and irritants, heat, sharps
- Hand protection – gloves, barrier creams, and arm protectors
- Foot protection – safety shoes and boots with non-slip soles and heels
- Head and hair protection – hard hats, hair nets, cold
- Eye and vision protection – protective eyewear, laser protection
- Hearing protection – acoustic earmuffs and plugs
- 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 (PAPRs), labeling for

[41] Moracco KE, Runyan CW, Loomis DP, Wolf SH, Napp D, Butts JD. Killed on the clock: a population-based study of workplace homicide, 1977-1991. Am J Ind Med. 2000 Jun;37(6):629-36.

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.

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, American Society of Occupational Health Nurses, Risk Management and Decision Processes Center (The Risk Center) at the Wharton School, National Safety Council, European Agency for Safety and Health Agency, 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 wholesale and retail trade industry workers are listed in Appendix 2.

Wholesale and Retail Trade Organizations

The wholesale and retail trade industry and its many trade organizations also provide opportunities for partnership. Some wholesale and retail enterprises serve as distributors of PPE, which includes the self-employed. A few of these organizations are listed below.

- American Wholesale Marketers Association
- National Association of Safety Professionals
- Better Business Bureau
- American Pyrotechnics Association
- Lumber and Building Material Dealers Association
- National Lumber and Building Material Dealers Association
- National Grocers Association
- American Wholesale Marketers Association
- Healthcare Distribution Management Association
- Museum Store Association
- Tire Association of North America
- Chamber of Commerce

Trade Unions

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

- American Federation of Labor-Congress of Industrial Unions
- United Food and Commercial Workers
- International Brotherhood of Teamsters
- Service Employees International Union
- Laborers' International Union of North America
- Bakery, Confectionery, Tobacco Workers and Grain Millers International Union
- Retail, Wholesale and Department Store Union

Governmental Agencies

Another partner is the Occupational Safety and Health Administration (OSHA)[42] with its agreements with industrial entities such as through its Voluntary Protection 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 and the Department of Homeland Security. Regarding violent acts, the National Institute of Justice in the U.S. Department of Justice is a potential partner.[43] The Canadian Centre for Occupational Health and Safety is a potential partner in developing and providing training related to PPE.

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.[44] Communications are an important adjunct to the PPE ensemble as well. Particular attention is needed in protecting wholesale and retail workers delivering food and shelter supplies under emergency circumstances.

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

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42 Wallace WJ. Performing the PPE Hazard Analysis. *Occupational Safety and Health*. 2005;74(12):60, 62.

[43] http://www.ojp.usdoj.gov/nij/

44 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.

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.[45] Safety signs have been found to be ineffective in encouraging the donning of PPE.[46] 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., radiant heat and flame. Secondary protective clothing is designed for continuous wear.[47] Failures or deficiencies in hearing conservation programs can often be traced to inadequacies in the training and education of noise-exposed employees and those who conduct elements of the program.

Research Plan

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

• Engineering control or inherently safer systems should be used to negate the need for PPE. PPE should only be used as a "last line of defense" when engineering control systems or hazard elimination are not feasible.
• Employers should have credible preparedness plans to respond to PPE needs within their workplaces. Individual workers should be prepared for the use of PPE and be trained in the use of PPE for their particular working conditions.
• The private sector should play an integral role in PPE research and development and should be part of the national deployment of PPE technologies.

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45 Schroll RC. Emergency Response Training: How to Plan, Conduct, and Evaluate for Success. *Professional Success*. 2002;47(12):16-21.
46 Young SL, Franz JP, Rhoades TP, Darnell KR. Safety Signs and Labels. *Professional Safety*. 2002;47(9)18-23.
47 Gojdics R. Personal protective clothing: purchasing flame-resistant secondary clothing. *Professional Safety*. 2002;47(10):56-57.

• 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 wholesale and retail trade workplaces from small stores to large "big box" retail operations 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, undertake data collection efforts to fill gaps in surveillance data, provide support to state agencies to conduct occupational surveillance and associated prevention efforts, and work 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 wholesale and retail trade to identify severe injuries and illnesses that PPE could prevent and PPE failures to protect workers.***

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

Pillar 2. Standardization and Certification

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

Goal: To 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 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 retail 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 design training programs specific to special populations such as youth and minorities.

Appendix 1: Wholesale and Retail Trade Subsector Descriptions

423 Merchant Wholesalers, Durable Goods

Industries in the Merchant Wholesalers, Durable Goods subsector sell capital or durable goods to other businesses. Merchant wholesalers generally take title to the goods that they sell; in other words, they buy and sell goods on their own account. Durable goods are new or used items generally with a normal life expectancy of three years or more. Durable goods merchant wholesale trade establishments are engaged in wholesaling products, such as motor vehicles, furniture, construction materials, machinery and equipment including household-type appliances, metals and minerals, sporting goods, toys and hobby goods, recyclable materials, and parts.

424 Merchant Wholesalers, Nondurable Goods

Industries in the Merchant Wholesalers, Nondurable Goods subsector sell nondurable goods to other businesses. Nondurable goods are items generally with a normal life expectancy of less than three years. Nondurable goods merchant wholesale trade establishments are engaged in wholesaling products, such as paper and paper products, chemicals and chemical products, drugs, textiles and textile products, apparel, footwear, groceries, farm products, petroleum and petroleum products, alcoholic beverages, books, magazines, newspapers, flowers and nursery stock, and tobacco products.

425 Wholesale Electronic Markets and Agents and Brokers

Industries in the Wholesale Electronic Markets and Agents and Brokers subsector arrange for the sale of goods owned by others, generally on a fee or commission basis. They act on behalf of the buyers and sellers of goods. This subsector contains agents and brokers as well as business to business electronic markets that facilitate wholesale trade.

441 Motor Vehicle and Parts Dealers

Industries in the Motor Vehicle and Parts Dealers subsector retail motor vehicles and parts from fixed point-of-sale locations. Establishments in this subsector typically operate from a showroom and/or an open lot where the vehicles are on display. The display of vehicles and the related parts require little by way of display equipment. The personnel generally include both the sales and sales support staff familiar with the requirements for registering and financing a vehicle as well as a staff of parts experts and mechanics trained to provide repair and maintenance services for the vehicles. Sales of capital or durable nonconsumer goods, such as medium and heavy-duty trucks, are always included in wholesale trade, which are virtually never sold through retail methods.

442 Furniture and Home Furnishings Stores

Industries in the Furniture and Home Furnishings Stores subsector retail new furniture and home furnishings from fixed point-of-sale locations. Establishments in this subsector usually operate from showrooms and have substantial areas for the presentation of their products. Many offer interior decorating services in addition to the sale of products.

443 Electronics and Appliance Stores

Industries in the Electronics and Appliance Stores subsector retail new electronics and appliances from point-of-sale locations. Establishments in this subsector often operate from locations that have special provisions for floor displays requiring special electrical capacity to accommodate the proper demonstration of the products. The staff includes sales personnel knowledgeable in the characteristics and warranties of the line of goods retailed and may also include trained repair persons to handle the maintenance and repair of the electronic equipment and appliances.

444 Building Material and Garden Equipment and Supplies Dealers

Industries in the Building Material and Garden Equipment and Supplies Dealers subsector retail new building material and garden equipment and supplies from fixed point-of-sale locations. Establishments in this subsector have display equipment designed to handle lumber and related products and garden equipment and supplies that may be kept either indoors or outdoors under covered areas. The staff is usually knowledgeable in the use of the specific products being retailed in the construction, repair, and maintenance of the home and associated grounds.

445 Food and Beverage Stores

Industries in the Food and Beverage Stores subsector usually retail food and beverages merchandise from fixed point-of-sale locations. Establishments in this subsector have special equipment (e.g., freezers, refrigerated display cases, refrigerators) for displaying food and beverage goods. They have staff trained in the processing of food products to guarantee the proper storage and sanitary conditions.

446 Health and Personal Care Stores

Industries in the Health and Personal Care Stores subsector retail health and personal care merchandise from fixed point-of-sale locations. Establishments in this subsector are characterized principally by the products they retail, and some health and personal care stores may have specialized staff trained in dealing with the products. Staff may include pharmacists, opticians, and other professionals engaged in retailing, advising customers, and/or fitting the product sold to the customer's needs.

447 Gasoline Stations

Industries in the Gasoline Stations subsector group establishments retailing automotive fuels (e.g., gasoline, diesel fuel, gasohol) and automotive oils and retailing these products in combination with convenience store items. These establishments have specialized equipment for the storage and dispensing of automotive fuels.

448 Clothing and Clothing Accessories Stores

Industries in the Clothing and Clothing Accessories Stores subsector retailing new clothing and clothing accessories merchandise from fixed point-of-sale locations. Establishments in this subsector have similar display equipment and staff that is knowledgeable regarding fashion trends and the proper match of styles, colors, and combinations of clothing and accessories to the characteristics and tastes of the customer.

451 Sporting Goods, Hobby, Book, and Music Stores

Industries in the Sporting Goods, Hobby, Book, and Music Stores subsector are engaged in retailing and providing expertise on use of sporting equipment or other specific leisure activities, such as needlework and musical instruments. Book stores are also included in this subsector.

452 General Merchandise Stores

Industries in the General Merchandise Stores subsector retail new general merchandise from fixed point-of-sale locations. Establishments in this subsector are unique in that they have the equipment and staff capable of retailing a large variety of goods from a single location. This includes a variety of display equipment and staff trained to provide information on many lines of products.

453 Miscellaneous Store Retailers

Industries in the Miscellaneous Store Retailers subsector retail merchandise from fixed point-of-sale locations. Establishments in this subsector include stores with unique characteristics like florists, used merchandise stores, and pet and pet supply stores as well as other store retailers not otherwise covered.

454 Nonstore Retailers

Industries in the Nonstore Retailers subsector retail merchandise using methods, such as the broadcasting of infomercials, the broadcasting and publishing of direct-response advertising, the publishing of paper and electronic catalogs, door-to-door solicitation, in-home demonstration, selling from portable stalls and distribution through vending machines. Establishments in this subsector include mail-order houses, vending machine operators, home delivery sales, door-to-door sales, party plan sales, electronic shopping, and sales through portable stalls (e.g., street vendors, except food). Establishments engaged in the direct sale (i.e., nonstore) of products, such as home heating oil dealers and newspaper delivery are included in this subsector.

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

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 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

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 mits
ISO 13.340.50 Leg and foot protection, Including safety boots and shoes
ISO 13.340.60 Protection against falling and slipping, Including safety ropes, harnesses and fall arrestors
ISO 13.340.99 Other protective equipment
ISO 3873:1977 Industrial safety helmets
ISO 4007:1977 Personal eye-protectors, Vocabulary
ISO 4849:1981 Personal eye-protectors, Specifications
ISO 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

American Conference of Governmental Industrial Hygienists

Guidelines for Selection of Chemical Protective Clothing, 1987
A Guide for Control of Laser Hazards, 1990

Underwriters Laboratory

UL Standard 752, bulletproof vests

U.S. National Institute of Justice

Bulletproof vests