WOODWORKING

CIRCULAR-SAW ACCIDENTS

Bulletin No. 1190

UNITED STATES DEPARTMENT OF LABOR
James P. Mitchell, Secretary

BUREAU OF LABOR STATISTICS
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CIRCULAR-SAW ACCIDENTS

A detailed analysis of accidents resulting from the operation of woodworking circular saws, 1951 and 1952

Bulletin No. 1190
January 1956

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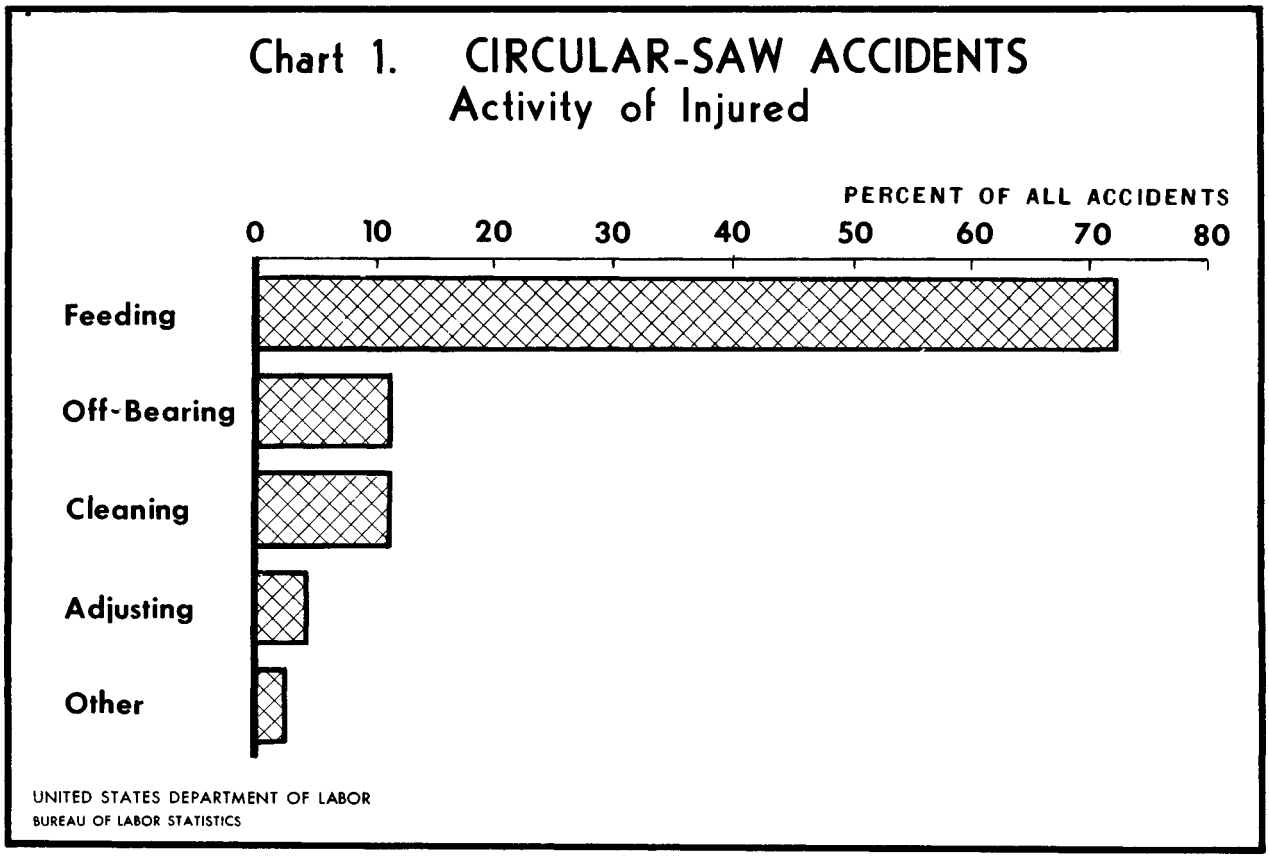

WOODWORKING CIRCULAR-SAW ACCIDENTS

SUMMARY

Because of their tendency to produce injuries of greater-than-average severity, woodworking circular-saw accidents deserve special attention in all accident-prevention programs. 1/ Deaths are not common in these accidents, but permanent disabilities occur much more frequently than in other kinds of accidents.

Nearly half (48 percent) of the disabling injuries in this survey resulted in some degree of permanent disability. In contrast, the proportion of permanent impairments among all disabling injuries experienced in manufacturing activities generally averages less than 6 percent. 2/

It is impossible on the basis of any data available to estimate either the annual volume of circular-saw accidents or the total amount of manpower lost because of those accidents. It is obvious, however, that the injury total is large and that the resulting economic losses are huge.

In nearly 80 percent of the circular-saw accidents analyzed, the injured person received his injury by coming into contact with the saw blade. Generally, he was feeding lumber into the saw at the time of injury, but contact with the blade also occurred frequently when: (a) removing scraps of lumber or sawdust from the saw table; (b) adjusting or changing blades; or (c) placing lumber on the saw table.

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

1/ Definitions appear under Scope and Method of Survey. For woodworking circular saw, see p. 3. For other definitions, see p. 4 et seq.

2/ See annual summaries of work injuries in the United States during 1951, 1952, and 1953; BLS Bulls. 1137 and 1164; and press release of October 7, 1954.

The injuries were predominately hand and finger cases. Cuts and lacerations were most common, but a high proportion were amputations. Many of these were multiple amputations.

Hazardous working conditions, which could have been corrected, and unsafe acts, which should not have been committed, were equally prominent among the causes of the accidents analyzed. Generally, both were involved, and generally they were so interrelated that if either had been absent the accident probably would not have occurred. Hazardous conditions were factors in the occurrence of 99 percent of the accidents for which full details were available and unsafe acts were causal factors in 96 percent.

The most common hazardous condition encountered was the absence of any cover guard for the saw blade. This was a factor in the occurrence of well over half of the accidents. Next in numerical importance were defective cover guards, that is, guards which were improperly designed, constructed, or adjusted and as a result failed to provide the intended protection. Significantly, 57 percent of the identified hazardous conditions constituted violations of applicable legal safety requirements.

The unsafe acts which most frequently contributed to the occurrence of the accidents were: placing the hand in line with the blade when feeding lumber; using the hand instead of a push stick to move material past the blade; failing to use available safety devices; and failing to adjust safety devices to the work being performed.

SCOPE AND METHOD OF SURVEY

This survey originated in discussions at the annual meetings of the International Association of Governmental Labor Officials. It was conducted as a joint project of the safety inspection services of the several States and the Bureau of Labor Statistics of the United States Department of Labor. The purpose of the survey was to assemble in as great detail as possible accurate information regarding the causes of circular-saw accidents.

Collection of the individual case reports was assigned to the State safety inspectors and the analysis of the data was undertaken by the Bureau of Labor Statistics. To assure a valid and representative analysis, the study was planned to include approximately 1,200 accidents drawn from not less than 12 States. Actually, 12 States 3/ and the District of Columbia participated. The volume of cases collected (1,021) fell somewhat short of the goal and, unfortunately, a rather high percentage of the cases reported was concentrated in 5 States (tables 1 and 15).

3/ Arkansas, California, Connecticut, Illinois, Iowa, Michigan, Minnesota, New Jersey, New York, Rhode Island, West Virginia, and Wisconsin.

In order to insure uniformity in the data, the following general principles were adopted and issued as instructions to the State inspectors:

1. Reports were requested for all types of accidents in which woodworking circular saws were involved in any way, and which resulted in injury to any person regardless of the severity of the injury. Reports were not to be limited to compensable cases, nor lost-time cases, but were to include minor injuries.

2. The term "woodworking circular saw" was defined as any type of circular saw commonly used in shopwork. Included were hand-fed table saws, self-feed table saws, swing cutoff saws, and radial-arm cutoff saws. Large circular saws used primarily in sawmill and logging operations and portable circular saws were specifically excluded.

3. Reports were requested for any accident in which a person was injured--

(a) By contact with any part of a woodworking circular saw, such as the blade, frame, bed, guard, motor, driving mechanism, electric circuits, etc.

(b) By contact with materials being fed to, or taken from, a saw.

(c) By being struck by any material, chips, splinters, sawdust, etc., thrown by a saw.

(d) While setting up, adjusting, or performing any other work in connection with a saw.

Strains, sprains, etc., resulting from slips, falls, or overexertion when associated in any way with the operation or servicing of a saw were reportable.

4. Reportable cases were to be identified through reference to plant records or through inquiry during regular plant visits of the State inspectors and were to be selected without regard to the industry or type of operation in which the accident occurred. A request was made that compensation reports on file in State offices not be used as the source of leads because that procedure generally would result in the omission of many minor-injury cases. Circular-saw accidents occurring during 1951 and up to the time of the inspector's visit in 1952 were reportable.

5. It was requested that each report be based on an actual investigation and represent the personal findings of the State inspector. The investigation was to include (a) an inspection of the saw involved in the accident and of the premises in which

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the saw was located and (b) an interview with each available person who could supply information regarding the accident and its causes.

As a test procedure, the survey proved that the collection of analytical data in routine visits by State safety inspectors is highly feasible in respect to accidents resulting in disabling injuries. However, the lack of plant records relating to accidents which produced only minor injuries made the reporting of such cases less than satisfactory and precluded any effort to establish a ratio between disabling and nondisabling injuries or to provide a separate analysis of nondisabling-injury cases. In some of the cooperating jurisdictions, efforts to obtain reports on nondisabling-injury cases were abandoned after a few unsuccessful attempts.

Definitions

Disabling Work Injury.--A disabling work injury is defined as an injury which arises out of and in the course of employment resulting in death, permanent-total disability, permanent-partial disability, or temporary-total disability. The definitions of these several disability classifications, given in the American Standard Method of Compiling Industrial Injury Rates approved by the American Standards Association, 1945, are as follows:

(1) Fatality.--A death resulting from an industrial injury is classified as an industrial fatality regardless of the time intervening between injury and death.

(2) 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) one eye and one hand, or arm, or leg, or foot; (c) any two of the following not on the same limb: hand, arm, foot, or leg.

(3) 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 a function 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; (f) fractures healing completely without deformities or displacements.

(4) 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 day of injury.

Nondisabling Work Injury.--An injury other than those defined above, which arises out of, and in the course of employment, is classified as a nondisabling work injury. Included in this group are those injuries which did not require the loss of time except for medical or first-aid treatment.

Average Time Charge per Disabling Injury.--The relative severity of a temporary injury is measured by the number of calendar days during which the injured person is unable to work at any regularly established job, open and available to him, excluding the day of injury and the day on which he returns to work. The relative severity of death and permanent impairment cases is determined by reference to a table of economic time charges included in the American Standard Method of Compiling Industrial Injury Rates. These time charges, based upon an average working-life expectancy of 20 years for the entire working population, represent the average percentage of working ability lost as the result of specified impairments, expressed in unproductive days. The average time charge per disabling injury is computed by adding the days lost for each temporary injury and the days charged according to the standard table for each death and permanent impairment and dividing the total by the number of disabling injuries.

The accident-cause analysis procedure used in this survey differs in some respects from the procedure 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 "agency of injury" and the modification of the standard definitions of some of the other factors. These changes permit more accurate cross classifications. The factors used and their definitions are:

Agency of Injury.--The standard classification provides for the selection of but 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 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 accidents because of their condition, location, structure, or method of use. The development of the classification "agency of injury" represents an attempt to separate and classify separately these two agency concepts.

As used in this study, the "agency of injury" 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 the injury and is related specifically to the agency of injury. It indicates how the injured person came into contact with, or was affected by, the previously selected agency of injury, as for example, fell against saw blade. The definition represents a change from the standard procedure in two respects: First, the accident-type classification is specifically related to the previously selected agency 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 the point-of-operation of a circular saw. 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 which will 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 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 saw which was unguarded. Its selection, therefore, is directly associated with the hazardous condition leading to the occurrence of the accident and not with the actual occurrence of the injury. In many instances,the agency of injury and the agency of accident were identical. The double agency classification, however, avoids 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 CIRCULAR SAW AND ITS HAZARDS

The circular saw is one of the most widely used machines in industry. A basic machine of the woodworking industry, it is also used extensively in lumber yards, wholesale and retail building supply stores, in pattern shops of foundries and other plants where models or patterns may be needed, and in the shipping and maintenance departments of companies in nearly all industries.

Despite a general awareness that circular saws are extremely hazardous when improperly used, the casual use of these machines by untrained operators is not only tolerated, but apparently is the rule rather than the exception in many establishments. The roster of occupations represented in the injury list compiled for this study clearly reflects this practice. In addition to the regular woodworking occupations, such as saw operators, cabinet workers, and carpenters, the list includes porters, janitors, custodians, elevator operators, hand truckers, truckdrivers, maintenance mechanics, punch-press operators, plumbers, electricians, welders, sheet-metal workers, shipping clerks, and salesmen. The list also includes single cases of injury to the president of a manufacturing firm, the vice president of another firm, a student, an instructor, and an artist. In many instances the inherent hazards of the machine were intensified or released because of the lack of understanding of those hazards on the part of these casual operators. The hazard frequently lies not so much in the equipment as in the degree of control exercised by management over the use of the machine.

Circular saws are used, generally, for "ripping" (cutting lumber along its grain) or "cross cutting" (cutting lumber across its grain). However, with special attachments, "rabbeting," "dadoing" or "grooving," and "molding" operations may be completed. The circular saw is used, primarily, for cutting lumber, but it may be used for cutting wallboard, plastic, and other materials. Usually, special blades are necessary when processing materials other than lumber.

Basically, the circular saw is composed of a frame, a saw disc or blade, a table on which lumber is fed to the disc, and the power transmission apparatus for transmitting power to the cutting tool. With radial-arm saws and swing or jump cutoff saws, the lumber is held stationary on the table and the blade is moved against it. In the variety or universal type circular saw, the saw blade projects through the table and the lumber is moved against the blade. In some instances, lumber is fed to the blade mechanically but generally feeding is done manually.

The most obvious hazard in circular-saw operations is the possibility that the operator will contact the rapidly moving blade while he is feeding

or removing stock. A slight miscalculation of distance, a knot, cross grain, or damp spot in the wood sufficient to alter its resistance to the saw, causing it to vibrate or change the speed with which it accepts the cut, are sufficient to throw the operator's hand into the blade if it is unguarded. The inability of the human eye to register short and rapid interruptions of light intensifies this hazard. As the rim of the saw revolves, light is alternately passed between the saw teeth and momentarily interrupted by the passage of the teeth. The eye, adjusting to the intensity of the light passing between the teeth, frequently cannot register the shadows cast by the teeth, and the teeth become practically invisible, making it difficult for the operator to judge how close it is safe to come to the cutting point. For even the most skillful operator, a hood guard for protection at the point of operation and a firmly fixed shield to prevent contact with the portion of the blade beneath the table are essential.

A somewhat less obvious hazard, of which the unskilled operator frequently is not aware, is the possibility of being struck by materials thrown back by the saw. The forward or cutting edge of the blade, revolving downward, presses the lumber down against the saw table and tends to give the operator a feeling that the material is held firmly and safely in place. When a long piece is fed through the saw in a ripping operation, however, the severed portions of the material must pass the upturning back edge of the blade. If the cut stock is pushed out of line or if it tends to spring together as it leaves the blade, it may bind or catch on the up-riding saw teeth. Lacking an adequate hold-down guard, these teeth will not simply enlarge the cut; instead, they will carry the material up, over the top of the blade, and propel it violently toward the operator. Injuries from kickbacks tend to be serious and may result in death. As a minimum gesture to safety, operators should be trained to stand out of line with the blade. Effective prevention of kickbacks, however, requires the installation and use of mechanical devices. Hoods, which completely cover the blade and automatically maintain a downward pressure on the stock, will not only prevent contact with the blade, but will resist any tendency of the stock to ride up and over the blade. Properly alined metal strips, called "splitters," fixed rigidly behind the saw blade will spread the cut wood to prevent its binding on the back of the saw, and "antikickback-dogs" may be applied to restrain the backward movement of the stock if binding should occur.

Kickbacks are not common in the operation of swing saws or jump saws. Unless restrained by a device to prevent their being moved beyond the edge of the table, however, these saws are capable of inflicting serious injuries by coming into contact with the body of the operator. Here again the rule of standing out of line with the blade is an essential element in operator training.

Belts, pulleys, gears, and shafts used to transmit power to circular saw blades, when not properly covered, constitute serious hazards to operators, cleaners, and repairmen. Unguarded inrunning rolls of mechanical feed devices

with which some saws are equipped may offer a serious threat to the operator's fingers even though they reduce the possibility of his coming into contact with the saw blade. Sawdust thrown by the blade may produce eye irritations and, if allowed to accumulate on the floor, may create slipping hazards. Poor housekeeping in the area around a circular saw is particularly dangerous, since a slip or trip might cause the operator to contact the saw blade.

Some hazards encountered by saw operators, however, do not involve contact with the machine or with materials thrown by the machine. Since most of the operations require some manual handling of lumber, there is always the possibility of splinter punctures, of fingers being pinched in placing the materials in position, of fingers or toes being crushed by dropped or falling materials, or of muscles being strained in overlifting.

The hazards connected with the operation of circular saws have been widely recognized and a considerable amount of research has been done in trying to reduce them. Probably the most widely known work in this connection is the "American Standard Safety Code for Woodworking Machinery" approved by the American Standards Association in 1954. 4/ In addition, many of the States have developed safety codes or regulations covering the operation of circular saws. Besides the State safety codes which vary extensively, 5/ several States, as well as some private organizations, have prepared educational pamphlets dealing with safe practices in circular-saw operations. 6/

KINDS OF INJURIES EXPERIENCED

The 1,021 injuries reported in the survey included 1 fatality, 281 permanent-partial disabilities, 309 temporary-total disabilities, and 430 nondisabling injuries. (See table 1.) 7/ Nearly two-thirds of the injuries

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4/ Reprinted in part in appendix B, (p. 48).

5/ For a comparison of the State safety codes with the American Standard, see Bureau of Labor Standards report, Woodworking Machines: A Comparison of State Safety Codes with A.S.A. Code 01.1, 1950.

6/ For examples, see excerpts printed in appendix C, (p.65), from the National Association of Mutual Casualty Companies, Woodworking Circular Saws: Protection for Variety and Universal Types, 1950, and State of California, Department of Industrial Relations, Division of Industrial Safety, Taming the Circular Saw, 1950.

7/ Because nondisabling injuries were not fully reported, the number included should not be considered as indicating the respective occurrence ratios of disabling and nondisabling injuries.

were cuts or lacerations, whereas more than one-fifth were amputations. Almost 90 percent of the cases and practically all those resulting in permanent-partial disability were hand or finger injuries; about 5 percent were head injuries; and slightly more than 4 percent were injuries to the trunk (table 4).

Death

The single death case reported was unusual in that the extreme seriousness of the injury was not apparent at the time of the accident. In this accident, a jointer operator, who was temporarily using a circular saw, touched the saw blade while he was attempting to remove a piece of scrap lumber from the saw table. His ring finger was amputated and his thumb badly lacerated. His death two days later was attributed to schock.

Permanent-Partial Disabilities

The 281 permanent-partial disabilities included 223 amputations, and 58 lacerations and fractures which culminated in some residual loss of use of a body part or function. In 1 of the amputations, a hand was lost; in 157, a single finger or thumb was lost; and in 65, 2 or more fingers were lost.

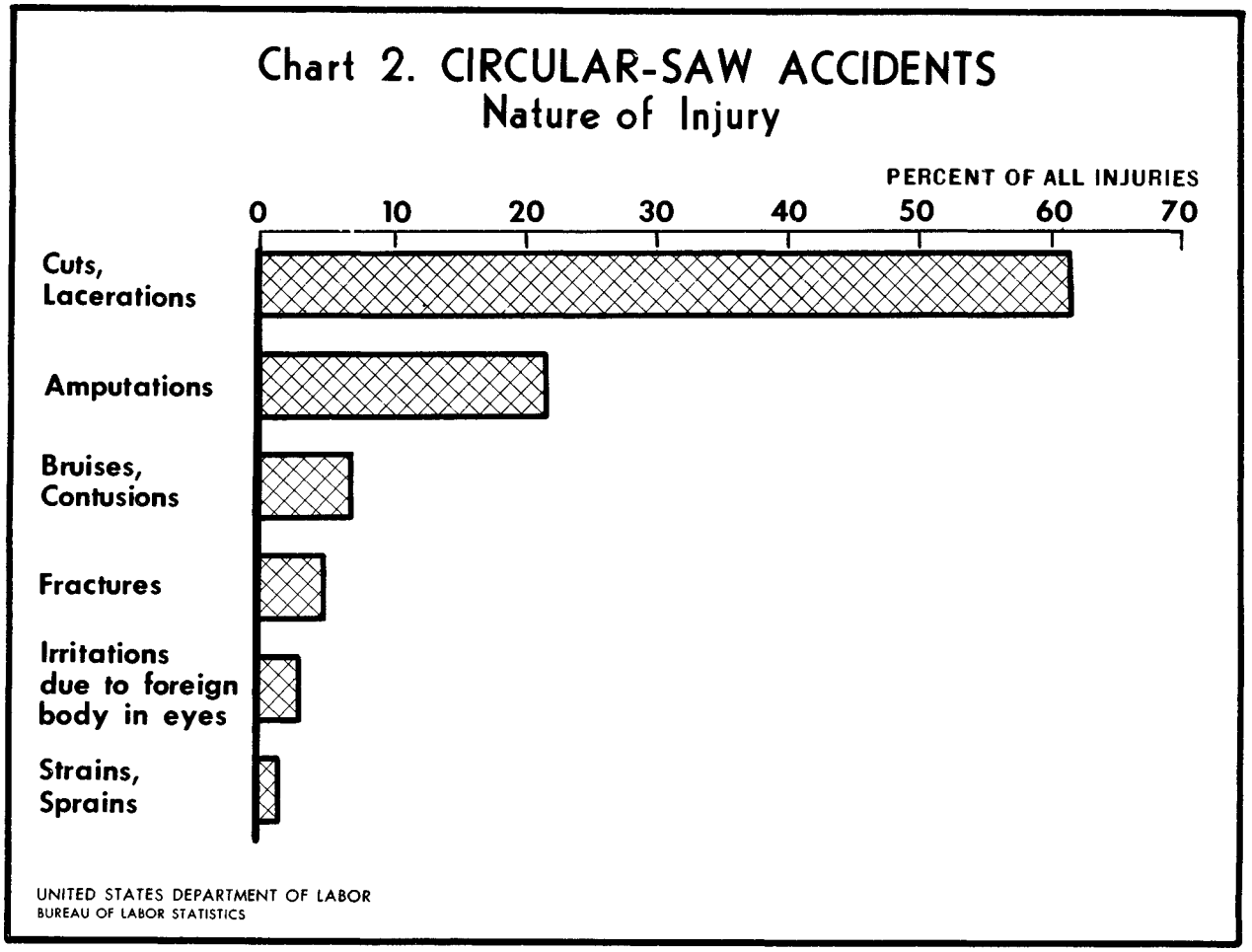
All but 3 of the amputations resulted from contact with the saw blade. The 3 exceptions included 1 case in which an operator's finger was caught between the conveyor belt of a mechanically fed ripsaw and the saw frame. Another case involved an operator who was wearing gloves. An arbor nut caught his glove and his finger was pulled off at the second joint. In the third case the operator mashed his finger against the saw table while he was piling lumber beside the saw.

The 58 permanent loss-of-use injuries included 50 cuts or lacerations and 8 fractures. Fingers were affected in all of the fractures but 1 (a nose fracture) and in all of the laceration cases but 6 (5 hands and an arm). All but two of the permanent loss-of-use injuries resulted from contact with the saw blade. The two exceptions, a nose fracture and a permanent impairment of both thumbs, occurred when the operators were struck by lumber kicked back by the saw.

Temporary-Total Disabilities

The temporary-total disabilities consisted primarily of cuts and lacerations (77 percent of the total), fractures (12 percent), and bruises and contusions (9 percent). The remaining 2 percent included 1 case of eye irritation and 7 cases of strains or sprains. (See table 4.)

Finger and thumb injuries were most common, accounting for 230 of the 309 temporary-total disabilities. The remainder included 30 hand injuries, 11 arm injuries, 25 injuries to the trunk, 11 head injuries, and 2 foot injuries. The arm, hand, and finger injuries were primarily cuts, lacerations, or fractures. The trunk injuries were mostly bruises and contusions.



Ninety percent of the cuts and lacerations resulted from contact with the saw blade. All but one of these were arm, hand, or finger injuries. Most of the other temporarily disabling cuts and lacerations were inflicted by lumber, primarily by lumber kicked back by the saw.

Nearly two-thirds of the temporarily disabling fractures resulted from contact with the saw blade; most of the remainder occurred when the operators were struck by lumber kicked back from the saw. All but three of the fractures were hand or finger injuries. The others included two cases of ribs fractured by kicked-back lumber and a fractured ankle. The latter injury occurred in a most unusual manner. The operator of a self-feed ripsaw shut off the saw and climbed onto the machine to remove a large knot which had jammed the feed rolls. In getting down he lost his balance and fell against the starting switch. When the saw started, his foot was drawn into the feed rolls.

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Most of the disabling bruises and contusions were inflicted by kicked-back lumber. Trunk injuries predominated, but kickbacks were also responsible for 4 eye injuries, 2 arm injuries, 2 finger injuries, and a hand injury.

Nondisabling Injuries

The nondisabling-injury pattern was very similar to that of the temporary-total disabilities. Approximately 80 percent were cuts or lacerations, about 10 percent were bruises and contusions, and most of the remainder were eye irritations. Nearly all of the cuts and lacerations and one-half of the bruises and contusions were hand, finger, or arm injuries. Most of the other bruises and contusions were trunk injuries.

About 87 percent of the nondisabling cuts and lacerations resulted from contact with the saw blade. Kicked-back lumber inflicted most of the others, although there was an appreciable number of hand and finger punctures from splintered lumber.

Most of the nondisabling bruises and contusions resulted from kickbacks. Flying sawdust produced most of the eye irritations.

ACTIVITY OF INJURED AT TIME OF INJURY

Nearly three-fourths of the reported injuries occurred while the injured person was feeding material into a saw. In about 11 percent of the cases he was removing material from the saw and in another 11 percent he was cleaning on or around the machine at the moment of injury. The remainder of the injuries occurred while the operator was either making adjustments to the machine or was moving materials to or from the machine.

The most serious injuries, that is, those which resulted in permanent-partial disability, fell into much the same activity pattern. About 70 percent occurred in feeding operations; about 13 percent, in the course of removing material from the saw; almost 13 percent, during cleaning operations; and about 4 percent, in other associated operations (table 3).

Cuts and lacerations were the most common injuries in each of the designated activities. The high degree of hazard associated with circular saw operations, however, was vividly indicated by the fact that amputations were the second most common kind of injury in every activity classification. Even more significant, in each of three activity classifications (feeding, removing materials, and cleaning), the number of amputations was greater than the total of all injuries other than cuts and lacerations (table 5).

ACCIDENT ANALYSIS

Agency of Injury

A very high proportion (80 percent) of the injuries to circular-saw operators as reported in this study resulted from direct contact with the saw blade (tables 7, 8, and 9). Only a few (2 percent) resulted from contact with other parts of the machines. Most of the other injuries were inflicted by lumber (15 percent) or sawdust (3 percent).

About one-fourth of the injuries resulting from contact with the saw blade were amputations; most of the remainder were cuts or lacerations. The injuries inflicted by lumber were primarily bruises, contusions, or cuts. Those inflicted by sawdust were all eye irritations.

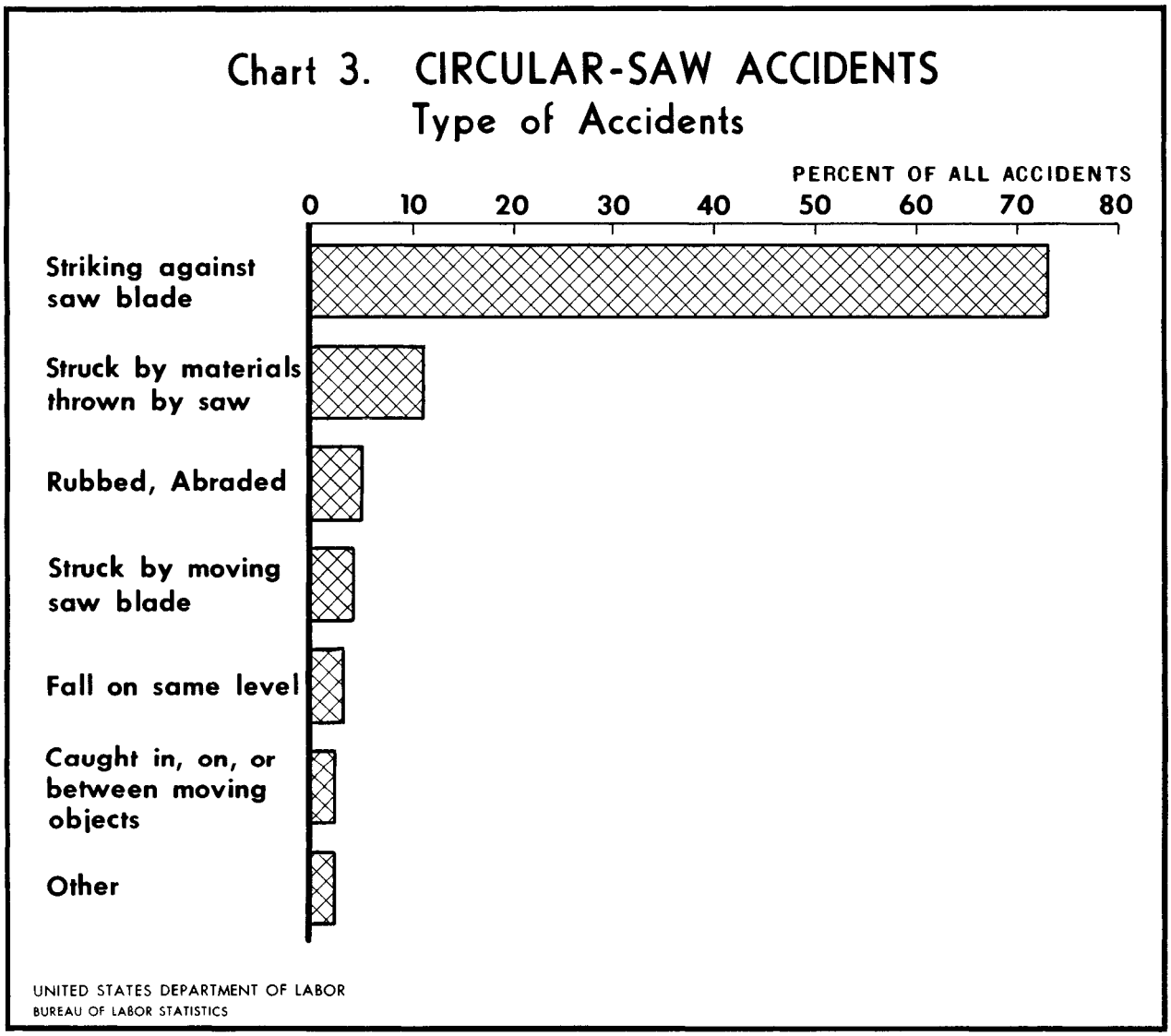
Accident Types

Although no two of the reported accidents were exactly alike in every detail, the general characteristics of the accidents in circular saw operations formed a pronounced pattern.

Emphasizing the most obvious accident possibility in the operation, 78 percent of the cases involved contact between the operator and the moving saw blade (tables 9-13 inclusive). A few of these, occurring in the operation of swing saws or radial-arm saws, were instances in which the saw itself moved into contact with the operator. Their small representation in the total, however, is not indicative of the relative accident potential associated with these saws--it merely reflects the relatively small number of such saws in use.

Contact with the revolving blade of a table saw occurred in a variety of ways. In the most common occurrence, the operator simply pushed his hand into the blade along with the lumber he was feeding to the machine; one-fourth of all the reported accidents occurred in this manner. In some of these instances the operator simply misjudged the distance to the cutting point and allowed his hand to come too close to the blade. This circumstance reflects in large measure the inability of the human eye to distinguish the dark areas of the saw teeth from the open areas between the teeth when the blade is moving at high speed. This same tendency of the moving teeth to become invisible undoubtedly was also a factor in the considerable number of accidents (about 18 percent) in which the operator touched or moved his hand into the blade while he was removing materials from the saw table.

Accidents originating as kickbacks of the lumber being fed to the saw are commonly associated with impact injuries inflicted by the flying materials. A considerable number of such cases were reported--about 11 percent of the total were cases in which the operator was struck by material thrown by the saw. However, a somewhat greater proportion of the total (14 percent), were cases in which kickbacks threw the operator's hand into the saw blade.



Another significant group, about 8 percent, in which the initiating circumstance was closely allied to a kickback was composed of cases in which the operator's hand slipped from the material being fed and struck against the saw blade. Some of these were "slips" in the simple sense of the word. In many instances, however, the slip was precipitated by vibration or unexpected resistance to the forward movement of the lumber being fed.

Although most of the accidents involving contact with the saw blade occurred in the course of cutting operations, there were enough other cases to emphasize that a saw is potentially hazardous at any time. In somewhat over

2 percent of the cases, the operator moved his hand into the blade while he was making adjustments to the machine. In nearly 2 percent of the accidents, his hand struck the moving blade while he was stacking material on the saw table. And, more remotely associated with saw operations, some 2.5 percent of the cases were incidents in which people fell and in falling struck against a revolving saw blade. Some of these persons were merely passing the machine when they tripped or slipped and had no duties connected with its operation.

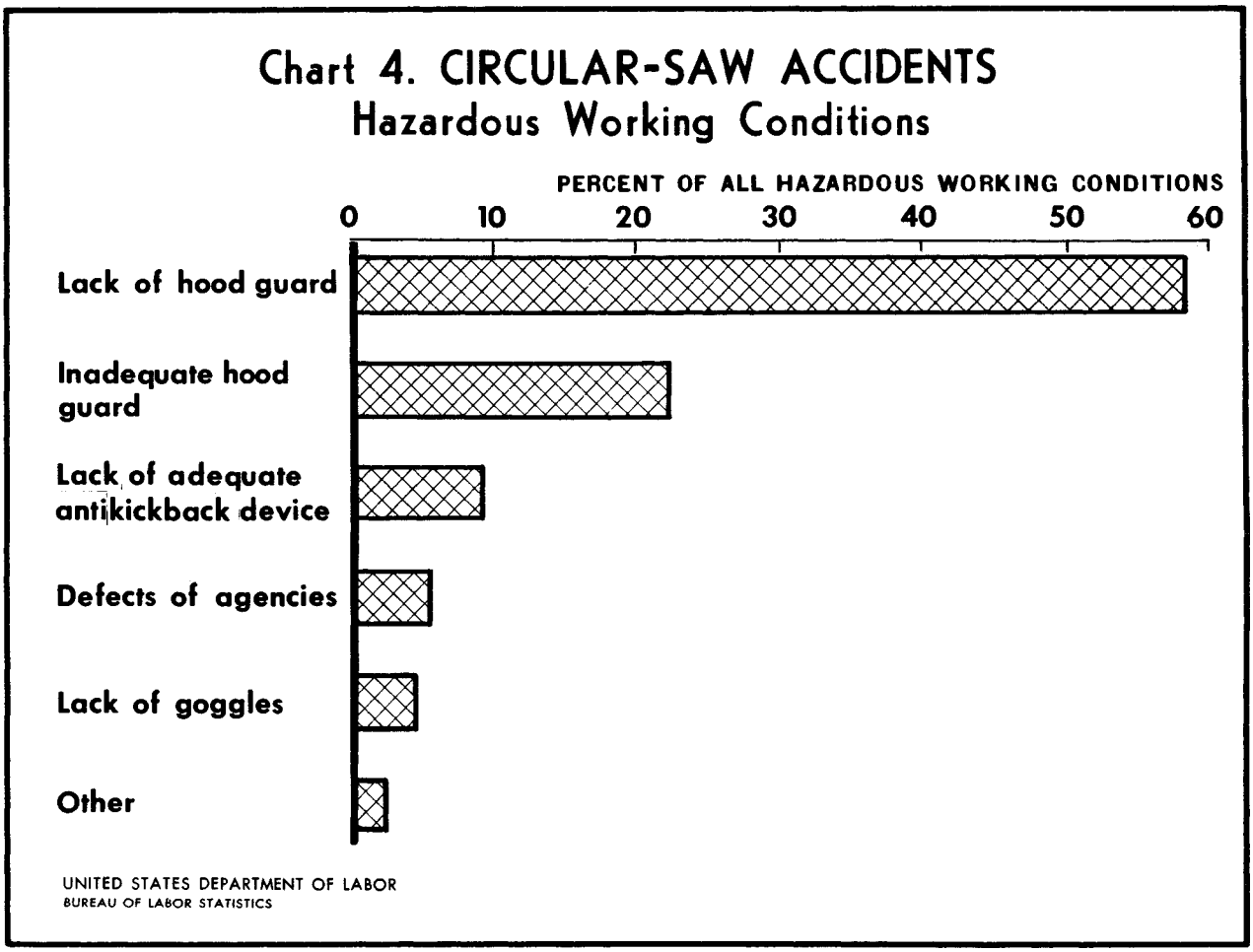
The relatively small group of accidents which did not involve contact with either the saw blade or the material thrown by the saw was quite varied. The largest number of these accidents, although probably of least importance in terms of the seriousness of the resulting injuries, were those in which the operators' eyes were irritated by flying sawdust. A small number of operators crushed their fingers under lumber which they were moving to or from the saw, and a few experienced strains from overlifting. Another small group consisted of cases in which fingers or toes were caught in feed rolls or power belts attached to the saws.

ACCIDENT CAUSES

Modern accident analysis is based on two premises: First, there is an identifiable cause for every accident; and, second, when that cause is known, it is usually possible to eliminate it or counteract it as a source of future similar accidents. In many instances a variety of circumstances contribute to the occurrence of an accident, and the course accident prevention should take may seem confused because of the multiplicity of possible avenues of action. It is commonly accepted, however, that every accident may be traced to the existence of some hazardous working condition, to the commission of an unsafe act, or to a combination of these accident-producing factors.

The sole purpose of accident analysis, as applied to large groups of cases, is to determine what specific factors within each of these two categories of accident causes are most frequently involved in the occurrence of accidents. It is then possible to plan a safety program focused on the elimination of the most common specific accident causes to the end that the volume of injuries will be substantially reduced.

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 control of the safety program. In addition, it must be recognized that in accident analysis, the two factors--hazardous working condition and unsafe act--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 (2) whether the accident was directly associated with an unsafe act.

The findings of this survey indicate that hazardous working conditions contributed to at least 98 percent of the circular-saw accidents reported and unsafe acts, to 85 percent. There were, however, some cases for which full details were lacking. In those cases, it was not possible to determine whether hazardous working conditions existed or whether unsafe acts were committed. Excluding these accidents for which data were incomplete, 99.7 percent of the reported circular-saw accidents were associated with hazardous working conditions and 96.6 percent were related to unsafe personal actions.

Hazardous Working Conditions

Nearly 90 percent of the reported accidents can be ascribed to one general category of physical hazards--inadequate guarding of the circular saw itself. The remainder were largely associated with defects in materials or equipment (5 percent of the total) and the lack of eye protection for the operators (4 percent). A relatively small number were attributed to general

environmental hazards or to placement hazards (tables 17, 18, and 19).

Significantly, 57 percent of the hazardous working conditions identified in these cases represented violations of the State safety laws or regulations applicable in the jurisdictions where the particular accidents occurred. For the accidents which resulted in serious injuries--i. e., permanent-partial disabilities--the proportion involving legal violations was 65 percent. Obviously, greater compliance with the applicable State safety requirements would drastically reduce the volume of circular-saw accidents.

Inadequately Guarded Agencies.--The group of accidents attributed to inadequate guarding is particularly important--not only because it constitutes such a large proportion of the total volume of cases, but because of the severity of the resulting injuries. The 1 reported death and 99 percent of the permanent disabilities resulted from accidents in this group. On the average, each disabling injury arising from these accidents represents 380 days lost or charged.

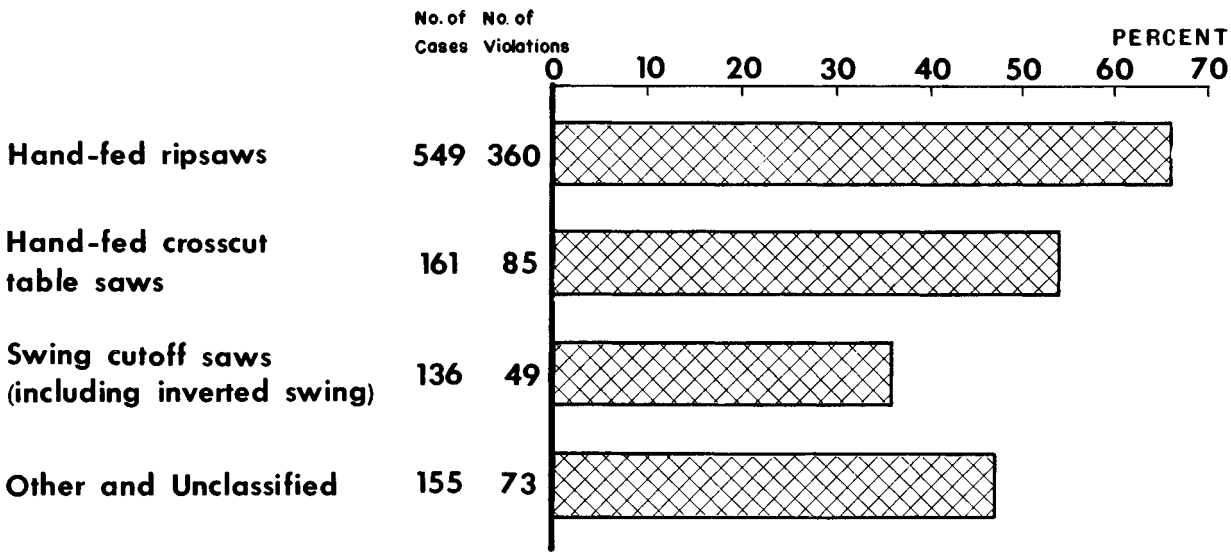
Nearly two-thirds of the accidents in this group (58 percent of all cases analyzed) resulted from a single very obvious hazardous condition--the absence of a hood or cover guard for the circular-saw blade. This lack of protection constitutes a legal violation in practically all jurisdictions and probably is the most readily recognized hazard associated with saw operations. Only rarely can either the owner of the equipment or the operator reasonably claim to be ignorant of the existence of such a hazard.

A more insidious hazard arises when an inadequate cover guard is provided. Here the semblance of protection instills a false sense of safety and, in effect, invites the operator to omit the precautions he would normally take if no guard were present. This false sense of security was responsible for 24 percent of the accidents attributed to inadequate guarding (21 percent of all cases reported)--more than a third as many cases as were attributed to the absence of any guard. Most of these inadequate hood guards were either ineffectively designed or improperly applied to the saw so that they did not completely and automatically cover the blade.

The absence of antikickback devices was responsible for about 7 percent of the accidents ascribed to inadequate guarding, and the inability of provided devices to perform their intended function was responsible for 2 percent more. The other accidents falling in the inadequate guarding category arose primarily from the absence of guards on automatic feed rolls and from the absence of restraining devices to prevent the movement of swing saws beyond the edge of the saw table.

Defective Agencies.--Although the group of accidents ascribed to defective agencies was relatively small, it encompassed a wide variety of specific hazards. The most commonly encountered hazard in the group consisted of rough or splintered lumber--but few of the accidents resulting from such a hazard produced disabling injuries.

Chart 5. CIRCULAR-SAW ACCIDENTS
Violations of State Safety Codes



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In the more serious category two cases were reported in which chips from cracked saw blades were thrown against the operators. Several accidents involving swing saws resulted from defects in the counterweight mechanism. In two instances improperly adjusted counterweights failed to hold the saws at the end of the back swing, permitting them to bounce forward unexpectedly. In five other instances the counterweight cables broke and allowed the saw to swing freely.

Three accidents were caused by improperly adjusted feed rolls, and three resulted from broken hood guards or defects in the arms supporting the guards, which permitted the guards to touch the saw blade. In one case an unstable platform, on which the operator was standing, tipped--throwing him against the saw table. Similarly, an uneven place in the floor caused an operator to fall against his machine; another operator was struck by a kickback because the antikickback dog which should have protected him had been bent and not replaced; and, in another instance, a gouge in the surface of the saw table threw the lumber being fed out of line, causing a kickback.

Other Hazardous Conditions.--Although the American Standard Safety Code for Woodworking Machinery specifies that eye protection shall be provided

wherever danger from dust, flying chips, etc., exists, relatively few circular saw operators are provided with goggles or face shields. The absence of such protection was responsible for about 4 percent of the reported accidents, but fortunately none of the resulting eye injuries was permanently disabling.

Inadequate space around the saw and the absence of lifting equipment for handling heavy timbers accounted for most of the environmental hazards. The placement hazards noted were primarily those of poor housekeeping: either discarded scrap on the floor or improperly piled lumber.

Unsafe Acts

Most of the unsafe acts associated with the accidents under study were violations of simple and fundamental rules of safe practice--rules which should be so ingrained into the thinking of every operator that their observance becomes automatic. The fact that violations of these rules occur so frequently constitutes an indictment of the supervisory control, or the lack of such control, exercised over the use of circular saws. Many of the injured persons were casual or occasional operators who presumably had received little or no training in the use of the equipment. The errors they committed probably reflect their lack of know-how. A restriction limiting the use of circular saws to qualified operators might have prevented many of these accidents. Such a restriction, however, is only a partial answer to the problem. The majority of the injured persons were regular operators--presumably trained and experienced in the safe operation of the equipment. Their lapses point to the need for continued reemphasis of safe practices and procedures, and supervisory enforcement of the rules of safe practice.

Misuse of Hands.--The most common unsafe act encountered was the failure of the operator to protect his own hands (tables 20 and 21). This occurred primarily in three ways: (1) he used his hands where he should have used a tool or jig, thus bringing his hands unnecessarily into the danger zone of possible contact with the saw blade; (2) he held improperly the material which he was feeding into the saw; or (3) he failed to hold the material securely. In most of these instances the saw blade was unguarded and the hazard should have been obvious.

The most common fault in this general category was that of holding the lumber so that the hand was directly in line with the saw blade. With the hand in this position, the slightest miscalculation of distance or the slightest vibration of the material can result in the operator's pushing his hand directly into the blade. This happened in 18 percent of the cases studied.

In nearly as many cases, 16 percent of the total, the fault of the operator was that he attempted to push a narrow piece of lumber past the blade by hand instead of using a jig or push stick; or he attempted to remove scrap or sawdust from around the blade with his hand instead of using a brush or push stick. In many of these instances the contact with the blade was the result of miscalculation as to where the cutting point of the blade was. In others,

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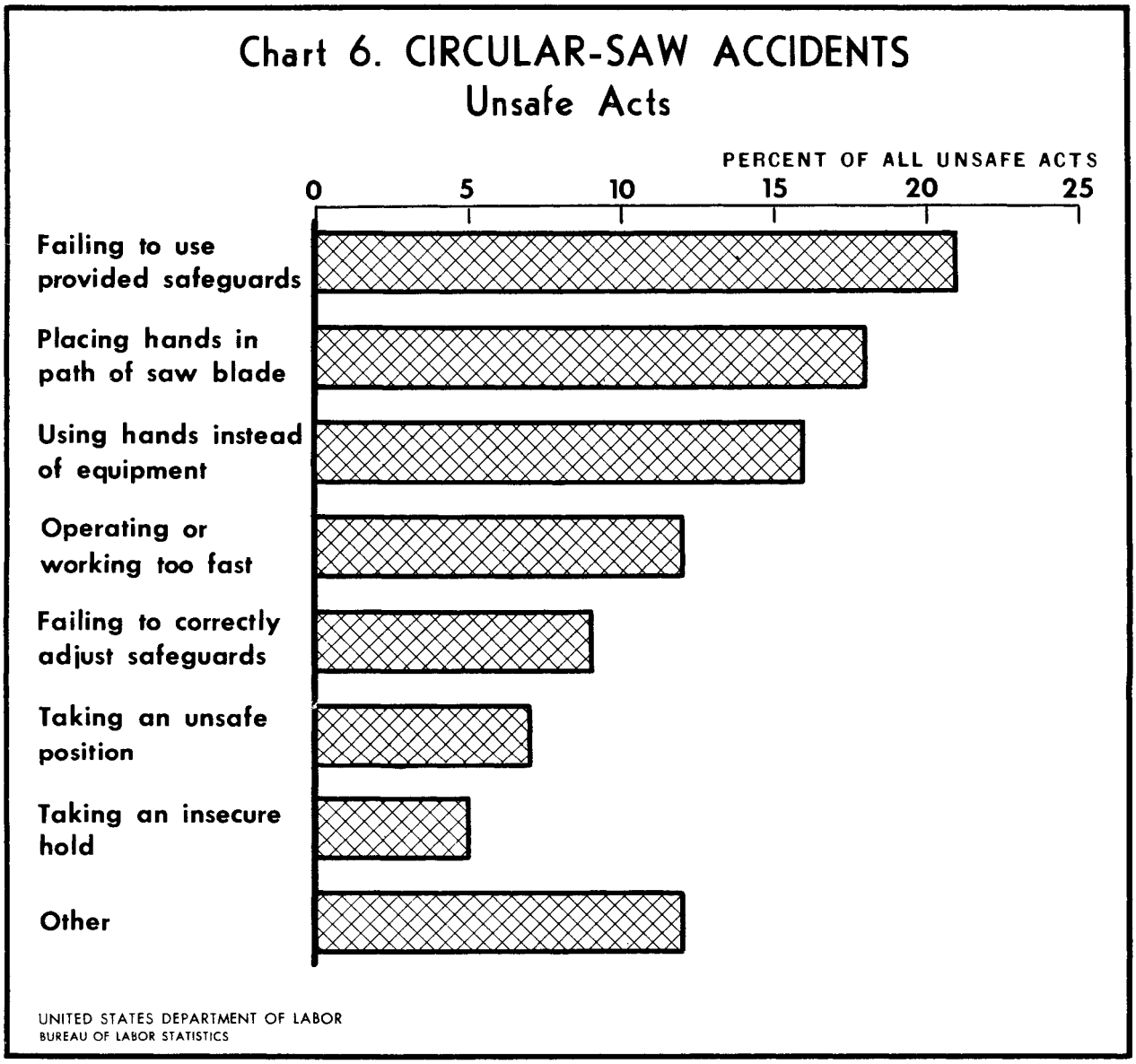

where the operator was attempting to remove cutoff strips from between the blade and the guide, the strip caught on the blade and threw his hand against the teeth.

The third major group of unsafe acts in the misuse-of-hands category con-

sisted of instances in which the operator failed to maintain a good grip on the material he was feeding to the saw. Because of this failure, some operators' hands simply slipped off the material and plunged into the blade. Others failed to hold the lumber firmly enough to prevent its vibrations from throwing their hands off and into the saw. These cases constituted 5 percent of the unsafe acts.

All of the misuse-of-hands cases reflect either deliberate and unnecessary chance-taking or a complete lack of appreciation of circular-saw hazards. It is significant, however, that relatively few of these violations of safe operating procedure could have resulted in serious injury if the saws had been equipped with adequate hood guards.

Misuse of Equipment.--Closely allied to the misuse of hands were the attempts to use circular saws for purposes other than those for which they were designed--such as attempting cuts which should be made on a band saw, a router or a shaper. Here again, some of the safe practice violations can be ascribed to the operator's lack of training, but some of the injured operators were experienced and should have known better. Similarly, there were instances in which operators attempted to use obviously defective equipment despite the self-evident rule that a defective circular saw should never be used. The unsafe acts of this general category comprised about 4 percent of the total.

Making Safety Devices Inoperative.--In a significant number of instances the operator was injured simply because he failed to use an available hood guard or other safety device, or because he failed to adjust the guard which was in place so that it would function properly. This group included 30 percent of the cases studied. Again, the operator's lack of training in the use of circular saws accounts for some of the faulty performances, but in the majority of cases the violation of good practice appears to have been due simply to a desire to avoid the inconvenience of replacing or adjusting the guard, or perhaps to a lack of patience for the time required to observe the safe practice.

Operating or Working at Unsafe Speeds.--In some 12 percent of the unsafe acts the hazards of haste were more obvious than in the preceding cases. The most common violation of the safe procedure in the group of accidents attributed to unsafe operating speeds was the practice of cleaning or adjusting the equipment while the blade was running. The risk involved in such an action should be obvious to anyone who has any training or experience in the operation of machinery. Somewhat less obvious to anyone other than an experienced saw operator is the error of forcing the work or feeding too fast. A number of the kickback accidents in the study resulted from this fault of being hasty.

This general group of unsafe acts also included a few instances which did not involve inherent hazards in the equipment. These were cases in which the operator was injured in moving materials to and from the saw table--most commonly the injuries were either splinter punctures or pinched fingers. The splinter wounds generally resulted from taking hold of lumber or sliding the hand along a piece of lumber without first looking to see if the lumber was rough or splintered. The pinched fingers resulted primarily from lack of attention when placing lumber on the saw table.

Unsafe Position.--About 7 percent of the accidents in the study occurred because the operator unnecessarily placed himself in a hazardous position. Most commonly he stood directly in line with the saw blade while he performed ripping operations. This invites injury in the event a kickback occurs.

Less commonly, some operators climbed onto the saw table for one reason or another while the saw was running, or stood on boxes or pieces of lumber to reach across the saw table. The lucky ones simply fell against the table or to the floor. Some fell or slipped against the blade.

Failure to Wear Safe Attire.-- About 2 percent of the accidents resulted from unsafe acts of this general category -- two-thirds of the accidents in this group occurred because the operators wore unsafe apparel, and one-third occurred because the operators failed to wear recommended protective devices.

Workers who handle lumber commonly wear gloves or leather hand protectors while they pile or move the material. This is desirable protection in such operations, but all rules of safe practice positively forbid workers to use hand covers while they are working on or around moving machinery. Similarly, it is a fundamental safety rule that machine operators should not wear loose clothing while at their machines--loose sleeves and neckties are particularly hazardous.

The most serious accidents in this group were those in which the operators' gloves were caught by the saw teeth and their hands were pulled into the blade. One operator lost four fingers in such an accident. Loose sleeves were responsible for a number of similar accidents.

Safe practice rules invariably prescribe that workers wear protective goggles or face shields in any operation where there is a possibility of dust or materials being thrown off by the equipment being used. Circular-saw operators as a group tend not to observe this safety rule and as a result experience a considerable number of eye injuries. A majority of these injuries

are minor irritations inflicted by flying sawdust, but serious eye injuries inflicted by heavier materials thrown by the saw are not uncommon. By chance, only one case included in the study was of a serious nature. In this case, the operator was struck by a knot thrown back by the saw. Any of the minor injuries, however, might have been serious. In any event, all of the injuries might have been prevented if the operator had been wearing goggles or a face shield.

RECOMMENDATIONS FOR ACCIDENT PREVENTION

To illustrate the general types of accident problems arising in the operation of circular saws, a number of accidents were selected for detailed study. These accidents were then analyzed by a member 8/ of the Division of Safety Standards and Services of the United States Department of Labor's Bureau of Labor Standards and suggestions were made to indicate how these accidents might have been prevented.

In presenting these accident-prevention suggestions, there is no intent to imply that they constitute a comprehensive set of safety rules for the operation of circular saws. The accidents described here are typical cases of frequent occurrence, but they do not in any sense represent the full range of hazards encountered in saw operations.

Many of the comments include references to specific provisions in safety standards which have been developed and issued through the American Standards Association. These standards have received wide acceptance as authoritative guides to the safe conduct of industrial operations, and observance of their recommendations can do much to eliminate the possibility of injury in the use of woodworking and other industrial equipment. It should be emphasized, however, that conformance with the American Standards Safety Codes will not always constitute compliance with the legal safety requirements of the several States. A knowledge of the State regulations and full compliance with their requirements is mandatory, but the safety-minded operator will also want to be familiar with the American Standards and will apply their recommendations to eliminate any hazards which are not covered in the State regulations.

8/ Sheldon W. Homan, Safety Engineer.

The accident case stories on which this analysis is based have been grouped under three major headings of unsafe physical conditions. A discussion of the accident case stories follows.

Unguarded or Inadequately Guarded Saw Blade

The unguarded saw blade is the unsafe physical condition for which there can be no excuse because guards are available which can be used for most cutting operations. But an unsafe physical condition alone does not necessarily lead to an accident--in most cases an unsafe act is also involved. And when an unsafe act is performed where an unsafe physical condition exists, an accident is bound to happen sooner or later.

A basic rule for operating any machine, "Never attempt to clean the machine while it is in motion," is particularly applicable to the circular saw. Under some conditions it might be permissible to use a brush to clear away scraps or sawdust from the table while the blade is turning, but under no condition should the hands be used for this purpose. The violation of this basic rule in the following two cases indicates lack of proper employee training and inadequate supervision by management.

1. As a saw operator reached across the saw blade to remove some lumber scraps from the table, his hand struck the blade.

a. Circular saws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery.

b. Operators should use a brush to remove scraps or sawdust from the saw table; hands alone should never be used for that purpose. Stopping the saw before attempting to clean the table constitutes an even better practice.

2. A chip of wood was wedged between the spreader and the throat piece. The operator attempted to remove it while the saw was running. The chip loosened suddenly and the workman's hand struck the blade. He amputated his index finger.

a. Circular saws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery.

b. When scrap wood cannot be removed with a brush, the workman should open the switch and wait for the blade to come to rest before cleaning the machine.

Closely alined to cleaning machinery in motion is the unsafe act of adjusting machinery in motion. A common fault in circular-saw operation is

attempting to adjust or reset the fence while the blade is running. Aside from the danger involved, more accurate setting can be made if the saw is at rest. Another dangerous practice is adjusting the height of the saw above the table or adjusting the tilt of the table while the power is on. Accidents of this type indicate that recognized safe practices were not a part of standard operating procedures.

3. An employee was adjusting the fence while the unguarded saw was in motion. His fingers struck the blade and were severely lacerated.

a. Circular saws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery.

b. Workmen should make adjustments on the saw only when the saw is at rest.

4. While a cabinetmaker was using a ripsaw, he reached under the table to loosen the table-tilting handle. He missed the handle and struck the blade, amputating his index finger. Investigation disclosed that the portion of the blade under the table was guarded in front by the tilting quadrant and on the side by a piece of sheet metal but that there was a gap of several inches between the quadrant and the sheet metal.

a. Portions of circular-saw blades, beneath and behind tables, should be guarded in conformance with Section 4.1.1 of the American Standard Safety Code for Woodworking Machinery.

b. Employees should make adjustments on the saw only when the saw blade is at rest.

Machinery accidents frequently occur when gloves or loose clothing catch in the moving equipment and draw the operator into contact with some part of the machine. When the part of the machine contacted is a rapidly revolving unguarded saw blade, results can be disastrous.

5. A carpenter had ripped a board into two strips. As he reached over the blade for one of the strips, his sleeve was caught by the saw and his arm pulled against the blade. Investigation disclosed that the saw was unguarded and that the carpenter was wearing a loose-sleeved shirt.

a. Circular ripsaws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery.

b. Saw operators should not wear loose flowing garments, long sleeves, neckties, etc. (See Section 7.4.1 of the Standard.)

6. A workman was wearing gloves while using a circular saw. The blade

caught one of his gloves and his thumb was amputated.

a. Circular saws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery.

b. Gloves should not be worn while operating woodworking machines. (See Section 7.4.1 of the Standard.)

Poor housekeeping and unguarded machines together are a dangerous combination. Without good housekeeping, which includes an exhaust system to remove sawdust in woodworking shops, accidents are bound to happen. An effective system of sawdust removal and floor maintenance would have removed the contributing cause of the two accidents (7 and 8) described below.

7. An operator was ripping a piece of lumber. As he neared the end of the cut, his foot slipped on some sawdust and he fell, striking the saw.

a. Circular saws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery.

b. Good housekeeping should be maintained around woodworking machinery. (See Section 7.1.2 of the Standard.) Provision should be made for the removal of shavings and sawdust. (See Section 2.1.1(d) of the American Standard Safety Code for Woodworking Machinery and the American Standard Regulations for the Installation of Blowers and Exhaust Systems for Dust, Stock, and Vapor Removal.)

8. A boat builder was sawing plywood parts on a circular saw. While reaching for a piece of stock, he stepped in a depression in the floor, causing him to fall against the table saw. Investigation disclosed that (1) the operator had removed the guard from the saw, and (2) the floor was in poor condition.

a. The provision of Section 4.1.2(a) of the Standard has been violated when the hood is removed.

b. A system of floor maintenance is a necessity around woodworking machinery. (See Section 2.2.1 of the Standard.)

In many cases where both an unsafe physical condition and an unsafe act are involved, it is difficult to determine which was the more important factor. It may be even more difficult to determine the reason for the unsafe act. The unsafe act may be due to inattentiveness on the part of the operator because of worry, anger, or some other personal factor. It may be due to lack of skill or training. Unsafe work practices, particularly when coupled with inadequate supervision, are the cause of many injuries. One or more

unsafe acts contributed to each of the following accidents:

9. An employee was ripping a board on a circular saw. As he fed the board to the saw, his thumb, being in line with the blade, was amputated. Investigation disclosed that the guard was the stationary or fixed type and had been set at three inches above the table.

a. Circular saws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery. The hood and mounting of the saw should be arranged so that the hood will automatically adjust itself to the thickness of, and remain in contact with, the material being cut.

b. Before operating a circular saw, the workman should receive careful instructions in the hazards of the saw and the safe method of operation. (See Section 7.5 of the Standard.) The workman should stand to the side of the lumber being cut with his hands out of line with the saw blade.

10. A saw operator was using a swing cutoff saw to cut short pieces of material. He pulled the saw through his finger. Investigation disclosed that the saw was unguarded.

a. Swing cut-off saws should be equipped with hoods in conformance with Section 4.1.7 of the American Standard Safety Code for Woodworking Machinery.

b. Before operating a circular saw, the workman should receive careful instructions in the hazards of the saw and the safe method of operation. (See Section 7.5 of the Standard.) Employee should grasp the handle of the saw with his right hand, hold the lumber being cut against the stop rail with his left, and keep his body well away from the path of the saw.

11. An employee was ripping a piece of wood on a saw which was near the door to the office. When someone called to him from the office, he turned his head. His hand struck the blade and he amputated three fingers.

a. Circular saws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery.

b. The operator's lack of concentration on the work being done is apparent. On the other hand, no one should call to, or in any way distract, an operator when he is feeding lumber through a saw.

12. A laborer was sawing a piece of lumber on a circular saw. The saw blade was dull and pinched the lumber, throwing his hand into the unguarded saw.

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a. Circular saws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery.

b. Systematic inspection of all woodworking machines and safety equipment should be maintained. (See Section 7.1.1 of the Standard.) Dull saw blades should be immediately removed from service. (See Section 7.1.2 of the Standard.) Violation of these principles indicates lack of planning and supervision.

13. A maintenance man was ripping a narrow board. As he fed the stock to the saw, his hand struck the blade and amputated his thumb. Investigation disclosed that the saw was unguarded.

a. Circular saws should be equipped with hoods in conformance with Section 4.1.2(a) of the American Standard Safety Code for Woodworking Machinery.

b. Push sticks should be used when cutting short or narrow pieces of material. (See Section 1.4.3 of the Standard.) This unsafe work practice is the cause of many accidents.

14. A woodworker was using a dado blade to cut a groove from the center of a board to six inches from each end. In order to make the cut, he removed the guard from the saw and placed the board down on the blade. When he dropped the board, it kicked back and his hand struck the blade.

When necessary to remove the hood guard, jigs or other devices should be used to hold the lumber being cut. (See Section 7.2.6 of the Standard.)

Lack of Protection Against Kickbacks

Kickbacks can be caused by a dull or poorly set saw, warped wood, knots, forcing the cut, or other reasons. The remedy is well known--a spreader, an antikickback device attached to the hood, and safe operating practices such as not forcing the cut and standing to one side of the board being ripped.

15. While an employee was ripping a board, it kicked back and struck his chest. Investigation disclosed that the saw was unguarded and that the employee stood directly in front of the saw.

a. In addition to a hood, circular saws should be equipped with spreaders and nonkickback fingers or dogs in conformance with Section 4.1.2(b) and (c) of the American Standard Safety Code for Woodworking Machinery.

b. Employees should receive careful instructions in the hazards of circular saws and the safe method of operation before being permitted to operate them. (See Section 7.5 of the Standard.) Workmen should stand to one side of the material being cut.

Other Unsafe Physical Conditions

Not all woodworking machine accidents are due to lack of a hood or anti-kickback devices. Other unsafe physical conditions also contribute to the accident experience as shown by the following accident case stories.

16. While an employee was using a swing cutoff saw, the counterweight chain broke and the saw swung forward, striking the workman's hand. Investigation disclosed that the chain was worn.

a. Counterweights shall not depend for their proper functioning upon any rope, cord, or spring. (See Section 4.1.7(b) of the American Standard Safety Code for Woodworking Machinery.)

b. A systematic inspection of all woodworking machines and safety equipment (Section 7.1 of the Standard) would have revealed the worn chain and proper maintenance would have assured its replacement.

17. While an employee was using a swing cutoff saw, the unguarded belt jumped from the pulley and struck his hand, lacerating it.

a. Driving power for woodworking machinery should be provided by individual motor or motors mounted on the machine whenever possible, or on a separate base adjacent to the machine with power transmission medium properly guarded. (See Section 3.1.2 of the American Standard Safety Code for Woodworking Machinery.)

b. All belts and pulleys should be guarded in accordance with the specific requirements of the American Standard Safety Code for Mechanical Power Transmission Apparatus. (See Section 3.1.1(j) of the American Standard Safety Code for Woodworking Machinery.)

18. An operator was cutting stock on a swing saw. When he released the arm, it swung and then bounced back, the blade striking his hand.

A latch or equivalent device should be provided to catch and retain the saw at the rear of the table to prevent its rebounding. (See Section 4.1.7(d) of the American Standard Safety Code for Woodworking Machinery.)

19. A millman was using a radial saw with a dado blade to notch end sections of window sills. As he was sliding a piece into position for cutting, his hand struck the saw blade. Investigation disclosed that the saw was not designed so that the saw would return automatically to its "rest" position.

A radial saw should be installed with the front end of the unit slightly higher than the rear so that the cutting head will return gently to the starting position when released by the operator. However, the tilt should not be enough to cause a rebound. (See Section 4.1.9(d) of the American Standard Safety Code for Woodworking Machinery.)

20. A carpenter was changing the guard on a ripsaw. As he turned, he struck the starting switch and his finger was amputated by the blade.

Switches should be installed so as to minimize the danger of accidental operation. (See Rule 320, National Electrical Safety Code.) This accident could have been avoided by a recessed "start" button.

21. A saw operator was stacking material on the saw table of a jump saw preparatory to cutting. He accidentally stepped on the treadle and the blade swung, amputating his third finger. Investigation disclosed that the blade was unguarded.

a. Inverted swing cutoff saws (jump saws) should be equipped with hoods. (See Section 4.1.8 of the American Standard Safety Code for Woodworking Machinery.)

b. Operating treadles should be protected against unexpected or accidental tripping. (See Section 3.1.3(f) of the Standard.) This accident would have been prevented by a guard placed over the treadle.

22. While a workman was using a circular saw, a piece of sawdust became embedded in his eye.

Proper eye protection should be provided and used to offset the danger of flying chips, sawdust, etc. (See Section 7.4.2 of American Standard Safety Code for Woodworking Machinery and the American Standard Safety Code for the Protection of the Head, Eyes, and Respiratory Organs.)

APPENDIX A--STATISTICAL TABLES.

For definitions of circular-saw accident, death, permanent-partial disability, temporary-total disability, and nondisabling injury, see section on Scope and Method of Survey, page 2.

Table 1.--Injuries resulting from circular-saw accidents, by State, and extent of disability, 1951-52.

State	Total number of injuries	Number of non-disabling injuries	Number of disabling injuries				Total number of days lost or charged	Average number of days lost or charged per disabling injury
			Total	Resulting in--				
				Death	Permanent-partial disability	Temporary-total disability		
Total.....	1,021	430	591	1	281	309	218,214	369
State No. 1..	380	185	195	-	112	83	86,765	445
State No. 2..	199	100	99	1	39	59	39,568	400
State No. 3..	137	55	82	-	45	37	34,084	416
State No. 4..	105	55	50	-	22	28	14,248	285
State No. 5..	103	-	103	-	41	62	26,395	256
State No. 6..	29	13	16	-	10	6	6,854	(1/)
State No. 7..	20	6	14	-	3	11	3,746	(1/)
State No. 8..	18	7	11	-	4	7	2,920	(1/)
State No. 9..	12	2	10	-	1	9	963	(1/)
State No. 10.	9	4	5	-	3	2	2,128	(1/)
State No. 11.	4	3	1	-	1	-	300	(1/)
State No. 12.	3	-	3	-	-	3	198	(1/)
State No. 13.	2	-	2	-	-	2	45	(1/)

1/ Not computed because of small number of injuries in sample.

Table 2.--Injuries resulting from circular-saw accidents, by kind of saw and activity of injured, 1951-52.

Activity of injured	Total number of injuries	Kind of saw			
		Hand-fed ripsaws	Hand-fed crosscut table saws	Swing cutoff saws	Other and unclassified
Total	1,021	555	162	139	165
Feeding: total	725	428	105	91	101
Moving material	669	427	105	36	101
Onto table	22	8	4	4	6
To self-feed devices	16	-	-	-	16
To or through blade	582	400	98	10	74
On top of blade	23	17	3	-	3
Other	26	2	-	22	2
Moving saw blade	56	1	-	55	-
Off-bearing: total	109	61	15	17	16
By saw operator	97	59	13	15	10
By other workmen	12	2	2	2	6
Cleaning: total	107	42	24	12	29
Saw table	96	41	21	10	24
Saw, except table	8	1	2	1	4
Other	3	-	1	1	1
Adjusting or replacing: total	35	14	12	4	5
Blade	19	8	6	2	3
Other	16	6	6	2	2
Other activities	23	8	4	4	7
Unclassified; insufficient data	22	2	2	11	7

Table 3.--Injuries resulting from circular-saw accidents, by activity of injured and extent of disability, 1951-52.

Activity of injured	Total number of injuries		Number of non-disabling injuries	Number of disabling injuries			
				Total	Resulting in--		
	Number	Percent[1/]			Death	Permanent-partial disability	Temporary-total disability
Total	1,021	100.0	430	591	1	281	309
Feeding: total	725	72.6	313	412	-	188	224
Moving material	669	67.0	293	376	-	173	203
Onto table	22	2.2	11	11	-	1	10
To self-feed devices	16	1.6	8	8	-	1	7
To or through blade	582	58.3	251	331	-	157	174
On top of blade	23	2.3	4	19	-	10	9
Other	26	2.6	19	7	-	4	3
Moving saw blade	56	5.6	20	36	-	15	21
Off-bearing: total	109	10.9	45	64	-	37	27
By saw operator	97	9.7	42	55	-	33	22
By other workmen	12	1.2	3	9	-	4	5
Cleaning: total	107	10.7	39	68	1	33	34
Saw table	96	9.6	35	61	1	32	28
Saw, except table	8	.8	3	5	-	1	4
Other	3	.3	1	2	-	-	2
Adjusting or replacing: total	35	3.5	19	16	-	7	9
Blade	19	1.9	13	6	-	2	4
Other	16	1.6	6	10	-	5	5
Other activities	23	2.3	9	14	-	5	9
Unclassified; insufficient data	22	-	5	17	-	11	6

1/ Percents are based on classified cases only.

Table 4.--Injuries resulting from circular-saw accidents, by nature of injury, part of body injured, and extent of disability, 1951-52.

Nature of injury and part of body injured	Total number of injuries		Number of non-disabling injuries	Number of disabling injuries			
				Total	Resulting in--		
	Number	Percent			Death	Permanent-partial disability	Temporary-total disability
Total	1,021	100.0	430	591	1	281	309
NATURE OF INJURY							
Amputations	224	21.9	-	224	1	223	-
Bruises, contusions	70	6.9	43	27	-	-	27
Cuts, lacerations	631	61.8	343	288	-	50	238
Fractures	50	4.9	6	44	-	8	36
Irritations due to foreign bodies in eyes	31	3.0	30	1	-	-	1
Strains, sprains	15	1.5	8	7	-	-	7
PART OF BODY INJURED							
Head: total	53	5.2	41	12	-	1	11
Eye	44	4.3	35	9	-	-	9
Other	9	.9	6	3	-	1	2
Trunk: total	43	4.2	18	25	-	-	25
Abdomen	24	2.3	12	12	-	-	12
Chest, ribs	8	.8	3	5	-	-	5
Other	11	1.1	3	8	-	-	8
Upper extremities: total	918	89.9	336	552	1	280	271
Arm	18	1.8	6	12	-	1	11
Hand	69	6.8	30	39	-	9	30
Thumb	276	27.0	124	152	-	76	76
1 finger	348	34.0	156	192	1	108	83
2 fingers	96	9.4	36	60	-	33	27
3 fingers	26	2.5	3	23	-	12	11
4 fingers	21	2.1	2	19	-	12	7
Thumb and 1 or more fingers	64	6.3	9	55	-	29	26
Lower extremities: total	7	.7	5	2	-	-	2
Leg	3	.3	3	-	-	-	-
Foot	3	.3	1	2	-	-	2
Toe	1	.1	1	-	-	-	-

Table 5.--Injuries resulting from circular-saw accidents, by activity of injured, part of body injured, and nature of injury, 1951-52.

Activity of injured and part of body injured	Total number of injuries	Nature of injury					
		Amputations	Bruises, contusions	Cuts, lacerations	Fractures	Irritations due to foreign bodies in eyes	Strains, sprains
Total	1,021	224	70	631	50	31	15
ACTIVITY OF INJURED							
Feeding: total	725	154	56	435	40	26	14
Moving material	669	144	53	404	37	20	11
Onto table	22	1	3	13	2	-	3
To self-feed devices	16	-	4	10	1	-	1
To or through blade	582	131	45	347	32	20	7
On top of blade	23	9	-	13	1	-	-
Other	26	3	1	21	1	-	-
Moving saw blade	56	10	3	31	3	6	3
Off-bearing: total	109	28	7	71	2	1	-
By saw operator	97	24	6	65	2	-	-
By other workmen	12	4	1	6	-	1	-
Cleaning: total	107	22	-	82	2	1	-
Saw table	96	21	-	72	2	1	-
Saw, except table	8	1	-	7	-	-	-
Other	3	-	-	3	-	-	-
Adjusting or replacing: total	35	4	2	25	3	-	1
Blade	19	1	1	15	2	-	-
Other	16	3	1	10	1	-	1
Other activities	23	5	5	8	2	3	-
Unclassified; insufficient data	22	11	-	10	1	-	-
PART OF BODY INJURED							
Head: total	53	-	6	13	1	31	2
Eye	44	-	6	7	-	31	-
Other	9	-	-	6	1	-	2
Trunk: total	43	-	30	5	2	-	6
Abdomen	24	-	19	4	-	-	1
Chest, ribs	8	-	6	-	2	-	-
Other	11	-	5	1	-	-	5
Upper extremities: total	918	224	31	611	45	-	7
Arm	18	-	4	14	-	-	-
Hand	69	1	12	51	2	-	3
Thumb	276	64	7	191	12	-	2
1 finger	348	94	7	224	21	-	2
2 fingers	96	28	1	65	2	-	-
3 fingers	26	8	-	16	2	-	-
4 fingers	21	9	-	12	-	-	-
Thumb and 1 or more fingers	64	20	-	38	6	-	-
Lower extremities: total	7	-	3	2	2	-	-
Leg	3	-	2	1	-	-	-
Foot	3	-	1	1	1	-	-
Toe	1	-	-	-	1	-	-

Table 6.--Injuries resulting from circular-saw accidents, by activity of injured and part of body injured, 1951-52.

Activity of injured	Total number of injuries	Part of body injured							
		Head	Trunk	Upper extremities					Lower extremities
				Total	Arm	Hand	1 finger or thumb	2 or more fingers or thumbs	
Total.....	1,021	53	43	918	18	69	622	209	7
Feeding: total.....	725	44	39	639	10	49	444	136	3
Moving material.	669	35	37	594	6	44	416	128	3
Onto table...	22	1	4	16	-	3	12	1	1
To self-feed devices...	16	1	4	10	1	2	6	1	1
To or through blade.....	582	33	29	519	3	34	373	109	1
On top of blade.....	23	-	-	23	-	2	10	11	-
Other.....	26	-	-	26	2	3	15	6	-
Moving saw blade	56	9	2	45	4	5	28	8	-
Off-bearing: total.	109	3	3	102	3	6	68	25	1
By saw operator.	97	1	2	93	2	6	62	23	1
By other workmen	12	2	1	9	1	-	6	2	-
Cleaning: total....	107	1	-	106	2	5	65	34	-
Saw table.....	96	1	-	95	1	5	60	29	-
Saw, except table.....	8	-	-	8	-	-	3	5	-
Other.....	3	-	-	3	1	-	2	-	-
Adjusting or replacing: total	35	-	-	35	2	6	20	7	-
Blade.....	19	-	-	19	2	1	14	2	-
Other.....	16	-	-	16	-	5	6	5	-
Other activities...	23	4	1	15	1	2	9	3	3
Unclassified.....	22	1	-	21	-	1	16	4	-

Table 7.--Injuries resulting from circular-saw accidents, by agency of injury and extent of disability, 1951-52.

Agency of injury	Total number of injuries		Number of non-disabling injuries	Number of disabling injuries			
				Total	Resulting in--		
	Number	Percent 1/			Death	Permanent-partial disability	Temporary-Total disability
Total	1,021	100.0	430	591	1	281	309
Saws: total	831	81.7	306	525	1	275	249
Blade (point-of-operation)	810	79.6	298	512	1	273	238
Rotating at full speed	767	75.3	273	494	1	268	225
Slowing to stop	23	2.3	9	14	-	3	11
Starting up	4	.4	-	4	-	2	2
At rest	16	1.6	16	-	-	-	-
Other parts	21	2.1	8	13	-	2	11
Lumber	147	14.5	90	57	-	3	54
Sawdust	30	2.9	29	1	-	-	1
Other agencies	9	.9	4	5	-	-	5
Unclassified; insufficient data	4	-	1	3	-	3	-

1/ Percents are based on classified cases only.

Table 8.--Injuries resulting from circular-saw accidents, by agency of injury and nature of injury, 1951-52.

Agency of injury	Total number of injuries	Nature of injury					
		Amputations	Bruises, contusions	Cuts, lacerations	Fractures	Irritations due to foreign bodies in eyes	Strains, sprains
Total	1,021	224	70	631	50	31	15
Saws: total	831	220	8	564	36	-	3
Blade (point-of-operation)	810	218	2	557	33	-	-
Rotating at full speed	767	216	-	519	32	-	-
Slowing to stop	23	2	-	20	1	-	-
Starting up	4	-	-	4	-	-	-
At rest	16	-	2	14	-	-	-
Other parts	21	2	6	7	3	-	3
Lumber	147	1	60	61	14	-	11
Sawdust	30	-	-	-	-	30	-
Other agencies	9	-	2	5	-	1	1
Unclassified; insufficient data	4	3	-	1	-	-	-

Table 9.--Circular-saw accidents, by type of accident and agency of injury, 1951-52.

Type of accident	Total number of accidents	Agency of injury						
		Saws			Lumber	Sawdust	Other	Unclassified
		Total	Blade	Other parts				
Total	1,021	831	810	21	147	30	9	4
Striking against objects: total.	740	739	738	1	-	-	1	-
Saw blades	738	738	738	-	-	-	-	-
Hand held in path of blade.	257	257	257	-	-	-	-	-
While removing scraps, sawdust, etc.	181	181	181	-	-	-	-	-
Hand thrown against blade by kickback.	138	138	138	-	-	-	-	-
Hand slipped from lumber.	83	83	83	-	-	-	-	-
While adjusting or replacing blades.	24	24	24	-	-	-	-	-
While placing lumber on table.	17	17	17	-	-	-	-	-
Other	38	38	38	-	-	-	-	-
Other objects	2	1	-	1	-	-	1	-
Struck by moving objects: total.	164	47	46	1	112	-	5	-
Objects thrown by saw	112	-	-	-	108	-	4	-
Lumber, chips	108	-	-	-	108	-	-	-
Other objects	4	-	-	-	-	-	4	-
Saw blades	46	46	46	-	-	-	-	-
Other objects	6	1	-	1	4	-	1	-
Falls: total	28	26	26	-	1	-	1	-
On same level	27	25	25	-	1	-	1	-
Against saw blades	25	25	25	-	-	-	-	-
Against other objects.	2	-	-	-	1	-	1	-
To lower level	1	1	1	-	-	-	-	-
Rubbed, abraded: total	55	4	-	4	20	30	1	-
By splinters	13	-	-	-	13	-	-	-
By other objects	42	4	-	4	7	30	1	-
Caught in, on, or between moving objects: total.	23	12	-	12	10	-	1	-
Lumber and parts of saw	10	1	-	1	9	-	-	-
Rolls, conveyor chains, etc.	6	6	-	6	-	-	-	-
Other objects	7	5	-	5	1	-	1	-
Overexertion	7	3	-	3	4	-	-	-
Unclassified; insufficient data.	4	-	-	-	-	-	-	4

Table 10.--Circular-saw accidents, by type of accident and extent of disability, 1951-52.

Type of accident	Total number of injuries		Number of non-disabling injuries	Number of disabling injuries			
				Total	Resulting in--		
	Number	Percent[1/]			Death	Permanent-partial disability	Temporary-total disability
Total	1,021	100.0	430	591	1	281	309
Striking against objects: total	740	72.7	278	462	1	244	217
Saw blades	738	72.5	277	461	1	244	216
Hand held in path of blade.	257	25.2	100	157	-	82	75
While removing scraps, sawdust, etc.	181	17.7	68	113	1	65	47
Hand thrown against blade by kickback.	138	13.6	41	97	-	52	45
Hand slipped from lumber.	83	8.2	26	57	-	31	26
While adjusting or replacing blades.	24	2.4	15	9	-	5	4
While placing lumber on table.	17	1.7	13	4	-	-	4
Other	38	3.7	14	24	-	9	15
Other objects	2	.2	1	1	-	-	1
Struck by moving objects: total	164	16.1	79	85	-	22	63
Objects thrown by saw	112	11.0	60	52	-	2	50
Lumber, chips	108	10.6	59	49	-	2	47
Other objects	4	.4	1	3	-	-	3
Saw blades	46	4.5	14	32	-	20	12
Other objects	6	.6	5	1	-	-	1
Falls: total	28	2.8	8	20	-	9	11
On same level	27	2.7	8	19	-	8	11
Against saw blades	25	2.5	7	18	-	8	10
Against other objects	2	2	1	1	-	-	1
To lower level	1	1	-	1	-	1	-
Rubbed, abraded: total	55	5.4	49	6	-	-	6
By splinters	13	1.3	11	2	-	-	2
By other objects	42	4.1	38	4	-	-	4
Caught in, on, or between moving objects: total	23	2.3	12	11	-	3	8
Lumber and parts of saw	10	1.0	7	3	-	1	2
Rolls, conveyor chains, etc.	6	.6	2	4	-	1	3
Other objects	7	.7	3	4	-	1	3
Overexertion	7	.7	3	4	-	-	4
Unclassified; insufficient data	4	-	1	3	-	3	-

1/ Percents are based on classified cases only.

Table 11.--Circular-saw accidents, by type of accident and nature of injury, 1951-52.

Type of accident	Total number of accidents	Nature of injury					
		Amputations	Bruises, contusions	Cuts, lacerations	Fractures	Irritations due to foreign bodies in eyes	Strains, sprains
Total	1,021	224	70	631	50	31	15
Striking against objects: total	740	196	1	513	30	-	-
Saw blades	738	196	1	512	29	-	-
Hand held in path of blade.	257	70	-	176	11	-	-
While removing scraps, sawdust, etc.	181	46	-	131	4	-	-
Hand thrown against blade by kickback.	138	47	-	85	6	-	-
Hand slipped from lumber.	83	21	-	58	4	-	-
While adjusting or replacing blades.	24	3	1	18	2	-	-
While placing lumber on table.	17	-	-	16	1	-	-
Other	38	9	-	28	1	-	-
Other objects	2	-	-	1	1	-	-
Struck by moving objects: total	164	14	55	79	13	-	3
Objects thrown by saw	112	-	53	46	10	-	3
Lumber, chips	108	-	52	43	10	-	3
Other objects	4	-	1	3	-	-	-
Saw blades	46	14	-	30	2	-	-
Other objects	6	-	2	3	1	-	-
Falls: total	28	8	2	15	2	-	1
On same level	27	7	2	15	2	-	1
Against saw blades	25	7	1	15	2	-	-
Against other objects	2	-	1	-	-	-	1
To lower level	1	1	-	-	-	-	-
Rubbed, abraded: total	55	-	5	15	-	31	4
By splinters	13	-	-	13	-	-	-
By other objects	42	-	5	2	-	31	4
Caught in, on, or between moving objects: total.	23	3	7	8	5	-	-
Lumber and parts of saw	10	1	3	3	3	-	-
Rolls, conveyor chains, etc.	6	1	1	3	1	-	-
Other objects	7	1	3	2	1	-	-
Overexertion	7	-	-	-	-	-	7
Unclassified; insufficient data	4	3	-	1	-	-	-

Table 12.--Circular-saw accidents, by type of accident and part of body injured, 1951-52.

Type of accident	Total number of accidents	Part of body injured							
		Head	Trunk	Upper extremities					Lower extremities
				Total	Arm	Hand	1 finger or thumb	2 or more fingers or thumbs	
Total	1,021	53	43	918	18	69	622	209	7
Striking against objects: total	740	-	-	739	7	30	522	180	1
Saw blades	738	-	-	738	7	30	521	180	-
Hand held in path of blade	257	-	-	257	-	5	203	49	-
While removing scraps, sawdust, etc.	181	-	-	181	4	6	120	51	-
Hand thrown against blade by kickback	138	-	-	138	-	9	84	45	-
Hand slipped from lumber	83	-	-	83	-	4	62	17	-
While adjusting or replacing blades	24	-	-	24	2	2	16	4	-
While placing lumber on table	17	-	-	17	-	1	13	3	-
Other	38	-	-	38	1	3	23	11	-
Other objects	2	-	-	1	-	-	1	-	1
Struck by moving objects: total	164	20	36	105	8	24	55	18	3
Objects thrown by saw	112	19	36	56	6	19	24	7	1
Lumber, chips	108	17	36	54	6	18	23	7	1
Other objects	4	2	-	2	-	1	1	-	-
Saw blades	46	-	-	46	2	3	30	11	-
Other objects	6	1	-	3	-	2	1	-	2
Falls: total	28	-	3	25	1	3	14	7	-
On same level	27	-	3	24	1	3	13	7	-
Against saw blades	25	-	1	24	1	3	13	7	-
Against other objects	2	-	2	-	-	-	-	-	-
To lower level	1	-	-	1	-	-	1	-	-
Rubbed, abraded: total	55	31	-	23	2	8	11	2	1
By splinters	13	-	-	12	-	6	6	-	1
By other objects	42	-	-	11	2	2	5	2	-
Caught in, on, or between moving objects: total	23	-	-	21	-	3	17	1	2
Lumber and parts of saw	10	-	-	10	-	-	9	1	-
Rolls, conveyor chains, etc.	6	-	-	5	-	1	4	-	1
Other objects	7	-	-	6	-	2	4	-	1
Overexertion	7	2	4	1	-	1	-	-	-
Unclassified; insufficient data	4	-	-	4	-	-	3	1	-

Table 13.--Circular-saw accidents, by activity of injured and type of accident, 1951-52.

Activity	Total number of accidents	Type of accident													
		Striking against objects			Struck by moving objects				Falls			Abraded	Caught in or between moving objects	Overexertion	Unclassified
		Total	Saw blades	Other	Total	Objects thrown by saw	Saw blades	Other	Total	On same level	To lower level				
Total	1,021	740	738	2	164	112	46	6	28	27	1	55	23	7	4
Feeding: total	725	502	502	-	136	100	34	2	21	20	1	46	13	6	1
Moving material	669	493	493	-	104	96	6	2	19	18	1	38	10	4	1
Onto tables	22	8	8	-	4	1	1	2	3	3	-	2	2	3	-
To self-feed devices	16	-	-	-	10	10	-	-	1	1	-	1	3	1	-
To blade	582	448	448	-	85	85	-	-	14	13	1	31	3	-	1
On top of blade	23	22	22	-	-	-	-	-	1	1	-	-	-	-	-
Other	26	15	15	-	5	-	5	-	-	-	-	4	2	-	-
Moving saw blade	56	9	9	-	32	4	28	-	2	2	-	8	3	2	-
Off-bearing: total	109	92	92	-	10	7	1	2	2	2	-	3	2	-	-
By saw operator	97	87	87	-	9	6	1	2	1	1	-	-	-	-	-
By other workmen	12	5	5	-	1	1	-	-	1	1	-	3	2	-	-
Cleaning: total	107	102	102	-	3	1	2	-	-	-	-	1	1	-	-
Saw table	96	91	91	-	3	1	2	-	-	-	-	1	1	-	-
Saw, except table	8	8	8	-	-	-	-	-	-	-	-	-	-	-	-
Other	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
Adjusting or replacing: total	35	28	27	1	3	-	3	-	1	1	-	1	1	1	-
Blade	19	16	15	1	2	-	2	-	-	-	-	-	1	-	-
Other	16	12	12	-	1	-	1	-	1	1	-	1	-	1	-
Other activities	23	9	8	1	3	2	-	1	3	3	-	3	5	-	-
Unclassified	22	7	7	-	9	2	6	1	1	1	-	1	1	-	3

Table 14.--Injuries resulting from circular-saw accidents, by violation or nonviolation of State safety requirement and extent of disability, 1951-52.

Item	Total number of injuries		Number of nondisabling injuries	Number of disabling injuries			
				Total	Resulting in--		
	Number	Percent 1/			Death	Permanent-partial disability	Temporary-total disability
Total	1,021	100.0	430	591	1	281	309
Violation of State requirement	567	56.8	208	359	1	175	183
Nonviolation of State requirement	431	43.2	213	218	-	96	122
Unclassified	23	-	9	14	-	10	4

1/ Percents are based on classified cases only.

Table 15.--Injuries resulting from circular-saw accidents, by State, and violation or nonviolation of State safety requirements, 1951-52.

State	Number of injuries involving violation of State safety requirements				Number of injuries involving nonviolation of State safety requirements			
	Total	Resulting in--			Total	Resulting in--		
		Death or permanent-partial disability	Temporary-total disability	No disability		Death or permanent-partial disability	Temporary-total disability	No disability
Total.....	567	176	183	208	431	96	122	213
State No. 1.	202	70	43	89	174	42	40	92
State No. 2.	136	29	40	67	62	11	18	33
State No. 3.	87	30	26	31	44	11	11	22
State No. 4.	26	6	13	7	73	12	14	47
State No. 5.	76	31	45	-	27	10	17	-
State No. 6.	14	6	4	4	15	4	2	9
State No. 7.	5	-	2	3	10	1	7	2
State No. 8	3	-	2	1	15	4	5	6
State No. 9.	7	1	5	1	4	-	4	-
State No. 10	7	3	1	3	2	-	1	1
State No. 11	2	-	-	2	2	1	-	1
State No. 12	2	-	2	-	1	-	1	-
State No. 13	-	-	-	-	2	-	2	-

Table 16.--Injuries resulting from circular-saw accidents, by kind of saw and violation or nonviolation of State safety requirements, 1951-52.

Item	Kind of saw							
	Hand-fed rip-saws		Hand-fed crosscut table saws		Swing cutoff saws		Other and unclassified	
	Number	Percent1/	Number	Percent1/	Number	Percent1/	Number	Percent1/
Total.....	555	100.0	162	100.0	139	100.0	165	100.0
Violation of State requirement	360	65.6	85	53.8	49	36.0	73	47.1
Nonviolation of State requirement	189	34.4	73	46.2	87	64.0	82	52.9
Unclassified.....	6	-	4	-	3	-	10	-

1/ Percents based on classified cases only.

Table 17.--Circular-saw accidents, by type of accident and hazardous working condition, 1951-52.

Type of accident	Total number of accidents	Hazardous working condition										
		Inadequately guarded						Defects of agencies	Lack of goggles	Environmental hazards	Placement hazards	None and unclassified
		Total	Lack of hood guard	Inadequate hood guard	Lack of anti-kickback device	Inadequate anti-kickback device	Other					
Total	1,021	901	586	216	67	19	13	52	36	11	7	14
Striking against objects: total	740	733	531	192	-	-	-	14	-	-	1	2
Saw blades	738	723	531	192	-	-	-	14	-	-	-	1
Hand held in path of blade	257	255	180	75	-	-	-	2	-	-	-	-
While removing scraps, etc.	181	176	122	54	-	-	-	5	-	-	-	-
Hand thrown against saw by kickbacks	138	137	116	21	-	-	-	1	-	-	-	-
Hand slipped from lumber	83	81	58	23	-	-	-	2	-	-	-	-
While adjusting or replacing blades	24	24	20	4	-	-	-	-	-	-	-	-
While placing lumber on table	17	14	8	6	-	-	-	3	-	-	-	-
Other	38	36	27	9	-	-	-	1	-	-	-	1
Other objects	2	-	-	-	-	-	-	-	-	-	1	1
Struck by moving objects: total	164	141	38	16	64	19	4	12	6	4	-	1
Objects thrown by saw	112	99	14	1	64	19	1	7	6	-	-	-
Lumber, chips	108	96	12	-	64	19	1	6	6	-	-	-
Other objects	4	3	2	1	-	-	-	1	-	-	-	-
Saw blades	46	41	24	15	-	-	2	5	-	-	-	-
Other objects	6	1	-	-	-	-	1	-	-	4	-	1
Falls: total	28	24	16	8	-	-	-	1	-	-	3	-
On same level	27	24	16	8	-	-	-	-	-	-	3	-
Against saw blades	25	24	16	8	-	-	-	-	-	-	1	-
Against other objects	2	-	-	-	-	-	-	-	-	-	2	-
To lower level	1	-	-	-	-	-	-	1	-	-	-	-
Rubbed, abraded: total	55	3	-	-	1	-	2	20	30	2	-	-
By splinters	13	-	-	-	-	-	-	13	-	-	-	-
By other objects	42	3	-	-	1	-	2	7	30	2	-	-
Caught in, on, or between moving objects: total	23	10	1	-	2	-	7	3	-	2	2	6
Lumber and parts of saw	10	3	1	-	2	-	-	1	-	2	1	3
Rolls, conveyor chains, etc.	6	6	-	-	-	-	6	-	-	-	-	-
Other objects	7	1	-	-	-	-	1	2	-	-	1	3
Overexertion	7	-	-	-	-	-	-	2	-	3	1	1
Unclassified	4	-	-	-	-	-	-	-	-	-	-	4

Table 18.--Circular-saw accidents, by hazardous working condition and agency of accident, 1951-52.

Hazardous working condition	Total number of accidents	Agency of accident						
		Saws			Lumber	Other	None	Unclassified
		Total	Points of operation	Other parts				
Total	1,021	973	928	45	27	7	3	11
Inadequately guarded: total	901	901	889	12	-	-	-	-
Lack of hood guard	586	586	586	-	-	-	-	-
Inadequate hood guard	216	216	216	-	-	-	-	-
Lack of antikickback device	67	67	67	-	-	-	-	-
Inadequate antikickback device	19	19	19	-	-	-	-	-
Other	13	13	1	12	-	-	-	-
Defects of agencies: total	52	33	4	29	16	3	-	-
Rough, splintered	15	-	-	-	15	-	-	-
Improperly designed or constructed (except guards)	9	7	1	6	-	2	-	-
Other	28	26	3	23	1	1	-	-
Lack of goggles	36	35	35	-	-	1	-	-
Environmental hazards	11	4	-	4	6	1	-	-
Placement hazards	7	-	-	-	5	2	-	-
No hazardous conditions	3	-	-	-	-	-	3	-
Unclassified	11	-	-	-	-	-	-	11

Table 19.--Circular-saw accidents, by activity of injured and hazardous working condition, 1951-52.

Activity of injured	Total number of accidents	Hazardous working condition										
		Inadequately guarded						Defects of agencies	Lack of goggles	Environmental hazards	Placement hazards	None and unclassified
		Total	Lack of hood guard	Inadequate hood guard	Lack of anti-kickback device	Inadequate anti-kickback device	Other					
Total	1,021	901	586	216	67	19	13	52	36	11	7	14
Feeding: total	725	639	411	140	66	18	4	39	29	8	4	6
Moving material	669	598	386	127	65	18	2	35	22	8	2	4
Onto table	22	12	8	3	1	-	-	2	-	4	2	2
To self-feed devices	16	10	2	-	1	5	2	5	-	1	-	-
To blade	582	537	344	117	63	13	-	19	22	2	-	2
On top of blade	23	23	22	1	-	-	-	-	-	-	-	-
Other	26	16	10	6	-	-	-	9	-	1	-	-
Moving saw blade	56	41	25	13	1	-	2	4	7	-	2	2
Off-bearing: total	109	102	74	25	-	-	3	4	1	2	-	-
By saw operators	97	93	70	23	-	-	-	2	-	2	-	-
By other workmen	12	9	4	2	-	-	3	2	1	-	-	-
Cleaning: total	107	102	65	36	-	-	1	4	1	-	-	-
Saw table	96	91	58	32	-	-	1	4	1	-	-	-
Saw, except table	8	8	5	3	-	-	-	-	-	-	-	-
Other	3	3	2	1	-	-	-	-	-	-	-	-
Adjusting or replacing: total	35	31	23	6	-	-	2	2	-	-	-	2
Blade	19	17	15	-	-	-	2	-	-	-	-	2
Other	16	14	8	6	-	-	-	2	-	-	-	-
Other activities	23	12	8	2	1	-	1	1	4	1	3	2
Unclassified	22	15	5	7	-	1	2	2	1	-	-	4

Table 20.--Circular-saw accidents,
by type of accident and unsafe act, 1951-52.

Type of accident	Total number of accidents	Unsafe act														
		Using unsafe equipment; hands instead of equipment; etc.					Making safety devices inoperative				Operating or working at unsafe speeds	Taking unsafe positions or postures	Failing to wear safe attire	Other	None	Unclassified
		Total	Using hands instead of equipment	Taking wrong hold of objects	Taking insecure hold	Other	Total	Failing to use safety devices	Failing to adjust devices correctly	Other						
Total	1,021	394	135	184	45	30	262	178	75	9	100	61	18	29	45	112
Striking against objects: total	740	333	127	151	38	17	218	148	61	9	75	2	7	18	14	73
Saw blades	738	332	127	151	38	16	218	148	61	9	75	1	7	18	14	73
Hand held in path of blade	257	156	31	120	-	5	81	57	23	1	2	-	4	7	-	7
While removing scraps, sawdust, etc.	181	71	66	3	-	2	51	28	17	6	31	1	2	3	6	16
Hand thrown against saw by kickbacks	138	52	16	20	10	6	38	31	7	-	8	-	-	5	4	31
Hand slipped from lumber	83	45	11	5	27	2	35	26	9	-	2	-	-	-	1	-
While adjusting or replacing blades	24	1	-	-	-	1	1	-	1	-	21	-	-	1	-	-
While placing lumber on table	17	4	-	3	1	-	3	1	2	-	3	-	-	-	1	6
Other	38	3	3	-	-	-	9	5	2	2	8	-	1	2	2	13
Other objects	2	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-
Struck by moving objects: total	164	42	8	20	7	7	33	24	9	-	8	48	5	5	7	16
Objects thrown by saw	112	16	4	-	6	6	31	23	8	-	2	46	1	2	2	12
Lumber, chips	108	15	4	-	6	5	28	20	8	-	2	46	1	2	2	12
Other objects	4	1	-	-	-	1	3	3	-	-	-	-	-	-	-	-
Saw blades	46	24	4	20	-	-	2	1	1	-	6	-	4	2	4	4
Other objects	6	2	-	-	1	1	-	-	-	-	-	2	-	1	1	-
Falls: total	28	-	-	-	-	-	8	4	4	-	-	5	-	-	5	10
On same level	27	-	-	-	-	-	8	4	4	-	-	5	-	-	4	10
Against saw blades	25	-	-	-	-	-	8	4	4	-	-	3	-	-	4	10
Against other objects	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
To lower level	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Rubbed, abraded	55	9	-	6	-	3	2	2	-	-	13	3	5	3	17	3
Caught in moving objects	23	9	-	7	-	2	1	-	1	-	4	2	1	2	2	2
Overexertion	7	1	-	-	-	1	-	-	-	-	-	1	-	1	-	4
Unclassified	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4

Table 21.--Circular-saw accidents,
by activity of injured and unsafe act, 1951-52.

Activity of injured	Total number of accidents	Unsafe act														
		Using unsafe equipment; hands instead of equipment; etc.					Making safety devices inoperative				Operating or working at unsafe speeds	Taking unsafe positions or postures	Failing to wear safe attire	Other	None	Unclassified
		Total	Using hands instead of equipment	Taking wrong hold of objects	Taking insecure hold	Other	Total	Failing to use safety devices	Failing to adjust devices correctly	Other						
Total	1,021	394	135	184	45	30	262	178	75	9	100	61	18	29	45	112
Feeding: total	725	306	66	176	41	23	196	143	52	1	30	51	10	21	33	78
Moving material	669	272	62	152	37	21	194	141	52	1	28	48	7	19	28	73
Onto table	22	4	-	2	2	-	3	3	-	-	5	4	-	1	1	4
To self-feed devices	16	4	-	1	-	3	-	-	-	-	2	8	-	-	1	1
To blade	582	249	60	139	34	16	183	134	48	1	14	36	6	17	21	56
On top of blade	23	8	2	4	-	2	4	4	-	-	1	-	-	1	2	7
Other	26	7	-	6	1	-	4	-	4	-	6	-	1	-	3	5
Moving saw blade	56	34	4	24	4	2	2	2	-	-	2	3	3	2	5	5
Off-bearing: total	109	29	20	4	4	1	38	25	11	2	10	2	3	4	6	17
By saw operators	97	28	19	4	4	1	36	25	9	2	7	1	2	3	6	14
By other workmen	12	1	1	-	-	-	2	-	2	-	3	1	1	1	-	3
Cleaning: total	107	51	49	-	-	2	20	6	10	4	31	1	1	-	1	2
Saw table	96	50	48	-	-	2	18	6	8	4	25	1	-	-	1	1
Saw, except table	8	1	1	-	-	-	2	-	2	-	4	-	1	-	-	-
Other	3	-	-	-	-	-	-	-	-	-	2	-	-	-	-	1
Adjusting or replacing: total	35	4	-	1	-	3	2	1	1	-	26	-	-	1	1	1
Blade	19	3	-	1	-	2	-	-	-	-	16	-	-	-	-	-
Other	16	1	-	-	-	1	2	1	1	-	10	-	-	1	1	1
Other activities	23	3	-	2	-	1	4	2	1	1	1	6	3	2	-	4
Unclassified	22	1	-	1	-	-	2	1	-	1	2	1	1	1	4	10

APPENDIX B

Excerpts from

American Standard Safety Code for Woodworking Machinery[9/]

1. General

1.4 Definitions

1.4.1 ***"Shall" and "Should."*** The word "shall" is to be understood as mandatory, the word "should" as advisory.

1.4.2 ***Point of Operations.*** The term "point of operations" shall be understood to mean that point at which cutting, shaping, boring, or forming is accomplished upon the stock.

1.4.3 ***Push Stick.*** The term "push stick" shall mean a narrow strip of wood or other soft material with a notch cut into one end and which is used to push short pieces of material through saws.

1.4.4 ***Block.*** The term "push block" shall mean a short block of wood, provided with a handle similar to that of a plane and a shoulder at the rear end, which is used for pushing short stock over revolving cutters. (See Appendix A1.4.4.)

2. Plant Layout

2.1 Machinery

2.1.1 ***Machine Layout***

(a) Machines should be so located that there will be sufficient space in which to handle the material with the least possible interference from or to workmen or machines. Machines should be so placed that it will not be necessary for anyone to stand in or so near an aisle as to be liable to hazard. [See Appendix A2.1.1*(a)*.]

(b) Woodworking machinery shall be firmly secured to substantial floors or foundations. Small units shall be secured to benches, tables, or stands of adequate strength and designed so as to prevent overturning or unintentional movement. This rule does not apply to portable hand tools.

NOTE: Wherever plant layout permits, it is advisable to locate heavy-duty machines on the ground floor. [See Appendix A2.1.1*(b)*.]

9/ Approved by the American Standards Association, 1954. Reprinted here are only those sections of the Standard applying to circular saws. The complete Standard may be purchased from American Standards Association, 70 East 45th Street, New York, N. Y. Price $1.00.

(c) Machines should be located, with respect to sources of both natural and artificial light, so that light of sufficient intensity will fall on the work. Supplementary illumination at the point of operation should be provided where necessary. Direct or reflected glare and shadows, including moving shadows, should be avoided.

NOTE: For specific requirements see American Standard Practice for Industrial Lighting, A11.1-1952. See Appendix A2.1.1(c).

(d) Provision should be made for the removal of shavings and dust.

NOTE: For specific requirements see American Standard Regulations for the Installation of Blowers and Exhaust Systems for Dust, Stock, and Vapor Removal, Z33.1-1950.

2.2 Floors and Aisles

2.2.1 ***Floor Maintenance.*** All floors shall be kept in good repair and shall be free from protruding nails, splinters, holes, unevenness, and loose boards.

2.2.2 ***Non-slip Floors.*** Floors in the working area about all woodworking machines shall be provided with effective means to prevent slipping. (See Appendix A2.2.2 for suggestions for non-slip floors.)

2.2.3 ***Aisles.*** Aisles for one-way traffic shall be not less than the width of the widest vehicle or load plus 3 feet. For two-way traffic the minimum width of aisles shall be not less than twice the width of the widest vehicles or loads plus 3 feet. Lines shall be painted on the floor, or some similar method employed to mark aisleways.

3. Machines and Equipment

3.1 Machine Construction, Drive, Feed, Speed, and Control. (See Appendix A3.1)

3.1.1 ***Machine Construction***

(a) The height of the table or working surface of each machine should be designed to provide the best efficiency and the least amount of fatigue for the operator. (See Appendix A3.1.1.) This also applies to auxiliary tables or supports for the work in operation; these supports should be provided so that large or unwieldy

pieces can be handled in a safe and nonfatiguing manner.

(b) Each machine shall be so constructed as to be free from sensible vibration when the largest size tool is mounted and run idle at full speed.

(c) Arbors and mandrels shall be constructed so as to have firm and secure bearing and be free from play.

(e) Any automatic cut-off saw that strokes continuously without the operator being able to control each stroke shall not be used.

(f) Saw frames or tables shall be constructed with lugs cast on the frame or with an equivalent means to limit the size saw that can be mounted, so as to avoid overspeed caused by mounting a saw larger than intended.

(g) Circular saw fences shall be so constructed that they can be firmly secured to the table or table assembly without changing their alignment with the saw. For saws with tilting tables or tilting arbors the fence shall be so constructed that it will remain in a line parallel with the saw, regardless of the angle of the saw with the table.

(h) Circular saw gages shall be so constructed as to slide in grooves or tracks that are accurately machined, to insure exact alignment with the saw for all positions of the guide.

(i) Hinged saw tables shall be so constructed that the table can be firmly secured in any position and in true alignment with the saw.

(j) All belts, pulleys, gears, shafts, and moving parts shall be guarded in accordance with the specific requirements of the American Standard Safety Code for Mechanical Power-Transmission Apparatus, B15.1-1953, or the latest revision thereof approved by the American Standards Association, Incorporated.

3.1.2 ***Machine Drive.*** (See Appendix A3.1.2.)

(a) Driving power for woodworking machinery should be provided by individual motor or motors mounted on the machine whenever possible, or on a separate base adjacent to the machine with power transmission medium properly guarded.

(b) Power-driven woodworking machinery, including the metal frame of the machine, should be electrically grounded in accordance with the American Standard National Electrical Code, C1-1953, or the latest revision thereof approved by the American Standards Association, Incorporated.

(c) It is recommended that each power-driven woodworking machine be provided with a disconnect switch that can be locked in the off position.

3.1.3 *Machine Control*

(a) A mechanical or electrical power control shall be provided on each machine to make it possible for the operator to cut off the power from each machine without leaving his position at the point of operation.

(b) On machines driven by belts and shafting, a locking-type belt shifter or an equivalent positive device shall be used. (See Appendix A3.1.3.)

(c) On applications where injury to the operator might result if motors were to restart after power failures, provision shall be made to prevent machines from automatically restarting upon restoration of power.

(d) Power controls and operating controls should be located within easy reach of the operator while he is at his regular work location, making it unnecessary for him to reach over the cutter to make adjustments. This does not apply to constant pressure controls used only for setup purposes.

(e) On each machine operated by electric motors, positive means shall be provided for rendering such controls or devices inoperative while repairs or adjustments are being made to the machines they control.

(f) Each operating treadle shall be protected against unexpected or accidental tripping.

3.1.4 *Self-Feed.* Automatic feeding devices on machines should be installed wherever the nature of the work will permit. Feeder attachments shall have the feed rolls or other moving parts so covered or guarded as to protect the operator from hazardous points.

3.1.5 *Speeds.* The operating speed shall be etched or otherwise permanently marked on all circular saws over 20 inches in diameter or operating over 10,000 peripheral feet per minute. A saw so marked shall not be operated at a speed other than that stipulated on the blade. When a marked saw is retensioned for a different speed, the marking shall be corrected to show the new speed. (See Appendix A3.1.5.)

4. Woodworking Machinery

4.1 Circular, Rip, Crosscut, Resaw, and Swing Cut-Off Saws

NOTE: It is recognized that the standards for saw guards in 4.1 are not perfectly applicable to all operations for which saws are used. The standards given are those which woodworkers have agreed are most generally useful. Since there are a considerable number of cases not satisfactorily met by these standards, the enforcing authority should exercise rather wide latitude in allowing the use of other devices which give promise of affording adequate protection. It may be expected that by so doing further progress in saw guarding will be encouraged.

4.1.1 *Guarding of Saws Beneath and Behind Tables.* For all circular saws where conditions are such that there is a possibility of contact with the portion of the saw either beneath or behind the table, that portion of the saw shall be covered with an exhaust hood, or, if no exhaust system is required, with a guard that shall be so arranged as to prevent accidental contact with the saw.

4.1.2 *Hand-Fed Rip Saws*

(a) Hoods. Each circular hand-fed rip saw shall be guarded by a hood which shall completely enclose that portion of the saw above the table and that portion of the saw above the material being cut. The hood and mounting shall be arranged so that the hood will automatically adjust itself to the thickness of and remain in contact with the material being cut, but it shall not offer any considerable resistance to insertion of material to saw or to passage of the material being sawed. The hood shall be made of adequate strength to resist blows and strains incidental to reasonable operation, adjusting, and handling, and shall be so designed as to protect the operator from flying splinters and broken saw teeth. It shall be made of material that is soft enough so that it will be unlikely to cause tooth breakage. The material should not shatter when broken, should be nonexplosive, and should be no more flammable than wood. The hood shall be so mounted as to insure that its operation will be positive, reliable, and in true alignment with the saw; and the mounting shall be adequate in strength to resist any reasonable side thrust or other force tending to throw it out of line. [For discussion of various hoods and hood mountings, see Appendix A4.1.2*(a)*.]

(b) Spreaders. Each hand-fed circular rip saw shall be furnished with a spreader to prevent material from squeezing the saw or being thrown back on the operator. The spreader shall be made of hard tempered steel, or its equivalent, and shall be thinner than the saw kerf. It shall be of sufficient width to provide adequate stiffness or rigidity to resist any reasonable side thrust or blow tending to bend or throw it out of position. The spreader shall be attached so that it will remain in true alignment with the saw even when either the saw or table is tilted, and should be placed so that there is not more than 1/2 inch space between the spreader and the back of the saw when the largest saw is mounted in the machine. The provision of a spreader in connection with grooving, dadoing, or rabbeting is not required. On the completion of such operations, the spreader shall be immediately replaced. [For discussion of spreaders, see Appendix A4.1.2*(b)*.]

(c) Non-Kickback Fingers or Dogs. Each hand-fed circular rip saw shall be provided with non-kickback fingers or dogs so located as to oppose the thrust or tendency of the saw to pick up the

material or to throw it back toward the operator. They shall be designed to provide adequate holding power for all the thicknesses of materials being cut. [For discussion of kickbacks, see Appendix A4.1.2(c).]

4.1.3 ***Hand-Fed Crosscut Table Saws (Including Trimmer Saws)***

(a) Each circular crosscut table saw shall be guarded by a hood which shall meet all the requirements of 4.1.2(*a*) for hoods for circular rip saws.

(b) Each circular crosscut saw should also be provided with a spreader which should meet all the requirements of 4.1.2(*b*).

(c) Hoods for trimmer saws with mechanical feed should remain in contact with the material being cut, but this is not mandatory. (For a discussion of jigs and fixtures for circular saws, see Appendix A4.1.3.)

4.1.4 ***Revolving Double Arbor Saws.*** Revolving double arbor saws shall be fully guarded in accordance with all the requirements for circular crosscut saws or with all the requirements for circular rip saws, according to the kind of saws mounted on the arbors.

4.1.5 ***Circular Resaws***

(a) Each circular resaw shall be guarded by a hood or shield of metal above the saw. This hood or shield shall be so designed as to guard against danger from flying splinters or broken saw teeth.

(b) Each circular resaw (other than self-feed saws with a roller or wheel at back of the saw) shall be provided with a spreader fastened securely behind the saw. The spreader shall be slightly thinner than the saw kerf and slightly thicker than the saw disk.

4.1.6 ***Self-Feed Circular Saws***

(a) Hoods. Feed rolls and saws shall be protected by a hood or guard to prevent the hands of the operator from coming in contact with the inrunning rolls at any point. The guard shall be constructed of heavy material, preferably metal, and the bottom of the guard shall come down to within 3/8 inch of the plane formed by the bottom or working surfaces of the feed rolls. This distance (3/8 inch) may be increased to 3/4 inch, provided the lead edge of the hood is extended to be not less than 5 1/2 inches in front of the nip point between the front roll and the work.

(b) Non-Kickback Fingers. Each self-feed circular rip saw shall be provided with sectional non-kickback fingers for the full width of the feed rolls. They shall be located in front of the saw and so arranged as to be in continual contact with the wood being fed.

4.1.7 *Swing Cut-Off Saws.* The requirements of 4.1.7 are also applicable to sliding cut-off saws mounted above the table. (For radial saws see 4.1.9.)

(a) Hood. Each swing cut-off saw shall be provided with a hood that will completely enclose the upper half of the saw, the arbor end, and the point of operation at all positions of the saw. The hood shall be constructed in such a manner and of such material that it will protect the operator from flying splinters and broken saw teeth. Its hood shall be so designed that it will automatically cover the lower portion of the blade, so that when the saw is returned to the back of the table the hood will rise on top of the fence, and when the saw is moved forward the hood will drop on top of and remain in contact with the table or material being cut.

(b) Counterweights. Each swing cutoff shall be provided with an effective device to return the saw automatically to the back of the table when released at any point of its travel. Such a device shall not depend for its proper functioning upon any rope, cord, or spring. If there is a counterweight, the bolts supporting the bar and counterweight shall be provided with cotter pins; and the counterweight shall be prevented from dropping by either a bolt passing through both the bar and counterweight, or a bolt put through the extreme end of the bar, or, where the counterweight does not encircle the bar, a safety chain attached to it.

(c) Limit Stops. Limit chains or other equally effective devices shall be provided to prevent the saw from swinging beyond the front or back edges of the table or beyond a forward position where the gullets of the lowest saw teeth will rise above the table top.

(d) Latches. A latch or equivalent device should be provided to catch and retain the saw at the rear of the table and to prevent its rebounding.

4.1.8 *Inverted Swing Cut-Off Saws (Jump Saws).* Inverted swing cut-off saws shall be provided with a hood that will cover the part of the saw that protrudes above the top of the table or above the material being cut. It shall automatically adjust itself to the thickness of and remain in contact with the material being cut.

4.1.9 Radial Saws. (See Appendix A4.1.9.)

(a) Hoods and Guards. The upper hood shall completely enclose the upper portion of the blade down to a point that will include the end of the saw arbor. The upper hood shall be constructed in such a manner and of such material that it will protect the operator from flying splinters, broken saw teeth, etc, and will deflect sawdust away from the operator. The sides of the lower exposed

portion of the blade shall be guarded to the full diameter of the blade by a device that will automatically adjust itself to the thickness of the stock and remain in contact with stock being cut to give maximum protection possible for the operation being performed.

(b) Spreaders. When radial saws are used for ripping, a spreader should be provided. [See 4.1.2(*b*).]

(c) Non-Kickback Fingers or Dogs. Each radial saw used for ripping shall be provided with non-kickback fingers or dogs located on both sides of the saw so as to oppose the thrust or tendency of the saw to pick up the material or to throw it back toward the operator. They shall be designed to provide adequate holding power for all the thicknesses of material being cut. [For discussion of kickbacks, see Appendix A4.1.2(c).]

(d) Adjustable Stops and Return Devices

(1) An adjustable stop shall be provided to prevent the forward travel of the blade beyond the position necessary to complete the cut in repetitive operations.

(2) Installation shall be in such a manner that the front end of the unit will be slightly higher than the rear, so as to cause the cutting head to return gently to the starting position when released by the operator. **CAUTION!** Tilt should not be enough to cause rebound.

(e) Direction of Feed. Ripping and ploughing shall be against the direction in which the saw turns. The direction of the saw rotation shall be conspicuously marked on the hood. In addition, a permanent label not less than 1 1/2 inches by 3/4 inches shall be affixed to the rear of the guard at approximately the level of the arbor, reading as follows:

DANGER: DO NOT RIP OR PLOUGH FROM THIS END

Such a label should be colored standard danger red.

7. Operating Rules

7.1 Inspection and Maintenance

7.1.1 *Inspection.* Emphasis is placed upon the importance of maintaining systematic inspection of all woodworking machines and safety equipment to insure the discovery of developing defects and permit their prompt correction.

7.1.2 *Maintenance*

(a) Dull, badly set, improperly filed, or improperly tensioned saws shall be immediately removed from service, before they begin to cause the material to stick, jam, or kickback when it is fed to the saw at normal speed. Saws to which gum has adhered on the sides shall be immediately cleaned. (See Appendix A7.1.2.)

(c) Bearings shall be kept free from lost motion and shall be well lubricated.

(d) Arbors of all circular saws shall be free from play.

(e) Sharpening or tensioning of saw blades or cutters shall be done only by persons of demonstrated skill in this kind of work.

(f) Emphasis is placed upon the importance of maintaining cleanliness around woodworking machinery, particularly as regards the effective functioning of guards and the prevention of fire hazards in switch enclosures, bearings, and motors.

7.2 Selection and Operation of Machines

7.2.1 *Selection of Suitable Machines and Tools*

(a) Machines should not be used for operations of such variety as to necessitate the removal of safeguards suitable for the usual service. The specific operations involving special hazards should be assigned to machines suitable for such work. [See Appendix A7.2.1*(a)*.]

(b) No saw, cutter head, or tool collar shall be placed or mounted on a machine arbor unless the tool has been accurately machined to size and shape to fit the arbor.

7.2.2 *Circular Rip and Cut-Off Saws*

(a) All cracked saws shall be removed from service. (See Appendix A7.2.2.)

(b) The practice of inserting wedges between the saw disk and the collar to form what is commonly known as a "wobble saw" shall not be permitted.

(c) Push sticks or push blocks shall be provided at the work place in the several sizes and types suitable for the work to be done.

7.2.6 *Combs (Featherboards).* Combs (featherboards) or suitable jigs shall be provided at the work place for use when a standard guard cannot be used, as in dadoing, grooving, jointing, moulding, rabbeting.

7.4 Clothing and Goggles Worn by Operators

7.4.1 *Clothing*

(a) Gloves should not be worn while operating machines.

(b) Loose flowing garments, sleeves, neckties, etc, offer a decided accident hazard and shall not be worn by operators of machines.

(c) Where there is danger of kickback from any operation, anti-kickback aprons shall be provided and worn.

7.4.2 *Goggles.* Where danger from dust, flying chips, etc, exists, proper eye protection shall be provided and used. (See American Standard Safety Code for the Protection of the Heads, Eyes, and Respiratory Organs, Z2-1938, or the latest revision thereof approved by the American Standards Association, Incorporated.)

7.5 Selection and Training of Operator

(a) Before an inexperienced workman is permitted to operate any woodworking machine, he shall receive careful instructions in the hazards of the machine and the safe method of operation.

(b) Minors under 18 years of age shall not be permitted to operate or assist in the operation of power-driven woodworking machines.

APPENDIX

(This Appendix is not a part of the American Standard Safety Code for Woodworking Machinery, 01.1-1954. It includes a discussion of the rules and recommendations for ways and means of putting the rules into effect and illustrations of a few typical saw guards.)

(The numbers in the Appendix refer to the pertinent items in the standard.)

A1.4.4 Push blocks should be at least 3/8 inch thick if made of hardwood or 3/4 inch thick if made of softwood. Wherever space permits, the block should be at least 10 inches by 6 inches so as to give protection to the hand pushing down on the work.

A2.1.1

A2.1.1 *(a)* In order to give each operator sufficient space in which to handle the material with the least possible interference from or to other workmen or machines it is suggested that the following conditions be maintained:

(1) *Rip and Crosscut Bench or Table Saws.* The minimum distance or clearance on each working side of the saw table should be equal to 3 feet more than the longest material handled.

In a production shop which uses jigs and fixtures, definite space either at the saw or in a storeroom should be provided for storing these fixtures.

It is also important in the location of a rip saw to be sure that no other employee is regularly working in line with the saw where he might be hit by material in case of a kickback. If it is necessary to locate a machine in such a position, a heavy metal or plank barricade should be erected to protect the workman.

A2.1.1 *(b)* By locating heavy-duty machinery on the ground floor, most of the vibration due to high operating speed can be eliminated. Undue vibration and noise caused by high-speed machinery may be eliminated to a large extent by cushioning the machine foundation. This can be done by inserting rubber, felt, cork, or other elastic material between the machine base and the floor beams or girders to which the machine is fastened. It must be borne in mind, however, that the bolts that hold the machine to the foundation must not pass through or touch the girders or floor beams of the building. The cushioning material must be fastened to the floor beams or girders by bolts that are independent of the machine base.

A2.1.1 *(c)* Lighting. Proper lighting is of vital importance. It is a widespread belief among men experienced in accident-prevention work that improper lighting is a factor in perhaps 25 percent of all avoidable accidents in the country. Too much light is often as bad as insufficient illumination. American Standard Practice for Industrial Lighting, A11.1-1952, or the latest revision thereof approved by the American Standards Association, Incorporated, gives values of intensities. It is also important that proper attention be given to the maintenance of all lighting equipment, i.e., cleaning and adjustment of reflectors. Dust accumulated on the lamp bulbs quickly cuts down the intensity of the light. Makeshift reflectors or those whose adjustment has been impaired have a tendency to spoil the efficiency of any carefully worked out lighting system. Recent investigations indicate that the color of ceilings, walls, floors, and equipment has a definite bearing on the absorption of light and the amount of energy required for the seeing task. In general, it is suggested that preference be given to colors which absorb less light and that important or dangerous parts of equipment be in a contrasting color in order that they will be seen easily.

A2.2.2 Suggestions for treatment of smooth slippery floors about woodworking machines:

(a) Paint the floor with glue or paint and throw on sharp sand or abrasive grains and, after the glue or paint has set, remove material which does not adhere.

(b) Some manufacturers now make a paint which includes an abrasive, making it non-slip.

(c) If a non-slip platform, mat, or other non-slip material is placed about the machine, the edges should be beveled to not more than 1/8 inch high at the point or edge of the bevel, or the floor should be recessed so that the material will be flush with the floor. Excellent maintenance to avoid tripping hazards is essential.

(d) Wood chips and sawdust, particularly on top of a wooden floor, may in themselves cause a slipping or a tripping hazard. The continued rubbing or sliding of chips and sawdust over a wooden floor may also cause the floor itself to become very smooth and slippery. It is therefore important that provisions should be made for collecting chips or sawdust so that they will not get on the floor, or the floors should be thoroughly cleaned at frequent periods.

A3.1 In order to attain the safest and most efficient operation, the proper type of saw blade should be used for plastics, plywoods, and synthetic boards.

A3.1.1

A3.1.1 *(a)* For maximum efficiency, it is recommended that the height of the table or point of operation above the floor for various machines be approximately as follows for operators of average stature:

Circular Saws (hand fed)	36 inches
Circular Saws (power fed)	32 inches

Whenever machines are used by persons of less-than-average stature, suitable adjustments should be made in the above distances.

A3.1.2 Motor Drive. The initial expense of individual motor drive is frequently higher than that of other power-transmission equipment such as line shafting, etc, but it has a great many advantages. It offers a better control of the individual machine. It also eliminates overhead shafting and belting, thereby improving lighting and the general appearance of the shop. Then, too, it eliminates injuries due to oiling and maintenance of overhead transmission equipment.

A3.1.3 Where there is electrical control, it is recommended that hand-fed circular saws, band saws, and machines of like operation be provided with an emergency foot switch which will make it possible for the operator to cut off the power without removing his hands from the work.

A3.1.5 The following table shows revolutions per minute for various diameters of saws when the peripheral speed is 10,000 feet per minute.

Diameter of Saw (Inches)	Rpm
8	4774
10	3819
12	3183
14	2728
16	2387
18	2122
20	1910
22	1736
24	1592
26	1469
28	1364
30	1273

A4.1.2

A4.1.2 *(a)* Circular-Saw Hoods and Mountings

(1) *Hood Construction*

a. Hoods may be made of aluminum or magnesium alloy.

b. If made of plywood, they should be of substantial construction.

c. Hoods should have thin liner piece of wood at bottom of cast-metal hood to protect the saw teeth.

(2) *Hood Mounting.* Saws are used for so many operations that it is doubtful if any one type of mounting will fit all possible conditions. For efficiency and serviceability of the guard, mountings are recommended in the following order:

a. Hood mounted on spreader attached to throat piece (throat piece should be locked in position)

b. Other spreaders attached to frame, carriage, or table

c. Arm mounting attached to table or frame

d. Ceiling, side-suspension, or floor-stand mountings should be used only when other types of mounting are impractical.

(3) *Discussion of Mountings*

a. If the hood is mounted on spreader, it can be used even if material being cut extends beyond the sides of the saw table, but this mounting is not practical for grooving, dadoing, or rabbeting operations.

b. If the hood is mounted on an arm attached to the side of the table, it can be used on most grooving, dadoing, and rabbeting operations, but this arm will restrict the size of work that can be cut on that side of the table.

c. The design and quality of material used will also affect the amount of supervision needed to be sure that the guards are properly used. Attachments should be such that it is easy to attach the mounting the right way or in the right position, but, at the same time, difficult or impossible to attach it the wrong way or out of line with the saw. If counterweights are used to make it easier for the workman to lift the hood, then extra supervision may be required to see that the counterweight is not altered or adjusted to keep the hood in a raised position at all times.

d. It will be an added advantage in some operations if the hood and mounting can be so designed that the hood will prevent the material being cut from being raised off the table by the centrifugal upward force of the saw in case of pinching or binding before material reaches the spreader.

e. For tilting-arbor or tilting-table saws, the hood should be mounted on the saw frame or carriage so that the hood will remain in line with the saw when the saw or table is tilted at an angle.

f. For multiple saws such as equalizer saws, hoods should be mounted so that they will be adjusted to true alignment with the saw whenever the location of the saw is changed. When these machines are provided with individual motors for each saw, the hood should be mounted to the same frame as the motor so that it will automatically move with each new location of the saw.

A.4.1.2 *(b)* Circular-Saw Spreaders. Each spreader should be so shaped on the side toward the saw that it will follow the curve of the saw approximately and should be not less than 3 1/2 inches wide at the level of the table. In some special cases this width cannot be obtained, but it should be not less than 2 inches.

The value of a spreader depends on its location directly behind the saw. If a saw machine is regularly used with a saw blade smaller than the maximum size permissible on the machine, serious consideration should be given to the possibility of locating the spreader within 1/2 inch of the clearance of the saw blade regularly used on the machine, even though this would require moving the spreader if the machine were to be used for the maximum size saw.

The design of the spreader mounting should provide for ease in attaching the spreader in the correct location and should make it difficult or impossible to mount the spreader in an incorrect or dangerous position.

For operations which do not permit the use of a spreader, serious consideration should be given to the use of jigs or fixtures to hold the work so that the hands of the operator are removed at least 12 inches from the point of operation. A spreader mounted on the saw arbor frame, and no higher than the saw teeth, may be used to good advantage in certain operations, such as grooving.

A4.1.2 *(c)* Circular-Saw kickbacks. Kickbacks on rip saws are usually caused by one of the following:

(1) Failure to provide spreader

(2) Improperly conditioned saw, allowing material to pinch on saw and rise from the table

(3) Improper alignment of gage or fence

(4) Improperly conditioned or twisted grain lumber

(5) Improper design or mounting of Kickback dogs

Some dogs are so designed as to be very effective for one thickness of material but have very little holding power when used on either much thicker or much thinner material. Other dogs have very good holding power but are so located that they do not come in contact with the material when it is in position to be thrown upward by the saw. For a circular saw, where the arbor is above the table, the rotation of the saw is reversed, and it would therefore be necessary to locate the kickback fingers in front or ahead of the saw to oppose the upward thrust of the saw.

A4.1.3

(a) Fillister Piece. In order to use the hood guard effectively on circular rip saws when cutting narrow strips, a fillister piece should be used. This should be made of wood about 2 inches wide. It should be about 3/4 inch thick or slightly thinner than the thickness of the material being cut. It should be provided with cleats or brackets at the ends, so that it will either fit down over the front and back ends of the table or can be quickly attached to the fence or gage.

(b) Special consideration should be given to the use of jigs or fixtures when cutting irregular pieces or oblique angles. A special application of this principle is the jig for cutting wedges and pointing stakes.

A4.1.9 Blade Coasting After Power Shutoff. A large percentage of radial saw accidents is caused by rotation of the saw blade after the power has been shut off. (Coasting time up to five minutes is not uncommon.) The practice of stopping this rotation by placing a piece of wood against the rotating blade can cause injury to the

operator and can cause the blade to crack, warp, or lose temper. It is recommended that a braking device to stop coasting, or a warning signal to indicate that the blade is still in motion, be provided.

A7.1.2 Maintenance. A large proportion of circular and band-saw accidents is caused by dull, badly set, improperly filed, and improperly tensioned saws, and by gum adhering to saws. Such conditions cause the material to stick, jam, stall the saw, or kickback at the operator. It is strongly recommended that users obtain and follow instructions from the saw manufacturers for proper maintenance of all saws. Band-saw wheels should be kept clean and free from accumulations of sap, gum, or resins.

A7.2.1

A7.2.1 *(a)* Selection of Suitable Machines. Under 7.2.1 of this code the statement is made that machines should not be used for operations of such variety as to necessitate the removal of safeguards suitable for the usual service. It is well to plan or route the work in such a way as to avoid too frequent adjustment of machines and altering of position of guards. The proper regard for this rule will increase production by reducing the time lost because of making adjustments and will also reduce accidents by insuring continued use of safeguards suitable to the work.

A7.2.2

A7.2.2 *(a)* Cracked Circular Saws. Saws should be inspected for cracks each time that the teeth are filed or set. Most cracks will start in the gullets of the saw teeth. If cracked saws are continued in service, the crack frequently grows larger and may eventually cause fragments of the saw to fly apart. If the saw is removed from service as soon as a crack is visible to the naked eye, the blade can usually be repaired either by welding the crack or by slotting the saw to remove the material on both sides of the crack and then making other slots to balance the blade. In either case, the saw should be retensioned after the repairs are made. Unless a skilled sawsmith is employed, saws should be returned to the manufacturer for welding, slotting, or tensioning.

To prevent cracking:

(1) The saw should be tensioned for the speed at which it is to operate. If not, the saw will wobble and vibrate causing it to heat, expand, and crack.

(2) The teeth must have sufficient clearance (set or hollow grinding) to prevent burning. If the saw gets hot and expands, then cracking results.

(3) The saw should be in perfect round. In other words, the rim should be concentric with the eye.

(4) The saw must be in perfect balance or cracking will result.

(5) Saws must be kept sharp at all times; otherwise, if the saw is not cutting, it will pound itself through the wood and thus cause heat and vibration, expansion, and then cracking.

APPENDIX C--SAFE OPERATING PRACTICES

The following two excerpts are examples of educational literature, prepared by States and other organizations, covering safe operating practices in circular saw operations.

From "Woodworking Circular Saws: Protection for Variety and Universal Types" 10/

The safe practices involved in circular saw operations will vary slightly in accordance with the types of machines in use and the operations conducted on these machines. For example, on high-production operations or where jigs and fixtures are used, the safe practices would be comparatively simple. On the other hand, the safe use of a circular saw in a pattern shop or maintenance department is somewhat more involved because of the variety of work conducted on the machine under these conditions.

The following safe practice specifications are outlined as examples of rules that should be considered:

1. Shut off power and wait until saw blade stops revolving before making adjustments.

2. Do not attempt to stop the travel of the saw blade (after the power is shut off) on direct driven saws by forcing a piece of material against the saw blade.

3. When changing saw blades, check collars to make sure that they are free of sawdust and are in good condition to assure the saw's running true on the arbor.

4. Use only sharp and properly conditioned saw blades. Immediately remove dull saws from the arbor and have reconditioned.

5. Before using a machine, check to see that the saw revolves freely, the blade is tight on the arbor, and that screws and clamps of fence and gage are securely fastened.

6. Use push sticks on operations where their use will eliminate the need for the hand to be near the danger zone.

10/ Prepared by National Association of Mutual Casualty Companies, 1950, (pp. 28 and 29).

7. If the stock binds in the cut or is excessively hard to feed, immediately check alignment of the rip fence and condition of saw blade.

8. Use only saw blades that are of a diameter within range of the machine speed. Saw blades larger than that recommended for any one particular machine will run at an excessive speed and those that are too small for the speed of the machine will operate unsatisfactorily because of an underspeed condition.

9. Stock to be processed must have one straight edge and be held securely against the gage or fence.

10. Never sight gage on ripsaw operations. Plane one surface and use the rip fence.

11. Maintain good housekeeping conditions around circular saws. Keep the area free of scrap, sawdust, oil and grease, or other tripping or slipping hazards.

12. Whenever possible, stand to one side of material being cut. This is especially important on ripsaw operations to prevent the operator's being in line with a possible kickback.

13. Do not leave a saw running unattended. If lockout switches are provided, use them to prevent unauthorized use of machine.

14. Do not reach over running saw blade to recover material at the rear of the machine unless the saw blade is fully protected by a hood guard.

15. Do not use hand to clear small pieces of scrap away from saw blade. Use a push stick or piece of scrap stock.

16. Do not wax top of table with power on or with circular saw blade protruding above the table. The power must be off and the blade stopped before attempting this operation.

17. Do not allow bystanders to stand in line with the saw blade; travel on the operator's side.

18. When sawing long pieces or heavy material, use a take-away stand or roller table if available. Otherwise, a take-away man or helper is necessary.

19. For protection against possible eye injuries, goggles or some type of eye protection should be used.

20. Do not wear loose or ragged clothing such as neckties or gloves when operating circular saws.

21. Do not remove or make inoperative any guard or safety device installed on a machine.

22. Do not operate a circular saw unless you are properly instructed and authorized to do so.

From "Taming the Circular Saw" 11/

1. Be sure you know how to operate a circular saw before attempting to do so.

2. Inspect a saw to see that it is sharp and free from cracks.

3. Use the right saw for the right job. Don't use a ripsaw for crosscutting, or a crosscut saw for ripsawing.

4. Keep your body out of line with the board being sawed. Stand to one side.

5. Do not be distracted. Concentrate on your work.

6. Use a pusher stick to push short, narrow pieces through the saw.

7. Don't adjust the saw hood or gage while the saw is running.

8. Don't leave a saw running unattended.

9. Don't reach over a saw.

10. Lock the power controls in the "off" position before changing saw blades.

11/ Prepared by State of California, Department of Industrial Relations, Division of Industrial Safety, 1950.

11. Don't feed wood faster than the saw will cut.

12. Get help when sawing long material.

13. Don't use your hands to remove scrap and dust from the saw table. Use a brush.

14. Keep the saw table clear of all scraps. They may touch the saw blade and be thrown back.

15. Keep the area around a saw free from loose material that might cause tripping or falling.

16. Store circular saw blades in a place where there is no likelihood of accidental contact with the teeth.

17. Get prompt first-aid treatment for even the slightest cut or scratch.

18. When sharpening or gumming circular saws with an emery wheel, use a free cutting wheel.

19. Don't let the teeth become case hardened, blued or glazed, for they are then likely to crack or break.

20. When setting a circular saw, make sure that the set is in the point of the tooth and not below the root of the tooth.

21. Make sure there is no end play or lateral motion in the arbor.

22. See that the collar and stem of the arbor fit perfectly.

23. Don't use wobbly saws.

24. Use suitable eye protection.

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