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Establishment of a Construction Safety Research Plan for NIOSH/DSR

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ACKNOWLEDGEMENTS

Division of Safety Research staff members who were instrumental in the preparation of this report include Pat Coleman, Chief, Data Analysis Section; Herb Linn, Writer-Editor; and Ron Stanevich, Safety Engineer, Accident Investigation Section. The contributions of other DSR support staff is also appreciated.

Chapter I

INTRODUCTION

Construction is a $300 billion per year industry in the United States [1]. The construction industry is a conglomerate of several specialized groups working together toward a common goal. There are three major classifications of construction in the Standard Industrial Classification (SIC). Building construction (SIC 15) is composed of companies which erect buildings ranging in size from residential houses to multi-story structures. Heavy construction (SIC 16) companies are involved in large projects, which range from street and highway construction to the building of dams. Special trades (SIC 17) are subcontractors who perform specialized tasks, such as plumbing, roofing, duct work, etc., for building and heavy construction contractors.

The construction industry has the highest injury and illness incidence rate of any major division of U.S. industry, with a fatality rate second only to mining [2]. During 1981, it is estimated that the construction industry suffered 800 fatalities and 538,300 injuries and illnesses [2]. Of these, 224,700 were reported to be lost workday cases which resulted in an estimated 4,044,600 lost workdays. The cost of injury benefits paid to construction workers for 1981 is estimated (in 1979 dollars) to range from $1.3 billion* to $3.4 billion.**

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* Derived from mean value of benefits paid for injuries [1].

** Derived from workers compensation benefits as a percentage of total construction cost [1].

The Public Health Service has established 1990 "Objectives for the Nation" [3]. The PHS Objectives are based upon a projected 10% reduction in the 1978 incidence rates and fatality figures. Changes in the injury incidence rates and numbers of fatalities of workers in the construction industry would directly impact on the three following specific PHS Objectives:

- By 1990, workplace accident deaths for firms or employers with 11 or more employees should be reduced to less than 3,750 per year. (In 1981, the construction industry accounted for 800 of the 4,370 work-related fatalities for firms or employers with 11 or more employees [3].)

- By 1990, the rate of work-related disabling injuries should be reduced to 8.3 cases per 100 full-time workers. (The 1981 construction industry rate was approximately 14.9 cases per 100 workers [3].)

- By 1990, lost workdays due to injuries should be reduced to 55 per 100 workers annually. (In 1981, approximately 112.1 workdays per 100 construction workers were lost [3].)

It is evident from the above rates that the construction industry is a prime candidate for NIOSH research toward achievement of injury reduction. Reducing the incidence of injuries and fatalities in the

construction industry by at least 10% would make a substantial contribution toward accomplishment of the abovementioned PHS 1990 Objectives.

The Division of Safety Research (DSR) within the National Institute for Occupational Safety and Health (NIOSH) has supported several projects concerned with the safety of construction workers. The basis for supporting these particular projects has generally been the apparent merit of a specific research need. No fundamental strategy for approaching safety problems unique to the construction industry has been employed in the planning of these projects.

The purpose of this report is to propose a strategy for NIOSH/DSR's future construction industry safety research efforts. The emphasis of this strategy is placed upon identification of those construction occupation categories that are exposed to a risk of incurring fatals and/or compensable injuries which are higher than the average construction occupation. These are defined as the high risk occupations. These occupations are then numerically ranked by further analysis of accident type, injury cost factors and frequency of injuries.

The strategy is summarized in the following fourfold approach:

1) Identify the high risk construction industry occupations

2) Numerically rank the occupations utilizing accident type, related injury cost and injury frequency factors.

3) Analyze the various tasks performed by the high risk occupations to determine those tasks which are producing a higher-than-average number of injuries. Powell et al concluded that work load influenced the injury rate along with the risks associated with the work load tasks. These risks are specific and could be changed by changing the detail of the task. [*]

4) Develop countermeasures which can be demonstrated as effective in reducing the injury toll within the high risk occupations.

The first and second phases of this fourfold approach are accomplished in this report. A methodology for numerically ranking the high risk occupations is developed in Chapter II, and the results of the ranking process are presented in Chapter III. Finally, recommended directions for future NIOSH/DSR research efforts related to the construction industry, and aimed at the phases 3 and 4 outlined above, are presented in Chapter IV.

[*] Sidwell A.C. "Why so many accidents", Occupational Safety and Health. January 1984. pp 12-22.

CHAPTER II

Identifying High Risk Occupations in the Construction Industry

In order to identify the high risk occupations within the construction industry, a numerical methodology was developed to utilize the available data contained in the Bureau of Labor Statistics' (BLS) Supplementary Data System (SDS). Records for the years 1977 through 1980 were utilized [4]. Preliminary analysis of the data supported the concept of developing occupation-specific risk indices for fatals, injuries, and types of accident, along with developing cost factors for specific accident types. These factors will be utilized in the numerical ranking scheme presented in Chapter III.

A. Determination of composite occupation-specific risk indices (CORI)

CORI values show which occupations are at greater risk of injury over several SDS yearly reporting periods. The CORI values are a weighted average of occupation-specific risk indices (ORI) which are determined for each SDS survey year. The ORI is a ratio of the occupation-specific case rate (occupation-specific injury freqeuncy to occupation-specific employment) to the overall annual industry case rate.

For determining an occupation-specific risk index (ORI), only occupations involved in 0.3% or more of the reported cases were considered. This judgemental cut-off was based on preliminary assessment of part of the total data which suggested that for occupations with less than 0.3% of the cases, a meaningful sample could not be obtained.

ORI values, based on injury frequency, were established for all the major occupations within each of the three main SIC codes of the construction industry. These ratios were developed for each year (1977-1980) independently. Also, weighted-average occupation-specific risk indices were established for the construction industry in general by consolidating the indices calculated for the building construction, heavy construction, and special trades segments of the industry.

The following procedure was used in the establishment of occupation-specific risk ratios:

1. Determination of occupation-specific injury frequencies

   The occupation-specific frequencies of workers' compensation cases were established from SDS data. For each year, the frequency counts for all occupations in the construction industry were established by two-digit SIC codes.

2. Determination of occupation-specific employment

Specific occupational employment figures by two-digit SIC for the SDS states were obtained by the following equation:

$$E_{o(year)} = NE_{o(1978)} \times \frac{E_{c(year)}}{NE_{c(1978)}}$$

where

$E_{o(year)}$ = Estimated employment by occupation in the participating SDS states for a given survey year and two-digit SIC.

$NE_{o(1978)}$ = National employment by occupation in the same two-digit SIC for 1978 according to "Occupational Employment in Selected Non-manufacturing Industries" [5].

$E_{c(year)}$ = Construction industry employment in the SDS states for the survey year. This was obtained by summing the SDS states' construction employment listed in "Employment and Earnings, State and Area" [6, 7] for the survey year in question.

$NE_{c(1978)}$ = National construction industry employment for 1978. This was obtained from "Occupational Injuries and Illnesses in the United States" [8].

3. Determination of case rates

Annual occupational-specific case rates were determined by dividing the number of reported workers' compensation cases in each SIC code (step 1) by the corresponding established occupational employment (step 2), and multiplying by 100 to obtain the number of cases per 100 workers. Overall construction industry annual case rates for years 1977 to 1980 were determined by dividing the total number of construction cases in each survey year by the corresponding construction employment in the SDS survey states.

4. Determination of composite occupation-specific risk indices (CORI)

The occupation-specific risk indices (ORI) were determined by dividing the occupation-specific case rate by the corresponding overall annual construction industry case rate. A composite (4 years, 3 SICs) weighted-average occupation-specific index (CORI) was established. These values were weighted according to employment under the assumption that the ORI values for SICs with larger employment populations for specific occupations are more reliable than values representing smaller employment. The weighting was accomplished in the following manner:

$$CORI = \sum_{n=1}^{3} \frac{[E_{o(SIC)} \quad X \quad ORI]}{E_o}$$

where

$E_{o(SIC)}$ = Employment population of a specific occupation within a two-digit SIC.

ORI = Occupation-specific risk index value for the specific occupation within the two-digit SIC.

E_o = Total employment population of the specific occupation in all three SICs. [Note: When case numbers were determined to be too small to yield reasonable results in a specific SIC, that SIC was dropped from consideration.]

The CORI values are given in Table II-1.

Table II-1

High Risk Construction Occupations -
Composite Occupational Risk Index (CORI)

	Occupation*	CORI
1.	Laborers	2.7
2.	Warehousemen	2.7
3.	Boilermakers	2.5
4.	Structural Metal Craftsmen	2.3
5.	Drywall Installers	2.1
6.	Engineering Sciences Tech.	2.1
7.	Mechanics	1.9
8.	Welders	1.9
9.	Roofer-Slater	1.5
10.	Glazier	1.4
11.	Millwright	1.4
12.	Asbestos Workers	1.3
13.	Carpenters**	1.1
14.	Carpet Installers	1.1
15.	Plumbers**	1.0
16.	Sheet Metal Workers	1.0
17.	Linemen	0.9
18.	Truck Drivers	0.9
19.	Painters	0.6
20.	Heavy Equipment Operators	0.5
21.	Cranemen	0.4

* Includes only occupations which were involved in greater than .3% of the total reported SDS cases in the construction industry, 1977-1980.

** These occupation categories include the SDS data on apprentice workers.

A CORI value of 1.0 indicates that the relationship between the number of injuries incurred by workers in a specific occupation and the number of injuries incurred in the construction industry in general, is equal to the relationship between the occupation-specific employment and the total employment in the construction industry. A CORI value greater than 1.0 indicates that workers in the specific occupation are at greater risk of incurring an SDS-recordable injury than the average construction worker. These workers are considered as working in a high risk occupation.

B. Occupation-specific Fatality Index

The FI expresses the ratio of the percentage of all construction industry fatalities incurred by workers in a specific occupations, to the percentage of the entire construction industry workforce represented by that occupation. It provides an indicator of occupations which have hazardous tasks that are more likely to result in fatal incidents. An occupation may have a low CORI but yet have a high FI. This would indicate that the occupation has fewer injuries than other occupations but a higher number of fatalities. This fatality factor is given consideration in the ranking of high risk occupations.

Not all the states in the SDS data system report fatalities. Number of states reporting fatals are presented as a ratio of the total number of states reporting into SDS by year, i.e., 1977 (7/29), 1978 (12/30), 1979 (8/31) and 1980 (10/26). The SDS-participating states which <u>did</u> report

construction industry fatalities from 1977 to 1980 were used to develop a fatality index (FI). The index was defined as:

$$FI = \frac{F_o}{F_t \times C_o}$$

where

FI = Fatality index value

F_o = The number of reported fatalities incurred by workers within a specific occupation.

F_t = The total number of reported construction industry fatalities.

C_o = The percentage of the construction work force represented by a specific occupation. The percentage of employment was obtained from BLS' "Occupational Employment in Selected Non-Manufacturing Industries." [5]

The fatality counts were obtained by summing the occupational fatalities reported in SDS over the four-year period from 1977 to 1980. Fatality index values were calculated for the building construction (SIC 15), heavy construction (SIC 16) and the special trades (SIC 17) industries, and the construction industry in general (SIC 15, 16, and 17 combined).

Composite, weighted-average occupation-specific FI values were established by multiplying the FI values by the SIC-specific employment, summing, and dividing by the sum of employment for that occupation. This is similar to the method used to develop the CORI values discussed previously. The FI values for the leading construction industry occupations are presented in Table II-2.

Table II-2

High Risk Construction Occupations - Fatality Index (FI)

	Occupation*	FI
1.	Asbestos Workers	4.9
2.	Structural Metal Craftsmen	4.7
3.	Boilermakers	4.5
4.	Millwright	4.5
5.	Cranemen	3.7
6.	Engineering Sciences Tech.	3.7
7.	Laborers	2.4
8.	Linemen	2.3
9.	Roofer-Slater	2.3
10.	Welders	1.8
11.	Truck Drivers	1.5
12.	Mechanics	1.4
13.	Painters	1.4
14.	Heavy Equipment Operator	1.2
15.	Drywall Installers	0.9
16.	Plumbers	0.8
17.	Sheet Metal Worker	0.8
18.	Carpenters**	0.5
19.	Carpet Installers	0.0
20.	Glazier	0.0

* Includes only occupations which were involved in greater than .3% of the total reported SDS cases in the construction industry, 1977-1980.

** These occupation categories include the SDS data on apprentice workers.

An FI value of 1.0 indicates that the relationship between the number of fatalities incurred by workers in a specific occupation and the number of fatalities incurred in the construction industry in general, is equal to the relationship between the occupation-specific employment and the total employment in the construction industry. If the FI value is greater than 1.0, it is assumed that a worker in that occupation has a higher risk of being fatally injured on the job than the average construction worker. These workers are considered as working in a high risk occupation. A fatality profile for each of the occupations with FI values 1.0 or more in SICs 15, 16, or 17 will be presented in a reference document to be submitted to NTIS in FY85 [9].

C. Occupation-specific Risk Factors (RF)

Occupation-specific risk factors were established for each occupation. This factor is a function of the CORI and FI values. The CORI gives a measure of the risk of an injury and the FI gives a measure of the risk of a fatality. In order to combine or weight the impact of the CORI and FI values into the risk factor a common basis of weighting was used. This was the percentage of total lost workdays. The American National Standards Institute. ANSI Z16.1 - 1967 (R 1973) "Method of Recording and Measuring Work Injury Experience", equates one fatality to 6,000 lost workdays. By computing the total lost workdays for the construction industry using the BLS 1981 data for lost workday cases and fatals, it was found that injuries accounted for 48% of the workdays lost and fatals

52%. Therefore, the CORI and FI values were given equal consideration in the following formula:

$$RF = \frac{CORI}{2} + \frac{FI}{2}$$

Table II-3 gives the results of the procedure described above. The list of occupations is shown in a descending RF value order. Number of states reporting fatals are presented as a ratio of the total number of states reporting into SDS by year; i.e., 1977 (7/29), 1978 (12/30), 1979 (8/31), and 1980 (10/26).

Table II-3

High Risk Construction Occuptations - Risk Factors (RF)

Occupation*	RF
Structural Metal Craftsmen	3.5
Boilermakers	3.5
Asbestos Workers	3.1
Millwright	3.0
Engineering Sciences Tech.	2.9
Laborers	2.6
Cranesmen	2.1
Roofer-Slater	1.9
Welders	1.9
Drywall Installers	1.9
Mechanics	1.7
Linemen	1.6
Warehousemen	1.4
Truck Drivers	1.2
Painters	1.0
Heavy Equipment Operator	0.9
Plumbers**	0.9
Sheet Metal Worker	0.9
Carpenters**	0.8
Glazier	0.7
Carpet Installers	0.6

* Includes only occupations which were involved in greater than .3% of the total reported SDS cases in the construction industry, 1977-1980.

** These occupation categories include the SDS data on apprentice workers.

D. Accident-type Risk Index (ARI)

The workers' compensation cases included in SDS are coded according to the ANSI Z16.2 system of coding. This system includes a group of categories indicating the "type of accident or exposure." Most of these classification categories indicate an event which immediately preceded the injury. Information about such events are useful given the general premise that prevention of such events will, in turn, prevent injuries. Thus, these events, or "accident type" categories, have been examined as part of the process of developing the strategy plan. An ARI was established in order to determine the relative risk of injuries resulting from particular accident types within the different high risk occupations. In order to establish accident-type risk factors, the 1977 to 1980 data was consolidated and analyzed by accident type. First, accident-type percentages for all construction cases were determined from the data. Next, the data were analyzed by occupation in order to determine the highest percentage of the injuries attributed to specific accident-type categories within the problem occupations. Only the accident types which accounted for 5% or more of the injuries within each occupation were considered. ARI values were determined with the following formula:

$$ARI = \frac{AT_O(\%) \times CORI}{AT_C(\%)}$$

where

ARI = Accident-type risk index

AT_o(%) = Occupation-specific accident type percentage

AT_c(%) = Accident type percentage based on all construction accidents

CORI = Composite occupation-specific risk index

Only ARI values of 1.0 or more were recorded (see Table II-4).

The development of ARI values serves an important function. The ARI values represent additional information which can be used to assess the particular hazards faced by workers in the construction industry. It is useful to know, for example, that a roofer faces thirteen times the risk faced by the average construction worker of being burned by a hot object.

E. Accident-type Cost Factors

The total cost of an accident is more than medical cost, it is a combination of medical costs, indemnity costs, material costs due to damage of the structure and machinery, and other related costs. As one report notes:

> "In 1972, the cost of Workmen's Compensation Insurance was approximately $2 billion; in addition, costs to construction companies for uninsured losses were assessed at between $6 billion and $16 billion (Levitt, 1975). A conservative estimate of total construction accident costs would therefore amount to $8 billion annually. An extrapolation, using today's building volumes, gives an estimate of construction accident costs of $12 billion, or approximately 8% of the total building costs" [10].

Table II-4

Risk Indices for Selected Accident Types

Type of Accident	Top Occupations	ARI
1. Struck by, NEC		
	1. Laborers	3.0
	2. Warehousemen	2.7
	3. Struct. Metal Cftmn.	2.2
	4. Boilermakers	1.9
	5. Eng. Sci. Tech.	1.9
	6. Glazier	1.9
	7. Drywall Installers	1.7
	8. Mechanics	1.7
	9. Carpet Installers	1.6
	10. Carpenters	1.5
	11. Welders	1.4
	12. Millwright	1.2
	13. Roofer-Slater	1.1
2. Overexertion - Lifting		
	1. Warehousemen	4.8
	2. Drywall Installers	3.1
	3. Laborers	2.8
	4. Struct. Metal Cftmn.	2.3
	5. Carpet Installers	2.1
	6. Mechanics	1.9
	7. Eng. Sci. Tech.	1.7
	8. Glazier	1.7
	9. Boilermakers	1.5
	10. Welders	1.5
	11. Roofer-Slater	1.4
	12. Millwright	1.2
	13. Carpenters	1.1
	14. Plumbers	1.1
	15. Sheet Metal Worker	1.0
3. Struck Against Stationary Object		
	1. Warehousemen	3.0
	2. Laborers	2.7
	3. Glazier	2.6
	4. Drywall Installers	2.5
	5. Boilermakers	2.1
	6. Eng. Sci. Tech.	1.9
	7. Struct. Metal Cftmn.	1.9

Table II-4 (Continued)

Risk Indices for Selected Accident Types (Cont'd)

Type of Accident	Top Occupations	ARI
3. Struck Against Stationary Object (Continued		
	8. Asbestos Wkrs.	1.7
	9. Mechanics	1.7
	10. Sheet Metal Wkrs.	1.5
	11. Carpet Installers	1.4
	12. Millwright	1.2
	13. Welders	1.2
	14. Carpenters	1.1
	15. Plumbers	1.0
	16. Roofer-Slater	1.0
4. Struck By Falling Objects		
	1. Warehousemen	3.9
	2. Laborers	3.5
	3. Struct. Metal Cftmn.	2.6
	4. Boilermakers	2.4
	5. Mechanics	2.2
	6. Welders	2.1
	7. Glazier	1.7
	8. Millwright	1.7
	9. Carpenters	1.0
5. Foreign Matter in Eye		
	1. Boilermakers	8.1
	2. Welders	5.4
	3. Struct. Metal Cftmn.	4.7
	4. Millwright	2.6
	5. Mechanics	2.3
	6. Plumbers	1.7
	7. Sheet Metal Worker	1.7
	8. Asbestos Wkrs.	1.6
	9. Glazier	1.3
	10. Carpenters	1.1
6. Fall from Elevation, NEC		
	1. Roofer Slater	3.9
	2. Drywall Installers	3.6
	3. Linemen	2.2
	4. Carpenters	1.8
7. Fall From Ladders		
	1. Asbestos Wkrs.	3.2
	2. Painters	2.7
	5. Sheet Metal Worker	1.8

Table II-4 (Concluded)

Risk Indices for Selected Accident Types

Type of Accident	Top Occupations	ARI
8. Fall from Scaffolds		
	1. Drywall Installers	6.4
	2. Asbestos Wkrs.	3.0
	3. Painters	1.4
9. Contact with Hot Objects		
	1. Roofer-Slater	13.6
	2. Welders	6.1
10. Falls From Vehicles		
	1. Truck Drivers	4.9
	2. Cranemen	2.3
	3. Heavy Equip. Op.	2.1

A review of the insured losses reveals that "about 33 percent of all industrial injuries account for 94 percent of total injury costs and only 2 percent of the injuries account for 50 percent of the total injury costs" [11].

In order to estimate an injury cost factor, indemnity compensation payments (the monetary awards provided to the injured employee for time lost, disfigurement or disability) were obtained from the SDS data over a four-year period (1977-1980). (As with fatality data, not all SDS participating states report indemnity cost data.*) An average indemnity payment per accident type that occurred in the construction industry was established by summing the total cost incurred over the four-year period and dividing by the number of cases. The cost factor was established by dividing the average indemnity cost by $1000. The cost factor per accident type is given in Table II-5. As noted, the average indemnity cost for contact with caustics was about $15,000 for inhalation and $2000 for absorption. Falls from elevations ranged from $4000 to $6000 per accident, and overexertion cases cost little over $3000 per case. The struck by cases cost a little over $2000 per case and contact with electric current averaged over $7000 per case. These are the leading costs per accident type within the construction industry.

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* States reporting indemnity cost information for 1977 through 1980 were Arkansas, Colorado, Delaware, Idaho, Montana, New York, North Carolina, South Carolina, Virginia, Washington, and Wisconsin.

Table II-5

Cost Factors By Accident Type

Accident Type	Cost Factor
Struck Against	
Stationary Object	1.5
Struck by	
Falling Object	2.5
NEC	2.3
Fall from Elevation	
From Scaffolds	6.0
From Ladders	4.2
From Vehicles	4.1
Into Shafts, Etc.	4.5
Fall to Lower Level, NEC	4.8
Falls on Same Level	
Fall on Working Surface	4.0
Fall Against Object	2.2
Caught In, Under, or Between	
Meshing Objects	2.8
Moving & Stationary Object	2.2
Collapsing Material	6.8
NEC	2.4
Rubbed or Abraded	
Leaning or Kneeling, Etc.	2.4
Foreign Matter in Eyes	1.0
Overexertion	
Lifting Objects	3.1
Pulling Objects	3.1
Throwing Ojects	4.7
NEC	3.3
Contact with Electric Current	7.3
Contact w/Temperature Extremes Hot Objects	1.4
Contact w/Radiation, Caustics, etc.	
By Inhalation	14.8
By Absorption	2.2
Motor Vehicle Accidents (All Types)	5.5
Overturned	4.5

Chapter III

Ranking the High Risk Occupations

The high risk occupations are ranked into a numerical ranking scheme. This scheme took into account the percentage of employment, risk factor, and accident type with related costs. Table III-1 shows the percentage of employment and the four leading accident types encountered by workers in these high risk occupations.

The occupations listed in Table III-1 were evaluated by calculating rating points for each via the following formula:

$$\text{Rating Points} = E_o(\%) \times RF \times \frac{\sum_{n=1}^{4} (AT\% \times CF)}{4}$$

where

$E_o(\%)$ = Employment in specific occupation as a percentage of construction industry employment.

RF = Risk factor.

AT% = Accident type percentage within the specific occupation.

CF = Cost factor related to accident type.

The resulting ranking scale is presented in Table III-2.

It should be noted that the rank order of the occupations in Table III-2 is different from those previously presented in Chapter II. The reason is that this method of rating the occupations is a function of several variables; namely, size of occupation employment, occupation risk factor, and occupation accident type with related cost factors. This scheme take into account frequency, severity and costs of injuries.

Table III-1

Leading Accident Types in the High Risk Occupations

Occupation	% Employment	Accident Type	%
Asbestos Wkrs.	0.71	1. Struck against, stationary object	10.8
		2. Struck by, NEC	7.8
		3. Overexertion, lifting	7.7
		4. Falls from ladders	7.4
Boilermakers	0.39	1. Foreign matter in eye	19.0
		2. Struck by, NEC	8.7
		3. Struck by, falling object	7.2
		4. Struck against, stationary object	6.9
Carpenters	11.71	1. Struck by, NEC	15.8
		2. Overexertion, lifting	10.2
		3. Struck against, stationary object	8.8
		4. Struck by, falling object	6.6
Carpet Installers	0.35	1. Overexertion, lifting	20.1
		2. Struck by, NEC	16.6
		3. Struck against, stationary object	11.0
		4. Overexertion, throwing object	6.7

Table III-1

Leading Accident Types in the High Risk Occupations (cont'd)

Occupation	% Employment	Accident Type	%
Cranemen	0.56	1. Falls from vehicles	9.3
		2. Struck by, NEC	9.2
		3. Falls from elevations	8.5
		4. Overexertion, lifting	7.5
Drywall Installers	0.82	1. Overexertion, lifting	15.8
		2. Struck against, stationary object	10.1
		3. Struck by, NEC	9.3
		4. Falls from scaffolds	6.7
Eng. Sci. Tech.	0.06	1. Struck by, NEC	11.2
		2. Overexertion, lifting	8.9
		3. Struck against, stationary object	8.3
		4. Fall to working surface	8.2
Glazier	0.26	1. Struck against, stationary object	17.3
		2. Struck by, NEC	17.3
		3. Overexertion, lifting	14.1
		4. Struck by falling object	9.8

Table III-1

Leading Accident Types in the High Risk Occupations (cont'd)

Occupation	% Employment	Accident Type	%
Heavy Equip. Op.	5.31	1. Struck by, NEC	10.2
		2. Overexertion, lifting	8.0
		3. Struck against, stationary object	7.6
		4. Falls from vehicles	6.7
Laborers	9.39	1. Struck by, NEC	13.0
		2. Overexertion, lifting	10.9
		3. Struck by, falling object	9.6
		4. Struck against, stationary object	8.4
Linemen	0.46	1. Struck by, NEC	12.1
		2. Falls to lower level	8.5
		3. Overexertion, lifting	8.0
		4. Falls from elevations	6.7
Mechanics	1.08	1. Overexertion, lifting	10.9
		2. Struck by, NEC	10.5
		3. Struck by, falling object	8.5
		4. Struck against, stationary object	7.4

Table III-1

Leading Accident Types in the High Risk Occupations (cont'd)

Occupation	% Employment	Accident Type	%
Millwright	0.39	1. Foreign matter in eye	11.0
		2. Struck by, NEC	10.0
		3. Struck by, falling object	9.2
		4. Overexertion, lifting	9.2
Painters	2.82	1. Falls from ladders	13.2
		2. Overexertion, lifting	9.7
		3. Struck against, stationary object	8.9
		4. Struck by, NEC	6.9
Plumbers	4.37	1. Overexertion, lifting	11.8
		2. Foreign matter in eye	9.8
		3. Struck against, stationary object	8.2
		4. Struck by, NEC	9.5
Roofer-Slater	1.67	1. Contact with hot objects	19.1
		2. Overexertion, lifting	10.3
		3. Falls to lower level, NEC	9.2
		4. Struck by, NEC	8.3

Table III-1

Leading Accident Types in the High Risk Occupations (cont'd)

Occupation	% Employment	Accident Type	%
Sheet Metal Wkr.	2.16	1. Struck against, stationary object	12.6
		2. Struck by, NEC	10.6
		3. Overexertion, lifting	10.6
		4. Foreign matter in eye	10.1
Struct. Metal Cftmn.	1.13	1. Foreign matter in eye	12.0
		2. Struck by, NEC	11.2
		3. Overexertion, lifting	10.6
		4. Struck by, falling object	8.3
Truck Drivers	2.64	1. Overexertion, lifting	9.9
		2. Struck by, NEC	8.7
		3. Falls from vehicles	8.7
		4. Struck by, falling object	6.8
Warehousemen	0.15	1. Overexertion, lifting	18.5
		2. Struck by, NEC	11.5
		3. Struck by, falling object	10.8
		4. Struck against, stationary object	9.7

Table III-1

Leading Accident Types in the High Risk Occupations (concluded)

Occupation	% Employment	Accident Type	%
Welders	0.81	1. Foreign matter in eye	16.8
		2. Struck by, NEC	8.5
		3. Struck by, falling object	8.3
		4. Overexertion, lifting	8.3

Table III-2

Ranking Scale for High Risk Occupations

Occupation	Rating Points
Laborers	613
Carpenters	229
Heavy Equip. Op.	103
Roofer-Slater	92
Struct. Metal Cftmn.	90
Truck Drivers	81
Painters	81
Plumbers	79
Asbestos Wkr.	49
Sheet Metal Wkr.	42
Mechanics	41
Drywall Installers	39
Welders	32
Cranemen	30
Millwright	25
Boilermakers	23
Linemen	20
Carpet Installers	8
Warehousemen	7
Glazier	6
Eng. Sci. Tech.	4

Chapter IV

Research Needs

A. Proposed Scope of Research

The methodology presented for identifying the high risk occupations in Chapter II resulted in the identification of 21 specific occupations which had fatality and/or injury risk indices greater than or equal to one. In addition to these indices, the rating scheme utilized percentage of employment, risk factor, and accident type with related cost in determining the high risk occupations. Attempts to perform research on the identified 21 high risk occupations is too large a task for present NIOSH/DSR resources. Present allocated resources are limited to $1,391,000 free funds and 40 research professionals. These resources are presently utilized in many different safety research areas, including limited research related to the construction industry. It is recommended that NIOSH/DSR pursue research in the the top eight occupations: laborers, carpenters, heavy equipment operators, roofer-slaters, structural metal craftsmen, truck drivers, painters and plumbers. Pursuit of the recommended research within these eight identified occupational areas will require allocation of additional NIOSH/DSR resources.

It is estimated that these eight occupational areas represent 39% of the construction industry workforce, 54% of the injuries, and 55% of the

fatalities. These percentages indicate that these eight occupations are indeed problem areas which need further investigation.

B. Discussion of High Risk Occupation Research Areas

The ARI's were used to identify the research areas within the top eight occupations. All type of accident categories which had an ARI value of 1.0 or more are considered potential research areas. Additionally, the primary types of accidents resulting in fatals within the occupation will be discussed. Development of the ARI values is based on the frequency of occurrence of a type of accident. This means that it is possible for a type of accident to be comparatively infrequent but result in rather high fatal counts. These type of accident categories were cross analyzed with source of injury, nature of injury and part of body injured. This provided more specific information for identifying potential research areas.

1. Laborers -- Laborers perform a variety of duties on construction projects, usually in the utility capacity. They frequently transfer from one task to another because of demands for required work. They work without close supervision in low skilled, manual intensive activities. They frequently assist other skilled workers in performance of their tasks.

a. Identified factors

1) Struck by falling object (ARI of 3.5 and 9.6% of injuries)

Further refinement revealed that the leading sources of injury for building construction were lumber (16%) and metal item, NEC (12%). In the heavy construction and special trades divisions, the leading sources of injury were metal items, NEC (over 15%), and mineral (dirt), (over 10%). The leading part of body injured was the foot including toes (over 30%). In the struck by falling object injuries, the leading nature of injury categories for all divisions of construction were contusion (30%) and fracture (20%).

2) Struck by, NEC (ARI of 3.0 and 13% of all injuries)

These struck by, NEC injuries are further refined to indicate that the hands and fingers are involved in 37% of the cases. In the building and special trades divisions, the leading source of injury is a hammer/sledge, with 10% of the injuries. Within the heavy construction division, highway vehicles accounted for 7.7% of the laborers' struck by, NEC injuries. The leading nature of injury is cuts/lacerations (40%). The struck by NEC category resulted in 14% (37 of 268) fatals to laborers. Laborers were struck by a vehicle in 70% (26) of these cases.

3) Overexertion, lifting (ARI of 2.8 and 10% of all injuries)

The leading source of injury in the building construction division was lumber, which accounted for 17% of the injuries. In the heavy construction and special trades divisions, containers, NEC accounted for about 10% of the injuries. The

back was injured in 65% of the overexertion by lifting injuries and the leading nature of injury was sprain/strain (80%).

4) Struck against stationary object (ARI of 2.7 and 8.4% of all injuries)

A review of these injuries revealed that the leading source of injury was the nail/spike (25%). The leading parts of the body injured were the fingers and/or hand (25%) and the foot (19%). Over 42% of the injuries in the struck against stationary object category were cuts/lacerations.

5) Caught in collapsing material (13% of the fatals)

This category resulted in 35 laborer fatals. Of these, 69% (24) were the result of collapsing dirt.

b. Known Research - The Bureau of Labor Statistics is presently conducting a Worker Injury Report (WIR) survey on construction laborers. This survey should provide valuable information concerning various factors associated with laborer injuries. When completed, the survey should be utilized as an analysis tool for defining more pertinent research areas concerning laborer tasks.

c. Potential interventions - Two areas indicate that safety footwear is a potential method for intervention of foot injuries. The foot and toes are injured over 30% of the time in the struck by falling

object category. Additionally the foot was involved in 19% of the struck against stationary objects where a nail/spike was thelikely object. The category of caught in collapsing material mainly dirt, indicates that proper sloping of excavations, provision of shoring, or provision of trench shields/boxes could impact upon the reduction of these fatals.

2. Carpenters -- Carpenters are primarily concerned with constructing, erecting, installing, and repairing structures and fixtures made of wood and materials that can be worked like wood. They use a variety of powered and nonpowered woodworking machinery and handtools.

a. Identified Factors

1) Falls to Lower Level, NEC (ARI of 1.8 and 5.5% of all injuries)

The review of fatalities revealed that 43% occurred from falls from elevation. A further refinement of the falls revealed that 50% of the deaths were due to falls from scaffold, and 34% were due to falls to lower level, NEC. Falls to lower levels resulted in fractures (30%) and sprains/strains (27%) which effected the back, ankle, and multiple body parts.

2) Struck by, NEC (ARI of 1.5 and 15.8% of all injuries)

In the building and special trade divisions, about 23% of these injuries are due to saws and 16% are due to hammers/sledges. The finger and/or hand were injured in about

53% of all struck by cases. Similar trends were noted for carpenter injuries in the heavy construction segment of the industry. The hammer/sledge accounted for 19.1% of the struck by, NEC injuries while the saw accounted for 9.2% of the injuries. Cuts/lacerations to are the leading nature of injury (55%) within this type.

3) Foreign matter in eye (ARI of 1.1 and 6.3% of all injuries)

Foreign matter in the eyes was the fifth most frequent accident type to carpenters. The ARI reveals that their risk of injury is only slightly greater than the risk encountered by the average construction worker. Wood items were the source of injury in 21% of these cases.

4) Overexertion, lifting (ARI of 1.1 and 10.2% of all injuries)

Lumber was the leading source of injury in the overexertion, lifting category, accounting for about 25% of the injuries. The back was injured in about 67% of the cases, and the leading nature of injury was sprain/strain (82%).

5) Struck against, stationary object (ARI of 1.1 and 8.8% of all injuries)

An analysis of this type of injury revealed that the leading source of injury was the nail/spike (30%). The fingers and/or hand were injured in about 25% of the cases, while the foot

was injured about 23% of the time. The leading nature of injury was cut/laceration, which accounted for about 66% of the injuries.

6) Struck by, falling object (ARI of 1.0 and 6.6% of all injuries)

A review of the struck by, falling object injuries revealed that the leading source of injury was lumber, which accounted for about 26% of these injuries. The foot and/or toes were injured in about 22% of the cases, and the fingers in about 14% of the cases. The leading nature of injury categories were contusion (28%), cut/laceration (20%), and fracture (22%).

7) Contact with electric current (11% of the fatalities)

This type of accident was only involved in 0.1% of all carpenter injuries; however, it accounted for 11% of the carpenter fatalities. Contact with live electric conductors and use of electrical equipment were the main sources of contact with electric current.

b. Known research - BLS conducted a WIR survey on saw injuries. This survey could be used in developing further research projects for determining causal factors of saw-related injuries. A preliminary analysis of carpenter tasks has been performed by the

Battelle Memorial Institute (12). This study was concerned with identifying the various tasks performed by construction carpenters, mainly for identifying training needs. However, the tasks could be utilized for injury causation purposes also.

c. Potential intervention - The foreign matter in eye category indicates that protective eyewear would potentially reduce the numbers of eye injuries. Two areas indicate that safety footwear is a potential method for intervention of foot injuries. These areas are the struck against stationary object and struck by, NEC categories.

3. Heavy Equipment Operators -- Heavy equipment operators are concerned with operating heavy earthmoving equipment in removal and placement of earth materials, and grading earth surfaces; placing concrete and other paving materials; constructing drainage systems and activities involving blasting and haulage of earth materials.

a. Identified injury factors

1) Falls, from vehicles (ARI of 2.1 and 7% of all injuries)

The injured workers suffered sprains/strains in 46% of the cases. The back was involved 22% of the time, and the ground was the major source of injury (59%).

2) Struck by, NEC (29% of the fatals)

This category accounted for 26 heavy equipment operator fatals. The construction machine was the source of the fatal in 28% of all the fatals.

b. Known Research -- DSR presently has on ongoing project to analyze heavy earthmoving equipment cases to determine causal factors associated with the injuries. The data base contains approximately 13,900 cases for analysis. Results of this work combined with the SDS data should provide insight into problems for resolution. The Bureau of Mines has conducted research on similar equipment used in surface mining operations. Their literature would be useful in developing areas for future research.

4. Roofers-slaters -- Roofers and slaters primarily are concerned with covering roofs and exterior walls of structures with slate, asphalt, aluminum, wood, and related materials.

a. Identified Factors

1) Contact with hot objects (ARI of 13.6 and 19.1% of all injuries)

An analysis of these injuries revealed that the leading source of injury was asphalt oil (82%), which resulted in a

burn/scald in 99% of the cases. The hand was injured in 25% of the burn cases, and multiple parts of the body in 22% of the cases studied.

2) Falls, to lower levels NEC (ARI of 3.9 and 9.2% of all injuries)

A review of these injuries revealed that the ground was the leading source of injury (70%). The leading parts of body injured were multiple parts (22%) and the back (13%). Fractures (34%) and sprains/strains (20%) were the leading natures of injury. Of the 34 fatals reported for roofers-slaters, falls to lower levels accounted for 71% of them.

3) Overexertion, lifting (ARI of 1.4 and 10.3% of the injuries)

The leading sources of injury were reel/roll (16%), bundle (13%), and container, NEC (10.4%). The back was injured in 69% of the cases reviewed, and the leading nature of injury was a sprain/strain (86% of the lifting cases).

4) Struck by, NEC (ARI of 1.1 and 8.3% of all injuries)

The knife was the leading source of injury (20%). The hand and/or finger was injured in 47% of the cases reviewed. The leading nature of injury for this category was cut/laceration, which accounted for 63% of the injuries.

5) Struck against stationary object (ARI of 1.0 and 6.5% of all the injuries)

A review of these injuries indicated that the leading source of injury is a nail/spike which results in 27% of the injuries. Metal items, NEC, account for another 20% of the injuries. The most prevalent nature of injury was a cut/laceration, 70% of the injuries. The hand and fingers were involved in 37% of the cases.

b. Known Research -- DSR presently has an ongoing project to analyze incidents involving roofers and slaters to determine causal factors associated with their injuries. Over 1000 insurance claims are being reviewed in order to understand the injuries and develop appropriate countermeasure research projects.

5. Structural Metal Craftsmen -- Structural metal craftsmen primarily join structural parts and components with bolts, screws, and related fasteners, or by filling (placing) reinforcing steel or iron in concrete forms to strengthen concrete.

a. Identified injury factors

1) Foreign matter in the eye (ARI of 4.7 and 12% of all injuries)

The leading source of injury were particle (47%), and metal item, NEC (38%). These incidents resulted in abrasions to the eye in about 90% of the cases studied.

2) Struck by, falling object (ARI of 2.6 and 8.3% of all injuries)

A review of these injuries revealed that the leading sources of injury were metal item, NEC (32%) and beam/bar (24%). The foot and/or toes were injured in 31% of the cases. The leading natures of injury in this category were contusion (31%) and fracture (30%).

3) Overexertion, lifting (ARI of 2.3 and 10.6% of all injuries)

A metal item, NEC (34%) and beam/bar (24%) were the leading sources of injury in this category. The back was injured in 70% of the cases reviewed, and sprain/strain was reported in 87% of the overexertion, lifting cases.

4) Struck by, NEC (ARI of 2.2 and 11.2% of all injuries)

A review of these injuries revealed that a metal item, NEC (30%) and beam/bar (13%) were the leading sources of injury. The finger was injured in 20% and the eye in 13% of the cases. Of the struck by, NEC injuries reviewed, the leading natures of injury were cut/laceration (34%), contusion (26%), and fractures (13%).

5. Struck against stationary object (ARI of 1.9 and 6.9% of all injuries)

A review of this injury data reveals that the leading sources of injury were metal items, NEC, 39% and beam/bar 17%. The parts of body most frequently injured were the finger, 16%; the knee, 14%; and the foot, 11%. Most of the injuries resulted in a cut/laceration, 43%; followed by contusion 24% and a sprain/strain in 14% of the cases.

6. Falls from elevations (49% of the fatals)

Falls from elevations resulted in 19 reported fatals. These fatals involved falls from scaffolds and ladders into shafts and to lower levels, NEC.

7. Contact with electric current (31% of the fatals)

Even though contact with electric current only accounted for 0.3% of all the structural metal craftsmen injuries, it did result in 12 reported fatals. The major sources of contact came from cranes, 26%; conductors, 23%; and electric apparatus, 18%.

b. Known Research -- DSR has studied a specialized group of structural metal craftsmen called connectors. These workers place and connect beams at the leading edge of construction.

The study revealed no major problems. However, it was revealed that the workers that follow up the connectors have problems with falls from elevations, being struck by falling objects, and other related injury types.

c. Potential Interventions - Two types of accidents indicate that protective eyewear is a potential method for intervention of eye injuries. The eye was abroded by foreign matter in 12% of all the structural metal craftsmen injuries. Additionally, the eye was involved in 13% of the struck by, NEC cases. Protective footwear has potentional in reducing the number of foot and toe injuries (31%) in the struck by falling object category.

6. Truck Driver - Truck drivers are involved with transporting various cargos from one location to another. They drive a variety of over-the-highway or off the highway trucks. The type of truck being driven dictates the tasks the driver must accomplish in fulfullment of their duties.

a. Identified factors

1) Falls from vehicles (ARI of 4.9 and 8.7% of all injuries)

The leading nature of injury for this category is sprain/strain which occurs in 43% of the injuries. Approximately 20% of the injuries result in fractures. The most frequently injured parts of body are the back (20%, ankle (18%) and knee (10%).

2) Struck by, NEC (14% of the fatals)

Of the 50 fatals reported for truck drivers, this category represented the majority with seven. Of these, the driver was struck by a highway vehicle in six cases.

b. Known Research - The Construction Safety Association of Ontario commissioned the Centre for Occupational Health and Safety, University of Waterloo, to undertake a detailed human factors engineering project to study the relation between design and usage of access systems on heavy mobile equipment. This study found that 20% of all lost time injuries in the construction industry related to construction equipment occur during the mounting and dismounting stage (13). The study suggests that a three-point contact on access systems will reduce lost time injuries during mounting and dismounting of equipment including trucks.

c. Potential interventions - The number of injuries resulting from falls from vehicles can potentially be reduced by (a) locating a handhold on the right of the driver's right door which is long enough to be accessible by the majority of drivers, and (b) locating a handhold on the corner of the dashboard as an alternative to the use of the steering wheel during mounting and as an aid in maintaining three-point contact. Alternatively, a recessed handhold in the door would be effective although less secure (13).

7. Painters - Painters are involved with applying paint and related materials with brushes and spray guns to machinery, equipment, buildings (exterior and interior), bridges, tanks and super structures.

a. Identified factors

1) Falls from ladders (ARI of 2.7, and 13.2% of the injuries and 18% of the fatalities)

The leading nature of injuries are fracture 35% and sprain/strain 25% of the cases. The most frequent parts of body injured are multiple parts (16%), back (14%), and ankle (11% of the cases). Fall from ladders accounted for 18% of the painter fatalities during the review period.

2) Fall from scaffolds (ARI of 1.4, 5.2% of the injuries, and 38% of the fatalities)

The leading nature of injury categories are fracture (41%), sprain/strain, (18%) and contusion, (12% of the cases). Multiple parts of the body was injured in 26%, while the back and foot were injured in 12% and 10% of the cases respectively. Falls of scaffolds were responsible for 38% of the painter fatalities.

b. Known Research - A WIR survey has been conducted on scaffold injuries (14). A review of the data revealed that the leading causes of accidents were: a) platform failure, b) cross bracing failure, and c) lack of proper guardrails. A study of falls from ladder studys is currently conducted at DSR, and the results are expected by FY 85.

8. Plumbers - Plumbers and/or pipe fitters primarily assemble and install gas, steam, and water plumbing, and related fixtures, pipes and fittings in structures.

a. Identified factors

1) Foreign matter in the eye (ARI of 1.7 and 9.8% of the injuries)

A particle (44%) and metal item, NEC (36% of the injuries) were the leading source of injury which resulted in an abrasion to the eye.

2) Overexertion by lifting (ARI of 1.1 and 11.8% of the injuries)

Pipes (35%) and metal item, NEC (10%) were the leading sources of injuries. About 70% of the injuries were to the back, and 83% of the injuries resulted in a sprain or strain.

3) Struck against stationary object (ARI of 1.0 and 8.2% of the injuries)

The leading sources of injury were metal item, (17%) nail/spike (17%) and pipe (13% of the injuries). The finger 19%, hand 12%, and foot 15% were the leading parts of body injuried. Over 52% of the injuries resulted in a cut/laceration, 18% in contusion, and 11% sprain/strain.

4) Caught in collapsing material (20% of the fatals)

There were a total of eight fatals reported for plumbers in this category. Of these fatals, 88% resulted from collapsing dirt. This category accounted for only 0.6% of all plumber injuries; however, it ranks as one of highest producers of fatals among plumbers.

5) Overexertion (20% of the fatals)

This category resulted in eight fatals to plumbers, which indicates that manual material handling is a potential problem area.

6) Falls from elevations, NEC (12% of the fatals)

This category resulted in five reported fatals for plumbers. The fatals were reported as resulting from falls from scaffolds, ladders, vehicle, and into a shafts.

b. Know Research - No known safety research specifically addresses plumbers or plumbing tasks.

c. Potential interventions - Foreign matter in the eye accounts for 9.8% of all plumbers injuries. A potential method of intervention for these injuries is the wearing of adequate protective eye wear. Plumbers are exposed to mass movements of soil while working in

excavations. The fatal data indicates that seven fatals were the result of collapsing dirt. Potential interventions are cutting the slopes of the excavations back to a stable angle of repose, and providing shoring or utilizing trench shields, boxes, or hydraulic shores.

C. Summary of Research Needs

The research areas described in section B are summarized in Table IV-1. Included is an estimated ranking (high, medium, low) assigned to the research areas. The ranking is a subjective evaluation of DSR's available personnel skills, knowledge, experience, and resources to perform the work over the next few years.

In order to accomplish these identified research objectives, the following tasks will have to be accomplished by DSR staff, research contractors, or grantees:

1. Solicit support and cooperation for the proposed research from industry associations, corporations, unions, and other interested parties.

2. Analyze the tasks performed by workers in the specific occupation to determine relationships of tasks to injuries. Those tasks which result in higher than average ratios of injuries should be further researched to determine pertinent causal factors. The causal factors would then lead to appropriate countermeasure research and demonstration of effectiveness.

3. Obtain all relevant accident descriptions related to the proposed research areas. This information could be obtained from insurance companies or through specialized surveys designed to obtain the essential analysis information.

4. Correlate information obtained during tasks 2 and 3 by direct observation of tasks being performed in the field. The researchers can obtain a much better working knowledge of task activities and associated hazards by first hand observation of the work. Previous experience has shown that the construction industry places more credibility on research work which was supported by field observations.

5. Develop controls once the occupational tasks and related hazards have been identified. These controls could be of several types, such as engineering, administrative, and training.

6. Demonstrate the effectiveness of any developed controls. If effectiveness is not demonstrated, acceptance and implementation by the industry will by unlikely.

D. Research Plan

Areas of potential research concerning the high risk occupations were discussed in section B of this chapter. More specific descriptions of potential research projects have been developed from the reviewed data

and are presented below. The detail of these projects is limited by the amount of information analyzed in the data. The projects are divided into three categories which reflect the priority assigned the project (H.M.L.) combined with the influence it would potentially have upon accomplishment of the PHS 1990 objectives. The three categories are as follows:

1) Immediate projects - Projects which have been assigned a high rating in section C and which appear most likely to impact on the 1990 objectives. These projects should be initiated in FY 1985.

   (a) Eye injuries

   Two types of accidents account for the majority of the eye injuries. These types are rubbed or abraded by foreign matter in the eye and struck by, NEC. They account for 8.9% of the injuries and mainly occur within the carpenter, structural metal craftsman, and plumber categories.

   A study should be performed to identify the tasks most frequently involved with eye injuries. This study should result in a refinement of the definition tae problem. We presently do not know if the problem is training, ineffective protective eyewear, management's non-commitment to an eye injury prevention program or task design. The problem needs to be defined in more specific detail for development of a countermeasure program.

(b) Foot Injuries

Two types of accidents account for the majority of the foot injuries within the high risk occupations. These types are struck by falling object and struck against stationary object. They account for 6.3% of the injuries.

(1) Struck by falling object - This type of accident occurs more frequently within the laborers, carpenter and structural metal craftsmen categories. A study should be initiated to determine the effect present types of foot protection would have upon reduction of injuries within these occupations. For example, is safety-toed footwear adequate for structural metal craftsmen or should footwear with a combination of safety toes and metatarsal guards be recommended.

(2) Struck against stationary object - This type of accident ocurs most frequently to plumbers, laborers, carpenters, and structural metal craftsmen. The source of injury most frequently identified with this type of accident is a nail/spike. The data indicate that the foot is being punctured by a nail/spike which penetrates the shoe. A study should be performed to validate this and to determine the effectiveness of a present countermeasure known as steel insoles.

(c) Burns to Roofers - The single major source of injury to roofers is burns from hot substances. This type of injury accounts for over 19% of their injuries. A study is ongoing which is reviewing roofing injuries and recommendations are being developed for future research.

(d) Falls from vehicles - This type of accident accounted for 2.5% of the injuries. The two occupations most effected were truck drivers and heavy equipment operators. Canadian research indicates that the majority of falls from vehicles occurs during mounting and dismounting the equipment. The research indicates that a three-point contact should be maintained at all times by the person mounting or dismounting the equipment. A study of falls from vehicles should be conducted to verify if the same problem exists in the U.S. (It is highly likely that it does). If so, the recommendations proposed by the Canadians should be verified to be effective. If positive this information should be presented to the equipment manufacturers and OSHA in hopes of correcting the problems. Additionally, recommendations for field modifications can be presented.

(e) Falls from scaffolds - Painters, carpenters, and plumbers are the occupations which suffer scaffold injuries within the top eight occupations. Research has been conducted by NBS on scaffold injuries, however, this research only identified

some potential problem areas. A review of the BLS WIR scaffold survey reveals that the welded tubular ladder scaffold, and two-point suspended scaffold are frequently used by these occupations. A review of the data reveals that a research study should be conducted into scaffold platform design and structural stability for the welded tubular and ladder scaffold. Presently, DSR is considering a project on investigating suspended scaffolds. The study would determine failure mechanisms and make recommendations.

(f) Overexertion - This type of accident results in 28.7% of the injuries within the high risk occupations. The data indicates that the back is most frequently injured due to lifting. This type effects all the high risk occupations. It is recommended that only two occupations be selected for study at this time. These would be structural metal craftsmen and plumbers. The structural metal craftsmen and plumbers were selected because of their ARI values, 2.3 and 1.1 respectively, combined with the numbers of injuries overall and the performance of more repetitive tasks. A study should be initiated to perform objective low back examinations of the injured workers. This would verify and locate the area of injury to the back. Then these injuries should be correlated to the workers tasks. If correlations are derived from these studies, then research into appropriate countermeasure development should begin.

(g) Contact with electric current - Electrocutions are one of the leading sources of fatalities among carpenters and structural metal craftsmen. The DSR FACE program could be used to investigate electrocutions to determine the common causual factors which lead to these incidents. Once common factors are identified, countermeasure development should begin.

(h) Collapsing material (dirt) - Collapsing material (dirt) is one of the leading sources of fatalities among laborers and plumbers. DSR worked with NBS and OSHA in the development of a draft excavation standard. The DSR FACE program could be used to verify the recommendations within the draft standard. Another area of research is to develop micro computer programs which would classify different soil types and design worker protection (trench shields, shoring, sloping of banks, etc.). The programs should be usable in the field and useability of the program in the field should be verified.

2) Intermediate projects - This category represents those projects which have been assigned a MEDIUM rating in section C and which will take more time to accomplish. This, in effect, would make them less likely to have an impact on the 1990 Objectives. It is recommended these projects begin in the period FY 86-87.

(a) Hand/finger Three types of accidents result in the majority of the hand/finger injuries. These types are struck by, NEC, struck by falling object and struck against stationary object. They account for 13.8% of the injuries.

1) Struck by, NEC - This type of accident occurs more frequently within the carpenter, roofer-slaters, and structural metal craftsmen categories. The data indicate that carpenters hands/fingers are being struck by powered hand saws and sawing machines such as table and radial arm saws. A study should be performed to determine the various factors which could lead to injuries while sawing and correlate the injuries to the factors. This would lead to identification of problems for which there probably are already countermeasures. Such as operating either type saw without appropriate guards. It could also lead to identification of state-of-the-art solutions such as possibly adding a follower guide in the cut to prevent blade backouts due to binding of the wood.

Laborers and carpenters are frequently injured by sledges/hammers. The cause of these injuries is unknown, so a study should be conducted which would determine the cause of injuries to the hand/finger by sledge/hammers. Also, the handle of hammers have been redesigned. A study should be conducted which would determine the effectiveness of the new design in preventing han and finger injuries.

Roofers are frequently injured by knives. A study should be conducted which would determine the conditions where the injury occurred. From this study it could be determined if the knives need to be redesigned, or which other countermeasures should be developed and inplemented in the field.

Structural metal craftsmen are frequently injured by beams/bars. A study should be conducted into the tasks associated with these injuries. From this study it could be determined if the tasks need to be redefined, and/or other countermeasures developed. Next, the results should be field tested.

(b) Falls from ladders - Falls from ladders account for 2.2% of the injuries within the construction industry. Within the top eight occupations, painters, carpenters and plumbers account for 59% of the ladder injuries. NIOSH has an ungoing ladder study which is determining the causual factors of ladder injuries. A study should be conducted which would correlate to the type of injuries from ladder within the construction industry or these three occupations to the results of the ladder study. Appropriate countermeasures should be developed and verified in the field.

3) Long Range Starts -These projects have been assigned a low rating in section C. Accomplishment of the projects probably would not be completed until after 1990 and would therefore have little, if any, impact on the 1990 Objectives. It is recommended these projects start in FY 88 or later.

(a) Struck by vehicles - The data indicate that this type of accident results in a high number of fatals to heavy equipment operators and truck drivers. Laborers are frequently injuried by this type; however, resulting in a lesser number of fatals. Research should be accomplished to determine if there are common factors related to the incidents within each occupation. For instance, ar laborers being struck by vehicles while flagging vehicles, working alongside highways, etc. Are proper barricades, warnings, signaling devices being used to protect the workers? Are truck drivers being killed on highways or on job-sites? More than likely heavy equipment operators are being killed on the job-site. However, what activities are they involved with when struck by a vehicle? Answers to these types of questions are needed in order to develop recommended countermeasures.

(b) Falls to lower level - Falls to lower level (out of building, off edge of roof, etc.) is one of the leading sources of injury and fatalities for roofers and structural metal craftsmen. A study should be undertaken to determine the conditions which

lead to these falls. The study should determine the task involved and the feasibility of using protective equipment (life lines, safety nets, warning lines, etc.) The study could compare construction sites where the equipment is used or where it is not used. Recommendations could be made to determine the safety means of protecting the worker from falls.

Table IV-1

Ranking of Proposed Research Areas

Occupation (SIC)	Research Area	Ranking
Laborer		
(15, 17)	Struck by, hammer/sledge	M
(16)	Struck by, highway vehicles	M
(15)	Overexertion, lifting lumber	M
(16, 17)	Overexertion, lifting containers	H
(15)	Struck by, falling lumber and metal item, NEC	M
(16, 17)	Struck by, falling minerals (dirt)	H
(15, 16, 17)	Struck against nails/spikes	H
(15, 16, 17)	Caught in collapsing material	H
Carpenter		
(15, 16, 17)	Struck by saws, hammers/sledges	M
(15, 16, 17)	Overexertion by lifting lumber	M
(15, 16, 17)	Struck by, falling lumber	M
(15, 16, 17)	Struck against nails/spikes	H
(15, 16, 17)	Falls from scaffolds	H
(15, 16, 17)	Foreign matter in eye	H
(15, 16, 17)	Contact with electric current	H
Heavy Equipment Operator		
(15, 16, 17)	Struck by construction machine	M
(15, 16, 17)	Overexertion by lifting metal items	M
(15, 16, 17)	Struck against a stationary construction machine	M
(15, 16, 17)	Fall from vehicle	H
Roofers-Slaters		
(15, 17)	Struck by a knife	M
(15, 17)	Overexertion by lifting rolls, bundles, and containers	H
(15, 17)	Burns by hot asphalt	H
(15, 17)	Fall to lower levels, NEC	L
(15, 17)	Struck against nails/spikes	H
Structural Metal Craftsmen		
(15, 16, 17)	Struck by beams/bars	L
(15, 16, 17)	Overexertion by lifting metal items, NEC and beams/bars	M

Craftsmen (continued)

(15, 16, 17)	Struck by falling metal items and beams/bars	M
(15, 16, 17)	Foreign matter in eyes	H
(15, 16, 17)	Struck against metal items	L
(15, 16, 17)	Contact with electric current	H

Truck Drivers

(15, 16, 17)	Falls from vehicles	M
(15, 16, 17)	Struck by highway vehicles	L

Painters

(15, 16, 17)	Falls from ladders	H
(15, 16, 17)	Falls from scaffolds	H

Plumbers

(15, 16, 17)	Foreign matter in eye	H
(15, 16, 17)	Overexertion from lifting pipe	H
(15, 16, 17)	Struck against nails/spikes	H
(15, 16, 17)	Caught in collapsing material	H
(15, 16, 17)	Falls from elevations	M

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APPENDIX A

This Appendix contains the background information for the development of the occupational risk indices.

Table A-1

Construction Industry Employment
for the SDS States, 1977-1980

SDS STATES	CONSTRUCTION EMPLOYMENT IN 1000's			
	1977	1978	1979	1980
Alaska	19.6	12.1	10.1	10.3
Arizona	--	--	56.5	50.2
Arkansas	37.2	39.9	41.9	--
California	366.1	417.5	463.3	431.3
Colorado	61.8	72.3	80.2	77.0
Connecticut*	43.7	48.7	--	--
Delaware	14.3	15.0	15.6	--
Hawaii	19.7	20.4	23.4	23.9
Idaho	19.0	20.3	19.1	16.7
Indiana	91.9	98.3	106.0	91.6
Iowa	57.6	61.1	59.9	47.4
Kentucky	58.4	67.9	69.2	57.9
Maine	19.8	19.1	19.4	19.7
Maryland	92.2	102.5	107.9	103.3
Michigan	124.1	138.8	139.5	117.1
Minnesota	68.7	79.6	83.2	76.2
Mississippi	--	--	--	43.7
Missouri	77.8	87.3	92.4	79.8
Montana	15.7	16.3	15.6	14.7
Nebraska	32.3	32.5	32.5	28.9
New Jersey	96.1	105.3	113.7	110.7
New Mexico	30.7	35.4	35.6	30.2
New York	--	197.5	210.3	--
North Carolina	106.8	118.1	126.1	--
Oregon	42.6	49.4	53.0	45.7
South Carolina	65.8	--	--	--
South Dakota	12.4	12.7	12.9	--
Tennessee	78.4	87.3	89.2	76.8
Utah	31.8	35.1	35.6	31.9
Vermont	8.2	9.5	10.3	10.0
Virginia	--	--	135.4	--
Washington	--	92.7	104.4	91.0
Wisconsin	64.7	78.5	80.5	70.0
Wyoming	14.9	19.3	20.8	20.1
Totals (# states)	1772.3 (29)	2190.4 (30)	2463.5(31)	1776.1 (26)

*Construction and Mining Employment Counts

Employment obtained form Ref. 6 and 7.

Table A-2

Employment by Occupation and Two-Digit SIC
in the Construction Industry in 1978*

Occupation	SIC 15	SIC 16	SIC 17	Total
Asbestos Wkr.	3560	950	27,500	32,010
Boilermaker	2170	5580	9910	17,660
Brickmason	23,750	1500	68,830	94,090
Carpenter	322,550	40,570	104,470	527,590
Carpet Installer	380	--	15,200	15,620
Craneman	3,050	13,100	9,000	25,150
Drywall Installer	4,060	--	32,960	37,030
Electrician	1,020	12,010	211,980	234,010
Eng. Sci. Tech.	--	2,000	--	2,830
Glazier	--	--	11,770	11,830
Heating & Refrig.	2,600	220	50,500	53,330
Heavy Equip. Op.	24,710	152,730	68,260	245,600
Laborer	126,600	163,280	88,860	378,250
Lineman	--	12,680	8,160	
Mechanic	3,080	28,860	23,380	55,300
Millwright	5,450	3,220	8,860	17,530
Painter	17,450	1,570	108,040	127,070
Plumber	13,620	20,540	162,860	197,020
Roofer-slater	4,490	--	70,600	75,120
Sheet Metal Wkr.	6,770	480	90,210	97,460
Struct. Metal Wkr.	10,300	6,620	33,870	50,790
Truck Driver	16,370	62,140	40,520	119,020
Warehouseman	1,320	1,790	3,480	6,590
Welder	7,040	15,500	13,840	36,380

* Ref

Table A-3

Number of SDS Cases by Year, 1977-1980

	FREQUENCY				
SIC	1977	1978	1979	1980*	Total/Average
15	40159	59852	68885	52800	
16	34964	45330	54361	44739	
17	63066	93171	110219	89224	
Frequencies Totals	138189	199353	233465	186763	757,770

Table A-4

Employments and Case Rates by Year, 1977-1980

Year	SDS States Employment (1,000's)	Case Rate	National Construction Employment (1,000's)	Correction Factor *
1977	1772.3	7.7	3833.0	.42
1978	2190.4	9.1	4271.0	.51
1979	2463.3	9.5	4483.0	.58
1980	1776.1	10.5	4399.0	.41

*National occupational employment by SIC for 1978 (see Table A-2) was used to determine occupational employment in the SDS states by SIC for each of the survey years. This was accomplished by multiplying the 1978 figures by the appropriate correction factor. The correction factor for each year was obtained by dividing the total construction industry employment in the SDS-participating states by the estimated national construction industry employment for 1978.

Table A-5

Calculation of Occupational-Specific Risk Indices (ORI) for 1977

	SIC 15					SIC 16					SIC 17				
Occupation	Freq.	%	Emp.	Rate	ORI	Freq.	%	Emp.	Rate	ORI	Freq.	%	Emp.	Rate	ORI
Mgr. Adm.*	1853	4.61	64264	2.9	.4	1798	5.14	30559	5.9	.8	2142	3.40	84025	2.5	.3
Eng. Sci. Tech	15	.04				198	.57	840	23.6	3.1	15	.02		20.8	2.7
Boilermakers	217	.54	911	23.8	3.0	354	1.01	2343	15.1	2.0	867	1.38	4162	20.8	2.7
Plumbers	517	1.29	5720	9.0	1.2	1017	2.91	8626	11.8	1.5	4639	7.36	68401	6.8	.9
Plumber App.	44	.11				53	.15				771	1.22	16842	4.6	.6
Brickmason	514	1.28	9975	5.2	.7	147	.42	630	23.3	3.0	1438	2.28	28908	5.0	.6
Carpenter	15184	37.81	160671	9.5	1.2	1312	3.75	17039	7.7	1.0	3885	6.16	43877	8.9	1.2
Carpenter App.	1142	2.84	52970	2.2	.3	81	.23	4111	2.0	.3	233	.37	9319	2.5	.3
Cement Finisher	384	.96	12486	3.1	.4	241	.69	7308	3.3	.4	680	1.08	22440	3.0	.4
Electrician	135	.34	4208	3.2	.4	488	1.40	5044	9.7	1.3	4445	7.05	89031	5.0	.6
Electric App.	13	.03				35	.10				775	1.23	15330	5.1	.7
Millwright	256	.64	2289	11.2	1.5	180	.52	1352	13.3	1.7	291	.46	3721	7.8	1.0
Painter Const.	327	.81	7329	4.5	.6	194	.56	659	29.4	3.8	1898	3.01	45376	4.2	.5
Plasterer	30	.08				1	.00				440	.70	6195	7.1	.9
Roofer Slater	108	.27	1885	5.7	.7	3	.01				3176	5.04	29652	10.7	1.4
Drywall Instl.	70	.17	1705	4.1	.5	2	.01				1957	3.10	13843	14.1	1.8
Sheet Metal	157	.39	2843	5.5	.7	82	.24				2599	4.12	37888	6.9	.9
Struc. Metal	637	1.59	4326	14.7	1.9	825	2.36	2780	29.7	3.8	1428	2.26	14225	10.0	1.3
Welder	279	.70	2956	9.4	1.2	752	2.15	6510	11.6	1.5	949	1.51	5812	16.3	2.1
Cranemen	77	.19				178	.51	5502	3.2	.4	97	.15			
Linemen	3	.01				297	.85	5325	5.6	.7	249	.40	3427	7.3	.9
Glazier	15	.04				0	0				360	.57	4943	7.3	.9
Tilesetter	19	.05				0	0				273	.43	5523	4.9	.6
Asbestos Worker	65	.16				17	.05				1034	1.64	1550	9.0	1.2
Carpet Instl.	46	.12				0	0				490	.78	6384	7.7	1.0
Heating/Refrig.	26	.07				3	.01				1239	1.97	21210	5.8	.8
Heavy Equip Op**	388	.97	10206	3.8	.5	3245	9.28	63478	5.1	.7	605	.96	27195	2.2	.3
Mechanic***	334	.83	945	35.3	4.6	1605	4.59	8160	19.7	2.6	1003	1.59	11323	8.9	1.2
Truck Driver	383	.95	6875	5.6	.7	2100	6.01	26098	8.0	1.0	931	1.48	17018	5.5	.7
Labor ****	11120	27.69	55818	19.9	2.6	13121	37.53	73655	17.8	2.3	12703	20.14	48220	26.3	3.4
Warehousemen	41	.10	554	7.4	1.0	42	.12				330	.52	1461	22.6	2.9

*Managers - Administrators, NEC, and Foremen, NEC

**Heavy Equipment Operatives - Bulldozer and Road Machine Operatives

***Mechanics - Heavy Equipment and Misc. Mechanic and Mechanic Not Specified

****Laborer - Misc. Operative and Construction Labor and Labor Not Specified and Miscellaneous Labor

Table A-6

Calculation of Occupational-Specific Risk Indices (ORI) for 1978

Occupation	SIC 15 Freq.	%	Emp.	Rate	ORI	SIC 16 Freq.	%	Emp.	Rate	ORI	SIC 17 Freq.	%	Emp.	Rate	ORI
Mgr. Adm. *	3613	6.04	78035	4.6	.5	2867	6.19	37107	7.7	.8	4111	4.41	102030	4.0	.4
Eng. Sci. Tech.	25	.04				187	.40	1020	18.3	2.0	33	.04			
Boilermakers	331	.55	1106	29.9	3.3	516	1.11	2845	18.1	2.0	909	.98	5054	18.0	2.0
Plumber	644	1.08	6946	9.3	1.0	1271	2.74	10475	12.1	1.3	7612	8.17	83058	9.2	1.0
Plumber App.	38	.06				53	.11				1208	1.30	20451	5.9	.6
Brickmason	711	1.19	12112	5.9	.6	158	.34	765	20.7	2.3	1980	2.13	35103	5.6	.6
Carpenter	24791	41.42	195100	12.7	1.4	2010	4.33	20690	9.7	1.1	6349	6.81	53279	11.9	1.3
Carpenter App.	1847	3.09	64321	2.9	.3	179	.39	4992	3.6	.4	360	.39	11316	3.2	.4
Cement Finisher	620	1.04	15162	4.1	.4	328	.71	8874	3.7	.4	1119	1.20	27249	4.1	.5
Electrician	196	.33	5110	3.8	.4	583	1.26	6125	9.5	1.0	7493	8.04	108109	6.9	.8
Electrician App.	20	.03				27	.06				1334	1.43	18615	7.2	.8
Millwright	251	.42	2779	9.0	1.0	235	.51	1642	14.3	1.6	485	.52	4518	10.7	1.2
Painter Const.	528	.88	8899	5.9	.7	220	.48	800	27.5	3.0	3066	3.29	55100	5.6	.6
Plasterer	22	.04				0	0				596	.64	7522	7.9	.9
Roofer/Slater	240	.40	2289	10.5	1.2	4	.01				5248	5.63	36006	14.6	1.6
Drywall Instl.	213	.36	2070	10.3	1.1	8	.02				3404	3.65	16809	20.3	2.2
Sheet Metal	235	.39	3452	6.8	.7	76	.16				4054	4.35	46007	8.8	1.0
Struc. Metal	1127	1.88	5253	21.5	2.4	970	2.09	3376	28.7	3.2	2469	2.65	17273	14.3	1.6
Welder	447	.75	3590	12.5	1.4	961	2.07	7905	12.5	1.3	1687	1.81	7058	23.19	2.6
Cranemen	90	.15				270	.58	6681	4.0	.4	138	.15			
Linemen	8	.01				416	.90	6466	6.4	.7	375	.40	4161	9.0	1.0
Glazier	26	.04				2	.00				743	.80	6002	12.4	1.4
Tilesetter	30	.05				3	.01				488	.52	6706	7.3	.8
Asbestos Worker	71	.12				35	.08				1589	1.71	14025	11.3	1.2
Carpet Instl.	45	.08				2	.00				889	.95	7752	11.5	1.3
Heating&Refrig.	25	.04				11	.02				1748	1.88	25755	6.8	.7
Heavy Equip Op.**	523	.87	12393	4.2	.5	4426	9.55	77081	5.7	.6	916	.98	33022	2.8	.3
Mechanic***	416	.70	1147	36.3	4.0	2165	4.67	9909	21.8	2.4	1563	1.68	13749	11.4	1.2
Truck Driver	583	.97	8348	7.0	.8	2902	6.26	31691	9.2	1.0	1383	1.48	20665	1.9	.2
Laborer****	17371	29.02	67779	25.6	2.8	18521	39.98	89438	20.7	2.3	18609	19.97	58553	31.8	3.5
Warehousemen	64	.11	673	9.5	1.1	35	.08				543	.58	1774	30.6	3.4

*Managers and Administrators NEC and Foremen, NEC
**Heavy Equipment Operatives - Bulldozer and Road Machine Operatives
***Mechanics - Heavy Equipment and Misc. Mechanic and Mechanic Not Specified
***Laborer - Misc. Operative and Construction Labor and Labor Not Specified and Misc. Laborers

Table A-7

Calculation of Occupational-Specific Risk Indices (ORI) for 1979

Occupation	SIC 15					SIC 16					SIC 17				
	Freq.	%	Emp.	Rate	ORI	Freq.	%	Emp.	Rate	ORI	Freq.	%	Emp.	Rate	ORI
Mgr. Adm. *	4376	6.36	88745	4.9	.5	3193	5.87	42200	7.6	.8	5015	4.55	116034	4.3	.5
Eng. Sci. Tech	22	.03				218	.40	1160	18.8	2.0	51	.05			
Boilermakers	264	.38	1258	21.0	2.2	568	1.05	3236	17.6	1.8	1488	1.35	5747	25.9	2.7
Plumber	943	1.37	7899	11.9	1.3	1603	2.95	11913	13.5	1.4	9118	8.27	94458	9.7	1.0
Plumber App.	82	.12				6512	.12				1542	1.40	23258	6.6	.7
Brickmason	689	1.00	13775	5.0	.5	153	.28	870	17.6	1.9	2775	2.52	39921	7.0	.7
Carpenter	27234	39.55	221879	12.3	1.3	2776	5.11	23530	11.8	1.2	7517	6.82	60592	12.4	1.3
Carpenter App.	1964	2.85	73149	2.7	.3	198	.36	5678	3.5	.4	392	.36	12870	3.0	.3
Cement Finisher	700	1.02	17243	4.1	.4	352	.65	10092	3.5	.4	1104	1.00	30989	3.6	.4
Electrician	320	.47	5811	5.5	.6	744	1.37	6965	10.7	1.1	8486	7.70	122948	6.9	.7
Electrician App.	17	.03				45	.08				1487	1.35	21170	7.0	.7
Millwright	522	.82	3161	16.5	1.7	359	.66	1867	19.2	2.0	546	.50	5138	10.6	1.1
Painter Const.	449	.65	10121	4.4	.5	204	.38	910	22.4	2.4	3495	3.17	62663	5.6	.6
Plasterer	50	.07				9	.02				684	.62	8555	8.0	.8
Roofer-Slater	302	.44	2604	11.6	1.2	6	.01				6101	5.54	40948	14.9	1.6
Drywall Instl.	283	.41	2354	12.0	1.3	15	.03				4220	3.83	19116	22.1	2.3
Sheet Metal	256	.37	3926	6.5	.7	127	.23				5000	4.54	52321	9.6	1.0
Struc. Metal	1940	2.82	5974	32.5	3.4	1580	2.91	3839	41.2	4.3	3239	2.94	19644	16.5	1.7
Welder	658	.96	4083	16.0	1.7	1198	2.20	8990	13.3	1.4	1839	1.67	8027	22.9	2.4
Cranemen	99	.14				220	.41	7598	2.9	.3	138	.13			
Lineman	14	.02				641	1.18	7354	8.7	.9	441	.40	4732	8.7	.9
Clazier	39	.06				6	.01				907	.82	6826	13.3	1.4
Tilesetter	16	.02				0	0				493	.45	7627	5.8	.6
Asbestos Wkr.	101	.15				85	.16				1986	1.80	15950	12.5	1.3
Carpet Instl.	63	.09				5	.01				935	.85	8816	10.6	1.1
Heating & Refrig.	45	.07				14	.03				2536	2.30	29290	8.7	.9
Heavy Equip Op.**	600	.87	14094	4.3	.5	5456	10.04	87661	6.2	.7	1131	1.03	37555	3.0	.3
Mechanic***	538	.78	1305	41.2	4.3	2540	4.67	11269	22.5	2.4	1880	1.71	15636	12.0	1.3
Truck Driver	628	.91	9494	6.6	.7	3163	5.82	36041	8.8	.9	1605	1.46	23501	6.8	.7
Laborer****	20246	29.39	77082	26.3	2.8	21520	39.59	101714	21.2	2.2	21460	19.47	66589	32.2	3.4
Warehousemen	90	.13	765	11.8	1.2	47	.09				599	.54	2018	29.7	3.1

*Managers and Administrators NEC and Foremen, NEC
**Heavy Equipment Operatives - Bulldozer and Road Machine Operatives
***Mechanics - Heavy Equipment and Misc. Mechanic and Mechanic Not Specified
****Laborer - Misc. Operative and Construction Labor and Labor Not Specified and Miscellaneous Labor

Table A-8

Calculation of Occupational-Specific Risk Indices (ORI) for 1980

Occupation	SIC 15 Freq.	%	Emp.	Rate	ORI	SIC 16 Freq.	%	Emp.	Rate	ORI	SIC 17 Freq.	%	Emp.	Rate	ORI
Mgr. Adm. *	3311	6.27	62734	5.3	.5	2556	5.71	29831	8.6	.8	4108	4.60	82024	5.0	.5
Eng. Sci. Tech	10	.02				141	.32	820	17.2	1.6	21	.02			
Boilermakers	308	.58	889	34.6	3.3	696	1.56	2287	30.4	2.9	1424	1.60	4063	35.0	3.3
Plumber	864	1.64	5584	15.5	1.5	1588	3.55	8421	18.9	1.8	7545	8.64	66772	11.3	1.1
Plumber App.	30	.06				88	.20				943	1.06	16441	5.7	.5
Brickmason	603	1.14	9737	6.2	.6	139	.31	615	22.6	2.2	1969	2.21	28220	7.0	.7
Carpenter	20172	38.21	156845	12.9	1.2	2707	6.05	16633	16.3	1.6	5709	6.40	42832	13.3	1.3
Carpenter App.	1481	2.81	51709	2.9	.3	194	.43	4013	4.8	.5	277	.31	9097	3.0	.3
Cement Finishe	600	1.14	12189	4.9	.5	355	.79	7134	5.0	.5	790	.89	21906	3.6	.3
Electrician	269	.51	4108	6.5	.6	602	1.35	4924	12.2	1.2	7395	8.29	86911	8.5	.8
Electrician App.	21	.04				51	.4				1132	1.27	14965	7.6	.7
Millwright	472	.89	2234	21.1	2.0	297	.66	1320	22.5	2.1	453	.51	3632	12.5	1.2
Painter Const.	411	.78	7154	5.7	.5	169	.38	643	26.3	2.5	2943	3.30	44296	6.6	.6
Plasterer	51	.10				2	.00				637	.71	6047	10.5	1.0
Roofer/Slater	190	.36	1840	10.3	1.0	4	.01				5074	5.69	28946	17.5	1.7
Drywall Instl.	212	.40	1664	12.7	1.2	4	.01				3300	3.70	13513	24.2	2.3
Sheet Metal	219	.42	2775	7.9	.8	112	.25				4125	4.62	38986	11.2	1.1
Struc. Metal	1686	3.19	4223	39.9	3.8	1405	3.14	2714	51.8	4.9	3153	3.53	13886	22.7	2.2
Welder	470	.89	2886	16.3	1.6	1061	2.37	6355	16.7	1.6	1671	1.87	5674	29.5	2.8
Cranemen	84	.16				227	.51	5371	4.2	.4	133	.15			
Linemen	7	.01				544	1.22	5198	10.5	1.0	495	.51	3349	14.8	1.4
Glazier	40	.08				3	.01				894	1.00	4825	18.5	1.8
Tilesetter	14	.03				0	0				480	.54	5391	8.9	.8
Asbestos Worker	93	.18				47	.11				1698	1.90	11275	15.1	1.4
Carpet Instl.	29	.06				0	0				707	.79	6232	11.3	1.1
Heating& Refrig.	21	.04				9	.02				2013	2.26	20705	9.7	.9
Heavy Equip Op **	599	1.13	9963	6.0	.6	4002	8.95	61967	6.5	.6	913	1.02	26547	3.4	.3
Mechanic***	454	.86	922	49.2	4.7	2072	4.63	7966	26.0	2.5	1514	1.70	11053	13.7	1.3
Truck Driver	488	.92	6711	7.3	.7	2497	5.54	25477	9.7	.9	1348	1.51	16613	8.1	.8
Laborer****	15241	28.87	54489	28.0	2.7	16704	37.34	71901	23.2	2.2	14692	16.47	47072	31.2	3.0
Warehousemen	77	.15	541	14.2	1.4	48	.11				519	.58	1426	36.4	3.5

*Managers and Administrators NEC and Foremen, NEC
**Heavy Equipment Operatives - Bulldozer and Road Machine Operatives
***Mechanics - Heavy Equipment and Misc. Mechanic and Mechanic Not Specified
****Laborer - Misc. Operative and Construction Labor and Labor Not Specified and Misc. Laborers

Table A-9

ORI Values by Occupation
for SICs 15, 16, and 17, and Overall

Occupation	SIC 15				SIC 16				SIC 17				
	1977	1978	1979	1980	1977	1978	1979	1980	1977	1978	1979	1980	AVE.
Mgr. Adm.	.1	.2	.2	.2	.2	.2	.2	.2	.1	.1	.1	.2	.2
Eng.Sci.Tech	-	-	-	-	3.1	2.0	2.0	1.6	-	-	-	-	2.1
Boilermaker	3.0	3.3	2.2	3.3	2.0	2.0	1.8	2.9	2.7	2.0	2.7	3.3	2.5
Plumber	1.2	1.0	1.3	1.5	1.5	1.3	1.4	1.8	.9	1.0	1.0	1.1	1.1
Plumber Ap.	-	-	-	-	-	-	-	-	.6	.6	.7	.5	.6
Bricklayer	.7	.6	.5	.6	3.0	2.3	1.9	2.2	.6	.6	.7	.7	.7
Carpenter	1.2	1.4	1.3	1.2	1.0	1.1	1.2	1.6	1.2	1.3	1.3	1.3	1.3
Carpenter Ap.	.3	.3	.3	.3	.3	.4	.4	.5	.3	.4	.3	.3	.3
Cement Finish.	.4	.4	.4	.5	.4	.4	.4	.5	.4	.5	.4	.3	.4
Electrician	.4	.4	.6	.6	1.3	1.0	1.1	1.2	.6	.8	.7	.8	.8
Electric Ap.	-	-	-	-	-	-	-	-	.7	.8	.7	.7	.7
Millwright	1.5	1.0	1.7	2.0	1.7	1.6	2.0	2.1	1.0	1.2	1.1	1.2	1.4
Painter Const.	.6	.7	.5	.5	3.8	3.0	2.4	2.5	.5	.6	.6	.6	.6
Plasterer	-	-	-	-	-	-	-	-	.9	.9	.8	1.0	.9
Roofer-Slater	.7	1.2	1.2	1.0	-	-	-	-	1.4	1.6	1.6	1.7	1.5
Drywall Inst.	.5	1.1	1.3	1.2	-	-	-	-	1.8	2.2	2.3	2.3	2.1
Sheet Metal	.7	.7	.7	.8	-	-	-	-	.9	1.0	1.0	1.1	1.0
Struc. Metal	1.9	2.4	3.4	3.8	3.8	3.2	4.3	4.9	1.3	1.6	1.7	2.2	2.3
Welder	1.2	1.4	1.7	1.6	1.5	1.3	1.4	1.6	2.1	2.6	2.4	2.8	1.9
Cranemen	-	-	-	-	.4	.4	.3	.4	-	-	-	-	.4
Linemen	-	-	-	-	.7	.7	.9	1.0	.9	1.0	.9	1.4	.9
Glazier	-	-	-	-	-	-	-	-	.9	1.4	1.4	1.8	1.4
Tilesetter	-	-	-	-	-	-	-	-	.6	.8	.6	.8	.7
Asbestos Wk.	-	-	-	-	-	-	-	-	1.2	1.2	1.3	1.4	1.3
Carpet Inst.	-	-	-	-	-	-	-	-	1.0	1.3	1.1	1.1	1.1
Heating & Ref.	-	-	-	-	-	-	-	-	.8	.7	.9	.9	.8
Heavy Equip.Op	.5	.5	.5	.6	.7	.6	.7	.6	.3	.3	.3	.3	.5
Mechanic	4.6	4.0	4.3	4.7	2.6	2.4	2.4	2.5	1.2	1.2	1.3	1.3	1.9
Truck Driver	.7	.8	.7	.7	1.0	1.0	.9	.9	.7	.2	.7	.8	.9
Laborer	2.6	2.8	2.8	2.7	2.3	2.3	2.2	2.2	3.4	3.5	3.4	3.0	2.7
Warehousemen	1.0	1.1	1.2	1.4	-	-	-	-	2.9	3.4	3.1	3.5	2.7
Annual Survey	15.0	15.9	16.3	15.5	16.0	16.6	16.6	16.3	15.6	15.8	16.0	15.5	

- = Less than .30% of reported cases for SIC one year

Table A-10

States Reporting Fatalities in SDS System

SIC 15 - Building Construction State	Number of Fatalities Reported 1977	1978	1979	1980
Arkansas	6	6	2	4
California	12	12	8	13
Connecticut	-	0	-	-
Colorado	-	-	6	10
Deleware	-	1	-	1
Idaho	3	2	-	1
Kentucky	4	-	-	-
Maine	-	2	-	-
Maryland	-	3	-	-
Michigan	-	16	-	-
Montana	5	-	0	2
New York	-	18	15	8
North Carolina	11	6	8	3
Virginia	-	-	5	-
Washington	-	-	-	6
Wisconsin	9	4	4	5
Wyoming	-	2	-	-
Total	50	72	48	53

SIC 16 - Heavy Construction State	Number of Fatalities Reported 1977	1978	1979	1980
Arkansas	5	6	3	4
California	24	36	29	30
Colorada	-	-	12	24
Connecticut	-	0	-	-
Deleware	-	1	-	0
Idaho	11	2	-	4
Kentucky	9	-	-	-
Maine	-	1	-	-
Maryland	-	8	-	-
Michigan	-	9	-	-
Montana	1	-	1	4
New York	-	15	17	15
North Carolina	16	17	11	13
Virginia	-	-	18	-
Washington	-	-	-	10
Wisconsin	10	5	4	7
Wyoming	-	9	-	-
Total	76	109	95	111

Table A-10

States Reporting Fatalities in SDS System

SIC 17 - Special Trades State	Number of Fatalities Reported 1977	1978	1979	1980
Arkansas	1	2	2	5
California	20	18	35	34
Colorado	-	-	7	16
Connecticut	-	4	-	-
Delaware	-	1	-	0
Idaho	5	2	-	3
Kentucky	9	-	-	-
Maine	-	2	-	-
Maryland	-	13	-	-
Michigan	-	19	-	-
Montana	3	-	1	3
New York	-	49	42	45
North Caroline	10	12	8	8
Virginia	-	-	11	-
Washington	-	-	-	13
Wisconsin	21	9	9	6
Wyoming	-	6	-	-
Total	69	137	115	133

Table A-11

Fatality Index

Occupation	SIC 15 Number	%	% Employment	FI	SIC 16 Number	%	% Employment	FI	SIC 17 Number	%	% Employment	FI	Ave.
Boilermakers	0	0	0.17	*	1	.26	0.60	*	9	1.98	0.44	4.5	4.5
Structural metal craftsmen	21	9.4	0.79	11.9	1	.26	0.71	*	17	3.74	1.49	2.5	4.7
Welders	2	0.90	0.54	*	2	.51	1.65	*	5	1.10	0.61	1.8	1.8
Millwrights	0	0	0.42	*	0	0	0.34	*	8	1.76	0.39	4.5	4.5
Carpenters, appren. helpers	56	25.11	39.07	0.6	11	2.81	5.37	0.5	8	1.76	5.59	0.3	0.5
Plumbers, appren.	4	1.79	1.34	1.3	6	1.53	2.64	0.6	31	6.83	8.95	0.8	0.8
Mechanics	1	.45	0.17	*	10	2.56	2.07	1.2	9	1.98	1.19	1.7	1.4
Laborers	53	23.77	10.21	2.3	124	31.71	18.70	1.7	91	20.04	5.06	4.0	2.4
Eng. & Sci. Tech.	0	0	0.05	*	3	.77	0.21	3.7	1	.22	0.01	*	3.7
Roofer & slaters	2	.90	0.34	*	0	0	-	*	32	7.05	3.11	2.3	2.3
Drywall installers	0	0	.31	*	0	0	-	*	6	1.32	1.45	0.9	0.9
Sheetmetal workers	0	0	.52	*	0	0	-	*	15	3.30	3.98	0.8	0.8
Asbestos/insalator W	1	.45	0.37	*	0	0	0.10	*	27	5.95	1.21	4.9	4.9
Carpet installers	0	0	0.03	*	0	0	-	*	1	.22	0.67	*	*
Glaziers	0	0	-	*	0	0	-	*	2	.44	0.52	*	*
Warehousemen	0	0	0.10	*	0	0	0.19	*	0	0	0.15	*	*
Brickmason & App.	4	1.79	2.85	0.6	3	.77	0.16	4.8	13	2.86	5.26	0.6	0.7
Painter & App.	3	1.35	1.56	0.9	1	.26	0.21	*	35	7.71	5.19	1.5	1.4
Manager & Admin.	23	10.31	11.75	0.9	17	4.35	7.76	0.6	8	1.76	8.83	0.2	0.5
Foremen	12	5.4	-	**	29	7.42	-	**	16	3.52	-	**	**
Electricians	1	.45	0.98	*	7	1.79	1.48	1.2	29	6.39	10.96	0.6	0.6
Linemen	0	-	-	*	12	3.07	1.35	2.3	1	.22	0.36	*	2.3
Bulldozer&Road Mach.	11	4.93	1.87	2.6	64	16.37	16.01	1.0	14	3.08	2.86	1.1	1.2
Truck Driver	1	.45	1.26	*	38	9.72	6.63	1.5	11	2.42	1.79	1.4	1.5
Cranemen	5	2.24	0.23	9.7	2	.51	1.40	*	3	.66	0.40	1.7	3.7
Heating & Refrig.	0		0.20	*	0	*	0.02	*	6	1.32	2.23	.6	0.6
Driller earth	1	-	-	*	1	.26	0.15	*	5	1.10	-	*	*
Other	22	9.87	24.87	0.4	59	15.09	32.20	0.5	51	11.3	27.30	0.4	0.4
Total	223	-	-		391		-	-	454	-	-	-	

FI=Fatality Index = $\frac{\%\text{ of Fatalities}}{\%\text{ employment}}$

* Numbers too small for reasonable results.

** Not obtained because accurate employment figures could not be obtained.

Appendix B

An occupational profile is given for each occupation with an occupation specific risk index (ORI) value of 1 or greater. The profile contains the following information:

1. Employment Figures
2. Description of Duties
3. Listing of Accident Type Risk Ratios
4. Tables
    a. Accident type percentages by year and an overall average percentage by 2 digit SIC
    b. Source of injury, part of body, and nature of injury for the leading accident types by 2 digit SICs
    c. Accident type percentages at the 4 digit SIC levels
5. A summery of accident trends
6. Related information obtained from Best-loss Control Manual and Employers Insurance of Wausau

Appendix B

An occupational profile is given for each high risk occupation. The profile contains the following information:

1. Employment Figures
2. Description of Duties
3. Listing of Accident Type Risk Ratios
4. Tables
   a. Accident type percentages by year and an overall average percentage by 2 digit SIC
   b. Source of injury, part of body injured, and nature of injury for the leading accident types by 2 digit SICs.
   c. Accident type percentages at the 4 digit SIC levels.
5. A summary of accident trends
6. Related information obtained from the Best-Loss Control Manual and Employers Insurance of Wausau.

BOILERMAKERS

Boilermakers assemble, erect, and repair boilers and related equipment, attachments, and accessories. This includes laying out, cutting, fitting and bolting, welding, or riveting heavy metal plates, boiler tubes, and castings. In 1978 the construction industry employed 17,660 boilermakers or 0.39% of the construction work force. Within the construction industry, boilermakers were employed as follows; building construction (SIC 15) - 2,170 or 0.17% of the building workforce, heavy construction (SIC 16) - 5,580 or 0.60% of heavy construction workforce, and special trades (SIC 17) - 9,910 or 0.44% of the special trade workforce.

From the dictionary of occupational titles [29] the duties of the boilermaker are described as:

1) 805.261-014-BOILERMAKER (boilermaking) I boilermaker, assembly and erection.

Assembles, analyzes defects in, and repairs boilers, pressure vessels, tanks, and vats in the field, following blueprints and using handtools and portable power tools and equipment: Locates and marks reference points for columns or plates on foundation, using master straightedge, squares, transit, and measuring tape, and applying knowledge of geometry. Attaches rigging or signals crane operator to lift parts to specified position. Alines structures or plate sections to assemble boiler frame, tanks, or vats, using plumb bobs, levels, wedges, dogs, or turnbuckles. Hammers, flame-cuts, files, or grinds irregular edges of sections or structural parts to facilitate fitting edges together. Bolts or arc-welds structures and sections together. Positions drums and headers into supports and bolts or welds supports to frame. Alines water tubes and connects and expands ends to drums and headers, using tube expander. Bells, beads with power hammer, or welds tube ends to insure leakproof joints. Bolts or welds casing sections uptakes, stacks, baffles, and such fabricated parts as chutes, air heaters, fan stands, feeding tube, catwalks, ladders, coal hoppers, and safety hatch to frame, using wrench.

Installs manholes, handholes, valves, gages, and feedwater connection in drums to complete assembly of water tube boilers. Assists in testing assembled vessels by pumping water or gas under specified pressure into vessel and observing instruments for evidence of leakage. Repairs boilers or tanks in field by unbolting of flame cutting defective sections or tubes, straightening plates, using torch or jacks, installing new tubes, fitting and welding new sections and replacing worn lugs on bolts. May rivet and calk sections of vessels, using pneumatic riveting and calking hammers. May line firebox with refractory brick and asbestos rope and blocks [BRICKLAYER, FIREBRICK AND REFRACTORY TILE (const.)]. May fabricate such parts as stacks, uptakes, and chutes, to adapt boiler to premises in which it is installed [BOILERMAKER (boilermaking)II].

2) 805.361-014 BOILERMAKER FITTER (boilermaking)

Positions, alines, and secures structural parts and related assemblies of pressure vessels, such as boilers, tanks, and vats in specified relationship for subsequent permanent assembly by BOILERMAKER (boilermaking) I or WELDER, BOILERMAKER (boilermaking). Locates and marks position of parts using measuring tape, transit, square, and plumb bob. Signals RIGGER (any ind.) to lift parts into position. Alines parts to specified fit, using 'dogs', wedges, turnbuckles, jacks, hammers, and 'drift pins'. Cuts, files, and grinds seams and joints to attain specified fit, using cutting torch, file, and power grinder. Straightens or reshapes bent plates or structure, using hammer, jacks, and torch. Clamps, bolts, or tack-welds parts in place for final welding or bolting. Climbs framework or ladders to position, fit, or secure parts. May fit plates; structures, or pipes to repair ships.

3) 805.381-010 BOILERMAKER (boilermaking) II boilermaker mechanic.

Assembles boilers, tanks, vats, and pressure vessels according to blueprint specifications, using power tools and handtools: Reads blueprint to determine location and relationship of parts. Connects firetubes to heads or watertubes to drums and headers of boilers, by expanding and belling ends, using tube expander and beading ends, using power hammer. Drills and taps hole for installation of studs, using portable drill. Tightens bolts to assemble frames, using hand or power wrenches. Mounts casings of watertube boilers, or attaches davit heads, burner, or furnace casing to fire tube boiler,using wrenches. Bolts or screws acessories, such as manholes, handholes, fans, gages, and valves to vessel, using handtools or power wrenches. Replaces defective parts, using power wrenches, prying bars, or handtools. May install and repair refractory brick [BRICKLAYER, FIREBRICK AND REFACTORY TILE (const.)]. May thread and install stay bolts, using pipe wrench and dies. May remove and replace rivets and calk seams to repair riveted shells and structures, using pneumatic chisel, riveter; and caulking hammer.

May cut out defective parts, using acetylene torch. Distinguish from BOILERMAKER (boilermaking) I who assembles and repairs boilers and related pressure vessels. May be designated according to work setting or location as BOILERMAKER, CENTRAL STEAM PLANT (boilermaking); BOILERMAKER, INDUSTRIAL BOILERS (boilermaking); BOILERMAKER, SHIP (boilermaking).

When compared to other construction workers, boilermakers have the highest accident type risk index value (ARI) for foreign matter in the eye with a value of 8.1, fourth highest risk for being struck by falling objects with a value of 2.1, fifth highest risk for struck against stationary object with a value of 2.1, and fourth highest risk for struck by, NEC with a value of 1.9, and ninth highest risk in overexertion by lifting with a value of 1.5.

As seen from Tables B-2 to B-4 a particle and metal item, NEC are the source of injury in over 80% of the foreign matter in the eye cases. In the struck by NEC injuries, the common sources of injury were metal item, NEC and hammers-sledges, the finger and eye were the common parts of body injured. The injuries resulted in contusions, cuts-lacerations and fractures. The leading source of injury for being struck by falling object was a metal item, NEC, and the foot and finger were the most common parts of body injured. The injuries were contusions, fractures, and cuts-lacerations.

In SICs 15 and 16, the fourth source of injury was struck against stationary object. The leading sources of injury were metal item, NEC and the common parts of the body injured were the knee, elbow and finger. The injuries were contusions, cuts-lacerations or sprains/strains. In SIC 16 the fourth accident type was overexertion by

lifting. The leading source was metal item, NEC, and the back and the abdomen were injured in 76% of the cases. The injuries were generally sprains and strains.

A review of Best-Loss Control Engineering Manual for boilermaking rated workmens' compensation high. The manual had the following to say about exposures and accidents.

> Exposures: Working in confined areas; unguarded machinery (point of operation and moving parts). High noise level; poor housekeeping, lighting and ventilation; flying particles and dust; and heavy lifting. Possible occupational disease hazard due to grinding, welding, cutting; exposure to X-Ray or radioactive materials during radiography of welds.
>
> Accidents: Foreign body and flash burns in eyes. Strains, burns and lacerations. Amputations, crushed hands and feet. Injuries from dropped objects. Respiratory and allergy disorders. Hearing damage.

STRUCTURAL METAL CRAFTSMEN

Structural metal craftsmen primarily joins structural parts and components with bolts, screws, and related fasteners, or by fitting (placing) reinforcing steel or iron in forms to strengthen concrete. In 1978 the construction industry employed 50,790 structural metal craftsmen or 1.13% of the construction work force. Within the construction industry, the structural metal craftsmen were employed as follows: building construction (SIC 15) - 10,300 or 0.79% of the building work force, heavy construction (SIC 16) - 6,620, or 0.71% of the heavy construction work force, and special trades (SIC 17) - 33,870, or 1.49% of the special trades work force.

From the Dictionary of Occupational Titles [29], the duties of the structural metal craftsmen are described as:

1) 801.381-010 Assembler, Metal Building (Const.)

Assembles prefabricated metal buildings according to blueprint specifications, using handtools, power tools, and hoisting equipment. Erects frame of building, using hoist. Bolts steel frame members together. Attaches wire and insulating materials to framework. Bolts sheet metal panels to framework. Reads blueprint to determine location of items, such as doors, windows, ventilators, and skylights and installs items, using cutting torch, wrenches, and power drill. Trims excess sheet metal, using cutting torch, power saw and tin snips.

2) 801.361-014 Structural Steel Worker (Const) bridge worker; housesmith; iron erector; ironworker, steel erector; structural iron erector; structural iron worker; structural-steel erector.

Performs any combination of following duties to raise, place, and unite girders, columns, and other structural-steel members to form completed structures or structure frameworks, working as member of crew: Sets up hoisting equipment for raising and placing structural-steel members. Fastens steel members to cable of hoist, using chain, cable or rope. Signals worker operating hoisting equipment to lift and place steel member. Guides member, using tab line (rope) or rides on member in order to guide it into position. Pulls, pushes or pries steel members into approximate position while member is supported by hoisting device. Forces members into final position, using turnbuckles, crowbars, jacks, and handtools. Alines rivet holes in member with corresponding holes in previously placed member by driving drift pins or handle of wrench through holes. Verifies vertical and horizontal alignment of members, using plumb bob and level. Bolts alined members to keep them in position until they can be permanently riveted, bolted, or welded in place. Catches

hot rivets tossed by RIVET HEATER (heat treat) in bucket and inserts rivets in holes, using tongs. Bucks (holds) rivets while RIVETER, PNEUMATIC (any ind.) uses airhammer to form heads on rivets. Cuts and welds steel members to make alternations, using oxyacetylene welding equipment. May specialize in erecting or repairing specific types of structures and be designated accordingly, as BRIDGE-MAINTENANCE WORKER (const.); CHIMNEY BUILDER, REINFORCED CONCRETE (const.); SCAFFOLD BUILDER, METAL (const.); STRUCTURAL-STEEL EQUIPMENT ERECTOR (const).

3) 801.684-026 Reinforcing-Metal Worker (const.) reinforcing-iron worker; reinforcing bar setter; reinforcing steel erector; reinforcing steel placer, reinforcing-steel setter; reinforcing steel worker.

> Positions and secures steel bars in concrete forms to reinforce concrete. Determines number, sizes, shapes and location of reinforcing rods from blueprints, skethes, or oral instructions. Selects and places rods in forms, spacing and fastening them together, using wire and pliers. Cuts bars to required length, using hacksaw, bar cutters, or acetylene torch. May bend tods with handtools or rodbending machine. May reinforce concrete with wire mesh. May weld reinforcing bars together, using arc-welding equipment.

When compared with other construction workers, structural metal craftsmen have the third highest accident type risk ratio for struck by, NEC with a value of 2.2, struck by falling objects with a value of 2.6, and foreign matter in eye with a value of 4.7. They have the fourth highest ratio for overexertion by lifting with a value of 2.3, seventh highest ratio for struck against a stationary object with a value of 1.9.

As seen from Tables B-7 to B-9, a particle and metal item NEC are the source of injury in over 80% of the foreign matter in the eye cases. These injuries result in an abrasion to the eye in about 90% of the cases. In struck by NEC injuries, the common sources of injury were metal item NEC and beam/bar, and the finger and eye were most commonly injured. The nature of injuries were cut-laceration, contusion and fractures. The leading source of injury for overexertion by lifting were a metal item, NEC and a Beam/Bar. Over 70% of the injuries were to the back and over 85% of the injuries were sprain-strains. Again the metal items, NEC and Beam Bar were the leading source of injury from being struck by falling object. The toe, foot (not toes) and finger were the most common part of body injured, and the common nature of injuries were contusion, fracture, and cut-laceration.

A review of Best-Loss Control Engineering Manual for Iron and Steel Erecting rated worker's compensation as high. The manual listed the following exposures, accidents and control.

Structural Frame (principally buildings over two stories in height)

> Exposures: Most severe exposures are from extreme heights, employees being struck by or getting caught between steel members as they are moved or prepared for movement; falling material, welding, snapping cables, and buckled booms.
>
> Accidents: Hands caught in sling or hook. Hand, foot, or leg being caught between steel members which are being moved into place. Falls from structures. Head and shoulder injuries from falling objects.

N.O.C. (Steel and Iron Structures usually associated with building, including one or two-story structural frame, pedestrian bridges, etc.)

> Exposures: Climbing and working at extreme heights. Cold, heat, weather, dust, sparks. Overhead operations, moving equipment, and materials.
>
> Accidents: Falls off high steel, ladders, crane hook or ball, on icy surfaces, through floor openings. Head injuries from dropped tools, bolts, swing loads, bumped objects. Hands caught between steel being erected, caught in shifted pile of steel, caught between cables and loads while hooking up. Cold, heat prostration. Loads dropped on feet, feet caught in steel pile which is shifting. Eye injuries from general dust, welding and cutting operations. Back injuries, strains while manually handling materials.

Metal Bridges

> Exposures: Extreme height, climbing, deep water, heavy lifting; high voltage, overhead operations, welding and cutting.
>
> Accidents: Serious falls often resulting in death. Drowning when working over water. Strains and sprains. Electric shock. Head injuries and crushed hands, limbs and feet. Eye damage from welding flash, flying chips and dust. Burns.

High Towers

Exposures: Elevated work areas, welding, grinding, falling objects, manual material handling and rigging.

Accidents: Falls from tower. Struck by falling objects. Trips and falls on ground. Eye injuries from welding, burning and grinding. Burns from welding and burning. Hand tool injuries. Sprains and strains from handling material.

The Employers Insurance of Wausau lists the following Injury Cause - Cost Analysis:

Iron or Steel Erection, NOC.

Percentage of Total Cost	MAJOR INJURY CAUSE (Based on a study of 1086 injuries costing $3,126,883)
37%	Falls from ladders, scaffolding, beams and elevated surfaces.
16%	Handling pipe or hose, steel or iron, metal stock and other objects. Two thirds of this cost involved back injuries.
11%	Falls on working surfaces.
11%	Struck by falling steel or iron and hoisting booms.

Iron or Steel Erection not over two Stories

Percentage of Total Cost	MAJOR INJURY CAUSE (Based on a study of 1059 injuries costing $2,835,502)
41%	Falls from scaffolding, ladders, roofs, structural steel and elevated surfaces.
18%	Struck gy falling beams, steel or iron, hoisting booms, and other objects.
11%	Handling steel or iron, beams, and other objects. More than one half of this cost involved back injuries.
5%	Falls on working surfaces.

A review of Tables B-7 to B-9 and the accidents listed in Best produce similar types of accidents. But a review of the injury cause-cost analysis, falls from elevation, has the highest percentage of cost

followed by manual handling and struck by falling objects. The percentage of falls for structural metal workers is given in Table B-11.

Overall, falls account for 9.1% of the accidents by type but they account for 39% of the accidents cost. Struck by falling objects account for 8.3% of the accidents and 14% of the costs, and overexertion by lifting account for 10.6% of the accidents and about 14% of the costs.

WELDERS

Welders primarily are concerned with joining, surfacing, or otherwise fabricating or repairing structures or parts of metal or other weldable material applying the arc or gas welding or cutting processes. In 1978 the construction industry employed 36,380 welders or 0.81% of the construction work force. The building construction (SIC 15) employed 7,040 welders or 0.54 % of the building workforce. The heavy construction (SIC 16) employed 15,550 welders or 1.65% of the heavy construction workforce, and the special trades (SIC 17) employed 13,840 welders or 0.61% of the special trades work force.

From the Dictionary of Occupational Titles [29], the duties of the welder are described as:

1) 810.384-014 Welder, ARC (welding)

Welds together metal components of such products as pipelines, automobiles, boilers, ships, aircraft and mobile homes, as specified by layout, blueprints, diagram, work order, welding procedures, or oral instructions, using electric arc-welding equipment: Obtains specified electrode and inserts into portable holder or threads consumable electrode wire through portable welding gun. Connects cables from welding unit to obtain amperage, voltage, slope, and pulse as specified by WELDING ENGINEER (profess. and kin) or WELDING TECHNICIAN (profess. and kin). Starts power supply to produce electric current. Strikes (forms) arc which generates heat to melt and deposit metal from electrode to workpiece and join edges of workpiece. Manually guides electrode or gun along weld line, maintaining length of arc and speed of movement to form specified depth of fusion and bead, as judged from color of metal, sound of weld, and size of molten puddle. Welds in flat, horizontal, vertical or overhead positions. Examines weld for bead size and other specifications. May manually apply filler rod to supply weld metal. May clear or degrease weld joint or workpiece, using wire brush, portable grinder, or chemical bath. May repair broken or cracked parts and fill holes. May prepare broken parts for welding by grooving or scarfing surfaces. May chip off excess weld, slag, spatter, using hand scraper or power chipper. May preheat workpiece, using hand torch or heating furnace. May position and clamp workpieces together or assemble them in jib or fixture. May tack assemblies together. May cut metal plates or structural shapes [ARC CUTTER (welding)]. May be designated according to type of equipment used as WELDER, CARBON ARC (welding); WELDER, FLUX-CORED ARC (welding); WELDER, GAS-METAL ARC (welding); WELDER GASTUNGSTEN ARC (welding); WELDER, HAND, SUBMERGED ARC (welding); WELDER PLASMA ARC (welding); WELDER SHIELDED-METAL ARC (welding). May be designated according to product welded as WELDER, BOILERMAKER (boilermaking). Important variations include types of metals welded, subprocesses used, tradename of equipment used, worksite (inplant, job shop, construction site, shipyard), method of application (manual, semiautomatic), high production or custom, level of ambidexterity required, type of joints welded (seam, spot, butt). May be required to pass employer performance tests or standard tests to meet certification standards of governmental agencies or professional and technical associations.

2) 811.684-014 WELDER, GAS (welding)

Welds metal parts, using gas welding equipment as specified by layout, welding diagram, or work order. Positions parts in jigs or fixtures on bench or floor, or clamps parts together along layout marks. Selects torch, torch tip, filler rod and flux, according to welding chart specifications or type and thickness of metal. Connects regulator valves and hoses to oxygen and fuel gas cylinders,

and welding torch. Turns regulator valves to activate flow or gases, light torch and adjusts gas mixture and pressure, to obtain desired flame, based on knowledge of gas-welding techniques. Holds torch at proper angle to metal and guides along weld joint, applying filler rod to molten area to form weld. Examines weld for bead size and other specifications. Repairs broken or cracked metal objects, fills holes, and builds up metal parts. May apply flux to workpiece instead of filler rod. May preheat workpieces in furnace or with torch. May outout, position, and tack weld workpieces. May weld along vertical or overhead weld lines. May scarf or groove weld prior to applying filler metal, using gas welding equipment. May chip or grind off excess weld, slag, or spatter [GRINDER-CHIPPER (any ind.)II]. May clean or degrease parts, using wire brush, portable grinder, or chemical bath. May cut metal plates or structural shapes using gas torch. May be designated according to type of gases used such as WELDER, ACETYLENE (welding); WELDER, OXYACETYLENE (welding); WELDER, OXYHYDROGEN, (welding). Important variations include type of metals welded, products, subprocesses, trade name of equipment, worksite (inplant, job shop, construction site, shipyard), high-production or custom, level of ambidexterity required or type of joints welded (seam, spot, butt). May be required to pass employer performance tests or standard tests to meet certification standards of governmental agencies or professional and technical associations.

When compared with other construction occupations, welders have the second highest accident type ratio for contact with hot objects and with a value of 6.1 and foreign matter in the eye with a value of 5.4. They have the sixth highest ratio for being struck by falling objects with a value of 2.1, tenth highest ratio for overexertion by lifting with a value of 1.5, and eleventh highest ratio for struck by NEC with a value of 1.4. The types of accidents experienced by welders are given in Table III-10. Percentages are given for the accident type in each two digit SIC on a yearly basis, along with the four year average. Also, the type's percentage for all welders in construction over the four year period is listed.

A review of Tables B-13 to B-15 reveals that a particle or metal item, NEC was the source of injury for foreign particle in the eye. Metal items, NEC and pipes were the leading sources of injury for overexertion by lifting which resulted in injuries to back and abdomen in

over 75% of the cases. The nature of injuries for overexertion by lifting were sprain-strains in over 80% of the cases and hernia-rupture in over 5% of the cases. In the struck by NEC accidents, the welder was struck by metal items(s) and hammer-sledge in over 35% of the cases, which resulted in injuries to the finger and eye in over 37% of the struck by NEC cases. The leading nature of injuries for struck by NEC were cut-lacerations, contusions and fractures. Struck by falling objects was the fourth accident studied for SICs 15 and 17. Metal item, NEC, beam/bar and pipe were the source of injury in about 55% of the cases. The toe, foot, and finger were the leading parts of body injured and the most common nature of injuries were fracture, contusion and cut-laceration. In SIC 16, the fourth accident type was contact with hot objects. The sources of injury were metal items, flame, fire and smoke, and molten metal. Over 23% of these injuries were to the eye and 9.8% were to the hand.

A review of Best-Loss Control Engineering Manual for welding, brazing, and cutting rated workmen's compensation as high. The manual listed the following exposures.

> Exposures: Infrared radiation, ultraviolet radiation, intense visible light, radiant energy, high voltage, toxic gases (carbon monoxide, carbon dioxide, nitrogen dioxide, phosgene, phosphine, and ozone), vapors and fumes (beryllium, cadmium oxide, chromic and dichromic acid, chromium trioxide, copper, fluorides, lead, magnesium, manganese, mercury, nickel and its compounds, phthalic-based paints, titanium dioxide, vanadium pentoxide, zinc), dust and particulates. Oxygen cylinders, compressed gas cylinders; unsafe storage, inadequate ventilation. Climbing and working at various heights, in confined areas, in difficult places and positions, in proximity to flammables and explosives. Welding on containers that previously held flammable or explosive materials. Lifting heavy items. Sharp or rough metal.

Best also listed the hazards for specific welding processes. A few of them are:

Arc Welding

Process	Description	Material & Equipment	Hazard
Stud Welding	Welding processes wherein coalescence is produced by heating with an arc drawn between a metal stud or similar part, and the other part until the surfaces to be joined are properly heated, when they are brought together under pressure. Used extensively in following fields: automotive, boiler, construction, equipment manufacture, railroads, and shipbuilding.	Stud welding gun, control unit, power source, stud	Electric shock
Gas Metal-Arc	Gas metal-arc welding is accomplished by means of a gas shielded arc maintained between the workpiece and a consumable electrode from which metal is transferred to the workpiece. Used in automotive, aluminim containers construction, aerospace, electronic, military, piping, surfacing and transportation industries.	Torch, power supply filler wire, shielding gases, wire feeder, various control mechamisms	High temperature, Exhaust fumes, Electric shock
Pressure Gas	Weld is produced by the application of pressure during the heating of the entire area of abutting metal surfaces. Heating is obtained from the combustion of gases. Oxyacetylene flame is almost always used. Filler metal is not.	Same equipment as used in oxyacetylene welding with the exception of clamps.	High pressure inhalation of of toxic gases. Eye protection needed against "flashes".

A review of the accident types and Best reveals that the leading injury is foreign matter in the eye, other eye injuries occurred in struck by NEC and contact with hot objects. Also, over 50% of the overexertion

injuries occurred when the worker was lifting a metal item, NEC, beam/Bar, and pipe.

MILLWRIGHTS

Millwrights primarily install, dismantle and move machinery and equipment. In 1978 the construction industry employed 17,530 millwrights or 0.39% of the construction force. Within the construction, the general building construction (SIC 15) employed 5,450 millwrights or 0.42% of the building construction workforce. The heavy construction (SIC 16) employed 3,220 millwrights or 0.34% of the heavy construction workforce. The special trades (SIC 17) employed 8,860 millwrights or 0.39% of the special trade workforce.

From the dictionary of occupational titles [29], the duties of the millwright are described as:

638.281-018 Millwright (any ind.)

> Installs machinery and equipment according to layout plans, blueprints, and other drawings in industrial establishment, using hoists, lift trucks, handtools and power tools. Reads blueprints and schematic drawings to determine work procedures. Dismantles machines, using hammers, wrenches, crowbars, and other handtools. Moves machinery and equipment, using hoists, dollies, rollers, and trucks. Assembles and installs equipment, such as shafting, conveyors, and tram rails, using handtools and power tools. Constructs founation for machines, using handtools and building materials, such as wood, cement, and steel. Aligns machines and equipment using hoists, jacks, handtools, squares, rules, micrometers, and plumb bobs. Assembles machines and bolts, welds, rivets, or otherwise fastens them to founation or other structures, using handtools, and power tools. May operate engine lathe to grind, file, and turn machine parts to dimensional specifications. May repair and lubricate machines and equipment.

When compared with other construction occupations, millwrights have the fourth highest accident type ratio for foreign matter in the eye with a value of 2.6 and the eighth highest ratio for being struck by falling objects with a value of 1.7.

As seen from Tables B-18 to B-20, a metal item NEC and particle were the source of injury in over 80% of the foreign matter in the eye cases. The struck by falling objects accident had the metal metal, NEC and beam/bar as the source of injury in abut 40% of the cases. Injury to the toes, foot, and fingers occurred in over 55% of the cases, and over 78% of the nature of injury were fractures, contusions, and cut/lacerations. The hammer/sledge or metal item, NEC were the source of injury in over 27% of the struck by NEC. The finger or hand were injured in over 35% of the cases. The leading nature of injury was the cut-laceration, fracture and contusion. For the overexertion by lifting injuries, the leading source of injury was metal item, NEC. Most of the injuries were to the back and sprain/strain accounted for over 80% of the nature of injuries.

The Employers Insurance of Wausau lists the following injury cause-cost analysis for millwright work N.O.C.:

Percentage of Total Cost	MAJOR INJURY CAUSE (Based on a study of 3113 injuries costing $4,369,858)
21%	Handling material such as lumber, steel, boxes, crates, pipe and hose, and other objects. More than 75 percent of this cost involved back injuries.
17%	Falls from elevations such as ladders, scaffolding, and other elevated surfaces.
9%	Slips and falls on floors, steps or stairs, obstructions or holes and other working surfaces.
7%	Struck by falling steel, metal stock, cans, containers and other objects.
5%	Collision or upset of automobiles, factory trucks and other mobile equipment. More than two-thirds of this cost involved automobiles.
4%	Caught in conveyors, rolls, fans, and other machines.

As shown in Tables B-17 to B-20 and the Injury Cause - Cost Analysis, overexertion by lifting accounted for 9.2% of the accidents and 21% of the injury costs, and struck by falling object account for 9.2% of the accidents and 7% of the injury cost. Falls from elevation accounted for 17% of the injury cost but only accounted for 7.5% of the accidents which includes falls from ladders, scaffolds, piled materials, vehicles, on stairs, into shafts and falls to lower levels.

CARPENTERS

Carpenters primarily are concerned with fabricating, installing and repairing structural members made of wood and materials that can be worked like wood. In 1978 the construction industry employed 527,590 carpenters on 11.71% of the construction work force. The building construction industry (SIC 15) employed 382,550 carpenters or 29.38% of their work force. The heavy construction industry (SIC 16) employed 40,570 carpenters or 4.33% of their work force, while the special trades (SIC 17) employed 104,470 carpenters or 4.61% of their work force.

The Dictionary of Occupational Titles [29] describes the duties of the carpenter as:

860.381-022 Carpenter (const.)

> Constructs, erects, installs, and repairs structures and fixtures of wood, plywood, and wallboards, using carpenter's handtools and power tools, and conforming to local building codes: Studies blueprints, sketches, or building plan for information pertaining to type of

material required, such as lumber or fiberboard, and dimensions of structure or fixture to be fabricated. Selects specified type of lumber or other materials. Prepares layout, using rule, framing square and calipers. Marks cutting and assembly lines on materials, using pencil, chalk, and marking gage. Shapes materials to prescribed measurements, using saws, chisels, and planes. Assembles cut and shaped material and fastens them together with nails, dowel pins, or glue. Verifies trueness of structure with plumb bob and carpenter's level. Erects framework for structures and lays subflooring. Builds stairs and lays out and installs partitions and cabinet work. Covers subfloor with building paper to keep out moisture and lays hardwood, parquet, and wood-strip-block floors by nailing floors to subfloor or cementing them to mastic or asphalt base. Applies shock-absorbing, sound-deadening, and decorative paneling to ceilings and walls. Fits and installs prefabricated window frames, doors, doorframes, weather stripping, interior and exterior trim, and finish hardware such as locks, letterdrops, and kick plates. Constructs forms and chutes for pouring concrete. Erects scaffolding and ladders for assembling structure above ground level. May weld metal parts to steel structural members. When specializing in particular phase of carpentry is designed according to specialty as COMBINATION-WINDOW-INSTALLER (const); LAY-OUT CARPENTER (const); When specializing in finish carpentry, such as installing interior and exterior trim, building stairs, and laying hardwood floors is designated FINISH CARPENTER (const.). When erecting frame building and performing general carpentry work in residential construction is designated HOUSE CARPENTER (const.). May remove and replace sections of structures prior to and after installation of insulating materials and be designated BUILDING-INSULATING CARPENTER (const.; ret. tr.). May perform carpentry work in construction of walk-in freezers, and environmental test chambers and be designated CARPENTER, REFRIGERATOR (refrigerator equip.). Additional titles: DOOR HANGER (const); FINISHED HARDWARE ERECTOR (const); GARAGE-DOOR HANGAR (const); HARDWOOD FLOOR INSTALLER (const); JALOUSIE INSTALLER (const); STAIR BUILDER (const); TRIM SETTER (const); WEATHER STRIPPER (const); WOOD SASH AND FRAME CARPENTER (const); WOOD STRIP BLOCK FLOOR INSTALLER (const).

When compared with other construction workers, carpenters had the fourth highest accident risk ratio in fall from elevation NEC with a value of 1.8. They had the tenth highest ratio for struck by NEC with a value of 1.5 and fourteenth highest ratio for struck against stationary object with a value of 1.1.

As seen from Tables B-23 to B-25, a saw or hammer/sledge were the source of injury in over 30% of the struck by NEC cases. The finger or hand was injured in over 40% of the cases reported and the leading nature of injuries were cuts/lacerations and contusions. The leading source of injury for overexertion by lifting was lumber/wood item, NEC. Most of the injuries were to the back and the leading nature of injury was sprain/strain. In struck against stationary object the source of injury was nail/spike, or metal item, NEC in over 35% of the cases. The most common part of the body injured was the foot, finger, and hand, and in over 70% of the struck against cases, the nature of injury was a cut/laceration or contusion. In over 40% of the struck by falling object cases, lumber or wood item, NEC, was the source of injury. The finger, foot, and toe were injured in over 30% of the cases, and over 65% of the cases involved contusions, cut/lacerations, and fractures.

A review of Best-Loss Control Engineering Manual for carpentry rated workmen's compensaion as medium. The manual listed the following exposures, accidents and control.

Carpentry: Private Residence

> Exposures: Material handling activities such as lifting, bending, twisting. Improper handling of power equipment. Electrical shock hazards related to power equipment. Falls on same or different levels. Rough and/or splintering materials. Dust in suspension. Flying objects.
>
> Accidents: Sprains, strains, lacerations, and abrasions; electrical shock; eye injuries; falls from various heights due to careless practice of employee or faulty ladders and scaffolds; possible amputations from unguarded or misused power saws; puncture wounds from nails.

Carpentry: Cabinet Work or Installation

Exposures: Material handling activities such as lifting, bending, and twisting. Operation of power equipment. Dust in suspension. Possible O.D. exposure through the use of solvents in the spray painting operations.

Accidents: Sprains and strains, spliters, eye injuries, lacerations, amputations, and falls.

Carpentry: Installation of Parquet Flooring

Exposures: Use of electrical hand saws and hazards connected with cutting or ripping wood on power saws. Inhalation of toxic vapors from adhesives. Flammable vapors and adhesives. Flying particles.

Accidents: Cuts, foreign body in the eyes. Dizziness and nausea from inhalation of toxic vapors, burns from accidental ignition of flammable vapors. Inhalation of sander dust.

The Employer's Insurance of Wausau gives the following Injury Cause-Cost Analysis for Carpentry Shop only:

Percentage of Total Cost	MAJOR INJURY CAUSE (Based on a study of 2171 injuries costing $2,229,743)
18%	Cut by saws and caught in machinery.
13%	Handling material (mostly lumber and plywood). Back injuries accounted for 70% of the cost.
11%	Falls from elevations and on level surfaces.
8%	Struck by falling objects

As revealed by the injury analysis and the cost analysis, one of the leading sources of injury to carpenters is cuts. In the shop they account for about 18% of the injury costs and over 20% of the injuries to carpenters in general. Other sources of injury include overexertion by lifting lumber and struck against nails and metal items.

PLUMBERS AND/OR PIPEFITTER

Plumbers and/or pipefitters primarily assemble and install gas, steam, plumbing, and related fixtures, pipes, and fitting in structures. In 1978 there were 197,020 plumbers and/or pipefitters employed in the construction industry or 4.37% of the construction work force. The building construction (SIC 15) employed 13,620 plumbers and/or pipefitters or 1.05% of the work force. Heavy construction (SIC 16) had 20,540 plumbers and/or pipefitters employed which composed 2.19% of its work force. The special trades (SIC 17) employed 162,860 plumbers and/or pipefitters or 7.18% of the special trades work force.

The Dictionary of occupational titles [29] describes the duties of the plumber as:

862.381-030 Plumber (const.)

> Assembles, installs, and repairs pipes, fittings, and fixtures of heating, water, and drainage systems, according to specifications and plumbing codes: Studies building plans and working drawings to determine work aids required and sequence of installations. Inspects structure to ascertain obstructions to be avoided to prevent weakening of structure resulting from installation of pipe. Locates and marks position of pipe and pipe connections and passage holes for pipes in walls and floors, using ruler, spirit level, and plumb bob. Cuts openings in walls and floors to accommodate pipe and pipe fittings, using handtools and power tools. Cuts and threads pipe, using pipe cutters, cutting torch, and pipe-threading machine. Bends pipe to required angle by use of pipe-bending machine or by placing pipe over block and bending it by hand. Assembles and installs valves, pipe fittings, and pipes composed of metals such as iron, steel, brass, and lead, and nonmetals such as glass, vitrified clay, and plastic, using handtools and power tools. Joins pipes by use of screws, bolts, fittings, solder, plastic solvent, and calks joints. Fills pipe system with water or air and reads pressure gages to determine whether system is leaking. Installs and repairs plumbing fixtures such as sinks, commodes, bathtubs, water heaters, hot water tanks, garbage disposal units, dishwashers, and water softeners. Repairs and maintains plumbing by replacing washers in leaky faucets,

mending burst pipes, and opening clogged drains. May weld holding fixtures to steel structural members. When specializing in maintenance and repair of heating, water, and drainage systems in industrial or commercial establishments is designated PLUMBER, MAINTENANCE (any ind.).

When compared to other construction workers, the plumber and/or pipefitter have the sixth highest accident type risk ratio for foreign matter in the eye and fourteenth for overexertion by lifting.

As seen from Tables B-28 to B-30 a particle or metal item, NEC was the source of injury in over 80% of the foreign matter in the eye cases. A metal item, NEC or pipe was the source of injury in about 45% of the overexertion by lifting cases. Most of the injuries occurred to the back and the leading nature of injury was sprain/strain. In the struck by NEC accidents a metal item, NEC and pipe was the leading source of injury. The fingers, eye, and hand were the most common injured parts of the body, and the leading natures of injury were cut/laceration, contusion, and fractures. Again the metal item, NEC and pipe were the sources of injury in about 50% of the struck by falling object accidents in SICs 15 and 16. The toe and foot were most commonly injured. The leading natures of injuries for struck by a falling object were contusion, fracture, and cut/laceration. In SIC 17 the fourth accident type was struck against stationary object. About 50% of the injuries were caused by striking a metal item, NEC nail, spike, and pipe. The finger, foot, hand and knee were injured in about 57% of the cases and the leading sources of injury were cut/laceration, contusion, and sprain/strain.

The Best-Loss Control Engineering Manual rated plumber's workers' compensation as high. The following exposures were listed:

Exposures: Explosive and flammable dusts, gases, and fumes, blowtorches, furnace, or other igniting equipment. Unguarded or ungrounded electrical tools and equipment; cracked or deteriorated electrical wiring, wet conditions. Splattering of hot solder; contact with exposed electrical circuits or underground power lines. Lifting and carrying materials and equipment; working in awkward positions or in small confined areas; poor ventilation. Absorption of toxic vapors, lead; poorly aerated septic tanks; methane gas; health hazards from working with waste. Large excavations and trenches not properly shored or braced; falling soil and rock or debris from other trades. Floor openings, ladders, scaffolds, hoists.

The Employers Insurance of Wausau gives the following Injury Cause-Cost analysis for plumbers, N.O.C.

Percentage of Total Cost	MAJOR INJURY CAUSE (Based on a study of 4255 injuries costing $5,142,383)
22%	Handling pipe or hose, scaffolding, tanks, pumps, dies and various other tools, equipment, and materials. Over three-fourths of the cost was from back injuries.
18%	Falls from ladders, scaffolds, roofs, trucks and other elevated surfaces.
13%	Slips - trips and falls, slips and trips (no fall) and falls on wet, icy or oily surfaces; steps or strairs; on surface obstacles or holes in surfaces; and on regular working surfaces.
8%	Struck by falling pipe or hose, tanks, and other equipment and materials.
4%	Collision or upset of automobile, trucks, and other mobile equipment.

A review of the compensation cases and the Injury Cause-Cost Analysis reveals that overexertion-lifting accounted for 11.8% of the cases and about 22% of the compensation costs. The second greatest cost category is falls from ladders, scaffolds, roofs, trucks and other elevated surfaces, accounting for 18% of the compensation cost. The compensation data reveals that falls from elevations, (e.g., falls from scaffolds, ladders, piled materials, vehicles and fall to lower level) account for 6.6% of the cases. Also, struck by falling objects accounted for 6.8% of the injuries as compared to 8% of the injury cost.

MECHANICS

Mechanics are primarily concerned with repairing engines and accessories, power trains, suspension systems, and other mechanical units. In 1978 there were 48,640 mechanics employed in the construction industry or 1.08% of the construction work force. Building construction employed 2,250 mechanics or 0.17% of their work force. In heavy construction 19,430 mechanics were employed or 2.07% of their workforce, and the special trades had 26,960 mechanics employed or 1.19% of the special trades workforce.

The Dictionary of Occupational Titles [29] describes the duties of the mechanic as:

1) 625.281-010 Diesel Mechanic (any. ind.)

Repairs and maintains diesel engines used to power machines, such as buses, ships, trucks, railroad trains, electric generators, and construction machirery, using handtools, precision-measuring instruments, and machine tools: Diagnoses trouble, disassembles engines, and examines parts for defects and excessive wear. Reconditions and replaces parts, such as pistons, bearings, gears, valves, and bushings, using engine lathes, boring machines, handtooks, and precision-measuring instruments. May weld and cut parts, using arc-welding and flame cutting equipment. May be designated according to type of diesel engine or equipment repaired as DIESEL-ENGINE MECHANIC, AUTOMOBILE (auto ser.) DIESEL-ENGINE MECHANIC, BUS (auto ser.); DIESEL ENGINE MECHANIC, MARINE (ship & boat bldg. and rep); DIESEL-MECHANIC, CONSTRUCTION (const); DIESEL-MECHANIC, FARM (agric. equip); LOCOMOTIVE REPAIRER, DIESEL (loco & car bldg. & rep.).

2) 620.261-022 Construction Equipment Mechanic (const). Heavy Equipment Mechanic

Analyzes malfunctions and repairs, rebuilds and maintains construction equipment, such as cranes, power shovels, scrapers, paving machines, motor graders, trench-digging machines, conveyors, bulldozers, dredges, pumps, compressors and pneumatic tools: Operates and inspects machines or equipment to diagnose defects. Dismantles and reassembles equipment, using hoists and handtools. Examines parts for damage or excessive wear, using micrometers and gages. Replaces defective engines and subassembles such as transmissions. Tests overhauled equipment to insure operating efficiency. Welds broken parts and structural members. May direct workers engaged in cleaning parts and assisting with assembly and disassembly of equipment. May repair adjust and maintain mining machinery, such as stripping and loading shovels, drilling and cutting machines, and continuous mining machines and be designated MINE-MACHINERY MECHANIC (mining and quarrying).

3) 620.281-046 Maintenance Mechanic (const; Petrol Production; Pipe Lines) Service Engineer; Shop Mechanic).

Inspects, repairs, and maintains functional parts of automotive and mechanical equipment and machinery, such as pumps, compressors, pipe-laying machines, ditchdiggers, trucks, and tractors used in petroleum exploration, on oil fields, in pipeline construction, and in airfield maintenance and pipeline operations, using hoists, handtools, gages, drills, grinding wheels, and testing devices: Inspects defective equipment and diagnoses malfunctions, using motor analyzers, pressure gages, chassis charts, and factory manuals. Disassembles and overhauls internal combustion engines, pumps, pump power units, generators, transmissions, clutches, and rear ends, using handtools, and hoist. Grinds and reseats valves, using valve-grinding machine. Adjusts brakes, alines wheels, tightens bolts and screws, and reassembles equipment. Operates equipment to test its functioning. Changes oil, checks batteries, repairs tires and tubes, and lubricates equipment and machinery.

When compared with other construction workers, the mechanics have the fifth highest accident type risk ratio for foreign matter in the eye with a value of 2.3. They have the sixth highest ratio for overexertion by lifting with a value of 1.9, and the eleventh highest ratio for struck by NEC with a value of 1.4 and struck against stationary object with a value of 1.2.

As seen by Tables B-33 to B-35 the leading sources of injuries are struck by NEC accidents was metal item, NEC and hammer/sledge. The most common injured part of body was the finger and hand, and the common natures of injury were cut/laceration, contusions and fractures. In the overexertion by lifting case the leading source of injury was a metal item, NEC. The back received most of the injuries and the leading nature of injury was strain/sprain. In the struck against stationary object injuries the leading sources of injury were metal item, NEC and nail/spike. The leading parts of body injured were the finger and foot and most of the injuries were cut/lacerations and contusions. Metal item, NEC and autoparts were the leading source of injury in the struck by falling object. The finger, toe and foot were the most common part of body injured and the leading nature of injuries were fractures, cut/lacerations, and contusions.

The Best Manual and Employers Insurance of Wausau did not list any specific information on mechanics as related to their work in the construction industry.

LABORERS

Laborers perform duties, not elsewhere classified, concerned with building and repairing structures. In 1978 the construction industry employed 423,080 laborers or 9.39% of the construction work force. Building construction (SIC 15) employed 132,900 laborers or 10.21% of their work force. Heavy construction (SIC 16) employed 175,370 laborers

or 18.70% of their work force, while the special trades employed 114,810 laborers or 5.06% of the special trade work force.

The Dictionary of Occupational Titles [29] defines the duties of the laborer or construction worker as:

1) 869.664.014 Construction Worker (const.) I

Performs any combination of following duties on construction projects, usually working in utility capacity, by transferring from one task to another where demands require worker with varied experience and ability to work without close supervision: Measures distances from grade stakes, drives stakes, and stretches tight line. Bolts, nails, alines, and blocks up under forms. Signals operators of construction equipment to facilitate alinement, movement, and adjustment of machinery to conform to grade specifications. Levels earth to fine grade specifications, using pick and shovel. Mixes concrete, using portable mixer. Smooths and finishes freshly poured cement or concrete, using float, trowel or screed. Positions joins, alines, and seals pipe sections. Erects scaffolding, shoring and braces. Mops, brushes, or spreads paints or bituminous compounds over surfaces for protection. Sprays material such as water, sand, steam, vinyl, paint, or stucco through hose to clean, coat, or seal surfaces. Applies caulking, compounds by hand or with calking gum to seal crevices. Grinds, sands, or polishes surfaces, such as concrete, marble, terazzo or wood flooring, using abrasive tools or machines. Performs variety of tasks involving dextrous use of hands and tools, such as demolishing buildings, sawing lumber, dismantling forms, removing projections from concrete, mounting pipe hangars, and cutting and attaching insulating material. May be designated according to duties performed as BATTERBOARD SETTER (const); BILLBOARD ERECTOR HELP (const); BRICKLAYER, PAVING BRICK (const); BUILDING CLEANER, SANDBLASTER (const.); BUILDING CLEANER, STEAM (const); CALKER (const); Additional titles: CARPENTER HELPER, MAIN TENANCE (const.); CEMENT MASON, HIGHWAYS AND STREETS (const); CONCRETE SPRAYER, NOZZLE (conc. prod.; const.); CONCRETE-WALL-GRINDER-OPERATOR (const); CORRUGATED-SHEET-METAL MATERIAL SHEETER (const); CRADLE PLACER (const); DAMPPROOFER (const.); DRAIN LAYER (const.); DUCT INSTALLER (const.; mfd. bldgs.); FINE GRADER (const.); FITTER (const.; pipe lines); FLOOR FINISHER (const.); FLOOR-SANDING-MACHINE OPERATOR (const.); FORM-BUILDER HELPER (const.); FORM SETTER, METAL ROAD-FORMS (const.); FORM SETTER, STEEL FORMS (const.); FORM SETTER, STEEL-PAN FORMS (const.); FOUNDATION-DRILL-OPERATOR HELPER (const.); GLAZIER HELPER (const.); GROUND WIRER (const.); HOLDER, PILE DRIVING (const.);

HYDRANT-AND-VALVE SETTER (const.); INSULATION INSTALLER (const.); INSULATION WORKER (const.); JOIST SETTER, ADJUSTABLE STEEL (const.); LABORER, ADJUSTABLE STEEL JOIST (const.); LABORER, CARPENTRY (const.); LABORER, CARPENTRY, DOCK (const.); LAYER-OUT, PLATE GLASS (const.); LIGHTNING-ROD ERECTOR (const.); MARBLE-SETTER HELPER (const.); ORNAMENTAL-IRON-WORKER HELPER (const.); PAINTER, ROUGH (const.); PAINTER, STRUCTURAL STEEL (const.); PAINT-STRIPPING-MACHINE OPERATOR (const.); PERMASTONE DRESSER (const.); PILE-DRIVING SETTER (const.); PIPE CALKER (const.); PIPE LAYER (const.); PIPE-LINE WORKER (const.); PLUMBER HELPER (const.); POINTER, CALKER AND CLEANER (const.); PUMP-ERECTOR HELPER (const.); RECEIVER SETTER (const.); ROOFER, VINYL COATING (const.); SEAT INSTALLER (const.); SEPTIC-TANK SERVICER (const.); SEWER TAPPER (const.); SHORER (const.); STONE POLISHER (const.); TAPPING-MACHINE OPERATOR (const.); TERRAZZO-WORKER HELPER (const.); TILE SETTER HELPER (const.); TUCK POINTER (const.); WATERPROOFER (const.); WELL-DRILL-OPERATOR HELPER, CABLE TOOL (const.); WELL-DRILL-OPERATOR HELPER, ROTARY DRILL (const.); WRECKER (const.).

2) 869.687-026 CONSTRUCTION WORKER (const.) II

Performs any combination of following tasks, such as erecting, repairing, and wrecking buildings and bridges; installing waterworks, locks, and dams; grading and maintaining railroad right-of-ways and laying ties and rails; and widening, deepening, and improving rivers, canals, and harbors, requiring little or no independent judgment; Digs, spreads, and levels dirt and gravel, using pick and shovel. Lifts, carries, and holds building materials, tools, and supplies. Cleans tools, equipment, materials, and work areas. Mixes, pours, and spreads concrete, asphalt, gravel, and other materials, using handtools. Joins, wraps, and seals sections of pipe. Performs a variety of routine, non-machine tasks, such as removing forms from set concrete, filling expansion joints with asphalt, placing culvert sections in trench, assembling sections of dredge pipeline, removing wallpaper, and laying railroad track. Many of these jobs are not full time, the size of the project and organization of the work determining whether a worker spends all his time on one job or is transferred from task to task as the project progresses to completion. Some workers habitually work in one branch of the industry, whereas others transfer according to the availability of work or on a seasonal basis. May be designated according to specific work performed as AIR-HAMMER OPERATOR (const.); ASPHALT-PLANT WORKER (const.); ASPHALT RAKER (const.); BACKER-UP (const.); BELL-HOLE DIGGER (const.); BRICK CLEANER (const.). Additional titles; BRICKLAYER HELPER (const.); BRICK-PAVING CHECKER (const.); BUILDING CLEANER, BRICK OR STONE (const.); CAGE TENDER (const.); CARPENTER HELPER, HARDWOOD FLOORING (const.); CEMENT-MASON HELPER (const.); CLAMPER (const.) COLD PATCHER (const.); CONCRETE-PUMP-OPERATOR HELPER (const.); CONCRETE-VIBRATOR OPERATOR (const.); CONCRETE-VIBRATOR-OPERATOR HELPER (const.); CONNECTOR HAND (const.); CRANK HAND (constr.); CRUSHED-STONE GRADER (const.); CURB-SETTER HELPER (const.); DOPE POURER (const.); DREDGE PIPE INSTALLER (const.); DUMP GRADER (const.); FILTER-BED PLACER (const.); FLOOR-FINISHER HELPER (const.); FLOOR-LAYER HELPER (const.; ret.

tr.); FORM-SETTER HELPER (const.); FORM STRIPPER (conc. prod.; const.); FORM-STRIPPER HELPER (const.); FORM TAMPER (const.); GRADER (const.); GRADE TAMPER (const.); GROUTER HELPER (const.); HOD CARRIER (const.); HOOSIER POLE HAND (const.); INSERTER (const.); JOINTER FILLER (const.); LABORER BATCHING PLANT (const.); LABORER, BITUMINOUS PAVING (const.); LABORER, CEMENT-GUN PLACING (const.); LABORER, CORRUGATED-FRON-CULVERT PLACING (const.); LABORER, ELECTRIC POWER AND TRANSMISSION LINE (Light, heat, & powere; const.): LABORER, HEADING (const.); LABORER PILE DRIVING, GROUND WORK (const.); LABORER, PIPE-LINE (const.); LABORER, PLUMBING (const.); LABORER, ROAD (const.); LABORER, SHAFT SINKING (const.); LABORER, SHORE DREDGING (const.); LABORER, STEEL HANDLING (const.); LABORER, STONE BLOCK RAMMING (const.); LABORER, WRECKING AND SALVAGING (const.); LOFT WORKER, PILE DRIVING (const.); MATERIAL HAULER (const.); MINER HELPER (const.); MIXER, HAND, CEMENT GUN (const.); MOLD MAKER (const.); MORTER MIXER (conc. prod.; const.); MUCKER (const.); MUCKER, COFFERDAM (const.); MUD-JACK NOZZLE WORKER (const.); OIL SPRAYER (const.); PAINTER HELPER (const.); PAPERHANGER, PIPE (const.); PAPER LATCHER (const.); PAPER SPOOLER (const.); PAVING-BED MAKER (const.); PAVER RAMMER (const.); PIPE-LAYER HELPTER (const.); PIPE-MACHINE OPERATOR (const.); PIPE-MACHINE-OPERATOR HELPER (const.); PLASTERER HELPER (const.); PORTABLE GROUT-MIXER OPERATOR (conc. prod.; const.); PUDDLER, PILE DRIVING (const.); REINFORCING-IRON-WORKER HELPER (const.); REINFORCING-STEEL WORKER, WIRE MESH (const.); RIPRAP PLACER (const.); ROOFER HELPER (const.); ROOFER HELPER, VINYL COATING (const.); SHEETING PULLER (const.); SHEET-PILE-HAMMER OPERATOR (const.); SHEET-PILE-HAMMER-OPERATOR HELPER (const.); SKIP TENDER, CONCRETE MIXING OR BATCH PLANT (const.); SLICER (const.); SQUEEGEE FINISHER (const.); STAIN REMOVER (const.); STONE-AND-CONCRETE WASHER (const.); STONEMASON HELPER (const.); STONE UNLOADER (const.); STRUCTURAL-STEEL-WORKER HELPER (const.); SUBGRADE TESTER (const.); TRACK LAYER (const.); TRACK-REPAIRER HELPER (const.); TRENCH TRIMMER, FINE (const.); WALLPAPER REMOVER, STEAM (const.); WALL WASHER (const.); WATER-PROOFER HELPER (const.); WELL DIGGER (const.); WELL-DIGGER HELPER (const.); WHITE WASHER (const.).

When compared with other construction workers, laborers have the highest accident type risk ratio for struck by, NEC with a valve of 3.0. The second highest ratios for stuck against stationary object with a valve of 2.7 and struck by falling object with a valve of 3.5. They have the third highest ratio for overexertion by lifting with a valve of 2.8.

A review of Tables B-38 to B-40 reveals that in the struck by, NEC cases a metal item, NEC and hammer/sledge, were the most common source of injury. Over 25% of the struck by, NEC injuries were to the finger or hand and the leading natures of injuries were cut-laceration, contusion and fracture. The overexertion by lifting injuries had metal item, NEC as the leading source of injury. In most cases, these injuries were to the back and the leading nature of injury was a sprain/strain.

In SICs 16 and 17 the most common sources of injury for struck by falling object were metal item, NEC and mineral (dirt) NEC. In SIC 15 the common sources of injury were lumber and metal item, NEC. These injuries were generally to the foot, toe, or finger and usually resulted in a contusion, fracture or cut/laceration. A nail/spike or metal item, NEC were the common sources of injuries for struck against stationary objects. The leading injuried parts of the body were the finger and foot, and most of the injuries were cuts/lacerations or contusions.

The Best Manual and Employers Insurance of Wausau did not list any specific information on laborers as related to their work in the construction industy.

ENGINEERING AND SCIENCE TECHNICIANS, NEC

Engineering and science technicians perform duties not covered by the following technicians: Agriculture and biological, chemical, draftsmen, electrical and electronic, industrial, mechanical, mathematical, and

surveyors. Some of the duties include quality control of fresh concrete, soil-testing, soil computation tests, inspections of re-bar placements and other dities which exercise engineering controls. In 1978 the construction industry employed 2,830 engineering and science technicians or o.06% of the construction work force. A majority of the engineering and science technicians or 2,000 are employed in heavy construction and they compose 0.21% of the heavy construction work force. Therefore, only the technicians in SIC 16 were studied.

When compared to other construction workers, engineering and science technicians have the fifth highest accident risk ratio for struck by NEC with a value of 1.9. They also have the sixth highest ratio for struck against stationary object with a value of 1.9 and seventh highest ratio for overexertion by lifting with a value of 1.7.

A review of Table B-43 reveals that 53% of the struck by NEC injuries were caused by an axe, highway vehicle, hammer/sledge, or plant/tree. The finger and lower leg were the most common parts of the body injured, and 62% of the injuries were cut/lacerations or contusions. The overexertion by lifting injuries had the following sources of injuries: container, NEC, Misc. NEC, and barrel. Most of the injuries were to the back and a sprain/strain was the leading nature of injury. A nail/spike, axe, a metal item were the leading source of injury for struck against stationary object. The leading part of body injured were finger, hand, and foot and most of the injuries were cut/laceration, contusion, or sprain/strain. For the contact with a toxic substance by absorption from a plant or tree was the source of injury in 87% of the cases. The

contact resulted in contact dermatitis to the upper extreme or multiple parts of the body. In fall to working surface accidents, 64% of the injuries were to the back, angle, knee or multiple parts, and sprain/strain, contusions, cut/lacerations occurred in 74% of the cases.

The Best Manual and Employers Insurance of Wausau did not list any specific information on Engineering and Science technicians, NEC as related to their work in the construction industry.

ROOFERS AND SLATERS

Roofers and slaters primarily are concerned with covering roofs and exterior walls of structures with slate, asphalt, aluminum, wood, and related materials. In 1978 the construction industry employed 75, 120 roofers and slaters as 1.67% of the industry. Most of the roofers and slaters are employed in SICs 15 and 17. Therefore, only roofers and slaters accidents in these SICs were studied. In the building construction (SIC 15), 4,490 roofers and slaters were employed or 0.34% of the building construction workforce, and the special trades employed 70,600 roofers and slaters or 3.11% of the special trade workforce.

The dictionary of occupational titles [29] describes the duties of the roofer as:

866.381-010 ROOFER (const.)

Covers roofs with roofing materials, other than sheet metal, such as composition shingles or sheets, wood shingles, or asphalt and gravel, to waterproof roofs: Cuts roofing paper to size, using knife, and nails or staples it to roof in overlapping strips to form base for roofing materials. Alines roofing material with edge of roof, and overlaps successive layers, gaging distance of overlap with chalkline, gage on shingling hatchet, or by lines on shingles. Fastens composition shingles or sheets to roof, with asphalt, cement, or nails. Punches holes in slate, tile, terra cotta, or wooden shingles, using punch and hammer. Cuts strips of flashing and fits them into angles formed by walls, vents, and intersecting roof surfaces. When applying asphalt or tar and gravel to roof, mops or pours hot asphalt or tar onto roof base. Applies alternate layers of hot asphalt or tar and roofing paper until roof covering is as specified. Applies gravel or pebbles over top layer, using rake or stiff-bristled broom. May construct and attach prefabricated roof sections to rafters [CARPENTER (const.)]. May attach shingles to exterior walls and apply roofing paper and tar to shower pans, decks, and promenades to waterproof surfaces. When specializing in one type of roofing materials is designated according to specialty as ALUMINUM-SHINGLE ROOFER (cont.); ASBESTOS-SHINGLE ROOFER (const.); ASPHALT, TAR, AND GRAVEL ROOFER (contst.); COMPOSITION ROOFER (const.); ROOFER, GYPSUM (const.); SLATE ROOFER (const.); TILE-AND-TERRA-COTTA ROOFER (const.); WOOD-SHINGLE ROOFER (const.).

When compared with other construction workers, roofers and slaters have the highest accident type risk ratios for fall from elevation, NEC with a value of 3.9 and contact with hot objects with a value of 13.6.

As revealed in Tables B-46 and B-47, the major source of injury for the contact with hot objects accidents was asphalt oil, and the hand, upper extremities, or multiple parts were the most common injured parts of body. The back or multiple parts were commonly injured in the fall to lower level accidents. Most of these injuries, about 55%, were fractures or sprains/strains. A bundle or container were the common source of injury for the overexertion by lifting. The back was commonly injuried and the leading nature of injury was a sprain/strain. In the struck by NEC accidents, the common source of injury were a knife or metal item, Nec. Over 47% of the injuries were to the finger or hand and the leading natures of injury were a cut/laceration and contusions.

The Best's Lost Control Engineering Manual list the following exposures for workmens' compensation:

> Exposures: Physically demanding work; lifting and carrying heavy roofing materials; constantly changing and unfamiliar job sites; inexperienced help. Working at heights; using ladders, scaffolds and hoists. Hot composition work; operating kettles or tanks; filling and transporting buckets of molten asphalt or tar; mopping "hot stuff." Poor housekeeping; spills. Environmental exposures of wind and heat. Contact with irritating or toxic materials; fumes or vapors from chimneys, ventilation outlets, adhesives, asphalt, tar pitch or other solvents. Exposed nails on reroofing jobs. Working near poser lines or electrical installations. Fire (see Fire and E.C.).

The Employers Insurance of Wausau list the following major loss causes for roofing:

> MAJOR LOSS CAUSES: (Based on a study of 1349 injuries costing $1,857,815)
> 1. Falling from elevations accounted for 34 per cent of the injury cost.
> 2. Handling barrels, kegs, hand trucks, rolls, containers and other materials accounted for 14 per cent of the injury cost. The back was involved in over one-half of the cost.
> 3. Contact with hot substances produced 12 per cent of the injury cost.

As revealed from the major loss causes, falls from elevations account for 34% of the injury cost. The injury analysis reveals that 16.1% of the roofer and slater accidents were falls from elevations, such as, falls from scaffolds, ladders, into shafts, etc., and falls to lower level. The overexertion by lifting account for 10.3% of the injuries and about 14% of the injury losses, and contact with hot substances account for 19.1% of the injuries and 12% of the injury cost.

DRY WALL INSTALLERS AND LATHERS

Drywall Installers and Lathers are primarily concerned with installing, taping, and surfacing plasterboard and drywall to the interior of a structure. In 1978, the construction employed 37,030 drywall installers and lathers or 0.82% of the workforce. A review of injuries and employment revealed that most of the drywallers are employed in building construction (SIC 15) and the special trades (SIC 17). In the building construction 4,060 drywall installers and lathers were employed or 0.31% of the building construction workforce and the special trades employed 32,960 drywall installers and lathers or 1.45% of the special trades work force.

The Dictionary of Occupational Titles [29] define the duties of the Drywall Installer and Lathers as:

1) 842.381-010 DRY WALL APPLICATOR (const.) dry-wall installations mechanic, dry-wall installer; gypsum dry-wall systems installer.

Plans gypsum drywall installations, erects metal framing and furring channels for fastening drywalls, and installs drywall to cover walls, ceilings, soffits, shafts, and movable partitions in residential, commercial, and industrial buildings. Reads blueprints and other specifications, to determine method of installation, work procedures, and material, tool, and work aid requirements. Lays out reference lines and points for use in computing location and position of metal framing and furring channels and marks position for erecting metalwork, using chalkline. Measures, marks, and cuts metal runners, studs, and furring channels to specified size, using tape measure, straightedge and hand and portable cutting tools. Secures metal framing to walls and furring channels to ceilings, using hand and portable power tools. Measures and marks cutting line on drywall, using square, tape measure, and marking devices. Scribes cutting lines on drywall, using straightedge and utility knife and breaks board along cut line. Fits and fastens board into specified position on wall, using screws or adhesive. Cuts openings into board for electrical outlets, vents or fixtures, using keyhole saw or other cutting tools. Measures, cuts, assembles and installs metal framing and decorative trim for windows, doorways, and vents. Fits, alines, and hangs door and installs hardware, such as locks and kickplates [CARPENTER (const.)].

2) 842.664-010 TAPER (const.; mfd. bldgs) dry-wall finisher, finisher, wallboard and plasterboard; sheetrock taper; taper and bedder; taper and floater.

Seals joints between plasterboard or other wallboards to prepare wall surface for painting or papering: Mixes sealing compound by hand or with portable electric mixer, and spreads compound over joints between boards, using trowel, broadknife, or spatula. Presses paper tape over joint to embed tape into compound and seal joint or tapes joint, using mechanical applicator that spreads and embeds tape in one operation. Spreads and smooths cementing material over tape, using trowel or floating machine to blend joint with wall surface. Sands rough spots after cement has dried. Fills cracks and holes in wall and ceiling with sealing compound. May install metal molding at corners in lieu of sealant and tape. May apply texturing compound and primer to walls and ceiling preparatory to final finishing, using brushes, roller, or spray gun.

3) 842.681.010 DRY WALL APPLICATOR (const.: mfd. bldgs.) dry-wall nailer; sheetrock installer.

Installs plasterboard or other wallboard to ceilings and interior walls of building, using handtools and portable power tools. Installs horizontal and vertical metal studs for attachment of

wallboard on interior walls, using handtools. Cuts angle iron and channel iron to specified size, using hacksaw, and suspends angle iron grid and channel iron from ceiling, using wire. Scribes measurements on wallboard, using straightedge and tape measure, and cuts wallboard to size, using hacksaw. Cuts out openings for electrical and other outlets, using hawk-bill knife and hammer. Nails wallboard to wall and ceiling supports, using hammer. Trims rough edges from wallboard to maintain even joints, using knife. Nails prefabricated metal pieces around windows and doors and between dissimilar materials to protect drywall edges.

When compared with other construction workers, the drywall installer and lathes have the highest accident type risk ratio for falls from scaffolds with a value of 6.4. They have the second highest ratio for overexertion by lifting, with a value of 3.1 and falls from elevation, NEC with a value of 3.6. The fourth highest ratio for struck against stationary object with the value of 2.5., and the seventh highest ratio for struck by NEC with a value of 1.7.

As seen from Tables B-50 to B-51 the leading sources of injuries for overexertion by lifting were mineral (dirt) NEC, container, NEC, and misc., NEC. Over 64% of the injuries were to the back and 84% of the injuries were sprains/strains. In the struck by NEC injuries over 42% of the injuries were caused by a knife, the finger or hand were injured 68% of the time, and 76% of the injuries resulted in cut/laceration and contusions. The struck against stationary object-injuries resulted from striking against nail/spike or metal item, NEC, in over 35% of the cases. The injuries were to the finger or foot and the leading sources of injuries were cut/laceration, sprain/strain, and contusion. In the building construction, the fourth type of injury was falls to lower level, NEC. The back, ankle, elbow, or finger were injured in 54% of the cases and 74% of the injuries wereeither a sprain/strain or fracture. In

the special trades, the fourth type of injury was falls from scaffolds. The back, ankle, or multiple parts were injured in 40.5% of the cases, and 68.1% of the injuries were either a fracture, sprain/strain or contusion.

The Best Loss Control Engineering Manual lists the following exposures, accident and control for wallboard installation.

> Exposures: Working at varied heights, climbing, overhead operations, lifting, hammering, electrical hand tools, power actuated tools, flying particles.
>
> Accidents: Falls from scaffolds and ladders, injuries from using stilts, head and shoulder injuries, electric shock and hand punctures from power tools; particles in the eyes.

A comparison between the injury data and Best's Manual reveals that falls from elevations are a common problem. Falls from scaffolds, to lower level, ladders, and on stairs accounts for 19.5% of the injuries.

SHEET METAL WORKERS

Sheetmetal workers lay out, cut to size, bend or shape, solder, braze, or crimp sheet metal to fabricate or repair sheet metal items, such as gutters, hot and cold air vents, cabinets and light tanks. In 1978 there were 97,460 sheet metal workers employed in the construction industry or 2.16% of the construction workforce. The building construction (SIC 15) employed 6,770 sheetmetal workers or 0.52% of their work force, while the Special Trades (SIC 17) employed 90,210 sheetmetal workers or 3.98% of the special trades work force.

The Dictionary of Occupational Titles [29] describes the duties of the sheet metal worker as:

804.281-010 SHEET METAL WORKER (any ind.) sheet-metal mechanic.

Fabricates, assembles, installs and repairs sheet metal products and equipment such as control boxes, drainpipes, ventilators, and furnace casings, according to job order or blueprints. Selects gage and type of sheet metal according to product being fabricated and knowledge of metal. Locates and marks dimension and reference lines on metal sheet [SHEET METAL LAY OUT WORKER (any ind.)]. Sets up and operates fabricating machines, such as shears, brakes, bending rools, and punch and drill presses to cut, bend and straighten sheet metal. Shapes metal over anvils, blocks or forms using hammer. Sets up and operates soldering and welding equipment to join together sheet metal parts. Smooths seams, joints, or burred surfaces using files and portable grinder or buffer. Installs assembles in plant or worksite according to blueprint specifications, using handtools and portable power tools. Inspects assembles and installation for comformance with specifications, using measuring instruments; such as calipers, scales, and micrometer. May be designated according to type of metal used as COPPERSMITH (any ind.); TINSMITH (any ind.), or according to type of activity as FABRICATOR, SPECIAL ITEMS (any ind.); MODEL MAKER, SHEET METAL (any ind.); PRODUCT-DEVELOPMENT WORKER (any ind.); ROOFER, METAL (const.); SHEET METAL INSTALLER (any ind.); SHEET-METAL WORKER; MAINTENANCE (any ind.); SHOP MECHANIC (any ind).

When compared to other construction workers, the sheet metal worker has the third highest accident type ratio for falls from ladders with a value of 1.8 and the seventh highest ratio for foreign matter in the eye with a value of 1.7.

A review of Tables B-54 and B-55 reveals that the leading sources of injuries for struck by NEC are a Metal Item, NEC, Drill, and Knife. The finger or hand were injured in over 48% of the cases, and over 73% of the injuries were either a cut/laceration or contusion. The foreign matter in the eye injuries were caused by a metal item, NEC or particle in over 78% of the cases. A metal item, NEC or nail/spike were the two leading

sources of injuries for struck against a stationary object. Over 43% of the injuries were either to the finger or hand and the leading nature of injuries were either a cut/laceration or contusion. A metal item, NEC and heating equipment, NEC were the leading sources of injuries for overexertion by lifting. The back was the most common injured part of body and the leading nature of injury was a sprain/strain.

The Best Loss Control Engineering Manual lists the following exposure for Workmen's Compensation for sheet metal work:

Sheet Metal Work

Exposures: Heavy power machinery, electric hand tools, sharp edges, welding and cutting.

Accidents: Amputation of fingers or hands on power brakes or shears. Electric shock from small tools. Cuts on various parts of the body from sharp edged sheets of metal. Eye injuries from grinding or welding.

Sheet Metal Work - Shop Only

Exposures: Sharp metals, welding flashes, lifting hazards.

Accidents: Mainly cuts to hands and eye injuries from flash burns. Strains and sprains from lifting stock. Burns from welding sparks.

The Employers Insurance of Wausau list the following major loss causes for sheet metal work erection N.O.C.

MAJOR LOSS CAUSES
(Based on a study of 2,806 injuries costing $3,143,236)

1. Falls from ladders, scaffolds, roofs and other elevations caused 33 percent of the injury cost. Falls from ladders and scaffolds are the major agencies involved.

2. Material handling accounted for 16 per cent of the injury cost. Fifty per cent of this cost involved back injuries.

3. Falling objects striking personnel was responsible for seven per cent of the injury cost.

Falls from elevation account for 33% of the injury cost while compared to 11.6% of the injuries. Material handling, injuries, such as overexertion due to lifting, pullijng, throwing, and not elsewhere classified accounted for 18.3% of injuries and 16% of the injury cost.

GLAZIERS

Glaziers prepare and set glass in structures using bolts, screws, putty, grinding and buffing wheels. In 1978 there were 11,830 glaziers employed in the construction industry or 0.26% of the construction workforce. Most of the glaziers are employed in the special trades or SIC 17. They numbered 11,770 or 0.52% of the special trades workforce.

The Dictionary of Occupational Titles [29] describes the duties of the galzier as:

> 865.381-010 GLAZIER (const.) glass setter; glassworkers; glazier, plate glass.
>
> Installs glass in windows, skylights, store fronts, and display cases, or on surfaces, such as building fronts, interior walls, ceilings, and tabletops: Marks outline or pattern on glass, and cuts glass, using glasscutter. Breaks off excess by hand or with notched tool. Fastens glass panes into wood sash with glazier's points, and spreads and smooths putty around edge of panes with knife to seal joints. Installs mirrors or structural glass on building fronts, walls, ceilings, or tables, using mastic, screws, or decorative

molding. Bolts metal hinges, handles, locks, and other hardware to prefabricated glass doors. Sets glass doors into frame and fits hinges. May install metal window and door frames into which glass panels are to be fitted. May press plastic adhesive film to glass or spray glass with tinting solution to prevent light glare. May install stained glass windows. May assemble and install metal-framed glass enclosures for showers and be designated as SHOWER-ENCLOSURE INSTALLER (const.). May be designated according to type of glass installed as GLAZIER, STRUCTURAL GLASS (const.); PLATE-GLASS INSTALLER (const.).

When compared to other construction workers, the glazier has the third highest accident type risk ratio for struck against stationary object with a value of 2.6. The also have the sixth highest ratio for struck by, NEC with a value of 1.9, seventh highest ratio for struck by falling object with a value of 1.7 and eighth highest ratio for overexertion by lifting with a value of 1.7.

A review of Table B-58 reveals that over 64% of the struck by NEC injuries were caused by a class item, NEC or a knife. The finger and hand were injured in 62% of the cases and the deciding nature of injuries were cut-laceration and contusion. In the struck against stationary object injuries, glass items, NEC and metal items, NEC were the source of injury in over 69% of the cases. The finger and hand were injuried in 56% of the cases and most of the injuries were a cut-laceration. The sources of injury for the overexertion by lifting were glass items, NEC and a box. The back was injuried in 64% of the cases and a sprain/strain was the leading nature of injury. Glass items, NEC nad metal items, NEC are the leading sources of injury for struck by falling object. The finger, hand, foot, and forearm were injured in about 50% of the cases, and cuts-lacerations, contusions and fractures occurred in 89% of the cases.

The Best Manual and Employers Insurance of Wausau did not list any specific information on glaziers as related to their work in the construction industry.

ASBESTOS AND INSULATION WORKERS

Asbestos and insulation workers cover and line structures with asbestos, cork, glass or cellulose fibers, and related materials. In 1978 the construction industry employed 32,010 asbestos and insulation workers or 0.71% of the construction workforce. The special trades (SIC 17) employed 27,500 asbestos and insulation worker or 1.21% of the special trade workforce.

The Dictionary of Occupational Titles [29] describes the duties of the asbestos and insulation worker as:

1) 863.134-010 BUILDING-INSULATION SUPERVISOR (const.) insulation supervisor.

Supervises and coordinates activities of work crew engaged in inserting insulating material in walls, floors, ceilings, and roofs of buildings. Assigns workers to specific duties. Demonstrates to new workers techniques of cutting and installing insulation. Inspects installed insulation to determine conformance to specifications. Performs duties as described under SUPERVISOR (any ind.). May be designated according to type of insulating material used as MINERAL-WOOL-INSULATION SUPERVISOR (const.).

2) 863.134-010 SUPERVISOR, INSULATION (const.)

Supervises and coordinates activities of workers engaged in applying insulating material to exposed surfaces of equipment, such as boilers, tanks, air ducts or pipes: Estimates and requisitions

necessary materials and supplies. Assigns workers to specific duties. Demonstrates to new workers techniques of cutting and applying insulation. Inspects applied insulation for conformance to specifications. Compiles production and worker performance reports. Resolves employee grievances. Performs duties as described under SUPERVISOR (any ind.).

3) 863.381-010 CORK INSULATOR, REFRIGERATION PLANT (const.) insulation worker, interior surface.

Applies insulating slabs of cork or figerglass to walls, floor, and ceiling: Imbeds parallel rows of slabs in hot asphalt spread on surfaces or spreads cement mortar on slab with trowel and sticks it to surface. Nails slabs to walls and ceiling construction for additional security. May leave narrow space between wall and slab, if wall structure is rough and uneven, and fill space with cement mortar. May construct false ceiling by nailing slabs to wooden framework or by wiring slabs to T-irons. May construct cork partition walls by cementing rows of cork slabs one upon another. May finish cork surface of walls and ceiling with cement plaster or asphalt mastic compound. May spread concrete over floor slabs to form wearing floor [CEMENT MASON (const.); PLASTERER (const.)].

4) 863.381-014 PIPE COVERER AND INSULATOR (ship & boat bldg. & rep.)

Covers boilers, pipes, tanks, and refrigeration units, with insulating materials, such as asbestos, cork, plastic, and magnesia to reduce loss or absorption of heat, prevent moisture condensation, and to deaden sound: Wires prefabricated asbestos covering around steam and hot water piping, using handtools. Trowels mastic or brushes cement on asbestos cloth to obtain smooth finish and covers piping with cloth. Fits thermoblock and magnesia-block insulation around insulating boilers, evaporators, and turbines. Wires insulation on machinery and staples wire netting over insulation. Trowels cement on wire netting to protect insulating material. Wires cork on salt water, refrigeration, and air-conditioning piping and cements cloth over insulating material to obtain smooth finish. Cuts sheets of insulation into sections, using handsaw and miter box. Fits and cements sections around fittings. Covers gas piping of refrigeration or air-conditioning systems with molded plastic. Fabricates detachable insulation for valves or similar fitting by measuring connections, preparing patterns, cutting asbestos cloth, stuffing cloth with amosite (plastic pipe covering), and sewing cover together on power sewing machine. Wires detachable covers on valves or fitttings, using handtools. Installs fiber glass or spun glass on ventilating systems to deaden sound and prevent vibration.

5) BLOWER INSULATOR (loco. & car bldg. & rep.; ret. tr.; whole. tr.)

hose handler.

Blows insulating material into spaces within walls, floors, and ceilings, using hose attached to blower, to insulate buildings or railway cars: Inserts nozzle of hose through opening into spaces to be filled. Signals INSULATION-POWER-UNIT TENDER (const.; ret. tr.; whole. tr.) to start blower. Turns valve to regulate insulation flow from hose nozzle, and moves hose to distribute insulating material evenly. Climbs ladder or erects scaffold to reach working position. Seals insulation access holes of railway car with wooden bungs or metal caps, using hammer and punch. May insulate walls by covering them with sheets of insulating material, using nails or lacing wire.

When compared with other construction workers, the asbestos and insulation workers have the highest Accident Type Risk Ratio for falls from ladders with a value of 3.2. They also have the second highest ratio for falls from scaffolds with a value at 3.0, eighth highest ratio for struck against stationay object with a value of 1.7, and for foreign matter in the eye with a value of 1.6.

A review of Table B-61 reveals that a nail/spike and metal item, NEC was the source of injury in over 36% of the struck against stationary object. The finger, hand, and foot were injured in 52% of the cases and cut-laceration, contusion and sprain/strain were the leading natures of injury. In the struck by, NEC accidents, the knife and metal item, NEC were the leading sources of injury. Over 60% of the injuries were to the finger, hand, and eye, and over 60% of the injuries were cuts-lacerations and contusions. Lifting a container, NEC and box resulted in over 33% of the overexertion injuries. The back was the most common part of body injured and most of the overexertion injuries were sprain/strains. Most of injuries that resulted from a foreign matter in the eye were caused by a particle, glass item, NEC, or metal items, NEC.

The Best Loss Control Engineering Manual lists the following exposures for insulation contractors:

> Exposures: Climbing or working at heights, on scaffold or ladders; in crawl spaces and attics; in confined areas in awkward positions. Blowing, spraying, sawing or cutting materials; fiberglass irritants; asbestos inhalation; lead exposure from some caulking compounds; vapors from foams or other insulation material; dust, fumes, flying particles, scrap and debris. Defective, improperly grounded or unguarded electrical tools and equipment. Working near or around fixtures and wiring. Installations in buildings under construction; unprotected floor openings; hazards of the other trade operations. Unstable stacks of supplies. Vehicular accidents transporting employees to and from job sites. Fire (see Fire and E.C.).

A review of best exposures lists climbing or working at heights, on scaffolds or ladders as the first exposure. A review of fall from elevation injuries reveals that falls from scaffold, ladders, into shafts and falls to lower level account for 18% of the accidents. Also, the best manual lists exposure to flying particles and in injury analysis reveals that 7.2% of the injuries are foreign particles in the eye.

CARPET INSTALLERS

Carpet installers install carpeting on floor and stairs. In 1978 the construction industry employed 15,620 carpet installers or 0.35% of their work force. Most of the carpet installers are employed in the special trades (SIC 17), 15,200 or 0.67% of the special trade workforce.

The Dictionary of Occupational Titles [29] describes the duties of the carpet layer as:

1) 864.382-010 CARPET LAYER (ret. tr.)

Lays carpet and rugs: Measures and cuts carpeting to size according to floor sketches, using carpet knife. Sews sections of carpeting together by hand. Cuts and trims carpet to fit along wall edges, openings, and projections. May lay linoleum.

2) 864.687-010 CARPET-LAYER HELPER (ret. tr.)

Assists CARPET LAYER (ret. tr.) to lay carpeting on floors and stairs by performing any combination of the following duties: Stretches and tacks carpeting to floors. Cuts rug padding to specified size and tacks it in place on floor, using hammer. Trims carpeting to fit around openings, using knife. Nails metal treads across door openings to hold carpet in place. Performs other duties as described under HELPER (any ind.).

When compared to other construction workers, the carpet installer has the fifth highest accident type risk ratio for overexertion by lifting with a value of 2.1 and the nineth highest ratio for struck by, NEC with a value of 1.6.

A review of Table B-64 reveals that a reel/roll and floor covering was the source of injury in 69% of the overexertion by lifting injuries. The back was commonly injuried and a sprain/strain was the leading source of injury. In the struck by, NEC injuries, 77% of the injuries were caused by a knife or hammer/sledge. The finger and hand was injured in 76% of the cases and about 90% of the struck by, NEC injuries were cuts-lacerations or contusions. Tools, NEC, knife and nail/spike were the source of injury in 44% of the struck against stationary object. The knee and finger were injured in 64% of the cases and the leading natures of injury were cuts-lacerations, contusions, and sprain/strains. In the overexertion by throwing injuries, a reel/roll and floor covering were the source of injury in 80% of the cases. Injuries occurred to the back and knee in 67% of the cases and most of the injuries were sprains/strains.

The Best Manual and Employers Insurance of Wausau did not list any specific information on carpet installers as related to their work in the construction industry.

WAREHOUSEMEN, STOCK CLERK, STOCKROOM, AND STORAGE YARD

Warehousemen load and move materials and products, using work aids and other machines. The construction industry employed 6,590 warehousemen in 1978 or 0.15% of the construction workforce. The building construction employed 1,320 warehousemen or 0.10% of the building construction workforce, while the special trades employed 3480 warehousemen or 0.15% of the special trade workforce.

The Dictionary of Occupational Titles [29] describes the duties of the warehousmen as:

> 922.687-058 LABORER, STORES (any ind.) order picker; parts picker; stock selector; warehouse worker.
>
> Performs any combination of following tasks to receive, store, and distribute material, tools, equipment, and products within establishments: Reads production schedule, customer order, work order, shipping order or requisition to determine items to be moved, gathered, or distributed. Conveys materials and items from receiving or production areas to storage or to other designated areas by hand, handtruck, or electric handtruck. Sorts and places materials or items on racks, shelves, or in bins according to predetermined sequence, such as size, type, style, color, or product code. Sorts and stores perishable goods in refrigerated rooms. Fills requisitions, work orders, or requests for materials, tools, or other stock items and distributes items to production workers or assembly line. Assembles customer orders from stock and places orders on pallets or shelves, or conveys orders to packing station or shipping department. Marks materials with identifying information, using stencil, crayon, or other marking device. Opens bales, crates, and other containers, using handtools. Records amounts of materials or

items received or distributed. Weighs or counts items for distribution within plant to insure conformance to company standards. Arranges stock parts in specified sequence for assembly by other workers. May prepare parcels for mailing. May maintain inventory records. May restock aircraft commissary supplies, such as linens, glasses, emergency kits, and beverages and be designated COMMISSARY AGENT (air trans.). May be known according to specific duty performed as CLOTH-BIN PACKER (textile); COOLER WORKER (dairy prod.); ORDER FILLER (any ind.); PRODUCE CLERK (ret. tr.) II; TOOL CHASER (any ind.).

When compared with other construction workers, the warehousemen have the highest accident type risk ratios for: (1) overexertion by lifting with a value of 4.8, (2) struck against a stationary object with a valued 3.0, and (3) struck by falling object with a value of 3.9, and they have the second highest risk ratio for struck by, NEC with a value of 2.7.

As seen by Tables B-67 and B-68 the leading sources of injury for overexertion by lifting are a box or container, NEC. The back was most commonly injured and a sprain/strain was the leading natures of injury. In the struck by, NEC, followed by a wide range of sources. The finger and hand were injured in over 35% of the cases and the leading natures of injury were cut-laceration, contusion and fracture. A box and metal item, NEC were the common sources of injury for struck by falling object. The finger and toe were the common injured parts of body and the common natures of injury were contusion, fracture and cut-laceration. A nail/spike, metal item, NEC, and glass items, NEC were the common sources of injury for struck against a stationary object. The foot, finger, and hand were the leading sources of injury and a cut-laceration and contusion were the leading natures of injury.

The Best Loss Control Engineering lists the following exposures, accidents and control for warehousing and contractor's yard-permanent.

Warehousing

Exposures: Lifting and material handling. Falling objects. Sharp objects. Hazardous materials. Changing temperatures.

Accidents: Vehicle accidents. Strains and sprains. Head, shoulder, arm and hand injuries from falling objects or pinch-points. Cuts caused by metal straps, sharp or pointed edges, broken glass. Splinters from wooden crates. Skin or lung irritation caused by handling chemicals or other materials. Colds and pulmonary problems aggravated by temperature or atmospheric changes.

Contractor's Yard-Permanent

Exposures: Carbon monoxide, lifting, dust, flying particles, paint fumes, ladders, grease and oil spills, ungrounded portable electric tools and equipment, driving or operating vehicles or equipment, slippery hand tools, flammable liquids, live steam, explosions, material and equipment handling, unguarded machinery, sharp metals, congestion, noise.

Accidents: Sprains and strains, hernia and back injuries from lifting, handling and pushing. Eye injuries from metal cutting, grinding, sanding and welding. Cuts, punctures and lacerations from sharp objects and metals. Burns and electric shock. Dermatitis and rashes. Inhalation of fumes. Foot injuries. Getting caught in moving machinery. Vehicle/equipment accidents. Bruised, cut or broken fingers and hands from slipping tools. Slips and falls due to grease, oil and liquid spills. Arm and body injuries from vehicles or equipment slipping off jacks and failure to properly chock.

The Best Manual and injury data lists lifting and material handling as one of the major sources of injuries. A review of injury data show that overexertion account for 30% of the warehousemen injuries, that is overexertion by lifting, pulling, throwing, and NEC. Also, struck by falling objects and NEC account for 22% of the injuries.

BRICK MASONS AND PAINTERS

A review of occupation risk ratios for brickmasons and painters for the

building construction and special trades reveal values of less than 1.0. However, a review of occupation risk ratios for brickmasons and painters in heavy construction reveals values over 2.0. A review of employment by two digit SIC reveals that less than 1.6% of the brickmason and less than 1.2% of the painters were employed in SIC 16 or heavy construction. To further examine the differences in risk ratios, the accident types were studied by SIC. The accident types with 5% more of the cases in any SIC were compared and a summary is present in Table B-70 and B-71

To further explain the differences in the occupational risk ratios a comparison was made between the percent of accident types with the occupation to the average accident type percentage for each SIC. The results are given in Table B-72 and B-73.

As seen from Tables B-70 to B-73, there are differences in the accident types between SICs for brickmasons and painters. However, when the accident types for brickmasons and painters are compared to the averges for the different SICs and due to the fact that less than 1.5% of the brickmasons or painters are employed in SIC 16, it is concluded that the high occupational risk ratios in SIC 16 are due to usage of small numbers, not a major difference in risk.

Appendix C

A fatality profile is given for the high risk occupations and the other occupations with fatality indexes of one or more in SICs 15, 16, or 17. A table which lists the fatalities within each occupation by accident type is presented. Also, a summary is presented of accident trends and fatality indexes.

BOILERMAKER FATALITIES

Ten boilermaker fatalities were reported over the 4 year period. A fatality index was not developed for SICs 15 and 16, but in SIC 17 the index was 4.5. The types of accidents are listed in Table C-1. The leading accident type was falls from elevation which accounted for 40% of the fatalities.

STRUCTURAL METAL CRAFTSMEN FATALITIES

There were 39 structural metal craftsman fatalities reported over the 4 year period. Most of the fatalities occurred in SIC 15 and 17, which have Fatality Indexes of 11.9 and 2.5 respectively. The accident types are given in Table C-2. The leading accident types are falls from elevation with 19 fatalities and electrocutions with 12 fatalities. Twelve of the 19 falls from elevation were due to falls to a lower level, NEC.

WELDER AND FLAME-CUTTERS FATALITIES

There were nine fatalities reported to welders in the survey period. Due to limited number of fatalities in SICs 15 and 16, Fatality Indexes were not calculated. However, in SIC 17 the Fatality Index is 1.8. The

accident types are given in Table C-3. A review of the table yields that four of the nine fatalities were due to falls from scaffolds.

MILLWRIGHT FATALITIES

There were eight millwright fatalities reported during the 4 year period. All the fatalities occurred in SIC 17, and the Fatality Index for millwrights is 4.5. The accident types are reported in Table C-4. A review of the table indicates that half of the fatalities occurred when the worker fell from elevation.

CARPENTERS, CARPENTER APPRENTICES AND HELPERS FATALITIES

There were 75 fatalities reported to carpenters and related workers by the states who reported fatalities in the SDS data system. Of the 75 fatalities reported, 56 occurred in SIC 15 or Building construction. The fatality indices for carpenters and related workers are 0.6, 0.5 and 0.3 for SICs 15, 16, and 17 respectively. The accident types are given in Table C-5. The leading accident type was falls from elevation which occurred in 23 of the 75 fatalities. Sixteen of the falls were falls from scaffolds and 11 were falls to lower level. There were eight deaths due to electrocution and seven by struck by, NEC. Of the fatalities due to struck by, NEC, the leading sources of injury were saws and highway vehicles.

PLUMBER AND/OR PIPE FITTERS AND APPRENTICES FATALATIES.

Forty-one plumber and/or pipefitters fatalities were recorded from 1977

to 1980 by the SDS states. Of the 41 fatalities reported, 31 occurred in SIC 17 or the special trades. The fatality indexes for plumbers and/or pipe fitters are 1.3, 0.6, and 0.8 for SIC's 15, 16, and 17 respectively. The accident types are given in Table C-6. The leading accident type was caught in or under collapsing material. This accident type occurred in eight of the 41 cases and the collapsing material was dirt in seven of the eight cases. Another leading accident type was overexertion by lifting and throwing objects.

MECHANIC FATALITIES

Twenty mechanic fatalities were reported with one in building construction, 10 in heavy construction, and nine in the special trades. The Fatality Index for mechanics in heavy construction is 1.2 and 1.7 for the special trades. The accident types are reported in Table C-7. The leading accident type was struck by either a falling, flying, or not else classified object, where there seven fatalities.

LABORER FATALITIES

There were 268 laborer fatalities reported from 1977 to 1980 in the SDS data. The laborer fatality indexes are 2.3 for building construction (SIC 15), 1.7 for heavy construction (SIC 16), and 4.0 for the special trades (SIC 17). The accident types are reported in Table C-8. The leading accident types are struck by, NEC with 37 fatalities, caught in collapsing material with 35 fatalities, contact electric current with 21 fatalities, inhalation with 21 fatalities, and falls to lower level with 17 fatalities. Twenty-six of the 37 struck by NEC fatalities were caused

by a vehicle, 24 of the 35 collapsing material fatalities were caused by collapsing dirt, and eight of the 21 inhalation fatalities were caused by dirt.

ROOFER AND SLATER FATALITIES

There were 34 roofer and slater fatalities reported during the observed years. Thirty-two of the 34 fatalities occurred to roofers in the special trades (SIC 17). The corresponding Fatality Index is 2.3 and the accident types are reported in Table C-9. The leading accident type was falls to lower levels with 18 fatalities. The second leading accident type was falls from ladders with six fatalities.

SHEET METAL WORKERS, TINSMITH AND APPRENTICES FATALITIES

Fifteen sheet metal worker fatalities were reported from 1977 to 1980 by the states who reported fatalities in the SDS data system. All the fatalities occurred in the special trades (SIC 17), and the accident types are listed in Table C-10. A review of the table reveals that the leading accident types are falls to lower level and electricutions with five or three respectively.

ASBESTOS AND INSULATION WORKER FATALITIES

There were 28 asbestos and insulation worker fatalities reported in the SDS survey from 1977 to 1980. Twenty-seven fatalities occurred in the special trades (SIC 17) and in Table C-11 the accident types are given.

The corresponding Fatality Index is 4.9 and the leading accident type was contact with radiations, caustics, toxic and noxious substances by inhalation. This occurred in 20 of the 21 cases in which the source of injury was mineral (dirt) NEC.

ENGINEERING AND SCIENCE TECHNICIANS, DRYWALL INSTALLERS, GLAZIER, CARPET INSTALLERS, AND WAREHOUSEMEN FATALITIES.

By compensation claims, warehousemen are considered a high risk occupation, however, there were no fatalities reported in this occupation. There was one fatality reported for carpet installers, two for glaziers, and four for engineering and science technicians. Drywall installers had six fatalities reported and two were due to falls from scaffolds and one resulted from fall to lower level. Due to the limited number of fatalities, an in-depth analysis was not performed.

BRICKMASON, STONEMASONS AND APPRENTICE FATALITIES

Twenty brickmason occupational fatalities were reported in the SDS data system from 1977 to 1980. The fatality indexes are 0.6 for building construction (SIC 15), 4.8 for heavy construction (SIC 16), and 0.6 for the special trades (SIC 17). The accident types are reported in Table C-12. A review of the table reveals that eight of the fatalities were due to vehicle accidents and three were due to falls from scaffolds.

PAINTER AND APPRENTICE FATALITIES

There were 39 painter fatalities reported in the SDS data from 1977 to 1980. The fatality indices are 0.9 for building construction and 1.5 for the special trades. Thirty-five of the 39 fatalities occurred in the special trades (SIC 17). The accident types are reported in Table C-13. A review of Table C-13 reveals that 15 fatalities occurred when the painters fell from scaffolds and seven when they fell from ladders.

FOREMEN, NEC FATALITIES

Fifty-seven foremen fatalities were reported in the SDS data system from 1977 to 1980. The fatality index could not be calculated because accurate employment data could not be obtained. The accident types are reported in Table C-14. The leading accident types are struck by, NEC with 12 and vehicle accidents with 10. In the struck by accidents, six were caused by highway vehicle and five were caused by a construction machine.

ELECTRICIAN AND APPRENTICES FATALITIES

Thirty-seven electrician and apprentice fatalities were reported in the SDS data system for 1977 to 1980. Twenty-nine occurred in the special trades (SIC 17) and seven in heavy construction (SIC 16). The Fatality Indexes are 1.2 for heavy construction and 0.6 for the special trades. The accident types are reported in Table C-15. The leading accident type

was contact with electric current with 11 fatalities. The leading sources of injury were conductor-5, switch/fuse-2, and drill-2.

ELECTRIC POWER LINEMEN AND CABLEMEN FATALITIES

There were 13 linemen fatalities reported in the SDS data from 1977 to 1980. Twelve occurred in heavy construction (SIC 16) and the resulting Fatality Index is 2.3. The accident types are reported in Table C-16. All the fatalities occurred by falling to a lower level or contact with electric current.

BULLDOZERS, EXCAVATING, GRADING, AND ROAD MACHINE OPERATIVES FATALITIES

There were 89 bulldozer and road machine operator fatalities reported in the SDS data during the survey period. The fatality indexes are 2.6 for building construction (SIC 15), 1.0 for heavy construction (SIC 16) and 1.1 for the special trades (SIC 17). The accident types and are given in Table C-17. The leading accident types were struck by NEC with 17 fatalities, struck by falling object with nine fatalities, caught in collapsing material with seven fatalities and caught between a moving and stationary object with seven fatalities. The leading sources of injury for struck by a falling object was construction machine with four cases. In the struck by, NEC accidents the construction machine as the source of injury in eight cases and for caught in collapsing material accidents the construction machine the source of injury in six cases. In the caught in or between a moving and stationary object accidents, the construction machine was the source of injury in seven cases.

TRUCK DRIVER FATALITIES

There were 50 truck driver fatalities report in the SDS data from 1977 to 1980. Thirty-eight fatalities occurred in heavy construction (SIC 16) and 11 fatalities in the special trades (SIC 17). The Fatality Indexes are 1.5 for heavy construction and 1.4 for the special trades. The accident types are reported in Table C-18. Fifty-two percent of the fatalities were due to vehicle accidents, and 14% were due to struck by NEC. In six of the seven struck by, NEC fatalities the source of injury was a highway vehicle.

CRANEMEN, DERRICKMEN, AND HOISTMEN FATALITIES

There was 10 cranemen fatalities reported in the SDS data from 1977 to 1980. The Fatality Indexes are 9.7 for building construction (SIC 15), and 1.4 for the special trades (SIC 17). The accident types are given in Table C-19. The leading accident type, with three fatalities, was struck by falling object. The sources of injury were a crane in one case and a construction machine in two cases.

ALL OTHER OCCUPATIONS

There were 132 fatalities in reported for the other occupations within the construction industry. The fatality indexes for these occupations are 0.4 for building construction (SIC 15), 0.5 for heavy construction (SIC 16), and 0.4 for the special trades (SIC 17). The accident types are reported in Table C-20.

Table C-1 Boilermaker Fatalities

Accident Type	SIC 15	SIC 16	SIC 17
Struck by falling object	0	1	1
Fall from scaffold	0	0	1
Fall into shafts, etc.	0	0	1
Fall to lower level	0	0	2
Contact w/electric current	0	0	3
Accident type, NEC	0	0	2
Total	0	1	9

Table C-2 Structural Metal Craftsmen Fatalities

Accident Type	SIC 15	SIC 16	SIC 17
Struck against stationary obj.	0	0	1
Struck by falling object	2	0	2
Fall from scaffold	1	1	2
Fall from ladder	0	0	1
Fall into shafts, etc.	2	0	0
Fall to lower level, NEC	8	0	4
Caught in or under collapsing material	1	0	0
Contact w/electric current	7	0	5
Overexertion by throwing obj.	0	0	1
Accident type, NEC	0	0	1
Total	21	1	17

Table C-3 Welders and Flame Cutters Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by falling object	0	0	1
Struck by NEC	1	0	0
Fall from scaffolds	1	0	3
Caught in or under collapsing material	0	1	0
Non-class	0	1	1
Total	2	2	5

Table C-4 Millwrights Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Fall from elevation	0	0	3
Fall from scaffold	0	0	1
Contact w/hot object	0	0	2
By inhalation	0	0	1
Accident type, NEC	0	0	1
Total	0	0	8

Table C-5 Carpenter, Carpenter Apprentice, and Carpenter Helper Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by moving object	1	0	0
Struck by falling object	2	1	0
Struck by NEC	5	2	0
Fall from scaffold	11	2	3
Fall from ladders	2	0	0
Fall from vehicles	1		0
Fall from shafts, etc.	1	0	0
Fall on stairs	1	0	0
Fall to lower level, NEC	9	2	0
Fall on same level	1	0	0
Caught in or under collapsing material	2	0	1
Caught in or between moving or stationary object	1	0	0
Rubbed or abraded by leaning or kneeling	1	0	0
Overexertion by lifting objects	2	0	0
Overexertion by throwing objects	3	1	0
Contact w/electric current	6	1	1
Aircraft accident	2	0	0
Ran off road	1	0	1
By inhalation	0	1	0
Accident type, NEC	4	1	2
Total	56	11	8

Table C-6 Plumber and/or Pipe Fitters and Apprentices Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck against moving object	0	0	1
Struck by falling object	0	1	1
Struck by flying object	0	0	1
Struck by NEC	0	1	2
Fall from scaffolds	0	0	2
Fall from ladders	0	0	1
Fall into shafts, etc.	0	0	1
Fall from vehicles	0	1	0
Caught in or under collapsing material	1	2	5
Bodily reaction	0	0	1
Overexertion in lifting obj.	0	0	1
Overexertion in throwing obj.	0	0	7
Contact w/electric current	0	0	3
By inhalation	0	0	2
Accident w/vehicle	0	1	0
Accident type, NEC	2	0	3
Nonclass	1	—	0
Total	4	6	31

Table C-7 Mechanics Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by falling object	0	2	1
Struck by flying object	0	0	1
Struck by NEC	0	2	1
Fall into shaft section	0	1	0
Caught between moving and stationary object	0	1	0
Caught in, NEC	1	1	0
By inhalation	0	0	2
Overexertion throw object	0	0	
Contact w/electric current	0	0	2
Vehicle accident, run into/ off road	0	1	0
Oncoming vehicle	0	0	1
Accident type, NEC	0	1	0
Nonclass	0	0	1
Total	1	10	9

Table C-8 Laborer Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck against stat/obj.	0	0	2
Struck by	4	2	0
Struck by falling object	2	4	8
Struck by flying object	1	0	0
Struck by NEC	6	30	1
Fall from elevation	0	1	1
Fall from scaffold	1	1	6
Fall from ladder	1	2	2
Fall from vehicle	0	3	1
Fall into shafts, etc.	2	3	2
Fall to lower level	6	5	6
Meshing object	0	1	0
Caught between moving and stationary object	5	2	1
Caught under or in collapsing material	0	20	15
Caught in, NEC	2	3	0
Involuntary motions	0	0	1
Overexertion	1	0	
Overexertion by thrown obj.	5	1	5
Overexertion by pulling obj.	1	0	0
Overexertion by lifting obj.	1	0	2
Contact w/electric current	6	7	8
Contact from heat	0	1	1
Contact from hot object	2	5	2
Contact w/radiation	0	1	0
By inhalation	2	11	8
By absorption	0	1	0
By ingestion	0	0	1
Vehicle accident/noncollision	0	3	0
Motor vehicle accident	0	0	1
Vehicle moving in same direc.	1	0	0
Ran off road	0	0	1
Oncoming vehicle	1	0	4
Run into/off road	0	0	1
Overturned vehicle	0	1	1
Accident type, NEC	2	4	3
Nonclass	1	6	3
Run into/road	0	0	1
Accident w/vehicle	0	1	3
Total	53	124	91

Table C-9 Roofer and Slaters Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by falling object	0	0	1
Struck by NEC	0	0	1
Fall from scaffold	0	0	2
Fall from ladders	2	0	4
Fall to lower level, NEC	0	0	18
Overexertion in throwing object	0	0	2
Contact w/electric current	0	0	1
Motor vehicle accident	0	0	1
Accident w/oncoming vehicle	0	0	2
Total	2	0	32

Table C-10 Sheet Metal Worker, Tinsmith, and Apprentices Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by falling object	0	0	1
Fall from elevation	0	0	1
Fall from ladders	0	0	1
Fall into shafts, etc.	0	0	1
Fall to lower level	0	0	5
Caught between a moving & stationary object	0		1
Overexertion by throwing object	0	0	1
Contact w/electric current	0	0	3
Non class	0	0	1
Total	0	0	15

Table C-11 Asbestos and Insulation Worker Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Fall from scaffold	0	0	2
Fall from ladders	0	0	
By inhalation	0	0	21
By absorption	0	0	1
Oncoming vehicle	0	0	2
Accident type, NEC	1	0	0
Totals	1	0	27

Table C-12 Brickmason, Stonemason, and Apprentice Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by falling object	0	1	1
Fall from scaffold	0	0	3
Fall into shafts, etc.	1	0	0
Fall to lower level, NEC	0	0	1
Overexertion in throwing obj.	0	0	2
Contact w/hot object	0	0	1
By inhalation	0	0	1
Motor vehicle accident	1	1	0
Run into/road	0	1	0
Accident type, NEC	0	0	4
Oncoming vehicle	1	0	0
Nonclass	1	0	0
Total	4	3	13

Table C-13 Painter and Apprentices

Accident Types	SIC 15	SIC 16	SIC 17
Struck by, NEC	0	0	1
Fall from scaffold	1	0	14
Fall from ladder	1	0	6
Fall to lower level, NEC	0	0	2
Caught between moving and stationary object	0	0	1
Contact w/electric current	0	0	2
Contact w/hot object	0	0	1
Motor vehicle accident	0	0	1
Oncoming vehicle	0	0	1
Vehicle moving in same dir.	0	0	1
Noncollision accident	0	0	1
Run into/off road	0	1	0
Run off road	0	0	2
Accident type, NEC	0	0	1
Nonclass	1	0	1
Total	3	1	35

Table C-14 Foremen, NEC Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by falling object	2	2	3
Struck by NEC	1	10	1
Fall from scaffolds	1	0	1
Fall from ladders	0	1	1
Fall from vehicle	0	0	1
Fall into shafts	1	0	0
Fall to lower level, NEC	2	2	4
Contact w/electric current	2	1	2
Fall on working surface	0	1	0
By inhalation	1	1	0
Caught in	0	2	0
Caught in collapsing material	0	1	0
Overexertion in lifting object	0	0	1
Motor vehicle accident	0	1	0
Accident w/vehicle	1	0	0
Ran off road	0	1	0
Oncoming vehicle	0	1	1
Vehicle in same direction	0	1	0
Overturned	0	2	0
Ran into/off road	0	0	1
Accident type, NEC	0	2	0
Nonclass	1	0	0
Total	12	29	16

Table C-15 Electrician and Apprentices Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by falling objcect	0	1	1
Struck by flying object	0	0	3
Struck by NEC	0	2	1
Fall from ladder	0	0	3
Fall into shafts, etc.	0	0	1
Fall to lower level, NEC	0	1	2
Caught in, NEC	0	0	1
Overexertion in throwing obj.	0	0	4
Contact w/electric current	1	1	9
Motor vehicle accident	0	1	0
Run into/off road	0	0	1
Accident type, NEC	0	1	1
Nonclass	0	0	2
Total	1	7	29

Table C-16 Electric Power Linemen and Cable Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Fall to lower level, NEC	0	5	0
Contact w/electric current	0	7	1
Total	0	12	1

Table C-17 Bulldozer, Excavating, Grading, and Road Machine Operatives Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by	0	1	0
Struck by falling object	1	6	2
Struck by flying object	0	1	0
Struck by, NEC	0	14	3
Fall from vehicles	1	1	0
Fall to lower level, NEC	1	3	0
Fall on working surface	0	1	0
Caught in meshing objects	0	1	1
Caught in or between moving/stationary object	1	7	0
Caught in collapsing material	2	5	0
Caught in NEC	1	4	2
Overexertion by thrown obj.	0	0	2
Contact w/electric current	0	2	1
Contact w/hot object	0	1	0
By inhalation	0	5	0
By absorption	0	1	0
Oncoming	0	1	2
Overturned vehicle	1	4	0
At intersection	1	1	0
Ran off road	0	1	0
Accident type, NEC	2	3	1
Nonclass	0	1	0
Total	11	64	14

Table C-18 Truck Driver Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by falling objects	0	1	0
Struck by NEC	0	3	4
Fall from vehicles	0	2	0
Fall to lower level, NEC	0	0	1
Caught between moving and stationary object	0	2	0
Caught in collapsing material	0	3	0
Caught in, NEC	0	1	0
Overexertion, NEC	0	0	1
Contact w/electric current	0	1	0
By inhalation	0	2	0
Accident w/vehicle	0	4	0
Oncoming vehicle	0	2	0
Vehicle moving in same dir.	0	1	0
At intersection	1	4	0
Run into road	0	1	0
Run into/off road	0	1	0
Overturned	0	4	1
Run off road	0	2	1
Noncollision	0	0	1
Other	0	2	1
Standing vehicle	0	0	1
Accident type, NEC	0	2	1
Total	1	38	11

Table C-19 Cranemen, Derrickmen, and Hoistmen Fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by falling object	2	1	0
Struck by NEC	0	1	0
Struck by flying object	1	0	0
Caught in, NEC	0	0	2
Contact w/electric current	1	0	1
Nonclass	1	0	0
Total	5	2	3

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Table C-20 All other occupations fatalities

Accident Types	SIC 15	SIC 16	SIC 17
Struck by flying object	0	0	1
Struck by	0	1	1
Struck by falling object	3	7	4
Struck by NEC	1	10	3
Fall on working surface	0	1	0
Fall from scaffold	0	2	1
Fall from vehicle	0	1	1
Fall into shafts, etc.	3	0	0
Fall on stairs	0	0	1
Fall to lower level, NEC	1	1	2
Overexertion by pulling object	0	0	1
Overexertion in lifting object	1	0	0
Overexertion in throwing obj.	2	0	1
Overexertion, NEC	2	0	0
Caught between moving and stationary object	1	3	2
Caught in meshing objects	0	1	0
Caught in NEC	1	1	1
Contact w/electric current	0	1	3
Contact w/temp. extreme	1	0	0
Contact w/hot object	0		2
Caught in collapsing material	0	0	1
By inhalation	0	3	2
By absorption	0	1	0
Aircraft accident	0	3	1
Motor vehicle accident	4	3	3
Oncoming vehicle	0	1	4
Run into/off road	0	1	1
Run into road	0	1	0
Overturned	0	1	0
Stop/start vehicle	0	0	1
At intersection	0	1	1
Ran off Road	0	1	0
Vehicle in same direction	0		
Accident type, NEC	1	6	7
Nonclass	1	5	6
Other	0	1	1
Total	22	59	51