INJURIES AND ACCIDENT CAUSES IN THE BOILERSHOP-PRODUCTS INDUSTRY

Bulletin No.1237

UNITED STATES DEPARTMENT OF LABOR
James P. Mitchell, Secretary

BUREAU OF LABOR STATISTICS
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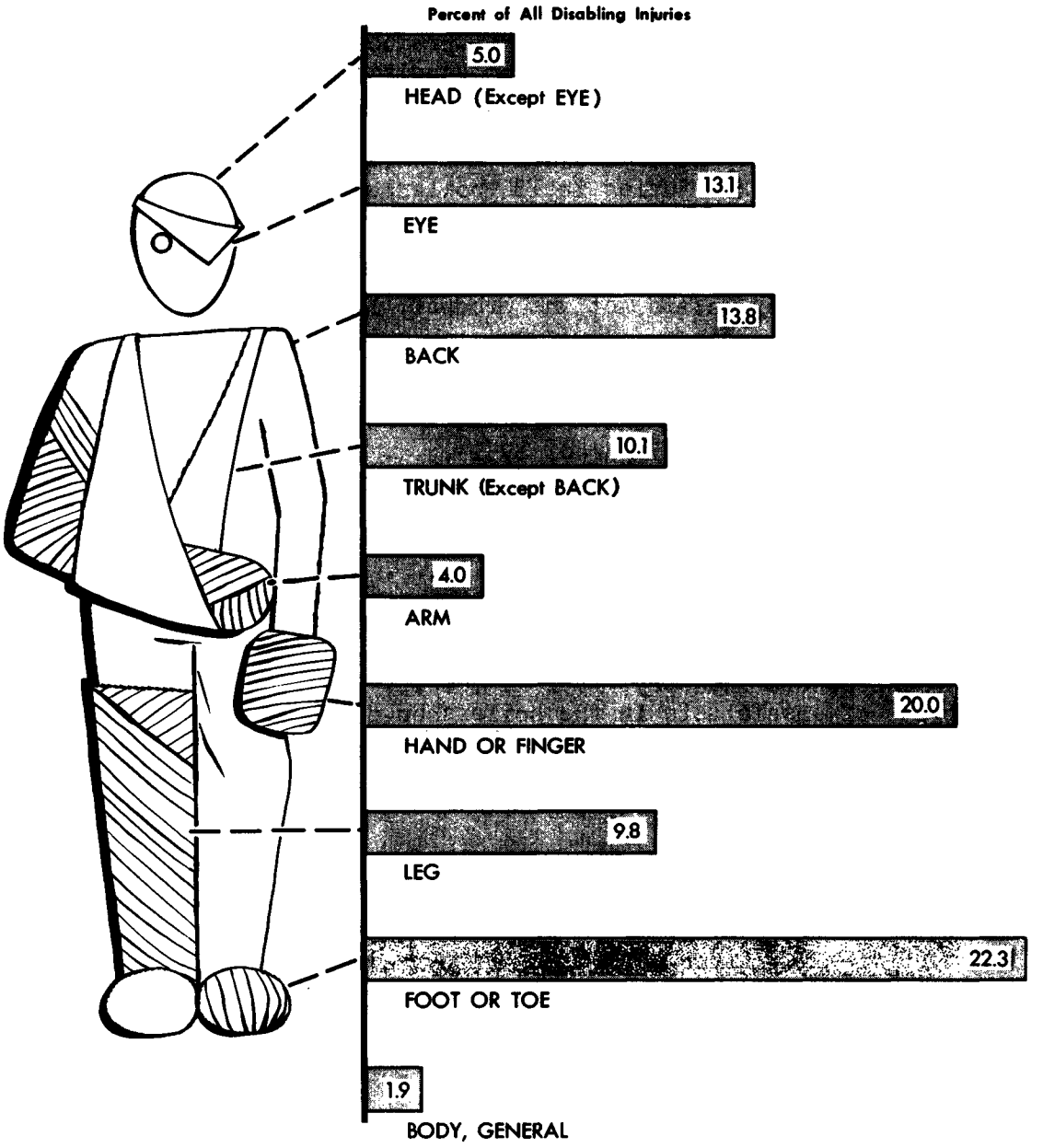
CONTENTS

CONTENTS--Continued

CONTENTS--Continued

Chart 1. DISABLING WORK INJURIES IN THE BOILERSHOP-PRODUCTS INDUSTRY By Part of Body Injured, 1951



UNITED STATES DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS

Injuries and Accident Causes in the Boilershop-Products Industry *

SUMMARY

Despite the obvious need for and wide use of mechanical lifting equipment in the industry, some 40 percent of the injuries in boilershop-products plants occur in the course of manual handling of materials. In the period covered by this survey, 1951, the most common single injury experienced in the industry was back strain from overexertion. A substantial number of bruises and fractures of the feet and toes were also associated with manual-handling operations.

The next largest volume of single injury consisted of eye irritations produced by foreign bodies entering the eye. These flying particles most commonly originated in handtool and machine operations.

Both hazardous working conditions and unsafe acts had a part in the occurrence of most of the reported accidents. Generally, the interrelationship was such that if either of these accident factors had been eliminated the accidents would not have happened. Hazardous conditions were identified in about 90 percent and unsafe acts in at least 85 percent of the cases studied.

The most commonly encountered hazardous working condition 1/ was the lack of adequate help in moving heavy materials. Other hazardous conditions frequently contributing to the occurrence of accidents included: Improperly piled or placed metal stock and assemblies; lack of adequate personal safety equipment for machine and handtool operations; lack of guards at the point of operation of machines and handtools; and defects in working surfaces, handtools, metal stock, assemblies, etc.

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*This report was prepared in the Division of Industrial Hazards, Bureau of Labor Statistics, U. S. Department of Labor, by Frank S. McElroy and George R. McCormack.

1/ For definitions of hazardous working condition and unsafe act, see Scope of Survey and Definitions, p. 2.

Nearly half of the recorded unsafe acts fell in the general category of "taking an unsafe position or posture." Prominent in this group were the specific acts of inattention to footing, inattention to surroundings, exposure under suspended loads, and exposure to falling or sliding objects. Other unsafe acts of frequent occurrence included: Gripping objects insecurely; taking wrong hold of objects; failure to block objects against unexpected movement; unsafe placing or loading of materials; and failure to wear safe attire.

SCOPE OF SURVEY AND DEFINITIONS

During 1952, the Bureau of Labor Statistics conducted a special, detailed survey, covering the preceding year, of work-injury rates in the boilershop-products industry. The final report of that study, BLS Report 28, Injury Rate Variations in the Boilershop-Products Industry, 1951, presented a detailed analysis of injury rates by product, plant size, region, and operating departments. 2/

The current study was designed to supplement the 1951 injury-rate survey by presenting information as to how and why injury-producing accidents occur in the industry. Such information helps to identify the hazards and unsafe practices which most commonly lead to accidents and thereby serves as a specific guide to accident-prevention activities.

The data for this study were collected in personal visits of Bureau representatives to 136 boilershop-products plants. The period covered was the same as that for the injury-rate survey (calendar year, 1951). Although this resulted in a considerable time lag for reporting the findings of the study, there is no evidence that the pattern of accidents has changed during the interval, especially since the methods of operations have changed little in the industry during the period. These 136 plants employed nearly 28,000 workers, about 44 percent of all workers in the industry. Since the objective was to obtain individual accident case records, only plants which had previously reported the occurrence of some injuries were visited. The average injury-frequency rate of the plants surveyed, 32.5, therefore, was higher than the industry average, 28.5, because of the exclusion of "no injury establishments." 3/

The Bureau representatives transcribed the following data from the original accident records of the plants: (a) place where the accident occurred; (b) nature of injury and part of body injured; (c) object or substance producing the injury; (d) type of accident; and (e) hazardous working condition and/or unsafe act leading to the accident. Individual case records for 2,017 disabling injuries were collected. Included were 5 fatalities, 1 permanent-total disability, and 103 permanent-partial disabilities. The other 1,908 cases were temporary-total disabilities.

2/ This report may be obtained free of charge upon request to the U. S. Department of Labor's Bureau of Labor Statistics.

3/ The injury-frequency rate is the average number of disabling work injuries per million hours worked.

The definitions of the several disability classifications as applied in this survey are as follows: 4/

Fatality.--A death resulting from a work injury is classified as a work fatality regardless of the time intervening between injury and death.

Permanent-Total Disability.--An injury other than death which permanently and totally incapacitates an employee from following any gainful occupation is classified as permanent-total disability. The loss, or complete loss of use, of any of the following in one accident is considered permanent-total disability:

(a) Both eyes; (b) 1 eye and 1 hand, or arm, or leg, or foot; (c) any 2 of the following not on the same limb: hand, arm, foot, or leg.

Permanent-Partial Disability.--The complete loss in one accident of any member or part of a member of the body, or any permanent impairment of functions of the body or part thereof to any degree less than permanent-total disability is classified as permanent-partial disability, regardless of any preexisting disability of the injured member or impaired body function. The following injuries are not classified as permanent-partial disabilities: (a) hernia, if it can be repaired; (b) loss of fingernails or toenails; (c) loss of teeth; (d) disfigurement; (e) strains or sprains not causing permanent limitation of motion; and (f) fractures healing completely without deformities or displacements.

Temporary-Total Disability.--Any injury not resulting in death or permanent impairment is classified as a temporary-total disability if the injured person, because of his injury, is unable to perform a regularly established job, open and available to him, during the entire time interval corresponding to the hours of his regular shift on any one or more days (including Sundays, days off, or plant shutdowns) subsequent to the date of injury.

The accident-cause analysis procedure used in this study differs in some respects from the procedures specified in the American Standard Method of Compiling Industrial Accident Causes. The deviations from the Standard include the introduction of an additional analysis factor, termed the "source of injury" and modification of the standard definitions of some of the other factors. These changes permit more accurate cross classifications.

Source of Injury.--The standard classification provides for the selection of one "agency" in the analysis of each accident. By definition, this agency may be either (a) the object or substance which was unsafe and thereby

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4/ See American Standard Method of Compiling Industrial Injury Rates, approved by the American Standards Association, October 11, 1945, p. 6.

contributed to the occurrence of the accident, or (b) in the absence of such an object or substance, the object or substance most closely related to the injury. Under this definition, therefore, a tabulation of "agencies" for a group of accidents includes objects or substances which may have been inherently safe and unrelated to the occurrence of the accidents, as well as those which led to the occurrence of the accidents because of their condition, location, structure, or method of use. The development of the classification "source of injury" represents an attempt to separate and classify separately these two agency concepts.

The "source of injury," as used in this study, is the object, substance, or bodily reaction which actually produced the injury, selected without regard to its safety characteristics or its influence upon the chain of events constituting the accident.

Accident Type.--As used in this study, the accident-type classification assigned to each accident is purely descriptive of the occurrence resulting in an injury, and is related specifically to the source of injury. It indicates how the injured person came into contact with, or was affected by, the previously selected source of injury, as for example, by "striking against" the named source of injury. The definition represents a change from the standard procedure in two respects: First, the accident-type classification is specifically related to the previously selected source of injury; second, the sequence of selecting this factor is specified.

Hazardous Working Condition.--Under the standard definition, the hazardous working condition indicated in the analysis is defined as the "unsafe mechanical or physical condition of the selected agency which could have been guarded or corrected." An example of such a hazard is the lack of a guard for a press. This implies the prior selection of the "agency" but does not provide for recognition of any relationship between the hazardous condition and accident-type classifications. Nor does the standard provide for any definite relationship between the "agency" and the "accident type" classifications.

To provide continuity and to establish direct relationships among the various analysis factors to permit cross classification, the standard definition was modified for this study to read: "The hazardous working condition is the hazardous condition which permitted or occasioned the occurrence of the selected accident type." The hazardous-condition classification, therefore, was selected after the determination of the accident-type classification. It represents the physical or mechanical reason for the occurrence of that particular accident without regard to the feasibility of guarding or correcting the condition.

Elimination of the condition "which could have been guarded or corrected" is based upon the premise that statistical analysis should indicate the existence of hazards, but should not attempt to specify the feasibility of corrective measures.

Agency of Accident.--For the purpose of this study, the agency of accident was defined as "the object, substance, or premises in or about which the hazardous condition existed," as, for example, the press which was unguarded. Its selection, therefore, is directly associated with the hazardous condition leading to the occurrence of the accident and not with the occurrence of the injury. In many instances, the source of injury and the agency of accident are identical. The two classifications, however, avoid any possibility of ambiguity in the interpretation of the "agency" tabulation.

Unsafe Act.--The unsafe act definition used in this survey is identical with the standard definition; i.e., "that violation of a commonly accepted safe procedure which resulted in the selected accident type."

THE INDUSTRY AND ITS HAZARDS

The boilershop-products industry is composed of "establishments primarily engaged in manufacturing industrial, power, and marine boilers; smoke stacks; heavy tanks; and other boilershop products; and fabricated plate work which involves the cutting, punching, bending, and shaping of steel plates for other industries, or for assembly on the job." 5/

The larger boilershops tend to concentrate on production items and are commonly departmentalized. Workmen in such shops usually perform only 1 or 2 specific operations, becoming especially adept at them. In the miscellaneous steel-plate fabricating plants, the end products are usually custom made according to the specifications of a contract. Large plants in this group generally have departmentalized their operations, but workers in the small plants frequently perform a number of operations, often being assigned to complete major portions of a particular job. As a result, the small plants have little or no departmental organization.

Whether the operations are departmentalized or not, however, they follow, basically, the same general pattern. Metal stock is laid out by marking, it is then cut and shaped, and finally, it is assembled.

Layout.--The layout area is usually located near the storage yard from which metal stock may be carried by cranes or other mechanical handling equipment. A layout man, following a template or blue print, marks the stock with a center punch, chalk, or paint, to indicate the operations which are to be performed. Templates may be made of metal, wood, or paper depending on the extent of their use.

The chief hazards of the layout departments are those associated with handling materials. Strained muscles through overexertion and lacerated hands

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5/ Standard Industrial Classification Manual, Executive Office of the President, Bureau of the Budget, November, 1945 (Vol. 1, Pt. 1, p. 53).

or fingers from contact with steel slivers may result from lifting, turning, and carrying metal stock. In addition, workmen may drop material on their feet or set it down on their hands or fingers. When it is moved by crane or other equipment, workers under that equipment may be struck by the slingload or by material falling from it. Workmen may pinch their fingers while hooking or clamping loads and, unless a handline is used, they may crush their fingers in the sling as they guide the load.

Some plants make their own templates. In that work, hazards associated with machine operations are common. Workmen may come in contact with the points-of-operation of circular saws and other machines; they may be caught by unguarded belts, gears, etc.; or they may be struck by objects thrown by the machines, i.e., kickbacks. In addition, in the manufacture of wood templates, sawdust may be blown or thrown into workmen's eyes.

Haphazard piling in storage yards may cause piles of materials to collapse on workmen. Uneven working surfaces present slipping and tripping hazards which are accented by poor housekeeping such as paint, spilled or dropped, on floors. Fingers or hands may be bruised through the misuse of hammers, used with center punches in marking the stock.

Machine Operations.--The metal stock after layout undergoes a series of machine operations where equipment operators perform work as indicated by the layout men. Stock is cut to size with a burning torch or machine shears and the edges are smoothed by a planer or grinding wheel. Rolls bend or curve steel plates to form shells for boilers and tanks. Press brakes and bending rams form angles in the metal and tube-bending machines shape boiler tubes without buckling their walls. Finally, drills and reamers are used to cut holes for rivets.

Hazards associated with the operation of powered equipment are common in these departments. Points-of-operation are frequently unguarded as are gears, belts, pulleys, etc. These hazards frequently are intensified by the improper layout of operations. Inadequate space and lack of clear passageways may require equipment operators, as well as others working in the area, to pass near the danger points.

In addition to the hazard of being caught in, or being struck by, moving parts of equipment, workmen in these operations are likely to suffer injuries by contact with sharp-edged metal chips. Sometimes, the chips are thrown by the machines and present a serious eye hazard. The most common, but less serious, injury consists of cut or lacerated hands experienced in removing the chips from machines, especially drills. Occasionally, the chips are hot and may produce burns.

The movement of stock from one operation to another is a danger in machine operations. Large and heavy pieces of metal are usually transported by crane or other mechanical equipment but small pieces are generally moved by hand or handtruck. The handling hazards noted under the layout departments are, therefore, common in machine operations.

Oils are used extensively as lubricants and coolants in many of these operations. Prolonged contact with these oils may produce dermatosis. In addition, the lubricants, when spilled or dropped on the floors, create slipping hazards.

Scraps of metal, discarded from machine operations, are frequently dropped on floors where they become tripping hazards. Elevated platforms, often unguarded, on which operators of large machines frequently stand, are another potential source of falls. Heavy metal plates occasionally are heated to facilitate machine operations. Workmen in those operations, therefore, may be burned.

Assembly.--After the metal has been cut and formed, it is assembled. The pieces may be bonded by electric welding or by riveting. Riveting is common in the manufacture of boilers and other pressure vessels.

Hazards originating in handtool operations are common in the assembly departments. In riveting operations, the riveting hammer and the bucking bar are the most commonly used handtools. However, reamers are used frequently to aline rivet holes before "driving" rivets. In addition to the welding torch, chipping hammers and grinders are used extensively in welding operations to smooth the welds.

Contact with the point-of-operation of handtools is an ever-present hazard, since that equipment is seldom guarded adequately. Electric handtools, frequently ungrounded, present a serious electrical hazard. Small particles thrown by handtool operations endanger the eyes of all workers in the area. In addition, the small particles are frequently hot and may inflict burns.

Isolating or shielding welding operations in this industry is difficult because of the size of the products fabricated. Consequently, nearly all workers in the industry are subjected, in some degree, to ultraviolet rays. Welders work occasionally in confined or close quarters. As a result, welding fumes may replace oxygen in those areas to a dangerous extent unless artificial ventilation is provided.

Hot rivets are usually thrown to the riveting crew. Misjudgment by the rivet passer or by the rivet catcher may result in hot rivets falling on other workmen. Metal rivets and welds retain their heat for some time. Workmen may be burned, therefore, by touching the hot surfaces.

On large fabrications, much of the assembly work must be performed well above the floor level. Safety in these operations requires the provision of stable and guarded working surfaces. Unfortunately, the provision of safely designed working platforms for this work is not common in the industry, and the fabricators frequently climb on the assemblies or utilize makeshift platforms to perform their work. Along with the hazard of falling, there is the possibility that the assemblies, unless securely supported, may collapse under the workers or topple over on them.

ACTIVITY OF INJURED AT TIME OF INJURY

More than three-fourths of all the reported injuries occurred in the course of three activities--handling materials, using handtools, and operating machines (table 1). Two of every five injured employees were handling materials or equipment at the time of their accidents. Most of them were lifting materials, but others were injured while they were holding, carrying, placing, pulling, pushing, or rolling materials or equipment. In general, these injuries were not severe--less than 5 percent of them resulting in serious disability.

About one-fourth of the disabled workers were injured while using handtools. Those most frequently used were welding and burning torches; hand grinders, buffers, and sanders; hammers and sledges; and wrenches. None of these injuries resulted in death and only 4 percent in permanent disability. However, because their permanent injuries were relatively severe, workers who were injured while using handtools had a slightly higher average disability (66 days) than those who were injured while handling materials (62 days).

One in seven of the injuries occurred in the operation of machines and other mechanical equipment. About a third of these injuries occurred in the operation of cranes and other hoisting equipment. More than 12 percent of them resulted in death or permanent disability. Consequently, their average disability, 135 days, was nearly 60 percent higher than the average for all injuries.

KINDS OF INJURIES EXPERIENCED

Although back strains were the most common single injury, bruises and contusions (commonly injuries of less than average severity) constituted the largest general category of injuries--24 percent of the total volume of disabling injuries. (See tables 2-4.) It is significant, however, that this is a lower ratio than that prevailing in 11 of the last 15 industries studied by the Bureau. 6/

Bruises and contusions occurred most frequently in material movement activities but were also common in handtool operations. Generally, these were injuries to feet, legs, toes, or fingers. The average disability for all

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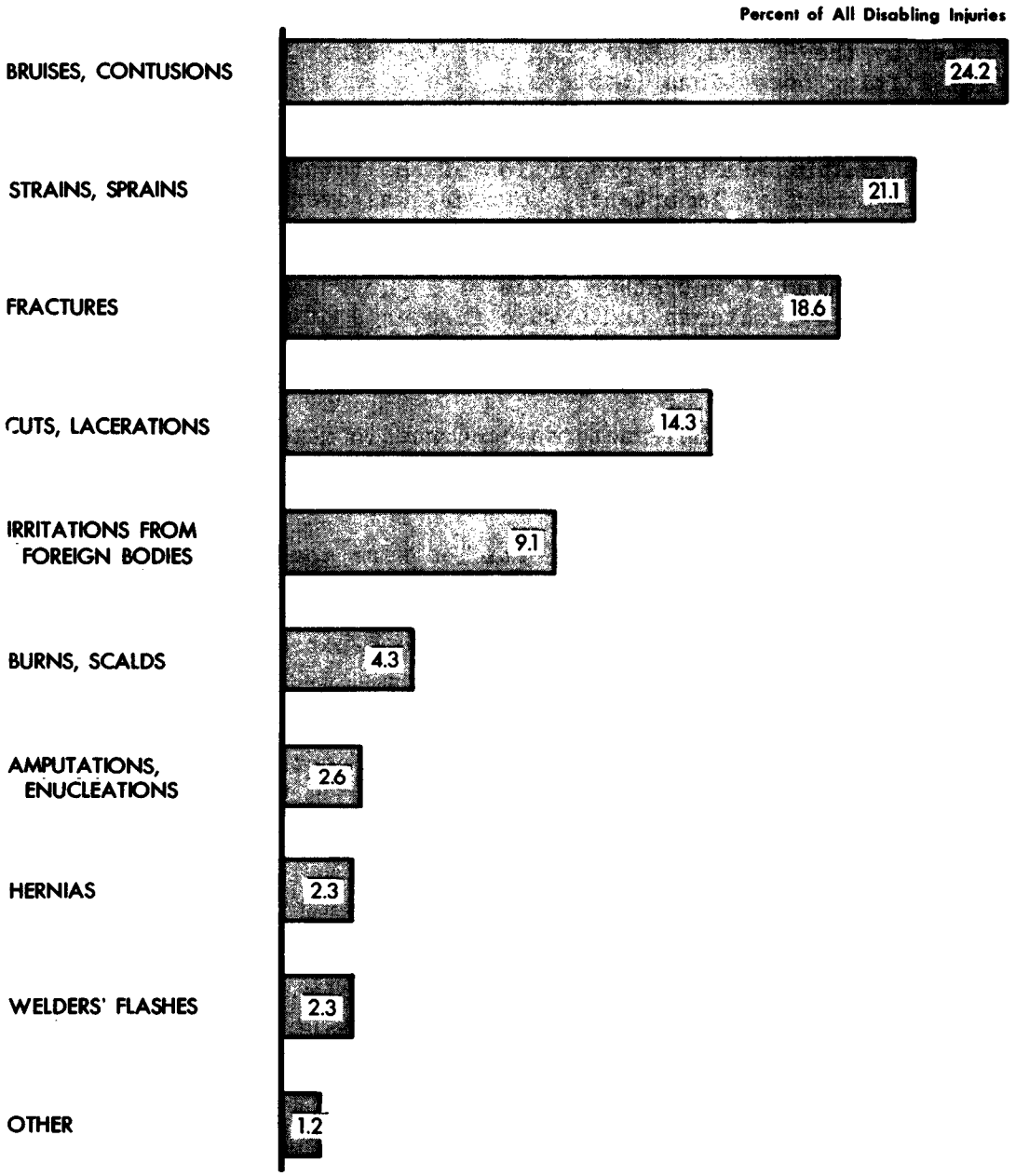
6/ Industries with higher proportions of bruises and contusions include: Hospitals, water-supply utilities, warehousing and storage, and the following manufacturing industries: Pulpwood logging, paperboard containers, paper and pulp, clay construction products, fertilizer, textile dyeing and finishing, breweries, and slaughtering and meat packing. Industries with a lower proportion of bruises and contusions include: Carpentry, plumbing, bottling of soft drinks, and the fabrication of structural steel and ornamental metalwork.

Chart 2. DISABLING WORK INJURIES IN THE BOILERSHOP-PRODUCTS INDUSTRY

By Nature of Injury, 1951



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disabling bruises and contusions was 23 days--766 days each for 9 cases which resulted in permanent-partial disability and 9 days each for 477 such injuries resulting in temporary-total disability.

Strains and sprains, the second largest general category of injuries, included 21 percent of all disabling injuries reported (chart 2 and tables 2 and 3). This also was a lower ratio than that prevailing in most other industries studied by the Bureau. More than half the strains and sprains occurred in material lifting operations (table 4). These were most commonly back (or trunk) injuries.

Fractures constituted a high proportion of the total injury volume--19 percent. 7/ Their numerical importance, however, was overshadowed by their characteristically high severity. In the aggregate, 38 percent of all disability days recorded were attributed to fractures, more than double the proportion contributed by any other class of injury. Five of the 375 reported fractures were skull fractures and 4 were fractures of the back. Despite the trend to wider use of safety shoes, toe fractures led the list, 110, followed by 79 foot fractures, and 72 finger fractures (table 5).

Nearly 45 percent of the fractures occurred in material handling activities, but machine and handtool operations also produced considerable numbers of these injuries (table 4).

Eye injuries produced by flying particles were common--9 percent of all the disabling injuries reported. None of the eye-irritation cases resulted in permanent impairment, but the resulting time loss averaged 4 days per case. These injuries occurred primarily in machine and handtool operations (table 4).

Slightly over 14 percent of the disabling injuries were cuts, lacerations, or punctures. These tended to be fairly severe injuries--11 of the 289 resulted in permanent impairments and the time loss for the remainder of the group averaged 12 days per case. Nearly half of these were hand or finger injuries and approximately one-fourth were leg and foot injuries. Most of the remainder were head injuries. (See table 5.)

This general pattern of injuries prevailed throughout the industry. No significant differences in the injury distribution were found when the reporting plants were classified on a product basis--i.e., by heavy tank plants, boiler plants, and those manufacturing miscellaneous boilershop products. Similarly, plant-size groupings produced no significantly different patterns.

7/ A higher proportion than in 14 of the last 15 industries studied by the Bureau.

The 2,017 disabling injuries studied in this survey included 5 fatalities, 1 permanent-total disability, and 103 permanent-partial disabilities. Some of these serious cases reflect unusual occurrences which might be overlooked in a general analysis. Others represent the results of common varieties of accidents and as such emphasize the thesis that no hazard can be considered "minor." Their severity gives these cases added importance in the injury pattern.

The Fatalities.--Two of the deaths resulted from skull fractures. In one instance, an electrician was making repairs at the end of a traveling crane. A second crane, operating on the same track, moved in and crushed his head between the two crane carriages. The second death from a skull fracture resulted from a fall--the worker was riding on a large boiler shell while it was being moved by a crane. He lost his balance and fell to the floor.

A double fracture resulted in one death. A crew was unloading an 18-inch steel pipe from a truck, using short pieces of small diameter pipe as rollers. One of the rollers became pinched under the heavy pipe. It snapped out of place under the pressure, struck a member of the unloading crew, and threw him headlong against a stanchion of the truck. His neck was broken and his skull was fractured.

The fourth fatality resulted from a crane accident. A heavy steel plate was being lowered into place. As it came to rest on its edge, the cable tension slackened, disengaging the hook. The unsupported plate toppled over onto the worker who was preparing to secure it in place.

The fifth fatality was a drowning to which there were no witnesses. The victim's body was found in a water tank on which he had been working alone.

The Permanent-Total Disability.--This was a case of silicosis, contracted by a sand blaster.

The Permanent-Partial Disabilities.--The 103 permanent-partial disability cases included 50 amputations, the removal of 2 eyes, and 51 bruises, cuts, lacerations, burns, scalds, fractures, and strains which resulted in the loss of use of a body part or function (table 2).

Handtool operations accounted for 1 and horseplay for the other of the 2 eye enucleations. In the first accident, an employee was using a sledge to aline steel on a machine. As he struck the steel, a small fragment chipped from the plate and pierced his eye. In the second case, horseplay caused an explosion which resulted not only in the permanent eye injury but in the perforation of both eardrums.

The 50 amputations included 45 finger (including thumb), 1 foot, and 4 toe injuries. Of the finger injuries, 8 involved two or more fingers. Hoisting equipment, mostly cranes, was responsible for 6 and machines for 20 of the finger (including thumb) amputations. Included in the hoisting equipment

accidents were 4 employees who were caught in chains, cables, or hooks, and 2 who were caught in the gears of cranes.

Of the 20 amputations attributed to machines, 15 resulted from contact with the working tool of the equipment. Five of the machines were shears, 5 were presses, 2 were woodworking circular saws, 1 was a cutoff machine, another a plate-bending machine, and the other a swedging machine. In another similar case, an employee had his finger amputated by the holddown device of a shear. Of the 4 remaining machine amputations, gears accounted for 2, and belts and cables for 2.

Falling materials and equipment were responsible for 8 of the finger or thumb amputations and for the 4 toe amputations. In 7 accidents, the objects, mostly steel plates, fell from crane hooks or clamps. In 2 cases, objects fell from dollies or hand trucks; in 2, from machines; and in another, from a workbench.

Materials and equipment being moved by hand produced 9 finger amputations. Steel stock was usually involved and, most frequently, the accidents occurred as workmen were placing the materials upon machine tables. In one instance, however, an employee lost a finger when it was crushed between a girder of the shop and a machine which he was moving.

Two men had fingers amputated while using handtools (an axe and a hammer). The foot amputation occurred as a workman stood on a crane rail to place a rope in the pulley of the crane. The crane moved, amputating his foot.

The 51 loss-of-use cases included 4 eye and 5 other head injuries; 3 back injuries; 2 arm, 6 hand, and 14 finger injuries; 4 leg, 7 foot, and 3 toe injuries; and 3 cases of multiple injuries. Falling materials accounted for 11 loss-of-use disabilities (a skull, a hand, an arm, a finger, a toe, 2 leg, and 4 foot injuries). In 6 of these cases, materials or subassemblies fell from hoisting equipment. Booms of cranes accounted for 2 more and an inadequately fastened part of a fabricated assembly for another. The other falling objects were a scrapbox which fell from a handtruck and a steel plate which fell from plate-bending rolls.

Eleven permanent loss-of-use cases (3 eyes, an ear, a wrist, a foot, 4 fingers, and an injury affecting the body generally) arose from handtool operations. Hammers inflicted 4 of these injuries, in 3 of which metal fragments produced by blows of hammers were thrown into workers' eyes. In the fourth case, the injured worker's finger was crushed between the handle of a hammer and a boiler head on which he was working. Burning torches produced 2 injuries; in one case, sparks partially destroyed the hearing of an employee 8/ and, in

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8/ Under the 1954 revision of the American Standard Method of Recording and Measuring Work Injury Experience, approved by the American Standards Association, the partial loss of hearing would not be classified as a permanent disability.

the other, an acetylene torch exploded when the gasline ruptured, resulting in multiple burns of the body. Two injuries (a finger and a wrist) were attributed to wrenches; in both cases, the wrenches slipped and workmen struck objects (a steel plate and a drill press) with sufficient force to injure themselves permanently. A ladle, a bar, and an air drill accounted for the remaining 3 loss-of-use injuries involving handtools. In one of these injuries, a foundry worker permanently injured his foot when he spilled hot metal from a hand ladle, in the second, a workman's finger was pinched when the bar slipped as he was using it to move a steel plate, and in the other injury, an employee's finger was caught in an air drill.

Falls produced 5 permanent disabilities (a skull, a wrist, a thumb, a foot, and a general body injury). In the latter case, the worker fell 40 feet from a ladder to a concrete floor, experiencing multiple fractures of the leg, arm, chest, and pelvis.

Ten workmen were permanently injured when they were squeezed by moving objects. Four of them crushed their fingers under or between objects which they were handling. One of the workmen suffered a hand injury, another a finger injury when they were caught between crane loads and other objects, and a third injured his leg when he was caught between the carriage of a crane and a wall. One employee had his finger crushed by the lever of a press, another had his thumb mashed as he was hitching a trailer to a truck, and a third had his toes crushed in plate-bending rolls when he stood on a plate being fed into the rolls.

Two men permanently injured their backs and one man injured his arm while they were lifting objects. Similarly, another employee experienced a permanent foot injury as a result of overexertion in pushing a large steel assembly unit. One workman suffered a permanent injury when he twisted his back.

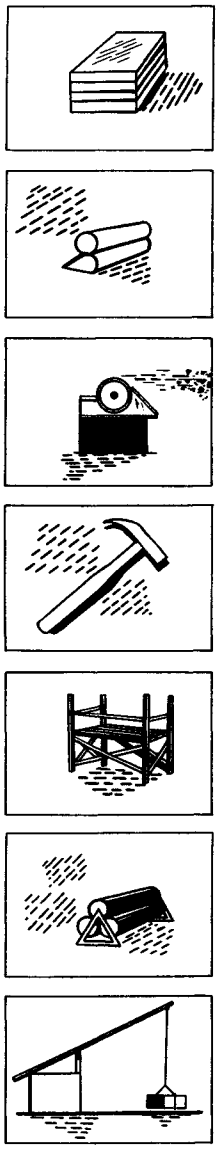
Exploding grinding wheels produced a permanent eye and a permanent head injury. Another head injury resulted when one employee, who jumped as he was startled, struck a second employee with his lunch bucket. Two men suffered permanent injuries when they bumped against objects; one had a back injury, the other a leg injury.

An electric heater in the cab of a crane shorted as the crane operator opened the switch, resulting in a permanent hand injury. A painter was permanently injured when he dropped a match into his clothes which were saturated with turpentine. A welder, working inside a tank, suffered a permanent finger injury when the tank toppled over and crushed his finger, and another worker crushed his toe when he rocked a tank he was moving onto his foot.

SOURCE OF INJURY

The objects and substances which directly inflicted the recorded injuries were many and varied. Several general categories, however, have particular significance as indicators of the most common sources of injury. In some instances,

Chart 3 MAJOR SOURCES OF INJURY IN THE BOILERSHOP-PRODUCTS INDUSTRY, 1951



Percent of All Agencies of Injury

METAL STOCK	23.4
ASSEMBLIES	12.4
CHIPS, PARTICLES, ETC.	11.9
HANDTOOLS	7.4
WORKING SURFACES	6.3
MACHINES	5.2
HOISTING APPARATUS	4.3
OTHER	29.1

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these objects and substances became injury producers because of their own inherently hazardous characteristics; in other cases, they inflicted injuries only because they were improperly used or because of their position at the time of an accident.

Metal stock, assemblies, and chips or flying particles were the most common sources of injury. In the raw materials category, metal stock items alone inflicted 23 percent of the reported injuries. Some 12 percent of the injuries were produced by contact with assemblies and another 12 percent were inflicted by chips or flying particles. (See chart 3 and tables 5, 6, and 10.)

Steel plates ranked very high among the injury-producing metal stock items. Angles, pipes, tubes, channels, I-beams, bars, and castings, however, were also substantially represented in the list. Two of the 5 recorded fatalities resulted from injuries inflicted by metal stock.

Bruises and contusions accounted for high proportion of the injuries produced by contact with metal stock and with assemblies, but nearly half of all the reported fractures were also attributed to these two sources. Most of these two types of injuries were to fingers, feet, toes, or legs. Back strains from lifting metal stock and assemblies were quite common.

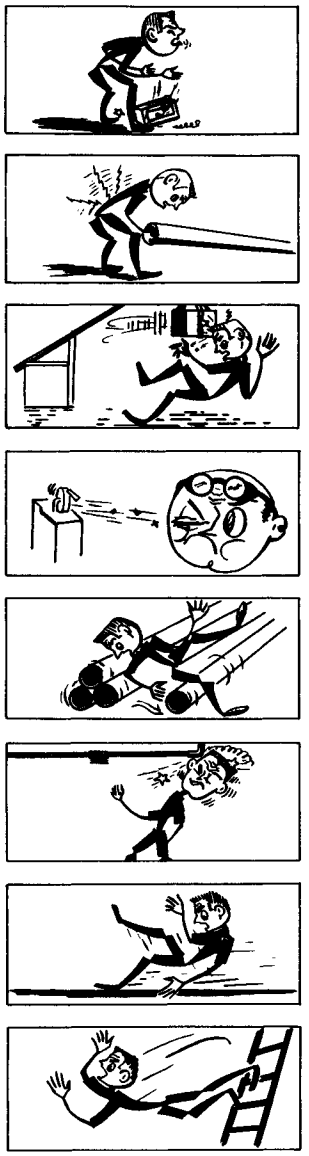
The large majority of the injuries inflicted by chips and flying particles--i.e., fragments of metal, sawdust, dirt, sand, dust, etc.--were eye cases. Most of these were relatively minor injuries, but the group included six cases of permanently impaired vision.

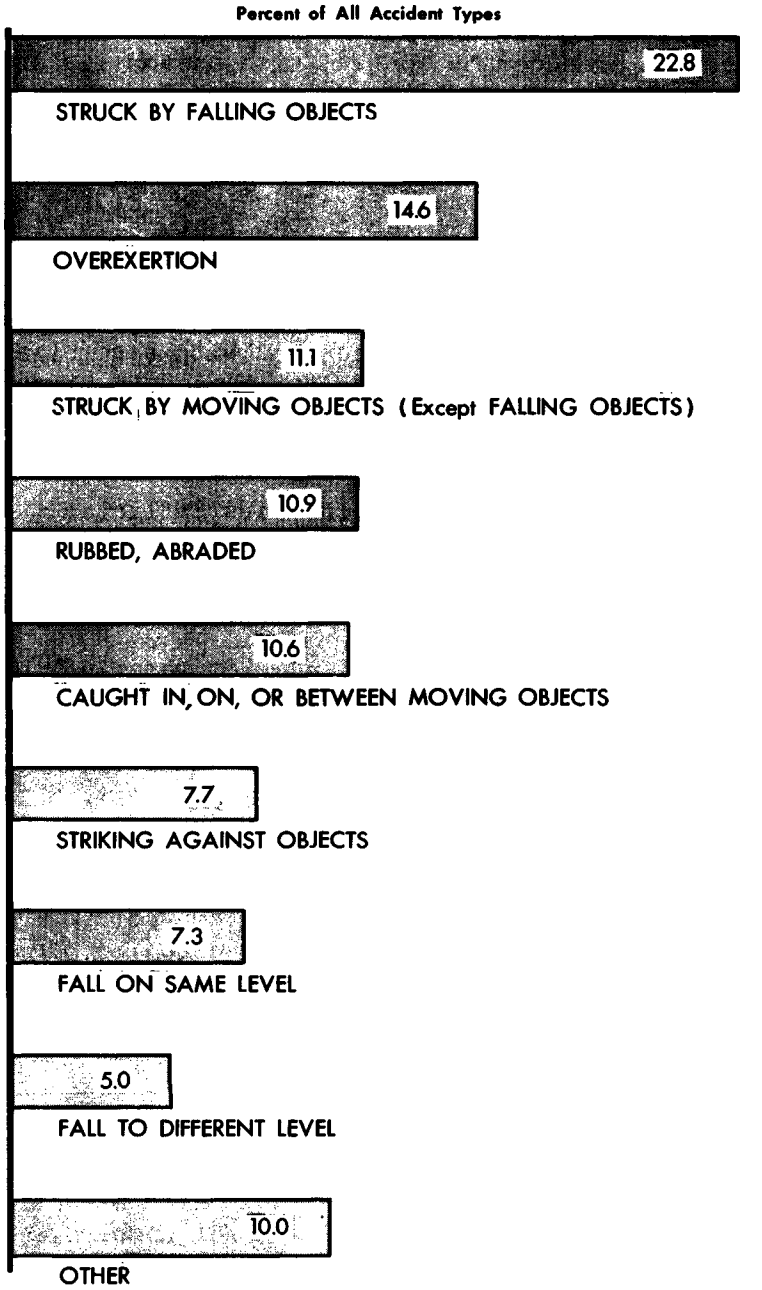
More than 7 percent of the injuries were inflicted by handtools--powered tools such as drills, and grinders as well as nonpowered hammers, were prominent in the list (table 5). Most of these occurred when the worker struck himself with the tool or dropped it on his foot or toes. The powered-tool injuries were most commonly cuts or lacerations, while those inflicted by hammers were most commonly bruises or fractures.

Some 6 percent of the injuries resulted from contact with working surfaces--floors, platforms, etc. Most of these contacts originated as falls. Only 3 of the 126 working-surface injuries resulted in permanent impairments, but the remainder tended to be much more severe than most temporary-total disability cases. Their average disability was 23 days per case, compared with a 16-day average for all temporary totals in the study. Nearly a third of the injuries in this group were fractures. Most of the others were strains, sprains, or bruises.

Because of their high average severity, the injuries inflicted by machines and by hoisting apparatus deserve particular attention even though they were not of outstanding importance in terms of numbers. Machine injuries amounted to somewhat over 5 percent of the total, and hoisting-equipment cases came to a little more than 4 percent. The machine injuries, however, included nearly one-fourth of all the recorded permanent impairments; the hoisting equipment

Chart 4. MAJOR TYPES OF ACCIDENTS IN THE BOILERSHOP-PRODUCTS INDUSTRY, 1951





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BUREAU OF LABOR STATISTICS

cases included 1 of the 5 reported deaths and more than 10 percent of the permanent impairments. The average time lost or charged for machine injuries was 162 days per case compared with 86 days per case for all injuries in the study. The hoisting equipment cases had an average of 226 days per case, which rose to 314 days for those injuries specifically inflicted by cranes.

Other injury sources, each of which produced at least 2 percent of the total number of injuries, included: machine parts; radiations; containers (boxes, drums, etc.); lumber; vehicles; and bodily motions. One of the injuries inflicted by vehicles became a fatality and 1 was a permanent impairment. As a group, the motor vehicle cases amounted to 2 percent of the injury volume, but they produced over 4 percent of the total time lost or charged. The radiation injuries were nearly all cases of welder's flash of relatively low severity. Three of the injuries produced by bodily motions were hernias, the remainder were strains or sprains.

ACCIDENT ANALYSIS

Accident Types.--The first step in accident analysis is to identify and classify the events which culminated in injuries. The classification of these events into groups of accident types creates a pattern which indicates the relative importance of the events which must be prevented from occurring if injuries are to be avoided. This relative importance is not measured simply in numbers of occurrences--it is a function of both the frequency of occurrence and the severity of the resulting injuries. Injury-frequency rates can be reduced most rapidly by concentrating accident-prevention efforts upon the kinds of accidents which occur most often. Humanitarian interests, employee relations, and operating cost elements, however, may dictate that first efforts should be directed to preventing those accidents which tend to produce the most serious injuries.

The accident pattern developed in this study of the experience of the Boilershop Products Industry highlights five general types of accidents in terms of volume of frequency of occurrence. (See tables 7-10 and chart 4.) It is interesting that this pattern was essentially the same for all major segments of the plants surveyed--there were no significant differences when the reports were tabulated in terms of plant products or on the basis of plant size. In regards to volume for all plants surveyed, the five most common types of accidents were found to be:

(a) Cases in which workers were struck by moving objects, accounting for one-third the total volume.

(b) Cases of overexertion, amounting to over 14 percent of the total.

(c) Cases in which the worker fell--over 12 percent of the total.

(d) Cases in which the injury was inflicted by pressure, friction, or abrasion--nearly 11 percent of the total.

(e) Cases in which the worker was pinched or crushed between objects--over 10 percent of the total.

An evaluation in economic terms, however, presents a somewhat different pattern of relative importance. Here the total amount of time lost or charged represents an approximation of the economic losses resulting from the various classes of accidents. Both the average severity of the resulting injuries and the volume of cases are factors in these aggregates; e.g., a low volume of serious injuries may produce the same amount of time lost or charged as a high volume of relatively minor injuries. In these terms of comparison, the top-ranking varieties of accidents were:

(a) Cases in which workers were struck by moving or flying objects--36 percent of the total time lost or charged.

(b) Cases in which workers were caught in, under, or between objects--24 percent.

(c) Falls--12 percent.

(d) Cases in which workers struck against objects--7 percent.

(e) Contact with radiations, caustics, and noxious substances--7 percent.

(f) Overexertion--7 percent.

A quite different pattern of relative importance emerges when the general classes of accidents are rated in terms of the average severity of the resulting injuries without regard to the volume of cases involved. On this basis the most important accident categories were:

(a) Cases in which workers were caught in, under, or between objects--192 days of disability per case.

(b) Contact with radiations, caustics, and noxious substances--181 days per case.

(c) Cases in which workers were struck by moving objects--92 days per case.

(d) All falls--86 days per case.

(e) Cases in which workers struck against objects--80 days per case.

Taking into account the rankings of all 3 evaluations, it appears that the 3 general classes of accidents deserving preferential attention in the safety programs of the industry are:

(a) Cases in which employees are struck by moving objects. This class of accidents ranked first in volume of cases and in total economic loss, and third in average severity of the resulting injuries.

(b) Cases in which workers are caught in, under, or between objects. This group of accidents ranked first in terms of the average severity of the resulting injuries, second in respect to economic loss, and fifth in terms of volume.

(c) Falls--These accidents ranked third in volume of cases and total economic loss and fourth in average severity of the resulting injuries.

The emphasis placed upon these three classes of accidents in no way minimizes the need for efforts to prevent other types of accidents. It merely pinpoints the areas in which accident prevention can achieve the greatest measurable results. Some clues as to the particular problems to be overcome are apparent in the details of the accidents reported in these three classes. (See tables 7-10.)

(a) The "struck by" cases--These accidents were highly concentrated in three general activities--the movement of materials, the use of handtools, and the operation of machines. In material movement operations, the objects which struck the workers were most commonly the materials being handled--characteristically, they were dropped by the workers; they fell from the material handling equipment; or they fell from the positions in which they had been placed for storage or processing.

A predominant category of "struck by" accidents in handtool operations consisted of those in which the workers dropped their tools or struck themselves while using the tools. In a considerable number of cases, workers were struck by flying materials set in motion by handtools.

In machine operations, the objects which struck the workers were primarily either machine parts which became dislodged and fell, or metal stock items which fell from the equipment during positioning or processing.

From the record, it appears that efforts to eliminate "struck by" accidents in this industry could most profitably be concentrated on improving the methods of handling materials.

The high volume of cases in which materials fell from the workers' hands suggests that perhaps more emphasis should be placed upon mechanization. The rather substantial number of accidents involving cranes, hoists, trucks, and other material movement equipment, however, indicates that mechanization alone may not be the answer, but that an awareness of safety practices on the part of both the employer and the employee also is essential.

(b) The "caught in, on, or between" cases--These accidents were associated primarily with material handling and machine operations. The most typical accident was that in which a worker's hand or finger was crushed between a piece of metal stock and some stationary object as he tried to move the metal stock into a desired position. Less common, but productive of more serious injuries were the cases in which workers were crushed between swinging crane loads and stationary objects, or between moving vehicles and stationary objects. Cases of workers being caught by the moving parts of machines were not numerous, but a considerable number of employees were pinched by metal stock while feeding it into or removing it from a machine. Here again, the indications are that successful accident prevention lies in improved material handling procedures.

(c) The "falls"--In about 60 percent of the falls, the injured person fell either to the surface on which he had been walking or standing or fell against some object. The bulk of these accidents were directly traceable to poor housekeeping or to inadequate work space.

The other 40 percent of the falls present more varied and complex prevention problems. These were the cases in which the injured fell from an elevation to a lower level. Their importance lies more in the severity of the resulting injuries than in their volume. Nearly a third of the falls from elevations were falls from ladders. Most of the other falls from elevations were falls from working positions on large fabrications. The need for stable and guarded working platforms for use in fabricating operations is strongly indicated by the record.

ACCIDENT CAUSES

Ability to recognize the conditions or circumstances which are likely to lead to the occurrence of accidents is a prerequisite to effective accident prevention. This is not an intuitive or inherent ability of certain favored individuals--it is an acquired ability stemming directly from a knowledge of the conditions and circumstances which have contributed to the occurrence of

accidents in the past. Every accident results from a particular combination of conditions and circumstances, and it is axiomatic that anytime a similar combination of conditions and circumstances is permitted to exist a similar accident is likely to happen.

Fortunately for the accident preventionist, he usually can avoid the occurrence of an accident by eliminating any one of the factors which together constitute a potential accident sequence.

Statistical analysis, as applied in this study, consists of classifying the individual case findings for a number of cases to determine whether or not the accident factors tend to concentrate into patterns. A relatively high concentration in any one of the accident factor classifications constitutes a signal for accident-prevention efforts to eliminate that particular variety of hazard. Among several areas of concentration of factors, the relative degree of concentration in each may assist in determining priorities for the accident-prevention program. The existence of any one accident factor, therefore, is a signal to the accident preventionist. The elimination of that factor may have prevented the development of any accident sequence to which the factor may have contributed.

Accident investigation is the process of determining and recording all of the conditions and circumstances associated with the occurrence of an accident. Accident analysis, on the other hand, is the process of sifting through the facts derived from the investigation and determining which of the recorded conditions and circumstances directly contributed to the occurrence of the accident.

It must be recognized, however, that accident analysis has definite limitations. At best, it can furnish clues only as to the direction in which accident-prevention activities can most effectively be pointed. The details of the safety program must be developed by the individual in charge of safety promotion. In addition, it must be recognized that in accident analysis, the two factors--hazardous working conditions and unsafe acts, (the only factors relating to causes of accidents) are not necessarily exclusive. In other words, the analysis procedure is not directed toward the determination of a single major cause for each accident. Such a determination would involve an exercise of analytical judgment seldom possible from the available facts. On the contrary, an effort is made to determine independently for each accident (1) whether there was a hazardous condition which contributed to its occurrence, and/or (2) whether the accident was directly associated with an unsafe act.

Many details were lacking for some accidents included in the survey. It was, therefore, impossible to determine whether hazardous working conditions or unsafe acts were the leading cause of accidents. The pattern of the specific factors within each general category is of more importance than the interrelationship between the major groups of accident causes. It is noteworthy, however, that hazardous working conditions were identified in at least 89 percent of the accidents studied and unsafe acts were found in at least 85 percent of the cases. For the balance, the causes were indeterminable.

The correction of hazardous working conditions usually is entirely within the powers of management and can be accomplished by management action. The avoidance of unsafe acts, on the other hand, requires cooperation and understanding by both management and workers. To achieve this, it is necessary for management to take the lead by providing safety-minded supervision and by making sure that all workers know the hazards of their operations and the means of overcoming those hazards.

Hazardous Working Conditions

Hazardous working conditions include not only the adverse physical conditions of the working environment, but also the inadequately planned or controlled methods and procedures applied in the work activities. The latter, as a matter of fact, was found to be the most prolific cause of accidents in the boilershop-products industry. In broad categories, the analysis indicated that the most common sources of accidents in the industry were: (1) Hazardous procedures; (2) placement hazards; (3) inadequate guarding; and (4) defective agencies. (See tables 11-15 and chart 5.)

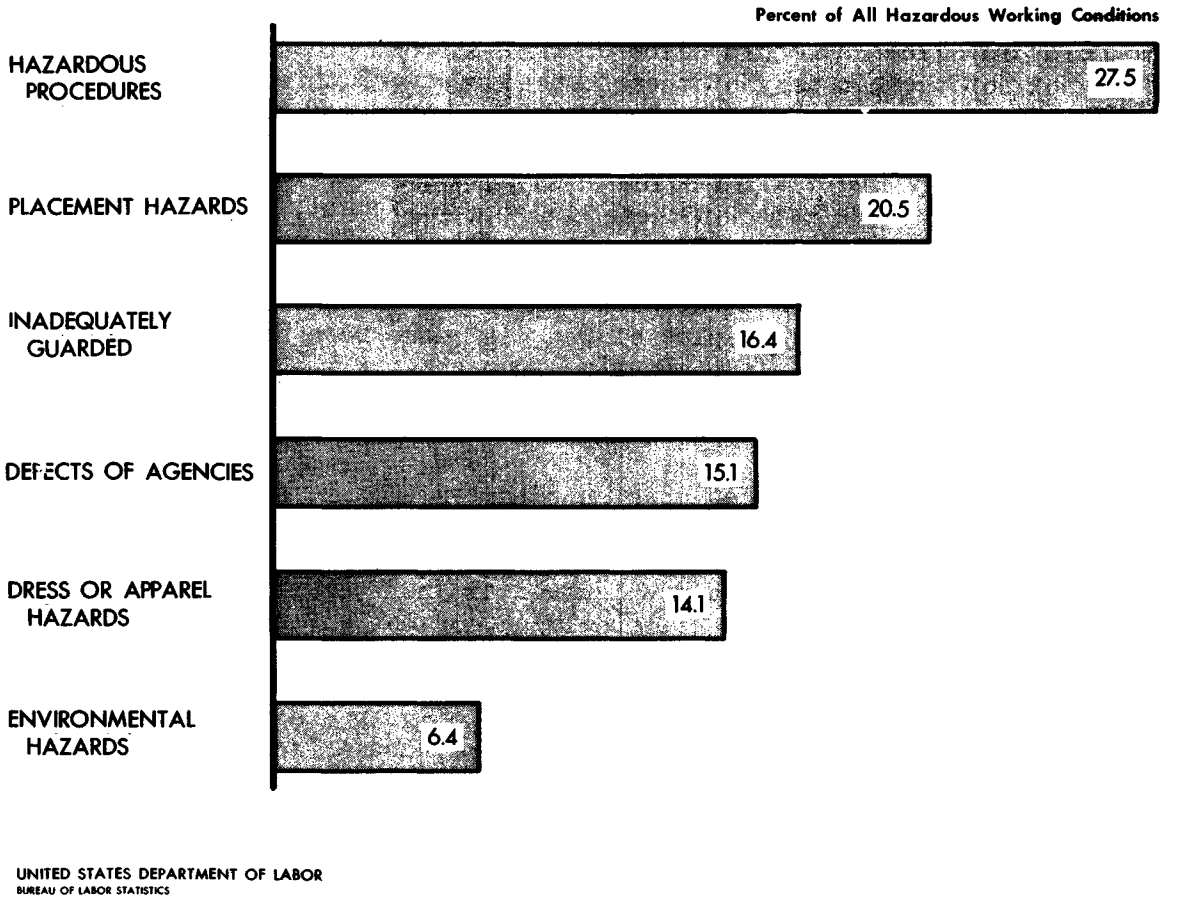
Hazardous Operations and Procedures.--These hazards arise primarily from management's failure in two important areas of supervisory responsibility--(1) to plan for safety in the operations and to provide proper equipment and facilities for the jobs to be done; and (2) to provide adequate supervision to insure safe performance of the designated activities. Inadequate provision for safe in-plant movement of heavy, bulky, and awkward materials, mostly metal stock and fabricated assemblies, was the most common accident cause in this general category. Obviously, no single corrective measure will resolve all of the problems in this area, but it is apparent from the case records that materials movement was frequently entirely unplanned and undertaken haphazardly by untrained workers. Materials which might be moved safely by mechanical equipment were too often moved by hand and without an adequate crew to divide and control the load. Overexertion, resulting in strains, sprains, hernias, etc., was the most common proof of these hazardous procedures, but there were also many instances in which workers were struck by objects which they were moving by hand and which went out of control during the movement. In other instances, workers were squeezed or crushed between the objects they were moving and fixed objects. These hazards were relatively much more common in small plants than in large ones and more prevalent in boiler plants than in tank plants.

The lack of adequate scaffolds, platforms, or other stable working surfaces for work at elevations was the basic cause for many falls from makeshift supports employed in work on large fabrications.

Many of the accidents arising in the movement of materials by crane resulted from hazardous procedures which adequate supervision may have prevented. Among these procedures was the practice of guiding sling loads by hand.

Placement Hazards.--Improper placement of materials and equipment caused about 1 in every 5 of the accidents studied--i.e., improperly placed in respect

Chart 5. MAJOR TYPES OF HAZARDOUS WORKING CONDITIONS IN THE BOILERSHOP-PRODUCTS INDUSTRY, 1951



to the position occupied; or improperly piled or inadequately secured in respect to stability in their position. Improper placement frequently constituted a violation of good housekeeping practices which commonly resulted in a tripping or bumping hazard in an aisle or work area. Metal stock, lumber, handtools, and small fabricated assemblies were the objects most commonly misplaced.

The hazard of improperly piled materials was encountered more frequently in the general working areas than in designated materials storage areas. Generally, these were instances in which working supplies or completed small fabrications

were accumulated at the workspace in unstable piles. These accumulations usually led to workers being struck by materials which slid or fell from the piles.

Accidents of the "struck by" variety were also the most common result of the hazards designated as inadequately secured materials. Some of these were instances in which fabrications or subassemblies had been placed in working positions from which they could slide or fall without provision of proper anchors or blocking. In many of these cases, however, this hazard applied to materials which became dislodged when they were moved on plant vehicles.

Inadequate Guarding.--The provision of physical barriers to prevent persons from coming into contact with moving machinery, equipment, or materials; to prevent falls from elevations; and to avoid contact with potentially dangerous objects or substances in the working environment constitutes the foundation of accident prevention. The need for such devices has become axiomatic among safety engineers and the principles of guarding have been incorporated into most safety standards and safety manuals, frequently with great technical detail. Guarding requirements for many kinds of machines and equipment, and for some industrial processes, have also been enacted into law in many States.

Despite the emphasis placed upon guarding as a basic element in accident prevention over many years and the general acceptance of these principles throughout the safety movement, there are still wide areas of industrial activity in which these principles are ignored or ineffectually applied. Most commonly, the reasons cited for not providing, or not enforcing the use of adequate guards are: the high cost of installing and maintaining guards; the reduction in efficiency (i.e., production rates) arising from the use of guards; resistance on the part of employees to the use of guards based upon assumed inconvenience imposed by the presence of a guard; and a lack of conviction that there is a real need for guards.

The answers to the first two of these objections lie in the field of engineering and design. For most equipment, simple guards, which not only provide protection but also increase efficiency, can be and have been designed. The answers to the last two objections lie in the record of the accidents which have occurred in the absence of adequate guarding and which might have been avoided if adequate guards had been in use.

More than 16 percent of the accidents reported in this survey were directly attributable to inadequate guarding. This fact alone is an impressive indication that improvement in guarding practices should have high priority in the safety programs of the boilershop-products industry. Even more significant and reflecting the resulting human suffering, this group of accidents produced 40 percent of the reported deaths and 43 percent of the permanent disabilities recorded in the study. From the viewpoint of costs, this group of cases was responsible for 34 percent of the total volume of days lost or charged to all injuries in the study. More specifically, the average time charge per case for the "inadequate guarding" group was 188 days, more than

double the average of 86 days for all cases in the survey. Even in respect to temporary disabilities, the comparison is unfavorable to this group. The average recovery time for temporary injuries resulting from inadequate guarding was 21 days, compared with 16 days for all temporary injuries in the survey.

The range of equipment found to be inadequately guarded was wide. Most prominent was the lack of adequate guarding at the point of operation of fixed machines such as rolls, presses, grinding machines, saws, shears, and drills. In many instances, however, powered handtools, particularly grinders, were the unguarded agencies.

The problem of providing adequate guards is not, however, limited to machines or powered equipment. Many accidents resulted from the absence of safety hooks or safety clamps on hoisting apparatus. The use of such protective devices might have avoided the dropping of crane loads which injured many persons. Similarly, wider use of safety shoes or anchors on ladders might have prevented a number of falls. Guard rails on scaffolds, platforms, and other elevated working surfaces might also have prevented some serious falls, and the provision of toe boards on elevated working surfaces might have prevented materials from falling on workers below.

Defects of Agencies.--The elimination of accidents resulting from defective material and equipment does not ordinarily require a high degree of engineering skill--but it does require continuing attention. These hazards frequently develop gradually and tend to merge into the environmental background. They become accepted characteristics of the workplace and their potential as accident producers is overlooked because "that's the way things are." Control of these insidious hazards rests primarily upon frequent inspection of all premises, materials, and equipment to detect defective items, and upon provisions for the prompt repair or removal of the defective items from service. In the main, these hazards tend to be obvious when a definite effort is made to find them.

More than 15 percent of the accidents analyzed in this survey were directly attributable to defective agencies and most, if not all, of these defective conditions could readily have been detected and corrected before they resulted in accidents. Defective floors--i.e., slippery from wear or from spilled oil or other materials, or irregular from wear--were prominent in this group of accident sources. All of these conditions were recognized as hazards which could have been corrected, but apparently no one thought about them before that time. Worn, cracked, sprung, mushroomed, or otherwise defective handtools also contributed to the occurrence of a substantial number of accidents. Here again the defects generally were such that they could have been recognized as hazards under an adequate inspection and replacement system.

Adequate maintenance for machinery is not only a safety measure--it is an economic and operating necessity. Evidence of failure to recognize this lies in the number of cases in which it was reported that machine parts broke or came loose from their supports during operation of the equipment and struck the operators or other persons nearby.

Burred edges on the metal plates and stock being fabricated were found to be another very common hazard in this group. The resulting cuts and lacerations to fingers and hands generally were not serious, but the possibility of severe infection developing is always present in such injuries. Injuries require time for treatment and tend to limit the activities of the injured persons until their wounds heal.

An interesting sidelight of the analysis, for which no reason is apparent, is that accidents ascribed to defective agencies were relatively more common in large boilershop-products plants than in small ones.

Miscellaneous.--The obvious conclusion that concentration on the elimination of the hazards already discussed will result in a highly favorable reduction in accident volume does not mean that other kinds of hazards should be ignored. Some of the less frequently encountered hazards which demand attention are important in terms of potentially serious injuries. One of the more important hazards which was found in this group was that of congestion in the working areas. More specifically, inadequate clearance for materials which were being moved was directly responsible for two of the fatalities reported in the survey.

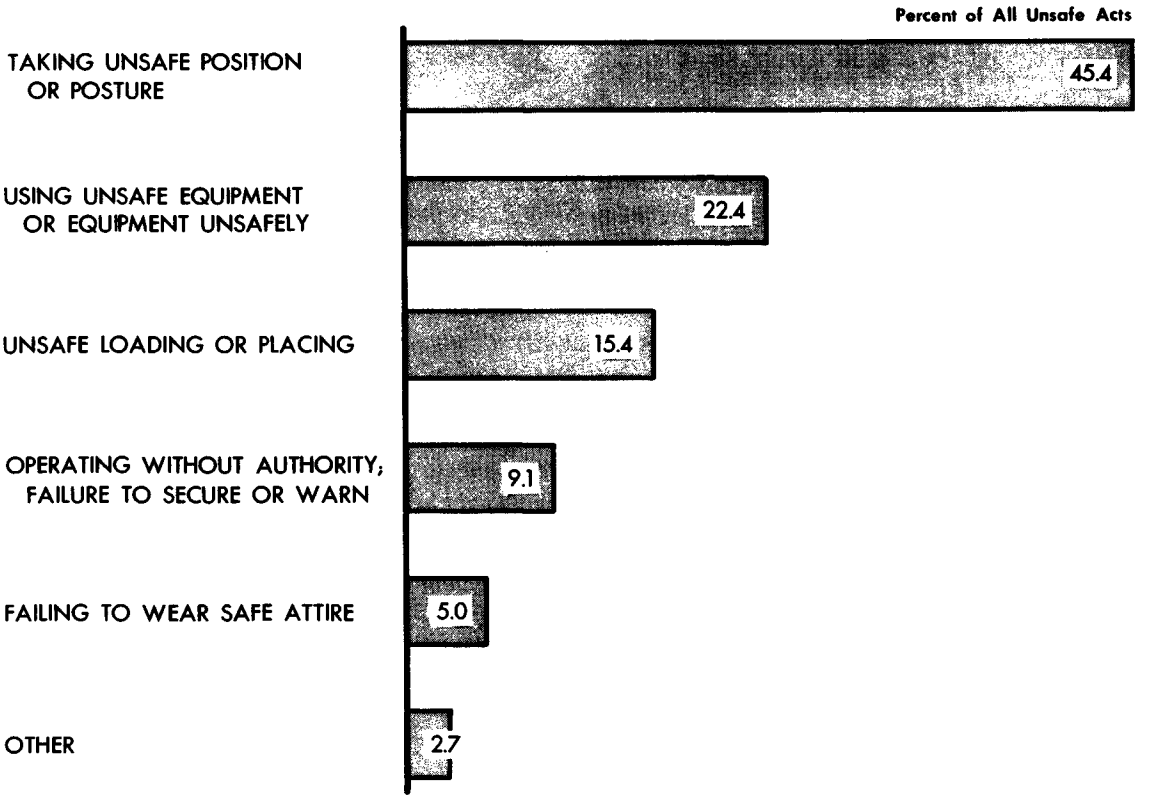
The need for more adequate provision of personal protective equipment throughout the industry is also apparent; for example, the record definitely indicates the need for a stronger goggle program for operations involving eye hazards. Expanded provisions for the use of gloves, safety shoes, and other protective devices, such as leather aprons, are needed for the safer performance of many of the industry's activities.

Unsafe Acts

For the purposes of this study, an unsafe act was defined as the "violation of a commonly accepted safe procedure which directly permitted or occasioned the occurrence of the injury-producing accident." By this definition, no action could be considered unsafe unless there was an alternative, safe procedure. For example, an employee who was injured by contact with a circular saw for which no guard was available was not considered as committing an unsafe act because he had no alternative but to use the unguarded saw. On the other hand, a worker who was injured after removing the guard, committed an unsafe act because he had the alternative of using the saw with the guard.

The definition, however, does not imply that the worker must necessarily know the alternative safe procedure. Although some workers obviously committed unsafe acts through choice, it was apparent in a study of the individual cases that many workers acted as they did because they simply did not know the safe method of performing their duties. The correction of unsafe acts, therefore, requires a twofold effort--education and enforcement. First, workers must be thoroughly trained in the safe performance of their duties and second, management must provide adequate supervision to assure that the safe procedures are used.

Chart 6. MAJOR TYPES OF UNSAFE ACTS IN THE BOILERSHOP-PRODUCTS INDUSTRY, 1951



The analysis indicated that two general kinds of unsafe acts are extremely common in the boilershop-products industry--taking unsafe positions or postures; and using unsafe equipment or using equipment unsafely. Somewhat less common, but nevertheless important, accident causes are unsafe loading or placing; and operating without authority or failing to secure the equipment against unexpected movement or failing to adequately warn others of the activities being performed in the area. (See tables 16-18 and chart 6.)

Taking Unsafe Positions or Postures.--In the majority of these cases, the specific unsafe act was either inattention to footing or inattention to surroundings. Inattention to footing was the more common fault, but the resulting

injuries were generally less severe than those arising from inattention to surroundings (table 17).

Basically, these unsafe acts consisted of the workers' failure to protect themselves against physical hazards of the workplace. The hazard frequently was not created by the person who was injured, but in most instances, it was one which should have been apparent and which could have been avoided through the exercise of reasonable attention and judgment.

The failure to observe and avoid tripping hazards was a very common cause of falls not only on the regular working surfaces but also on elevated surfaces where the prospect of serious injury should have stimulated greater attention. Poor housekeeping, inadequate maintenance of working surfaces, and improperly placed materials were contributing causes in many of these accidents.

Most of the accidents attributed to inattention to surroundings were those in which the injured person bumped into some stationary object in the working area and was injured either by the force of his contact or was struck by falling objects dislodged by his contact. Often these were instances in which a person turned sharply and struck a pile of material, a fabrication, a machine, or a parked industrial truck. Congestion of the workplace and improperly placed materials were frequently contributory causes in these accidents. In other fairly common instances, persons working in confined spaces either bumped into obstructions while moving about or had their own tools deflected against them when the tools struck obstructions.

The most serious accidents in this general group, however, were those in which the injured employee exposed himself to contact with moving materials or equipment. These unsafe acts included taking a position under a suspended load, standing between a swinging load and a fixed object, standing close to moving vehicles or moving machines, working under unsecured fabrications, and standing in front of rolling or sliding objects. In many of these instances, the employee's unfortunate choice of action might have been avoided by more adequate supervisory planning and control of the operation.

Using Unsafe Equipment or Equipment Unsafely.--In a high proportion of these cases, the specific unsafe act was that of not maintaining a secure hold on objects being handled. In many instances, the material simply slipped from the worker's hands and fell on his toes. In other instances, insecurely held tools went out of control and deflected against the worker's body. Few of the accidents resulting from these unsafe acts were serious, but in the aggregate they were responsible for a considerable volume of lost time. Wider use of safety shoes undoubtedly would have reduced the volume of injuries resulting from these accidents.

A related unsafe act, taking a wrong hold on objects, was responsible for a smaller number of accidents--but the resulting injuries tended to be more serious. These were primarily cases in which workers grasped objects which

they were moving in such a way that their fingers were caught when they set the objects down, or were mashed against other objects in the course of the operation.

The unsafe acts of using defective equipment (i.e., when there was a choice) or of using equipment for purposes other than that for which it was intended were not common. It seems significant, however, that the use of handtools was involved in most of these cases.

Unsafe Loading and Placing.--The unsafe acts designated as unsafe loading consisted specifically of cases in which the objects being moved were too heavy, bulky, or awkward in shape for the number of persons doing the lifting. All of the injuries resulting from this group of accidents were strains or sprains, mostly affecting the back.

Unsafe placing consisted primarily of placing objects in unstable positions or piles from which they ultimately fell, often inflicting injuries on persons other than those who did the unsafe placing. This group did not include cases of improper placing (i.e., in terms of position) nor did it include cases in which materials were properly placed but inadequately secured against sliding or falling.

Other Unsafe Acts.--Supplementing the major pattern, there was a wide range of somewhat less common unsafe acts which in the aggregate were responsible for a substantial volume of injuries. Because these may be somewhat of a rare occurrence in any individual establishment, their importance may be overlooked and the steps necessary for their elimination may not be taken. The industrywide summaries, however, indicate that several varieties of these "less common" unsafe acts do occur often enough to warrant special preventative action.

In particular, it is apparent that the failure to secure materials and equipment against unexpected movement is responsible for a considerable number of injury-producing accidents. In an appreciable number of cases, metal stock and assemblies had slid or toppled onto or against people who were working with them simply because the articles had been precariously placed and unsecured. Similarly, in other instances, workers had been struck by unattended industrial trucks which had been parked on slopes without being blocked against movement.

Another rather common unsafe practice deserving attention is the failure to make use of available personal protective equipment, particularly goggles. The failure to use goggles which had been provided was directly responsible for three of the reported cases in which workers lost the sight of an eye and for a considerable number of less serious injuries inflicted by flying particles or by welding radiations.

ACCIDENT-PREVENTION SUGGESTIONS

To illustrate the wide range of hazards encountered in the boilershop-products industry, a number of typical accidents were selected for individual analysis. 9/

In presenting these accident-prevention suggestions, there is no intent to imply that they constitute a comprehensive set of safety rules for the boilershop-products industry or that the suggested methods constitute the only effective means of avoiding such accidents. The accidents described are typical cases of frequent occurrence, but they do not in any sense represent the full range of hazards encountered in boilershop operations.

The purpose of the comments and suggestions is merely to indicate that there almost invariably is a relatively simple method of preventing practically any kind of accident. Many safety engineers, no doubt, would attack the problems involved in these accidents in different ways and would achieve equally good results. The method of prevention, of course, is of little importance as long as it accomplishes its purpose.

Case Descriptions and Accident-prevention Suggestions

1. While an employee was walking around a press, he stepped on a spot of grease and fell to the floor. He suffered a sprained shoulder, and was disabled 13 days. Investigation disclosed that the grease fell from an air hoist used to convey material to the press which had recently been serviced.

> a. Poor housekeeping practices obviously played an important part in the occurrence of this accident. Both maintenance men and operators should be trained to check the work area for grease, scrap, etc., after each servicing and should be required to clean up immediately any spilled or discarded material. The supervisor should make a personal check to see that this is done. Followup inspections should be made later to insure that further grease drippings are removed.

9/ These cases were reviewed by Sheldon W. Homan, Safety Engineer in the Division of Labor Standards, Bureau of Labor Standards, of the U. S. Department of Labor. For each case, Mr. Homan has made one or more suggestions as to the action which, if taken, might have prevented the described accident, and for many of the cases has provided general comments on the significance of that particular variety of accident.

b. The more important factor, however, was that the maintenance operation apparently had not been properly performed. In any greasing operation, it is essential that all excess grease be wiped from the fittings and that fittings which do not properly retain the grease be replaced. If dripping persists, a drip pan should be installed to keep the grease off the floor.

2. A worker was removing a steel tube from tubing piled on a rack. He pulled one tube from the center of the pile, causing the pile to slip and roll on his leg. He was disabled 102 days with a fractured leg. Investigation disclosed that the pile of tubing contained tubes of various sizes and that none of the tubes on the surface of the pile was the correct size that the worker wanted.

Good housekeeping practice would require that each tube size be kept in a separate rack.

3. A foreman stumbled over a piece of angle iron lying on the floor. He fell to the floor spraining his elbow. Lost time: 7 days. Investigation disclosed that the angle iron was scrap material discarded from a burning operation.

Good operating practices would require that a container be available at each workplace for disposal of scrap.

4. While an employee was operating a planer, he slipped and fell against bed plate of planer. He bruised his leg and was disabled for 1 day. Investigation disclosed that the floor was oily and covered with steel shavings.

A need for improved housekeeping procedures is strongly indicated. Shavings should not be allowed to accumulate on the floor around any machine. A sweeping compound which will absorb the cutting oil and permit its ready removal from the floor should be provided and its use required. Frequent inspection of the workplace by supervisors is necessary to insure compliance.

5. As an employee was walking to his workbench, he stepped on a nail projecting from a piece of lumber. He was disabled for 2 days as a result of a punctured foot. Investigation disclosed that the piece of lumber had been discarded when a scaffold had been removed.

It should be standard practice to require construction, maintenance, or service crews to remove all scrap, debris, excess material, etc., resulting from their operations, before leaving the area.

In dismantling any wooden structures, boxes, crates, etc., good safe practice calls for the immediate removal of all nails and projecting fasteners from each piece of lumber before it is discarded or piled for removal.

Unfortunately, these are safe practices which are frequently violated. Their observance can be insured only by close supervision. For his own protection, the regular supervisor of a work area should make a thorough inspection of the area immediately after the completion of a construction or repair job.

6. An employee was pulling a four-wheel handtruck loaded with steel plates. When the truck struck a hole in the floor, the plates fell from the truck and crushed his foot, which had to be amputated.

a. Under a good housekeeping and maintenance program, the hole in the floor would have been repaired.

b. A barrier on the truck might have prevented the plates sliding forward.

c. Generally speaking, it is an unsafe practice to pull rather than to push a loaded handtruck. In this instance, the employee would have been uninjured if he had been pushing the truck when its progress was suddenly stopped and the load shifted forward.

7. An employee was helping to assemble a tank. He stepped on a piece of round welding rod. When it rolled, employee twisted his knee. He was disabled for 22 days. Investigation disclosed that the welding rod had been discarded by a welder who had dropped it on the floor.

The unused ends of welding rods should be deposited in a container and disposed of as scrap. A metal container for this purpose is sometimes attached to the welding machine. This accident also points up the fact that employees must be trained to recognize conditions which can cause injury.

8. As employee was working near a pile of beams, one of which fell from the pile and struck his back. As a result of the bruised back, he was disabled for 9 days. Investigation disclosed that piled materials in the yard were, generally, not stable.

Stable piling of material is an essential of every safety program. Unsafe material piling indicates lack of safety consciousness on the part of the supervisor and perhaps, the management.

9. An employee was tightening a bolt with a monkey wrench. The wrench slipped from the bolt and employee, attempting to retain his balance, twisted his back. Lost time: 12 days. Investigation disclosed that the jaw of the wrench was worn loose through extended use.

a. An inspection system for tools and equipment is necessary so that worn tools will be repaired or discarded before they become hazardous to use.

b. Fixed-jaw wrenches are preferable when used on standard size nuts. The use of adjustable-jaw wrenches should be discouraged except for odd-sized nuts or bolts that cannot be fitted by standard fixed-jaw wrenches.

c. Employees should be instructed to make certain of footing and position before applying pressure on wrench--in case it should slip.

Accidents due to faulty tools and equipment can be eliminated if tools and equipment are maintained in good working order. To be effective, maintenance must be on a systematic and orderly basis so that each piece of equipment is inspected at regular intervals. This kind of maintenance is sometimes known as preventive maintenance.

Preventive maintenance involves a number of things. Its basic feature includes a routine inspection of all tools, equipment, and appliances at a definite time with records of the findings kept. It goes even further in that it involves the replacement of parts subject to wear at predetermined intervals even though some use still remains.

Maintenance is closely allied with other operating functions, such as good housekeeping. An efficiently operated toolroom, for example, must involve in addition to efficient tool storage, a system of effective tool maintenance and issuance to assure that all tools are in first-class condition and suitable for the job. Even where tools are owned by the workmen some inspection system should be used to assure that they are kept in good condition.

10. An employee was using a sledge hammer. The head of the hammer which was loose flew from the handle and struck the employee's face, disabling him for 3 days.

Ineffective tool control is indicated. Where tools are issued from a tool crib, they should be inspected before being issued. Where tools are owned by the men, a system of inspection by the foreman should be instituted.

Employees should also be trained to inspect their own tools and to obtain replacements for any which they find to be defective.

11. An employee was using a punch press. As the die contacted the steel plate, the die broke and a piece of steel struck the employee in the eye. Disability: 3 days.

This accident suggests that the die was in poor condition to cut properly. The die setter should make certain that the die is sharp and free of defects before it is installed.

12. A punch press operator was holding a steel plate on the press when, unexpectedly, the press tripped. His hand was caught between the dies and fractured. He was disabled for 129 days. Investigation disclosed that this punch press did not have a nonrepeat-type clutch and that the clutch dog was gummed up with grease and oil. It was reported to have repeated on other occasions.

a. Punch presses should be equipped with clutches designed to prevent repeating.

b. An adequate inspection and maintenance program probably would have prevented this accident by eliminating the "gummed up" condition of the clutch dog. In any event, the machine should have been immediately checked and put in good condition after the first time it repeated.

13. An employee became sick when he inhaled propane gas. Investigation disclosed employee was working near a burning operation and that the torch being used in that work had a worn hose. As a result, propane gas leaked from the hose.

a. An adequate program of preventative maintenance, including regular inspection of all equipment, coupled with the immediate repair or replacement of all items found to be defective probably would have prevented this accident.

b. Operators of burning equipment should be required to inspect their equipment and to report defective items each day before operating the equipment. Supervisors should make periodic checks to insure that this practice is followed.

14. When a grinding wheel exploded, a fragment struck the operator's arm and fractured it. Disability: 118 days. Investigation disclosed that the wheel had recently been changed and the wrong type of wheel used, and that the guard, which had been removed during the change, had not been replaced.

Abrasive wheels have different bursting strengths depending upon construction, kind of bond, size, etc. Adequate tool control through a well-operated toolroom would prevent the conditions which caused this accident. The foreman should personally check each new wheel before it is used to insure (a) that the proper wheel has been selected; (b) that the new wheel is in good condition; (c) that the wheel is properly mounted; and (d) that the guard is firmly fixed in place.

15. A welder received an electric shock from his welding torch. As a result, he was disabled for 87 days. Investigation disclosed defective insulation on the cable near the electrode holder.

a. An adequate program of preventive maintenance, including regular inspection of all equipment, coupled with immediate repair or replacement of all items found to be defective probably would have prevented this accident.

b. Operators of welding equipment should be trained and required to inspect their equipment and to report defective items each day before starting their work. Supervisory inspections should be made regularly to insure that this practice is followed.

16. An employee was unhooking a skid from an electric truck. The truck rolled back striking the employee's heel, disabling him for 16 days. An investigation disclosed that the employee did not set the brake on the truck.

Only qualified persons should be permitted to operate this equipment. Refresher courses should be given occasionally to remind operators of all safe work requirements.

17. A maintenance electrician was repairing an electric switch on a small crane. He was killed when he was struck and his head crushed by the lower span of a large overhead crane. Investigation disclosed that in order to repair the switch, the employee had to stand on a beam with his body extended above the small crane, that the clearance between the 2 cranes was approximately 3 inches, and that the operator of the overhead crane gave no signal as he approached.

The small crane should have been moved to the end of the runway, or, if this were impossible, all of the other cranes in the bay should have been blocked off so that they could not have been moved into the area.

In addition, a helper or standby guard should have been provided to warn of impending danger.

18. An employee was operating a planer. Without stopping the machine, he attempted to brush chips off the boiler plate, which was fastened to the bed of the planer. When the bed of the planer moved, employee's hand was struck by the plate. The lacerated hand became infected and the disability lasted 19 days.

a. This was a violation of a basic safety rule--machinery should not be cleaned while it is in motion.

b. Proper medical attention should have prevented the infection.

19. While he was operating a drill press, the loose sleeve of the jacket worn by the operator became entangled in the revolving drill. Employee fractured his arm and was disabled for 42 days.

Loose clothing such as shirt sleeves, neckties, etc., should never be worn about moving machinery. The accident suggests that better supervision was in order.

20. An employee attempted to lift a piece of steel plate weighing approximately 150 pounds onto a machine. He strained his back and was disabled 15 days. Investigation disclosed that the hoisting equipment, generally available, was being used elsewhere.

With proper training, the employee would have waited for the hoisting equipment or would have obtained help in lifting the plate.

21. A maintenance mechanic was repairing an overhead crane. He tried to carry a block and a coil of rope up a vertical ladder. He missed his handhold and fell to the floor. He was disabled for 50 days with a fractured pelvis and hip.

No one should attempt to climb a ladder carrying tools or equipment. A line, with pail for small parts if necessary, should be used to raise or lower materials from one elevation to another.

22. An employee was using a hand hoist to move an I-beam. One of the hooks slipped, permitting the beam to fall and strike his left foot. Disability: 48 days. Investigation disclosed that employee had not centered the load properly before attempting to move the beam.

a. All employees who have occasion to use hoists should be thoroughly instructed in the proper method of applying hooks, slings, and grabs and of making the lift.

b. In this case, the employee probably should have used "grabs" instead of hooks. A spreader bar might have helped.

c. Safety shoes might have minimized the injury.

23. An employee was using a portable grinder. Without stopping the tool, he tried to remove a "kink" in the air hose by whipping it. As he did so, he lost control of the grinder and dropped it against his leg. Disability: 3 days.

a. The possibility of using nonkink air hose should be investigated.

b. Employees should be instructed to check air hose before starting grinder.

c. Adjustments to mechanical equipment should never be made while the equipment is moving.

24. While painting tanks near a welding operation, a painter suffered flash burns. He was disabled for 6 days. Investigation showed that goggles were available, but the painter preferred not to use them.

The welding operation should be enclosed with a solid enclosure to prevent flash burns to others in the vicinity. This also raises the question of whether painting could be done at another place or at a different time.

25. An employee was carrying a steel beam weighing 120 pounds. It slipped out of his hands and fell on his foot. Employee was disabled for 5 days.

Safety shoes might have prevented the injury. The accident suggests that a study should be made to determine if some means of mechanical handling would be advantageous, not only for safety but also for efficiency.

If mechanical handling is not practical, additional help should be provided for lifting and transporting materials of this weight and shape.

26. Employee attempted to brush steel chips from the table of a drill press with his gloved hand. A chip became imbedded in his hand and, because of his failure to report for first aid, infection developed. He was disabled for 42 days.

a. Gloves should not be worn when operating a drill press or any other moving machinery.

b. A brush should be used for removing chips.

27. While a maintenance man was repairing an overhead crane, the crane operator moved it at the request of a workman on the shop floor. The maintenance man was caught between the moving crane and a rail. He was disabled 74 days. Investigation disclosed that the crane operator had been notified of the repair work but had forgotten that the maintenance man was still working on the crane.

The crane control switch should be locked open when repairs are being made. The key to the switch should be in the possession of the maintenance foreman, and he alone should have the authority to close the switch when repairs have been completed.

28. A welder was standing on a tank to tack weld a support for the tank. He lost his balance and fell to the floor, bruising his knee. He was disabled for 6 days. Investigation disclosed that there was no working platform or scaffold available.

This injury suggests that a study be made of the operation to see if a more efficient and safer way to do the job could be devised. If a platform is not practical, cord-type soles on shoes might be in order.

29. A drill press operator was drilling holes in a small steel plate. The drill became stuck in the material, spinning the material and the jig

which he was using. The jig struck his hand. He was disabled 9 days. Investigation disclosed that the bit had been dulled and that the jig had not been clamped to the press table.

Drilling should never be attempted until the material is clamped to the table. Also the fact that the drill was dull emphasizes the axiom that safety is synonymous with efficiency.

30. While an employee was getting tubes from a tube rack, an overhead crane passed carrying a boiler. The suspended boiler struck a tank and swung, striking employee in the abdomen. Employee suffered a hernia and was disabled 50 days. Investigation disclosed that crane was equipped with a warning signal, but that operator did not use it.

a. The warning gong should be installed so that it will sound automatically whenever the crane is in motion.

b. The movement of crane loads in congested areas should be planned in advance. All possible obstructions should be spotted and the riggers should be sure that the area is clear of other workers before giving the signal to move. Watchers should be assigned to signal the crane operator if the load comes close to any obstruction. In tight situations such as that described, taglines probably should be used to guide the load and prevent its swinging.

31. Employee was cleaning oil from the die of a forming machine without opening the power switch. While he was engaged in this work, the machine "tripped" suddenly and his fingers were crushed by the die. Investigation disclosed that the machine was activated by a foot pedal which was unguarded. It is assumed that operator may have accidentally touched the foot pedal.

a. When cleaning a press, the power should be disconnected, and preferably locked in the "off" position until the cleaning is completed.

b. The foot treadle should have a guard over it to prevent inadvertent operation of the press.

32. A hydraulic press operator was lifting a steel plate onto a roller. He caught his finger between 2 plates and amputated 1 finger. Investigation disclosed that the plates were heavy and that no mechanical handling equipment was available.

An accident of this kind calls for a thorough analysis of the job being performed. It may be

found possible to eliminate the lifting operation entirely; to provide mechanical lifting equipment; or it may be found that two men should be assigned to this operation. In any event, the elimination of the hazard probably will result in more efficient operations.

33. A welder was "hooking up" an engine on a crane in order to reposition engine. He had placed a hook in a cylinder hole at one end of the engine. While the welder was placing a second hook at the other end, the crane operator took up the slack in the chain and the welder's finger was caught between the hook and the engine and amputated. Investigation disclosed that the crane operator understood the nod of the welder's head to be a signal to lift.

"Hooking up" should preferably be done by a hookup man rather than the operator. A set of standard signals should be adopted and signals should be transmitted only by person doing the "hooking up." Crane operators should be required to accept only standard hand signals before moving crane.

34. An employee was at the end of a 75-foot shipping platform which had steps only at the other end. Instead of walking the length of the platform and using the steps, he jumped 4 feet to the ground and twisted his ankle. He was disabled 1 week.

Jumping from a loading platform is an unsafe practice which is very difficult to control. Its elimination requires thorough training in safe procedures and persistent enforcement of safe procedures by supervisors.

In a situation such as this, the provision of additional steps to eliminate the need for walking so far to get down from the platform would undoubtedly reduce the incentive to jump down.

35. An employee had been using a ladder to reach a slingload of pipe in order to adjust the sling. When he started to descend the ladder, it slipped away from the wall against which it had been placed. Employee fell 12 feet to the floor and bruised his feet. Lost time: 1 week. Investigation disclosed that the ladder was not equipped with safety shoes.

a. When necessary to adjust the sling, the hook should be lowered and adjustments made from the floor.

b. Ladders should be equipped with safety shoes, and employees should be thoroughly trained in the safe placement and use of ladders.

36. An employee was using a chain hoist to move a burner. When he released the chain, the burner tipped and employee strained his back trying to steady the burner. Lost time: 68 days. Investigation disclosed that employee attempted to "land" the burner on an uneven floor.

Efficient working conditions require even floors in all workplaces. An accident such as this indicates the need for an investigation of work practices throughout the shop, not only for safety but also for efficiency.

37. An employee was drilling holes in a boiler plate, using an electric portable drill with a T-handle. When the drill broke through the plate, it "hung" and twisted the handle out of employee's hands. When he tried to regain his hold while the handle was revolving, it struck and fractured his wrist. Disability: 121 days.

This accident may have resulted from a number of causes--a dull drill, a hard spot in the metal, inadequate power of the drill, poor footing, wearing gloves, etc. However, a pressure-type switch when released would stop the drill.

38. An employee was holding a drift pin, while a second employee struck it with a hammer. The coworker missed the pin and struck the first employee's finger. He was disabled for 3 days with a fractured finger. Investigation disclosed that the employee was not using any kind of holding tool to hold the pin.

Holding devices are practical but considerable effort is necessary to get the men to use them. Provision of the tools, training in their use, and supervisory enforcement of their use are all essential elements in eliminating this kind of accident.

39. An employee, descending steps into boilerroom, slipped and fell to the floor fracturing his leg. Disability: 74 days. Investigation disclosed that the stairway was steep, in the form of a spiral, and that there were no safety treads.

Spiral stairs are always dangerous and their installation should not be permitted. Where they are installed, handrails must be used if stairs are to be descended safely.

40. An employee was cranking an air compressor. The crank failed to release when the engine started and the employee was thrown against the wall of the building. He suffered multiple lacerations and contusions and a fractured wrist. He was disabled 22 days.

Obviously, a mechanical starter is the answer. Where a starter is not provided, the crank should be engaged at the bottom of the cycle and raised only to the top, with the thumb and fingers on the same side of the crank handle. No effort should be made to spin the crank. This is a procedure which must be taught to most workers.

41. An employee was cutting material on a shear without using a guide. As the knife descended, the metal stock slipped forward and employee's finger was amputated by the knife. Investigation disclosed that the shear was unguarded.

Shears should be equipped with a stock guide and a holddown device to prevent the stock from moving. A two-handed tripping device, a gate guard, or other device to prevent the hands of the operator from entering the danger zone is also necessary for safe operation.

42. An employee was standing on a temporary scaffold welding a tank. The scaffold had been assembled by the welding crew from lumber available in the shop. It was a stable structure, but it had neither a rail nor a toe board. The welder somehow lost his balance and fell to the floor. He was disabled 6 days with a broken rib.

The construction of safe scaffolds requires specialized training and skills which most workers do not possess. It is, therefore, an unsafe procedure to require or permit working crews to assemble their own scaffolds. This work should be assigned to a specialist who is well versed in the standard requirements for safe scaffolding. The supervisor of the workers who are to use the scaffold should personally check it for safety before it is used.

For in-plant work, a manufactured permanent-type scaffold, possibly equipped with casters for maneuverability, is generally safer and more economical than the use of temporary scaffolds.

43. An employee was operating a grinder. Without looking, he reached for the switch to open it. His thumb was caught between the V-belt and its pulley and amputated. Investigation disclosed that the grinder was unguarded.

a. All pulleys and V-belts, of 13/32-inch width or greater, should be guarded, according to the American Standards Safety Code for Mechanical Power-Transmission Apparatus. Any V-belt and pulley, regardless of size, is dangerous because of the shearing action of this type of equipment.

b. Good practice in machine design requires placement of the control switch in a readily accessible position, free from obstructions or the possibility of contact with moving parts.

44. An employee was using a circular saw to cut crating material. A splinter caught his glove and pulled his hand into the saw. Parts of two fingers were amputated. Investigation disclosed the saw was unguarded.

Rule 4.1.2 of the American Standards Safety Code for Woodworking Machinery requires that the saw be enclosed by a hood which will automatically adjust itself to the thickness of material being cut. Rule 7.4.1 says that gloves should not be worn while operating machines. Flagrant disregard for safe practices here shows the need for better supervision and education of employees and supervisors.

45. A grinder was standing on a platform working on a steel drum. After completing his work, he stepped back and fell 5 feet to the floor. He suffered multiple bruises and was disabled 29 days. Investigation disclosed that the platform was unguarded.

Temporary work platforms should be constructed with all the safety features required for permanent platforms--handrails, toeboards, etc. This type of accident raises the question of whether the work was being done in the most efficient way. A study might show that the drum could be so placed that all work could be done from the floor.

46. An employee walking in the plant aisle stepped on an air line of a riveting hammer and turned his ankle when the line rolled. As a result of the sprained ankle, he was disabled for 10 days. Investigation disclosed that

the air line was attached to a compressor located on the opposite side of the aisle from the riveting operation.

Air lines should never be laid across an aisle. If impossible to locate the compressor on the same side of the aisle where the riveting is being done, the air line should be carried overhead to a point as near the riveter as possible.

In case of temporary necessity, a sign mounted on a standard could be used to warn of the hazard. There is always a temptation for persons to step on something rather than over it.

47. An engineer was taking measurements for the base of a boiler which was to be installed. As he turned, he fell 6 feet into the furnace pit, fracturing his arm. Lost time: 6 weeks. Investigation disclosed that the pit was unguarded.

Temporary excavations are frequently left unguarded because the time and effort to guard them does not seem worthwhile. The fact that they are temporary and work is being done on them is all the more reason why they should be protected, either by flooring them over or by use of a standard railing or guard rail.

48. Two employees were placing a steel plate on a work table. As one of them pushed the plate onto the table, he lacerated his hand on a sharp edge of the plate. He was disabled 6 days. Investigation disclosed that employees were not wearing gloves.

Gloves or hand pads are a "must" when handling a steel plate. A job safety analysis might show that a better way could be found to move the plate.

49. As a foreman was passing a grinder, some steel particles from the hand-grinding operation lodged in his eye. He was disabled 2 days. Investigation disclosed that the grinding operation was located in such a way that the steel particles were directed across an aisle and that the foreman was not wearing goggles.

The foreman should always wear goggles in eye-hazard areas not only to protect himself but to set an example for his men.

50. While an employee was reaming holes in a piece of boiler plate, a piece of steel scale struck his eye. He was disabled 4 days. Investigation disclosed that employee was wearing spectacle-type goggles.

Spectacle-type goggles offer frontal protection only. In such operations as this where there is a possibility of particles flying from the side; cover-all, cup-type, or spectacle-type goggles with side screens should be used.

51. An employee was using a sledge hammer to aline steel in machines. As he struck the steel with the hammer, a small piece chipped off and struck his eye. Employee lost an eye. Investigation disclosed that the employee was using a hammer with a hardened head and that he was not wearing goggles.

Any operation which involves hammering or sledging of metal requires the operator to wear goggles. Lack of an eye-safety program is indicated. Possibly a better way than using a sledge could be found to line up the work. Where it is necessary to strike steel objects, brass or other soft metal hammers should be provided and used.

52. A welder was working in a boiler shell, kneeling on one knee. He was disabled for 3 days as a result of a sprained knee. Investigation disclosed that the boiler shell was small and that the welder was working in a cramped position, making it necessary to kneel on one knee.

Working in cramped quarters is always disagreeable and dangerous. Kneepads would have made the work less uncomfortable and might have prevented the injury.

53. An employee was using a file to chamfer the edge of a shaft being turned on a lathe. The file slipped from the shaft and employee's hand struck, and was cut by, the revolving shaft. Disability: 4 days. Investigation disclosed that the tool normally used for this operation was dull and that employee had removed the rest from the lathe.

Using a file on a lathe is always dangerous and should be prohibited, except for minor touchup under controlled conditions. This is a flagrant example of the unsafe practice of using the wrong tool to do the job.

The basic question raised by this accident is, of course, why didn't the employee obtain a replacement for the regular tool when it became dull? Was there none available? Was the toolroom inconveniently located? Was he under pressure to complete the job? The answer may point the way to the prevention of similar accidents.

54. An employee was using a wood chisel to pry open a door which was stuck. The chisel slipped from the door and struck him in eye. He was disabled for 23 days. Investigation disclosed that a crowbar was available, but the employee preferred to use the chisel.

Doors should be so fitted and hung that they need not be pried open. But here is a case where a makeshift tool was used instead of a tool provided for the purpose.

55. An employee was using a steel hammer to remove steel pins from an assembly. A piece of steel chipped from the hammer and struck employee in arm. He was disabled for 16 days. Investigation disclosed that a babbit hammer was available for this operation, but employee elected not to use it.

This is an excellent illustration of the fact that workmen must be educated to recognize hazards, trained to avoid them, and that supervision by the foreman must be vigilant and constant.

56. While employee was operating a stationary grinder, the wheel broke and a piece of it struck the employee's leg. Disability: 2 days. Investigation disclosed that the speed of the wheel exceeded the maximum operating speed established by the manufacturer.

Wheel speeds are set by the manufacturer on the basis of grain of the abrasive, kind of bond, diameter of wheel, etc. They should never be exceeded. Lack of adequate toolroom control is indicated. The fact that the grinder was equipped with standard hood, proper flanges, and safety washers minimized the injury.

57. A maintenance mechanic was standing on a box to repair a machine. He slipped off the box and fell to the floor. He was disabled 2 days, owing to a sprained back.

A permanent, but portable platform should be available for work that cannot be done from the floor. Lack of supervision is suggested by the use of a makeshift device.

Table 1. Disabling work injuries in 136 boilershop-products plants, classified by activity of injured and extent of disability, 1951

Activity of injured	Number of disabling injuries					Number of days lost or charged		Average number of days charged per--	
	Total		Resulting in--						
	Number	Percent 1/	Death and permanent-total disability 2/	Permanent-partial disability	Temporary-total disability	Number	Percent 1/	Disabling injury	Temporary-total disability
Total	2,017	100.0	(1) 6	103	1,908	172,660	100.0	86	16
Operating machines	276	14.6	1	33	242	37,172	24.0	135	16
Using hand tools	460	24.4	--	19	441	30,179	19.5	66	14
Handling materials	766	40.6	1	34	731	47,183	30.5	62	17
Walking, etc.	232	12.3	--	5	227	14,300	9.2	62	17
Other activities	152	8.1	2	9	141	26,091	16.8	172	15
Unclassified; insufficient data	131	--	(1) 2	3	126	17,735	--	135	15

1/ Percents are based on classified cases only.
2/ Figures in parentheses indicate the number of permanent-total disabilities included.

Table 2. Disabling work injuries in 136 boilershop-products plants, classified by nature of injury, part of body injured, and extent of disability, 1951

Nature of injury and part of body injured	Number of disabling injuries					Number of days lost or charged		Average number of days charged per--	
	Total		Resulting in--						
	Number	Percent 1/	Death and permanent-total disability 2/	Permanent-partial disability	Temporary-total disability	Number	Percent 1/	Disabling injury	Temporary-total disability
Total	2,017	100.0	(1) 6	103	1,908	172,660	100.0	86	16
NATURE OF INJURY									
Amputations, enucleations	52	2.6	--	52	--	28,500	17.1	548	--
Bruises, contusions: Total	486	24.2	--	9	477	11,419	6.9	23	9
Without infection	465	23.2	--	9	456	10,960	6.6	24	9
With infection	21	1.0	--	--	21	459	.3	22	22
Burns, scalds (not chemical): Total	87	4.3	--	5	82	8,057	4.8	93	13
Without infection	70	3.5	--	4	66	4,912	2.9	70	14
With infection	17	.8	--	1	16	3,145	1.9	(3/)	(3/)
Cuts, lacerations: Total	289	14.3	--	11	278	25,738	15.4	89	12
Without infection	255	12.6	--	11	244	25,315	15.1	99	12
With infection	34	1.7	--	--	34	423	.3	12	12
Fractures	375	18.6	3	21	351	63,165	38.0	168	35
Hernias	47	2.3	--	--	47	2,350	1.4	50	50
Irritations from foreign bodies	184	9.1	--	--	184	813	.5	4	4
Occupational diseases	10	.5	(1) 1	--	9	6,150	3.7	(3/)	(3/)
Strains, sprains	424	21.1	--	5	419	14,043	8.4	33	13
Welder's flashes	46	2.3	--	--	46	226	.1	5	5
Other	15	.7	1	--	14	6,169	3.7	(3/)	(3/)
Unclassified; insufficient data	2	--	1	--	1	6,030	--	(3/)	(3/)
PART OF BODY INJURED									
Head: Total	366	18.1	3	11	352	33,838	19.6	92	7
Eye	265	13.1	--	6	259	12,301	7.1	46	6
Brain, skull	39	1.9	2	2	35	13,386	7.8	343	11
Other	62	3.1	1	3	58	8,151	4.7	131	10
Trunk: Total	483	23.9	(1) 2	3	478	22,559	13.1	47	19
Back	279	13.8	--	3	276	5,669	3.3	20	15
Abdomen	66	3.3	--	--	66	2,667	1.5	40	40
Chest (lungs), ribs	64	3.2	(1) 2	--	62	12,746	7.4	199	12
Shoulder	49	2.4	--	--	49	880	.5	18	18
Hip, pelvis	20	1.0	--	--	20	443	.3	22	22
Other	5	.2	--	--	5	154	.1	(3/)	(3/)
Upper extremities: Total	485	24.0	--	67	418	58,844	34.0	121	14
Arm	81	4.0	--	2	79	9,285	5.4	115	16
Hand	132	6.5	--	6	126	17,767	10.3	135	17
Finger	272	13.5	--	59	213	31,792	18.3	117	12
Lower extremities: Total	645	32.1	--	19	626	49,371	28.6	77	20
Leg	197	9.8	--	4	193	20,265	11.7	103	22
Foot	273	13.6	--	8	265	24,889	14.5	91	21
Toe	175	8.7	--	7	168	4,217	2.4	24	13
Body, general	38	1.9	1	3	34	8,048	4.7	212	16

1/ Percents are based on classified cases only.
2/ Figures in parentheses indicate the number of permanent-total disabilities included.
3/ Not computed because of small number of injuries.

Table 3. Disabling work injuries in 136 boilershop-products plants, classified by nature of injury, part of body injured, and product, 1951

Nature of injury and part of body injured	Total number of disabling injuries		Product					
			Heavy tanks		Boilers		Other	
	Number	Percent 1/	Number	Percent 1/	Number	Percent 1/	Number	Percent 1/
Total	2,017	100.0	1,074	100.0	334	100.0	609	100.0
NATURE OF INJURY								
Amputations, enucleations	52	2.6	25	2.3	8	2.4	19	3.1
Bruises, contusions	486	24.2	260	24.1	79	23.6	147	24.2
Burns, scalds	87	4.3	50	4.7	15	4.5	22	3.6
Cuts, lacerations	289	14.3	154	14.4	42	12.6	93	15.3
Fractures	375	18.6	182	17.0	62	18.6	131	21.5
Hernias	47	2.3	24	2.2	9	2.7	14	2.3
Irritations from foreign bodies	184	9.1	87	8.1	38	11.4	59	9.7
Occupational diseases	10	.5	8	.7	2	.6	--	--
Strains, sprains	424	21.1	240	22.4	68	20.3	116	19.1
Welder's flashes	46	2.3	36	3.4	7	2.1	3	.5
Other	15	.7	7	.7	4	1.2	4	.7
Unclassified; insufficient data	2	--	1	--	--	--	1	--
PART OF BODY INJURED								
Head: Total	366	18.1	193	18.0	74	22.2	99	16.3
Eye	265	13.1	143	13.3	50	15.0	72	11.9
Brain, skull	39	1.9	18	1.7	11	3.3	10	1.6
Other	62	3.1	32	3.0	13	3.9	17	2.8
Trunk: Total	483	23.9	252	23.5	82	24.6	149	24.5
Back	279	13.8	157	14.7	38	11.4	84	13.8
Abdomen	66	3.3	34	3.2	11	3.3	21	3.4
Chest (lungs), ribs	64	3.2	23	2.1	18	5.4	23	3.8
Shoulder	49	2.4	23	2.1	12	3.6	14	2.3
Hip, pelvis	20	1.0	11	1.0	3	.9	6	1.0
Other	5	.2	4	.4	--	--	1	.2
Upper extremities: Total	485	24.0	265	24.7	76	22.8	144	23.6
Arm	81	4.0	43	4.0	14	4.2	24	3.9
Hand	132	6.5	74	6.9	22	6.6	36	5.9
Finger	272	13.5	148	13.8	40	12.0	84	13.8
Lower extremities: Total	645	32.1	341	31.7	94	28.0	210	34.5
Leg	197	9.8	112	10.4	24	7.2	61	10.0
Foot	273	13.6	138	12.8	44	13.0	91	15.0
Toe	175	8.7	91	8.5	26	7.8	58	9.5
Body, general	38	1.9	23	2.1	8	2.4	7	1.1

1/ Percents are based on classified cases only.

Table 4. Disabling work injuries in 136 boilershop-products plants, classified by nature of injury, part of body injured, and activity of injured, 1951

Nature of injury and part of body injured	Total number of disabling injuries	Activity of injured								
		Operating machines	Using hand tools	Handling materials				Walking, etc.	Other	Unclassified; insufficient data
				Total	Lifting materials	Other	Unclassified			
Total	2,017	276	460	766	260	221	285	232	152	131
NATURE OF INJURY										
Amputations, enucleations	52	24	4	20	3	7	10	--	3	1
Bruises, contusions	486	61	104	196	44	60	92	66	35	24
Burns, scalds	87	2	49	5	1	3	1	3	21	7
Cuts, lacerations	289	67	62	96	24	21	51	33	12	19
Fractures	375	64	59	165	33	61	71	36	25	26
Hernias	47	2	10	28	17	4	7	6	1	--
Irritations from foreign bodies	184	34	90	7	1	2	4	8	23	22
Occupational diseases	10	3	3	1	--	1	--	--	1	2
Strains, sprains	424	16	56	246	137	60	49	78	12	16
Welder's flashes	46	1	18	2	--	2	--	--	12	13
Other	15	1	5	--	--	--	--	2	6	1
Unclassified; insufficient data	2	1	--	--	--	--	--	--	1	--
PART OF BODY INJURED										
Head: Total	366	53	156	33	2	15	16	27	51	46
Eye	265	38	130	9	1	4	4	11	40	37
Brain, skull	39	5	7	11	--	6	5	8	6	2
Other	62	10	19	13	1	5	7	8	5	7
Trunk: Total	483	20	84	264	148	57	59	74	23	18
Back	279	9	33	180	109	41	30	37	10	10
Abdomen	66	4	17	35	21	7	7	7	3	--
Chest (lungs), ribs	64	1	14	25	12	4	9	15	5	4
Shoulder	49	4	16	16	5	4	7	8	4	1
Hip, pelvis	20	1	3	8	1	1	6	5	1	2
Other	5	1	1	--	--	--	--	2	--	1
Upper extremities: Total	485	123	89	196	46	57	93	21	36	20
Arm	81	14	17	28	6	12	10	6	11	5
Hand	132	20	33	53	15	13	25	10	11	5
Finger	272	89	39	115	25	32	58	5	14	10
Lower extremities: Total	645	76	120	271	64	91	116	103	31	44
Leg	197	19	45	58	15	22	21	47	14	14
Foot	273	32	41	122	31	38	53	51	11	16
Toe	175	25	34	91	18	31	42	5	6	14
Body, general	38	4	11	2	--	1	1	7	11	3

Table 5. Disabling work injuries in 136 boilershop-products plants, classified by part of body injured, source of injury, and nature of injury, 1951

Part of body injured and source of injury	Total number of injuries	Nature of injury											
		Amputations, enucleations	Bruises, contusions	Burns, scalds	Cuts, lacerations	Fractures	Hernias	Irritations from foreign bodies	Occupational diseases	Strains	Welder's flashes	Other	Unclassified; insufficient data
Total	2,017	52	486	87	289	375	47	184	10	424	46	15	2
PART OF BODY INJURED													
Head: Total	366	2	43	22	59	9	--	184	--	--	46	1	--
Eye	265	2	6	16	11	--	--	183	--	--	46	1	--
Brain, skull	39	--	13	1	20	5	--	--	--	--	--	--	--
Other	62	--	24	5	28	4	--	1	--	--	--	--	--
Trunk: Total	483	--	78	5	9	40	47	--	2	300	--	2	--
Back	279	--	23	2	3	4	--	--	--	247	--	--	--
Abdomen	66	--	10	1	3	--	47	--	--	4	--	1	--
Chest, ribs	64	--	22	2	2	24	--	--	2	11	--	1	--
Shoulder	49	--	14	--	1	5	--	--	--	29	--	--	--
Hip, pelvis	20	--	7	--	--	6	--	--	--	7	--	--	--
Other	5	--	2	--	--	1	--	--	--	2	--	--	--
Upper extremities: Total	485	45	108	25	148	118	--	--	2	36	--	3	--
Arm	81	--	29	8	14	17	--	--	--	12	--	1	--
Hand	132	--	24	13	46	29	--	--	2	17	--	1	--
Finger	272	45	55	4	88	72	--	--	--	7	--	1	--
Lower extremities: Total	645	5	249	26	70	207	--	--	1	86	--	1	--
Leg	197	--	85	13	41	18	--	--	--	39	--	1	--
Foot	273	1	108	13	24	79	--	--	1	47	--	--	--
Toe	175	4	56	--	5	110	--	--	--	--	--	--	--
Body, general	38	--	8	9	3	1	--	--	5	2	--	8	2
SOURCE OF INJURY													
Metal stock	470	16	147	2	80	110	11	--	1	102	--	--	1
Assemblies	249	2	82	1	25	62	11	--	--	66	--	--	--
Chips, particles	238	2	7	11	34	5	1	178	--	--	--	--	--
Hand tools: Total	148	2	49	2	29	31	6	--	--	29	--	--	--
Powered	42	--	8	--	18	7	--	--	--	9	--	--	--
Hammers, not powered	43	1	19	--	1	16	--	--	--	6	--	--	--
Other	63	1	22	2	10	8	6	--	--	14	--	--	--
Working surfaces: Total	126	--	26	--	7	38	1	--	--	54	--	--	--
Floors	93	--	20	--	4	26	1	--	--	42	--	--	--
Ground, yard	27	--	4	--	2	12	--	--	--	9	--	--	--
Other	6	--	2	--	1	--	--	--	--	3	--	--	--
Machines	105	21	22	1	29	20	1	--	--	11	--	--	--
Hoisting apparatus: Total	86	7	27	--	18	24	--	--	--	10	--	--	--
Cranes	59	6	20	--	11	20	--	--	--	2	--	--	--
Other	27	1	7	--	7	4	--	--	--	8	--	--	--
Machine parts	54	--	24	--	5	14	1	--	--	10	--	--	--
Radiations	48	--	--	2	--	--	--	--	--	--	46	--	--
Containers	47	--	7	--	7	5	5	--	--	23	--	--	--
Lumber	44	--	14	--	11	7	--	--	--	12	--	--	--
Vehicles	43	--	17	--	3	12	1	--	--	10	--	--	--
Bodily motions	42	--	--	--	--	--	3	--	--	39	--	--	--
Other	307	2	63	68	40	47	6	6	9	50	--	15	1
Unclassified; insufficient data	10	--	1	--	1	--	--	--	--	8	--	--	--

Table 6. Disabling work injuries in 136 boilershop-products plants, classified by source of injury and extent of disability, 1951

Source of injury	Number of disabling injuries					Number of days lost or charged		Average number of days charged per--	
	Total		Resulting in--						
	Number	Percent 1/	Death and permanent-total disability 2/	Permanent-partial disability	Temporary-total disability	Number	Percent 1/	Disabling injury	Temporary-total disability
Total	2,017	100.0	(1) 6	103	1,908	172,660	100.0	86	16
Metal stock	470	23.4	2	26	442	45,791	26.5	97	16
Assemblies	249	12.4	--	11	238	18,828	10.9	76	20
Chips, particles	238	11.9	--	7	231	12,888	7.5	54	7
Hand tools: Total	148	7.4	--	5	143	3,492	2.0	24	14
Powered	42	2.1	--	1	41	963	.6	23	16
Hammers, not powered	43	2.1	--	2	41	986	.6	23	9
Other	63	3.2	--	2	61	1,543	.8	24	15
Working surfaces: Total	126	6.3	--	3	123	6,965	4.0	55	23
Floors	93	4.7	--	2	91	5,654	3.2	61	24
Ground, yard	27	1.3	--	1	26	1,198	.7	44	23
Other	6	.3	--	--	6	113	.1	(3/)	(3/)
Machines	105	5.2	--	24	81	17,001	9.9	162	19
Hoisting apparatus: Total	86	4.3	1	11	74	19,423	11.3	226	18
Cranes	59	3.0	1	9	49	18,541	10.8	314	21
Other	27	1.3	--	2	25	882	.5	33	11
Machine parts	54	2.7	--	1	53	1,158	.7	21	12
Radiations	48	2.4	--	--	48	234	.1	5	5
Containers	47	2.3	--	1	46	4,765	2.8	101	17
Lumber	44	2.2	--	--	44	802	.5	18	18
Vehicles	43	2.1	1	1	41	7,497	4.3	174	22
Bodily motions	42	2.1	--	1	41	1,291	.7	31	19
Other	307	15.3	(1) 2	12	293	32,377	18.8	105	17
Unclassified; insufficient data	10	--	--	--	10	148	--	(3/)	(3/)

1/ Percents are based on classified cases only.
2/ Figures in parentheses indicate the number of permanent-total disabilities included.
3/ Not computed because of small number of injuries.

Table 7. Disabling work injuries in 136 boilershop-products plants, classified by type of accident and extent of disability, 1951

Type of accident	Number of disabling injuries					Number of days lost or charged		Average number of days charged per--	
	Total		Resulting in--						
	Number	Percent 1/	Death and permanent-total disability 2/	Permanent-partial disability	Temporary-total disability	Number	Percent 1/	Disabling injury	Temporary-total disability
Total	2,017	100.0	(1) 6	103	1,908	172,660	100.0	86	16
Striking against: Total	155	7.7	--	7	148	12,392	7.2	80	12
Stationary objects	119	5.9	--	4	115	11,018	6.4	93	11
Moving objects	36	1.8	--	3	33	1,374	.8	38	14
Struck by: Total	679	33.9	1	33	645	62,505	36.2	92	18
Falling objects: Total	455	22.8	1	17	437	39,932	23.1	88	19
From hands of workers	149	7.5	--	--	149	2,232	1.3	15	15
From equipment	149	7.5	1	13	135	26,950	15.6	181	19
From piles of materials	43	2.1	--	--	43	914	.5	21	21
From standing positions	39	1.9	--	--	39	883	.5	23	23
From other positions	75	3.8	--	4	71	8,953	5.2	119	21
Rolling or swinging objects	83	4.1	--	4	79	7,744	4.5	93	20
Flying objects	59	2.9	--	7	52	12,204	7.1	207	17
Hand-wielded objects	52	2.6	--	4	48	1,914	1.1	37	11
Other moving objects	30	1.5	--	1	29	711	.4	24	14
Falls on same level: Total	146	7.3	1	2	143	9,405	5.5	64	16
To walkways or working surfaces	54	2.7	--	1	53	1,509	.9	28	17
On or against other objects	92	4.6	1	1	90	7,896	4.6	86	16
Falls to different levels: Total	101	5.0	1	2	98	11,827	6.9	117	24
From ladders	30	1.5	--	2	28	4,370	2.5	146	31
From other elevations	71	3.5	1	--	70	7,457	4.4	105	21
Caught in, on, or between: Total	213	10.6	1	49	163	40,877	23.7	192	22
Between a moving and stationary object	176	8.8	1	38	137	33,922	19.7	193	22
Between two or more moving objects	26	1.3	--	10	16	6,377	3.7	245	(3/)
In a moving object	11	.5	--	1	10	578	.3	(3/)	(3/)
Rubbed, abraded: Total	219	10.9	--	--	219	1,136	.7	5	5
By foreign bodies in eyes	179	9.0	--	--	179	774	.5	4	4
By objects being handled	27	1.3	--	--	27	211	.1	8	8
By other objects	13	.6	--	--	13	151	.1	12	12
Overexertion: Total	294	14.6	--	4	290	12,318	7.1	42	17
Lifting or carrying objects	189	9.4	--	3	186	8,271	4.8	44	18
Pulling or pushing objects	78	3.9	--	1	77	3,822	2.2	49	18
Swinging objects	20	1.0	--	--	20	202	.1	10	10
Other activities	7	.3	--	--	7	23	(4/)	(3/)	(3/)
Contact with temperature extremes	78	3.9	--	4	74	4,927	2.9	63	13
Contact with radiations, caustics, and noxious substances	69	3.4	(1) 2	--	67	12,484	7.2	181	7
Bodily reactions	42	2.1	--	1	41	1,291	.7	31	19
Other accident types	12	.6	--	1	11	3,351	1.9	(3/)	(3/)
Unclassified; insufficient data	9	--	--	--	9	147	--	(3/)	(3/)

1/ Percents are based on classified cases only.
2/ Figures in parentheses indicate the number of permanent-total disabilities included.
3/ Not computed because of small number of injuries.
4/ Less than 0.05.

Table 8. Work accidents in 136 boilershop-products plants, classified by type of accident and activity of injured, 1951

Type of accident	Total number of accidents	Activity of injured					
		Operating machines	Using hand tools	Handling materials	Walking, etc.	Other	Unclassified; insufficient data
Total	2,017	276	460	766	232	152	131
Striking against: Total	155	20	33	35	54	6	7
Stationary objects	119	3	20	31	53	6	6
Moving objects	36	17	13	4	1	--	1
Struck by: Total	679	113	155	302	25	38	46
Falling objects: Total	455	75	65	244	13	22	36
From hands of workers	149	7	17	121	--	2	2
From equipment	149	55	19	44	4	7	20
From piles of materials	43	5	1	28	4	3	2
From standing positions	39	2	12	14	2	5	4
From other positions	75	6	16	37	3	5	8
Rolling or swinging objects	83	23	11	34	5	7	3
Flying objects	59	11	30	5	1	8	4
Hand-wielded objects	52	--	41	7	3	--	1
Other moving objects	30	4	8	12	3	1	2
Falls on same level: Total	146	7	19	36	67	11	6
To walkways or working surfaces	54	2	4	13	28	5	2
On or against other objects	92	5	15	23	39	6	4
Falls to different levels: Total	101	1	23	16	41	13	7
From ladders	30	--	2	3	18	4	3
From other elevations	71	1	21	13	23	9	4
Caught in, on, or between: Total	213	79	9	98	2	16	9
Between a moving and stationary object	176	60	8	88	1	13	6
Between two or more moving objects	26	14	--	9	--	2	1
In a moving object	11	5	1	1	1	1	2
Rubbed, abraded: Total	219	41	95	29	9	23	22
By foreign bodies in eyes	179	34	88	7	7	21	22
By objects being handled	27	4	3	20	--	--	--
By other objects	13	3	4	2	2	2	--
Overexertion: Total	294	9	33	239	7	4	2
Lifting or carrying objects	189	--	2	183	2	1	1
Pulling or pushing objects	78	6	13	56	1	2	--
Swinging objects	20	1	18	--	1	--	--
Other activities	7	2	--	--	3	1	1
Contact with temperature extremes	78	1	49	4	4	15	5
Contact with radiations, caustics, and noxious substances	69	4	24	2	1	19	19
Bodily reactions	42	--	15	3	22	--	2
Other accident types	12	1	3	1	--	7	--
Unclassified; insufficient data	9	--	2	1	--	--	6

Table 9. Work accidents in 136 boilershop-products plants, classified by type of accident and product, 1951

Type of accident	Total number of accidents		Product					
			Heavy tanks		Boilers		Other	
	Number	Percent 1/	Number	Percent 1/	Number	Percent 1/	Number	Percent 1/
Total	2,017	100.0	1,074	100.0	334	100.0	609	100.0
Striking against: Total	155	7.7	84	7.9	22	6.6	49	8.1
Stationary objects	119	5.9	64	6.0	17	5.1	38	6.3
Moving objects	36	1.8	20	1.9	5	1.5	11	1.8
Struck by: Total	679	33.9	334	31.1	116	35.1	229	37.6
Falling objects: Total	455	22.8	221	20.5	75	22.8	159	26.0
From hands of workers	149	7.5	70	6.5	33	10.2	46	7.6
From equipment	149	7.5	78	7.2	16	4.8	55	8.9
From piles of materials	43	2.1	17	1.6	9	2.7	17	2.8
From standing positions	39	1.9	16	1.5	10	3.0	13	2.1
From other positions	75	3.8	40	3.7	7	2.1	28	4.6
Rolling or swinging objects	83	4.1	38	3.6	19	5.7	26	4.3
Flying objects	59	2.9	24	2.2	9	2.7	26	4.3
Hand-wielded objects	52	2.6	30	2.8	11	3.3	11	1.8
Other moving objects	30	1.5	21	2.0	2	.6	7	1.2
Falls on same level: Total	146	7.3	81	7.6	24	7.3	41	6.7
To walkways or working surfaces	54	2.7	29	2.7	8	2.4	17	2.8
On or against other objects	92	4.6	52	4.9	16	4.9	24	3.9
Falls to different levels: Total	101	5.0	51	4.8	22	6.6	28	4.6
From ladders	30	1.5	16	1.5	6	1.8	8	1.3
From other elevations	71	3.5	35	3.3	16	4.8	20	3.3
Caught in, on, or between: Total	213	10.6	115	10.8	28	8.5	70	11.5
Between a moving and stationary object	176	8.8	92	8.6	20	6.1	64	10.5
Between two or more moving objects	26	1.3	16	1.5	6	1.8	4	.7
In a moving object	11	.5	7	.7	2	.6	2	.3
Rubbed, abraded: Total	219	10.9	105	9.8	43	13.0	71	11.7
By foreign bodies in eyes	179	9.0	84	7.8	36	10.9	59	9.7
By objects being handled	27	1.3	16	1.5	4	1.2	7	1.2
By other objects	13	.6	5	.5	3	.9	5	.8
Overexertion: Total	294	14.6	171	16.0	44	13.3	79	13.0
Lifting or carrying objects	189	9.4	108	10.1	25	7.6	56	9.2
Pulling or pushing objects	78	3.9	46	4.3	14	4.2	18	3.0
Swinging objects	20	1.0	12	1.1	5	1.5	3	.5
Other activities	7	.3	5	.5	--	--	2	.3
Contact with temperature extremes	78	3.9	47	4.4	14	4.2	17	2.8
Contact with radiations, caustics, and noxious substances	69	3.4	50	4.7	11	3.3	8	1.3
Bodily reactions	42	2.1	26	2.4	4	1.2	12	2.0
Other accident types	12	.6	5	.5	3	.9	4	.7
Unclassified; insufficient data	9	--	5	--	3	--	1	--

1/ Percents are based on classified cases only.

Table 10. Work accidents in 136 boilershop-products plants, classified by type of accident and source of injury, 1951

Type of accident	Total number of accidents	Source of injury														
		Metal stock	Assemblies	Chips, particles	Hand tools	Working surfaces	Machines	Hoisting apparatus	Machine parts	Radiations	Containers	Lumber	Vehicles	Bodily motions	Other	Unclassified; insufficient data
Total	2,017	470	249	238	148	126	105	86	54	48	47	44	43	42	307	10
Striking against: Total	155	29	23	2	14	6	36	4	2	--	4	7	8	--	20	--
Stationary objects	119	28	22	2	2	6	15	3	2	--	4	7	8	--	20	--
Moving objects	36	1	1	--	12	--	21	1	--	--	--	--	--	--	--	--
Struck by: Total	679	227	108	45	93	--	5	35	33	--	11	19	7	--	96	--
Falling objects: Total	455	201	92	--	36	--	2	5	29	--	10	9	--	--	71	--
From hands of workers	149	70	28	--	17	--	--	1	9	--	7	4	--	--	13	--
From equipment	149	71	28	--	9	--	1	1	13	--	--	2	--	--	24	--
From piles of materials	43	26	8	--	--	--	--	--	2	--	1	1	--	--	5	--
From standing positions	39	5	14	--	3	--	--	--	2	--	1	1	--	--	13	--
From other positions	75	29	14	--	7	--	1	3	3	--	1	1	--	--	16	--
Rolling or swinging objects	83	20	11	--	3	--	3	25	3	--	--	3	5	--	10	--
Flying objects	59	--	--	45	3	--	--	--	--	--	--	4	--	--	7	--
Hand-wielded objects	52	1	--	--	47	--	--	--	--	--	--	2	--	--	2	--
Other moving objects	30	5	5	--	4	--	--	5	1	--	1	1	2	--	6	--
Falls on same level: Total	146	27	16	--	4	52	10	--	2	--	2	6	6	--	21	--
To walkways or working surfaces	54	--	--	--	--	51	--	--	--	--	--	--	1	--	2	--
On or against other objects	92	27	16	--	4	1	10	--	2	--	2	6	5	--	19	--
Falls to different levels: Total	101	7	8	--	--	65	2	--	--	--	1	2	3	--	13	--
From ladders	30	1	1	--	--	25	--	--	--	--	1	--	--	--	2	--
From other elevations	71	6	7	--	--	40	2	--	--	--	--	2	3	--	11	--
Caught in, on, or between: Total	213	69	18	--	3	--	45	39	5	--	1	--	13	--	20	--
Between a moving and stationary object	176	63	18	--	2	--	26	31	5	--	1	--	13	--	17	--
Between two or more moving objects	26	6	--	--	--	--	11	7	--	--	--	--	--	--	2	--
In a moving object	11	--	--	--	1	--	8	1	--	--	--	--	--	--	1	--
Rubbed, abraded: Total	219	15	8	179	2	1	--	--	1	--	1	2	1	--	9	--
By foreign bodies in eyes	179	--	--	175	--	--	--	--	--	--	--	--	--	--	4	--
By objects being handled	27	13	4	2	2	--	--	--	1	--	1	1	1	--	2	--
By other objects	13	2	4	2	--	1	--	--	--	--	--	1	--	--	3	--
Overexertion: Total	294	94	67	--	31	2	7	8	11	--	27	8	5	--	33	1
Lifting or carrying objects	189	78	40	--	1	--	2	1	11	--	25	6	1	--	24	--
Pulling or pushing objects	78	15	27	--	11	--	2	7	--	--	2	1	4	--	9	--
Swinging objects	20	--	--	--	19	--	1	--	--	--	--	--	--	--	--	--
Other activities	7	1	--	--	--	2	2	--	--	--	--	1	--	--	--	1
Contact with temperature extremes	78	2	1	11	1	--	--	--	--	--	--	--	--	--	63	--
Contact with radiations, caustics, and noxious substances	69	--	--	1	--	--	--	--	--	48	--	--	--	--	20	--
Bodily reactions	42	--	--	--	--	--	--	--	--	--	--	--	--	42	--	--
Other accident types	12	--	--	--	--	--	--	--	--	--	--	--	--	--	12	--
Unclassified; insufficient data	9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9

Table 11. Work accidents in 135 boilershop-products plants, classified by type of accident and hazardous working condition, 1951

Type of accident	Total number of accidents	Hazardous working condition						
		Hazardous procedures	Placement hazards	Inadequately guarded	Defects of agencies	Dress or apparel hazards	Environmental hazards	Unclassified; insufficient data
Total	2,014	493	368	294	271	253	115	220
Striking against: Total	155	14	32	39	23	1	29	17
Stationary objects	119	13	32	5	23	1	29	16
Moving objects	36	1	--	34	--	--	--	1
Struck by: Total	677	145	209	119	91	7	22	84
Falling objects: Total	453	113	168	68	58	--	11	35
From hands of workers	148	103	1	7	21	--	--	16
From equipment	149	4	50	58	27	--	3	7
From piles of materials	43	1	37	--	--	--	5	--
From standing positions	38	1	32	--	2	--	2	1
From other positions	75	4	48	3	8	--	1	11
Rolling or swinging objects	83	12	29	20	12	--	5	5
Flying objects	59	6	3	25	13	6	1	5
Hand-wielded objects	52	6	--	4	6	1	4	31
Other moving objects	30	8	9	2	2	--	1	8
Falls on same level: Total	146	5	72	5	44	--	9	11
To walkways or working surfaces	54	1	19	2	20	--	6	6
On or against other objects	92	4	53	3	24	--	3	5
Falls to different levels: Total	101	35	7	32	26	--	--	1
From ladders	30	--	3	18	9	--	--	--
From other elevations	71	35	4	14	17	--	--	1
Caught in, on, or between: Total	213	50	27	80	7	--	28	21
Between a moving and stationary object	176	47	23	52	7	--	28	19
Between two or more moving objects	26	3	4	17	--	--	--	2
In a moving object	11	--	--	11	--	--	--	--
Rubbed, abraded: Total	218	6	1	1	30	156	--	24
By foreign bodies in eyes	178	3	--	--	2	154	--	19
By objects being handled	27	2	--	--	23	2	--	--
By other objects	13	1	1	1	5	--	--	5
Overexertion: Total	294	227	11	--	24	--	2	30
Lifting or carrying objects	189	167	4	--	12	--	2	4
Pulling or pushing objects	78	53	6	--	10	--	--	9
Swinging objects	20	5	--	--	--	--	--	15
Other activities	7	2	1	--	2	--	--	2
Contact with temperature extremes	78	5	2	11	5	37	6	12
Contact with radiations, caustics, and noxious substances	69	1	--	3	3	52	6	4
Bodily reactions	42	4	6	--	12	--	13	7
Other accident types	12	1	1	4	6	--	--	--
Unclassified; insufficient data	9	--	--	--	--	--	--	9

Table 12. Disabling work injuries in 135 boilershop-products plants, classified by hazardous working condition and extent of disability, 1951

Hazardous working condition	Number of disabling injuries					Number of days lost or charged		Average number of days charged per--	
	Total		Resulting in --						
	Number	Percent 1/	Death and permanent-total disability 2/	Permanent-partial disability	Temporary-total disability	Number	Percent 1/	Disabling injury	Temporary-total disability
Total	2,014	100.0	(1) 6	103	1,905	172,625	100.0	86	16
Hazardous procedures: Total	493	27.5	1	19	473	32,813	20.4	67	18
Manual handling of heavy objects	350	19.6	--	8	342	14,284	8.8	41	17
Lack of adequate working surface	51	2.8	1	1	49	10,871	6.8	213	18
Other	92	5.1	--	10	82	7,658	4.8	83	21
Placement hazards: Total	368	20.5	--	9	359	20,101	12.5	55	18
Improperly placed	196	10.9	--	1	195	3,737	2.3	19	18
Improperly piled	80	4.5	--	4	76	6,293	3.9	79	20
Inadequately secured	92	5.1	--	4	88	10,071	6.3	109	16
Inadequately guarded: Total	294	16.4	2	44	248	55,271	34.3	188	21
Lack of point-of-operation guard	132	7.4	--	23	109	14,901	9.3	113	19
Other	162	9.0	2	21	139	40,370	25.0	249	22
Defects of agencies: Total	271	15.1	--	11	260	18,651	11.6	69	16
Slippery	93	5.2	--	2	91	5,218	3.2	56	18
Worn, cracked, broken	72	4.0	--	5	67	5,305	3.3	74	18
Improperly constructed	32	1.8	--	2	30	3,680	2.3	115	13
Sharp-edged	27	1.5	--	--	27	280	.2	10	10
Other	47	2.6	--	2	45	4,168	2.6	89	15
Dress or apparel hazards: Total	253	14.1	--	5	248	9,111	5.7	36	5
Inadequate personal safety equipment	143	8.0	--	2	141	3,133	1.9	22	5
Lack of personal safety equipment	106	5.9	--	3	103	5,953	3.8	56	5
Inadequate clothing	4	.2	--	--	4	25	(4/)	(3/)	(3/)
Environmental hazards: Total	115	6.4	(1) 3	6	106	24,946	15.5	217	21
Inadequate work space	103	5.7	2	6	95	18,666	11.6	181	21
Other	12	.7	(1) 1	--	11	6,280	3.9	(3/)	(3/)
Unclassified; insufficient data	220	--	--	9	211	11,732	--	53	12

1/ Percents are based on classified cases only.
2/ Figures in parentheses indicate the number of permanent-total disabilities included.
3/ Not computed because of small number of injuries.
4/ Less than 0.05.

Table 13. Work accidents in 135 boilershop-products plants, classified by hazardous working condition and product, 1951

Hazardous working condition	Total number of accidents		Product					
			Heavy tanks		Boilers		Other	
	Number	Percent 1/	Number	Percent 1/	Number	Percent 1/	Number	Percent 1/
Total	2,014	100.0	1,074	100.0	334	100.0	606	100.0
Hazardous procedures: Total	493	27.5	264	27.8	89	30.6	140	25.3
Manual handling of heavy objects	350	19.6	188	19.8	64	22.0	98	17.7
Lack of adequate working surface	51	2.8	26	2.7	9	3.1	16	2.9
Other	92	5.1	50	5.3	16	5.5	26	4.7
Placement hazards: Total	368	20.5	195	20.5	46	15.9	127	22.9
Improperly placed	196	10.9	108	11.3	22	7.6	66	11.9
Improperly piled	80	4.5	33	3.5	13	4.5	34	6.1
Inadequately secured	92	5.1	54	5.7	11	3.8	27	4.9
Inadequately guarded: Total	294	16.4	149	15.7	43	14.8	102	18.4
Lack of point-of-operation guard	132	7.4	64	6.7	19	6.6	49	8.8
Other	162	9.0	85	9.0	24	8.2	53	9.6
Defects of agencies: Total	271	15.1	140	14.7	47	16.2	84	15.2
Slippery	93	5.2	48	5.0	18	6.3	27	4.8
Worn, cracked, broken	72	4.0	35	3.7	14	4.8	23	4.2
Improperly constructed	32	1.8	14	1.5	3	1.0	15	2.7
Sharp-edged	27	1.5	17	1.8	3	1.0	7	1.3
Other	47	2.6	26	2.7	9	3.1	12	2.2
Dress or apparel hazards: Total.	253	14.1	135	14.2	48	16.6	70	12.6
Inadequate personal safety equipment	143	8.0	72	7.6	26	9.1	45	8.1
Lack of personal safety equipment	106	5.9	61	6.4	21	7.2	24	4.3
Inadequate clothing	4	.2	2	.2	1	.3	1	.2
Environmental hazards: Total	115	6.4	67	7.1	17	5.9	31	5.6
Inadequate work space	103	5.7	59	6.2	15	5.2	29	5.2
Other	12	.7	8	.9	2	.7	2	.4
Unclassified; insufficient data	220	--	124	--	44	--	52	--

1/ Percents are based on classified cases only.

Table 14. Work accidents in 135 boilershop-products plants, classified by hazardous working condition and activity of injured, 1951

Hazardous working condition	Total number of accidents	Activity of injured					
		Operating machines	Using hand tools	Handling materials	Walking, etc.	Other	Unclassified; insufficient data
Total	2,014	276	460	765	232	152	129
Hazardous procedures: Total	493	18	40	380	26	24	5
Manual handling of heavy objects.	350	9	4	332	1	1	3
Lack of adequate working surface.	51	1	19	10	9	11	1
Other	92	8	17	38	16	12	1
Placement hazards: Total	368	34	56	156	74	28	20
Improperly placed	196	15	23	63	65	17	13
Improperly piled	80	6	3	61	7	2	1
Inadequately secured	92	13	30	32	2	9	6
Inadequately guarded: Total	294	125	59	44	25	17	24
Lack of point-of-operation guard.	132	77	36	7	3	1	8
Other	162	48	23	37	22	16	16
Defects of agencies: Total	271	40	61	92	46	22	10
Slippery	93	4	9	36	36	3	5
Worn, cracked, broken	72	9	37	15	6	4	1
Improperly constructed	32	12	4	11	1	2	2
Sharp-edged	27	5	3	18	--	--	1
Other	47	10	8	12	3	13	1
Dress or apparel hazards: Total	253	33	144	8	7	32	29
Inadequate personal safety equipment	143	15	100	2	1	11	14
Lack of personal safety equipment	106	18	41	6	6	21	14
Inadequate clothing	4	--	3	--	--	--	1
Environmental hazards: Total	115	12	18	37	29	11	8
Inadequate work space	103	12	15	36	26	8	6
Other	12	--	3	1	3	3	2
Unclassified; insufficient data	220	14	82	48	25	18	33

Table 15. Work accidents in 135 boilershop-products plants, classified by hazardous working condition and agency of accident, 1951

Hazardous working condition	Total number of accidents	Agency of accident													
		Metal stock	Hand tools	Assemblies	Machines	Hoisting apparatus	Goggles and shields	Working surfaces	Vehicles	Lumber	Containers	Ladders	Electrical apparatus	Other	Unclassified; insufficient data
Total	2,014	340	238	235	177	164	91	89	47	44	42	42	21	264	220
Hazardous procedures: Total	493	158	13	125	15	45	--	--	16	13	28	4	9	67	--
Manual handling of heavy objects	350	146	1	96	1	13	--	--	3	9	28	4	6	43	--
Lack of adequate working surface	51	1	3	24	8	3	--	--	5	1	--	--	1	5	--
Other	92	11	9	5	6	29	--	--	8	3	--	--	2	19	--
Placement hazards: Total	368	139	21	52	--	8	--	1	10	26	3	7	1	100	--
Improperly placed	196	58	16	10	--	5	--	1	5	21	2	7	1	70	--
Improperly piled	80	51	--	13	--	--	--	--	--	2	1	--	--	13	--
Inadequately secured	92	30	5	29	--	3	--	--	5	3	--	--	--	17	--
Inadequately guarded: Total	294	2	41	2	110	81	--	15	2	--	4	19	3	15	--
Lack of point-of-operation guard	132	--	34	--	98	--	--	--	--	--	--	--	--	--	--
Other	162	2	7	2	12	81	--	15	2	--	4	19	3	15	--
Defects of agencies: Total	271	30	46	19	15	16	1	69	8	4	4	12	8	39	--
Slippery	93	7	3	4	--	--	--	55	3	--	1	8	--	12	--
Worn, cracked, broken	72	1	28	5	1	8	--	7	3	1	--	4	1	13	--
Improperly constructed	32	--	4	3	10	2	1	3	--	--	1	--	2	6	--
Sharp-edged	27	15	--	6	1	--	--	--	--	1	1	--	--	3	--
Other	47	7	11	1	3	6	--	4	2	2	1	--	5	5	--
Dress or apparel hazards: Total	253	--	115	--	27	--	90	--	--	--	--	--	--	21	--
Inadequate personal safety equipment	143	--	45	--	3	--	90	--	--	--	--	--	--	5	--
Lack of personal safety equipment	106	--	66	--	24	--	--	--	--	--	--	--	--	16	--
Inadequate clothing	4	--	4	--	--	--	--	--	--	--	--	--	--	--	--
Environmental hazards: Total	115	11	2	37	10	14	--	4	11	1	3	--	--	22	--
Inadequate work space	103	11	2	34	10	14	--	4	11	1	2	--	--	14	--
Other	12	--	--	3	--	--	--	--	--	--	1	--	--	8	--
Unclassified; insufficient data	220	--	--	--	--	--	--	--	--	--	--	--	--	--	220

Table 16. Work accidents in 134 boilershop-products plants, classified by type of accident and unsafe act 1951

Type of accident	Total number of accidents	Unsafe act							
		Taking unsafe position or posture	Using unsafe equipment or equipment unsafely	Unsafe loading or placing	Operating without authority; failing to secure or warn	Failing to wear safe attire	Working at unsafe speed	Other	Unclassified; insufficient data
Total	2,011	778	384	263	156	85	27	19	299
Striking against: Total	155	105	27	1	7	--	12	2	1
Stationary objects	119	87	17	1	1	--	12	--	1
Moving objects	36	18	10	--	6	--	--	2	--
Struck by: Total	679	224	199	83	92	8	8	6	59
Falling objects: Total	455	151	151	68	63	--	1	1	20
From hands of workers	149	1	147	--	--	--	1	--	--
From equipment	149	92	3	14	33	--	--	1	6
From piles of materials	43	16	1	25	1	--	--	--	--
From standing positions	39	12	--	14	12	--	--	--	1
From other positions	75	30	--	15	17	--	--	--	13
Rolling or swinging objects	83	43	6	9	20	--	--	--	5
Flying objects	59	5	4	--	3	8	5	3	31
Hand-wielded objects	52	17	34	--	--	--	--	1	--
Other moving objects	30	8	4	6	6	--	2	1	3
Falls on same level: Total	146	133	9	--	1	--	1	1	1
To walkways or working surfaces	54	51	1	--	--	--	--	1	1
On or against other objects	92	82	8	--	1	--	1	--	--
Falls to different levels: Total	101	77	1	6	11	--	--	--	6
From ladders	30	12	1	6	9	--	--	--	2
From other elevations	71	65	--	--	2	--	--	--	4
Caught in, on, or between: Total	213	59	101	4	33	4	4	8	--
Between a moving and stationary object	176	48	84	4	31	--	4	5	--
Between two or more moving objects	26	9	14	--	1	--	--	2	--
In a moving object	11	2	3	--	1	4	--	1	--
Rubbed, abraded: Total	213	14	17	--	3	34	--	--	145
By foreign bodies in eyes	173	4	--	--	3	28	--	--	138
By objects being handled	27	4	16	--	--	5	--	--	2
By other objects	13	6	1	--	--	1	--	--	5
Overexertion: Total	294	99	15	168	2	--	1	--	9
Lifting or carrying objects	189	29	8	148	2	--	--	--	2
Pulling or pushing objects	78	50	4	18	--	--	1	--	5
Swinging objects	20	15	2	2	--	--	--	--	1
Other activities	7	5	1	--	--	--	--	--	1
Contact with temperature extremes	78	25	4	1	5	16	1	--	26
Contact with radiations, caustics, and noxious substances	69	5	4	--	1	23	--	--	36
Bodily reactions	42	35	4	--	1	--	--	--	2
Other accident types	12	2	3	--	--	--	--	2	5
Unclassified; insufficient data	9	--	--	--	--	--	--	--	9

Table 17. Disabling work injuries in 134 boilershop-products plants, classified by unsafe act and extent of disability, 1951

Unsafe act	Number of disabling injuries					Number of days lost or charged		Average number of days charged per--	
	Total		Resulting in--						
	Number	Percent 1/	Death and permanent-total disability 2/	Permanent-partial disability	Temporary-total disability	Number	Percent 1/	Disabling injury	Temporary-total disability
Total	2,011	100.0	(1) 6	103	1,902	172,625	100.0	86	16
Taking unsafe position or posture: Total	778	45.4	3	36	739	73,390	49.1	94	18
Inattention to footing	262	15.3	--	2	260	7,914	5.3	30	17
Inattention to surroundings	218	12.7	1	20	197	27,074	18.1	124	16
Exposure under suspended loads	60	3.5	1	7	52	19,475	13.0	325	22
Exposure to falling or sliding objects	49	2.9	--	2	47	3,761	2.5	77	23
Other	189	11.0	1	5	183	15,166	10.2	80	18
Using unsafe equipment or equipment unsafely: Total	384	22.4	--	33	351	23,834	16.0	62	15
Gripping objects insecurely	190	11.1	--	1	189	3,224	2.2	17	15
Taking wrong hold of objects	136	7.9	--	27	109	15,484	10.4	114	14
Using defective equipment	27	1.6	--	3	24	3,479	2.3	129	12
Other	31	1.8	--	2	29	1,647	1.1	53	14
Unsafe loading or placing: Total	263	15.4	--	4	259	13,590	9.1	52	18
Moving too heavy loads	167	9.8	--	3	164	7,677	5.1	46	16
Placing objects unsafely	96	5.6	--	1	95	5,913	4.0	62	20
Operating without authority; failing to secure or warn: Total	156	9.1	1	11	144	23,647	15.8	152	22
Failing to block or secure	110	6.4	--	6	104	14,370	9.6	131	18
Operating without giving signal	21	1.2	1	2	18	7,734	5.2	368	(3/)
Other	25	1.5	--	3	22	1,543	1.0	62	29
Failing to wear safe attire: Total	85	5.0	--	3	82	6,083	4.1	72	8
Failing to wear goggles	58	3.4	--	3	55	5,714	3.9	99	6
Other	27	1.6	--	--	27	369	.2	14	14
Working at unsafe speeds	27	1.6	--	4	23	3,829	2.6	142	23
Other unsafe acts	19	1.1	--	5	14	4,982	3.3	(3/)	(3/)
Unclassified; insufficient data	299	--	(1) 2	7	290	23,270	--	78	10

1/ Percents are based on classified cases only.
2/ Figures in parentheses indicate the number of permanent-total disabilities included.
3/ Not computed because of small number of injuries.

Table 18. Work accidents in 134 boilershop-products plants, classified by unsafe act and product, 1951

Unsafe act	Total number of accidents		Product					
			Heavy tanks		Boilers		Other	
	Number	Percent 1/	Number	Percent 1/	Number	Percent 1/	Number	Percent 1/
Total	2,011	100.0	1,074	100.0	329	100.0	608	100.0
Taking unsafe position or posture: Total	778	45.4	425	46.9	112	38.9	241	46.5
Inattention to footing	262	15.3	144	15.9	35	12.1	83	16.1
Inattention to surroundings	218	12.7	118	13.0	28	9.7	72	13.9
Exposure under suspended loads	60	3.5	28	3.1	8	2.8	24	4.6
Exposure to falling or sliding objects	49	2.9	32	3.5	6	2.1	11	2.1
Other	189	11.0	103	11.4	35	12.2	51	9.8
Using unsafe equipment or equipment unsafely: Total	384	22.4	186	20.5	74	25.7	124	23.9
Gripping objects insecurely	190	11.1	89	9.8	38	13.3	63	12.1
Taking wrong hold of objects	136	7.9	72	7.9	24	8.3	40	7.7
Using defective equipment	27	1.6	15	1.7	5	1.7	7	1.4
Other	31	1.8	10	1.1	7	2.4	14	2.7
Unsafe loading or placing: Total	263	15.4	146	16.1	44	15.3	73	14.1
Moving too heavy loads	167	9.8	103	11.4	26	9.1	38	7.3
Placing objects unsafely	96	5.6	43	4.7	18	6.2	35	6.8
Operating without authority; failing to secure or warn: Total	156	9.1	88	9.7	20	6.9	48	9.3
Failing to block or secure	110	6.4	61	6.7	13	4.5	36	6.9
Operating without giving signal	21	1.2	11	1.2	3	1.0	7	1.4
Other	25	1.5	16	1.8	4	1.4	5	1.0
Failing to wear safe attire: Total	85	5.0	45	5.0	24	8.3	16	3.1
Failing to wear goggles	58	3.4	30	3.3	17	5.9	11	2.1
Other	27	1.6	15	1.7	7	2.4	5	1.0
Working at unsafe speeds	27	1.6	8	.9	10	3.5	9	1.7
Other unsafe acts	19	1.1	8	.9	4	1.4	7	1.4
Unclassified; insufficient data	299	--	168	--	41	--	90	--

1/ Percents are based on classified cases only.

* U. S. GOVERNMENT PRINTING OFFICE : 1958 O—489288