



Regulations (Preambles to Final Rules) - Table of Contents

- **Record Type:** Control of Hazardous Energy Sources (Lockout/Tagout)
- **Section:** 3
- **Title:** Section 3 - III. Accident Data

III. Accident Data

The collection of data on accidents resulting from a failure to utilize proper lockout or tagout procedures is hampered because many accidents are not reported; are reported only locally; or are reported and categorized under other causal factor categories (such as "caught-in" or "caught-between").

OSHA also recognizes that there has been some underreporting of accident data -- either inadvertent or intentional. As a result, OSHA believes that the data available represent only a portion of the total injuries and fatalities that have occurred.

There have been several studies conducted to determine the magnitude and extent of the problem. These studies were conducted by: (a) The U.S. Department of Labor, Bureau of Labor Statistics; (b) OSHA's Office of Data Analysis (formerly Office of Statistical Studies and Analysis); (c) the National Institute for Occupational Safety and Health (NIOSH); (d) OSHA's Office of Experimental Programs; and (e) OSHA's Office of Mechanical Engineering Safety Standards.

A. Bureau of Labor Statistics Work Injury Report Study. The first study examined by OSHA was the Work Injury Report Study entitled "Injuries Related to Servicing Equipment" [Ex. 33]. This study is a compilation of reports of accidents and follow-up survey questionnaires sent out by the Bureau of Labor Statistics (BLS). The survey, conducted from August to November 1980, covered workers who were injured while cleaning, repairing, unjamming or performing other non-operating tasks on machines, equipment and electrical or piping systems.

Tables I through VI present tabulations of the results of the BLS Work Injury Report Study.

TABLE I: INDUSTRY DISTRIBUTION -- BY STANDARD INDUSTRIAL CLASSIFICATION (SIC) MAJOR DIVISION AND COMPANY SIZE

Industry	Workers	Percentages (1)
Total	833	100
Div A -- Agriculture, forestry and fishing		1
B -- Mining	1
C -- Construction	35	4
D -- Manufacturing	619	74
E -- Transportation and public utilities	19	2
F -- Wholesale trades	57	7
G -- Retail trades	31	4
H -- Finance, insurance and real estate	8	1
I -- Services	43	5

J & K -- Others	8	1
SIZE OF THE COMPANIES AT WHICH ACCIDENTS OCCURRED		
Total	(²) 794	100
1 to 19 employees	159	20
20 to 49 employees	123	15
50 to 99 employees	120	15
100 to 499 employees	234	29
500 or more employees	158	20

(¹) Due to rounding, percentages may not add to 100.

(²) The total of each table represents the number of respondents answering the pertinent question(s) of the survey.

TABLE II. -- OCCUPATIONAL DISTRIBUTION

Occupation	Workers	Percent
Total	833	100
Operators, excluding transport	373	45
Craft and kindred workers	281	34
Laborers, excluding farm	94	11
Service workers, excluding private household	19	2
Clerical and kindred workers	19	2
Managers and administrators	13	2
Professional, technical & kindred	12	1
Transport equipment operators	10	1
Farm laborers and supervisors	8	1
Nonclassified	4	(¹)

(¹) Less than .5.

Note. -- Due to rounding, percentages may not add to 100.

TABLE III. -- ACTIVITY OF TIME OF ACCIDENT

	Workers	Percent
WHAT WAS EMPLOYEE DOING? Total	833	100
Unjamming objects from equipment	250	30
Cleaning equipment	245	29
Repairing equipment	77	9
Performing maintenance (oiling, etc.)	34	4
Installing equipment	13	2
Adjusting equipment	99	12
Doing set-up work	57	7
Performing electrical work	29	3
Inspecting equipment	15	2
Testing material or equipment	2	(¹)

(¹) Less than .5 percent.

TABLE IV. -- CIRCUMSTANCES OF INJURIES

	Workers	Percent
HOW DID INJURIES OCCUR? Total	833	100
Injured by moving machine part	735	88
Injured by contact with energized electric parts	45	5
Injured by burners, hot liquids or other hazardous materials	29	3
Injured by falling machine parts	10	1

Other	14	2
WAS EQUIPMENT TURNED OFF BEFORE DOING TASK? Total	833	100
No	653	78
Yes	180	22
IF EQUIPMENT NOT TURNED OFF, REASON(S) GIVEN Total	(²)592	(²)
Worker felt it would slow down production or take too long	112	19
Not required by company procedure	69	12
Worker did not know how to	8	1
Did not think it necessary	209	35
Task could not be done with power off	209	35
Worker did not realize power was on	62	10
Other reasons	61	10
IF EQUIPMENT WAS TURNED OFF: a. What happened at the time of injury? Total	176	100
Injured employee accidentally turned equipment on	20	11
Co-worker accidentally turned equipment on	15	9
Co-worker turned equipment on, not knowing equipment was being worked on	56	32
Equipment or material moved when jam-up cleared	9	5
Parts were still in motion (coasting)	30	17
Other reason	46	26
IF EQUIPMENT WAS TURNED OFF: b. Were additional steps taken to de-energize equipment? Total	(²)160	(²)
No -- not necessary	49	31
No -- not required by company	23	14
No -- would slow down production	8	5
No -- worker did not have tools	4	2
No -- other reason	20	13
No -- reason not given	37	23
Disconnected main power	14	9
Tagged out equipment power controls	6	4
Locked out(³), installed blank flange or removed fuse	3	2
Disconnected electric line	5	3
Drained pressure or hazardous material	9	6
Other	11	6

(¹) Due to rounding percentages may not add to 100.

(²) Because more than one response is possible the sum of the responses and percentages may not equal the total number of persons who answered the question.

(³) The two accidents which occurred after the equipment was locked out took place because (1) the lockout had been done to the wrong power line and (2) a second power line had been spliced into the wiring beyond the lockout.

TABLE V. -- TRAINING

	Workers	Percent
WAS LOCKOUT INSTRUCTION PROVIDED EMPLOYEES? Total	554	100
Yes	214	39
No	340	61

IF INSTRUCTION PROVIDED, IN WHAT FORM? Total	273	100
Provided print instructions	25	9
Procedures posted on equipment	37	14
Instruction given as part of on-the-job training	176	64
Formal training given at meeting, etc.	28	10
Other	7	3
WHEN WAS LOCKOUT INSTRUCTION GIVEN? Total	186	100
After the accident	(¹)15	(¹)8
One to six months before accident	36	19
Six months to a year before accident	28	15
Upon hiring	84	45
Over a year before accident	60	32

(¹) Because more than one response is possible, the sum of the responses and percentages may not equal the total. Percentages are calculated by dividing each number of responses by the total number of persons who answered the question.

TABLE VI. -- ESTIMATED LOST WORKDAYS

Number of lost workdays	Workers	Percent
Total	793	100
No time lost	107	13
1 to 5 workdays lost	132	17
6 to 10 workdays lost	95	12
1 to 15 workdays lost	75	9
16 to 20 workdays lost	47	6
21 to 25 workdays lost	47	6
26 to 50 workdays lost	60	8
51 to 40 workdays lost	49	6
41 to 60 workdays lost	54	7
More than 60 workdays lost	41	5
No indication of number of lost workdays	86	11

B. Analysis of 83 Fatality Investigations by OSHA's Office of Data Analysis.

The second study examined by OSHA was the compilation of data from 83 fatality investigations conducted by OSHA between 1974 and 1980. This report is entitled "Selected Occupational Fatalities Related to Lockout/Tagout Problems as Found in Reports of OSHA Fatality/Catastrophe Investigations" [Ex. 3 5]. All of these accidents were identified as having been caused by failure to properly deenergize machines, equipment or systems prior to performing maintenance, repairs or servicing.

Tables VII through IX present tabulations of the results of the OSHA analysis of 83 fatality investigations.

TABLE VII. -- CAUSAL FACTORS

Cause	Number	Percent
Lack of adherence to safe work practices (no procedure or failure to follow procedure)	83	100
Accidental or inadvertent activation	21	35
Failure to deactivate	29	25
Equipment failure	27	8
Other	5	6

NOTE. -- Due to rounding, percentages may not add to 100.

TABLE VIII. -- NUMBER OF INJURY

Agent	Number	Percent
Total	83	100
Agitators and mixers	12	14
Rolls and rollers	11	13
Conveyors and augers	11	13
Saws and cutters	11	13
Hoists	8	10
Earth moving equipment	6	7
Crushers and pulverizers	4	5
Forges and presses	4	5
Electrical apparatus	4	5
Vehicles	3	4
Other	9	11

TABLE IX. -- EMPLOYEE ACTIVITY

Activity	Number	Percent
	83	100
Conducting normally assigned duties	69	83
Conducting other duties	14	17

In analyzing the 83 fatality investigation reports and assigning causes to each accident, no attempt was made to draw conclusions or inferences beyond the information contained in the reports. For example, if the employee was killed in operating machinery, unless the report stated otherwise, the cause of the accident was considered to be failure to shut off the machine, rather than a combination of causal factors such as failure to sit off the machine, failure to lockout, failure to document adequate procedures, and failure to provide sufficient employee training. Additionally, if a machine was found to be running, it was assumed that the employee failed to shut off the machine rather than that another employee restarted the machine.

C. *Analysis of 125 Fixed Machinery Fatalities by OSHA's Office of Data Analysis.* A Separate study by OSHA's Office of Data Analysis is entitled "Occupational Fatalities Related to Fixed Machinery as Found in Reports of OSHA Fatality/Catastrophe Investigations" [Ex. 3-6]. This study contained an analysis of investigative reports of 125 fatalities involving fixed machinery which occurred between 1974 and 1976, and which were investigated by OSHA. The primary causal factors under which the accidents were classified were operating procedures, accidental activation, lack of machine deactivation, equipment failure, and other causes.

The following is a tabulation of the results of this study.

TABLE X. -- CAUSAL FACTORS, OSHA ANALYSIS OF 125 FATAL ACCIDENTS

Causal factor	Number	Percent
Total	125	100
Failure to adhere to safe operating procedures	41	33
Accidental machine activation	31	25
Machine not deactivated	23	18
Equipment failure	21	17
Other	9	7

D. *National Institute for Occupational Safety and Health, Guidelines for Controlling Hazardous Energy During Maintenance and Servicing and Study of Hazardous Release of Energy Injuries in Ohio in 1983.* The next studies considered by OSHA were done by the National Institute for Occupational Safety and Health (NIOSH) [Ex. 4 and 2-80c]. In the first, fifty-nine out of a total of 300 accident reports were analyzed to illustrate situations in which adequate control of energy might have prevented the accidents. These case files were selected because they contained sufficient detail to enable NIOSH to evaluate the accidents and determine what countermeasures might have been available to prevent the accidents.

The report indicated that these types of accidents are preventable if effective energy control techniques are available, the workers are trained to use them, and management provides the motivation to ensure their use.

The following is a tabulation of the results of the first study.

TABLE XI. -- CAUSAL FACTORS, NIOSH STUDY

Factor	Number	Percent
Total	59	100
Failure to deenergize machine or control energy	27	46
Accidental reenergization	25	42
Ineffective energy isolation	6	10
Disregarding residual energy	1	2

The NIOSH draft report, undated, entitled: *"Study of Hazardous Release of Energy Injuries in Ohio in 1983"* (Ex 2-80c).

This report contains information on 339 accidents which occurred in the state of Ohio in 1983. These accidents were selected because: (1) They fell into likely categories of industry, occupation, type of accident, source of injury and diagnosis of injury; (2) the worker's compensation claim narrative suggested applicability; and (3) questionnaire responses by plant officials positively identified the injuries as resulting from an unexpected energy release during equipment repair, servicing or maintenance. The report defined an unexpected or unwanted release of energy "as when a press closes on an operator's hand or when steam escapes from a broken pressure line."

The "Ohio Study" was submitted by NIOSH in draft form. OSHA is not aware of whether the study results have since been finalized by NIOSH, or whether any further effort has been expended to follow-up on its findings. However, OSHA has evaluated the draft study and has determined that few definite conclusions can be drawn from the available data. For example, most of the injuries reported in the study (70%) occurred to production workers as a result of servicing which took place during normal production operations. Although the study indicated that firms where injuries occurred used tagout, it did not indicate whether either tagout or tagout procedures were applied in situations where production employees were performing servicing work, as well as maintenance employees. Without such information, it is not possible to determine whether the tagout procedure failed in situations where it was being applied, or whether tagout (or other type of employee protection, such as shutting down the equipment) was in use at the time of the accident. In addition, the study only considered the issue of locks versus tags, and did not evaluate the other elements of the lockout or tagout programs in place. As OSHA has emphasized the adequacy of a program for the control of hazardous energy relies on much more than whether a lockout device or a tagout device issued on the energy isolating means. Therefore, the Agency has determined that the draft Ohio study raises many more questions than it answers, and that no solid conclusions can be drawn from the data provided to date. OSHA encourages NIOSH to continue its review and analysis of this study, and looks forward to receiving a final version of the study after a full evaluation and revision has been performed.

The following is a tabulation of the usable results of this study.

TABLE XII. -- TASK BEING PERFORMED AT TIME OF ACCIDENT

Task	Number	Percent
Unjamming object	84	25
Cleaning equipment	75	22
Repairing equipment	41	12
Adjusting equipment	41	12
Doing set-up work	27	8
Inspecting equipment	11	3
Testing equipment	9	3
Installing equipment	9	3
Electrical work	8	2
Other tasks	34	10
Total	339	100

TABLE XIII. -- EQUIPMENT MODE WHEN INJURY OCCURRED

Equipment mode	Number	Percent
Production mode	230	70
Maintenance mode	99	30
Total	(¹) 329	100

(I) Ten respondents did not identify the equipment mode.

There were two additional OSHA studies which were conducted jointly by the Office of Experimental Programs and the Office of Mechanical Engineering Safety Standards. These studies were compilations and analyses of OSHA Form 36 reports [Ex. 3-7] and OSHA 5(a)(1) citations [Ex. 3-8], respectively.

An OSHA Form 36 (Preliminary Fatality/Catastrophe Event Report) is prepared each time an Area Office is notified of a serious accident resulting either in a fatality or in serious injury to five or more employees that necessitates their hospitalization. This report is used to determine whether or not OSHA will conduct an investigation of the circumstances surrounding the accident. Since OSHA does not receive notification of all accidents resulting in a fatality or catastrophe, the total number of Form 36 reports received does not equal the total number of workplace fatalities and serious injuries which occurred during this study period. However, OSHA believes that the causes of, and the circumstances leading to, the accidents clearly demonstrate the nature and seriousness of lockout/tagout-related accidents.

The OSHA Form 36 study which analyzed data reported during the period 1982-1983 [Ex. 3-7], utilized a list of 443 fatalities. From these fatalities, all of which occurred in industries subject to the present regulations, it was determined that 36 (8.1 percent) would have been prevented by the use of an effective lockout or tagout procedure.

The second study [Ex. 3-8] used information developed by OSHA's Office of Mechanical Engineering Safety Standards which identified, categorized and recorded "general duty clause" (section 5(a)(1) of the OSHA Act) citations from 1979 to 1984. A general duty clause citation is issued when, during an inspection, a "recognized hazard" is detected which is causing or is likely to cause death or serious physical harm to an employee, but which is not addressed in an OSHA standard applicable to that industry.

The citations in the latter study have been broken down between maritime, construction, and general industry. The general industry citations were further subdivided to reflect the nature of the hazard which the citation addressed, such as hazardous materials or material handling. When there was special Agency interest in an industry or hazard, the citations were further broken down by industry sector (such as oil and gas well drilling).

From 1979 through 1984, 3,638 inspections were conducted which resulted in the issuance of general duty clause citations. Of these 3,638 inspections, there were 376 inspections in which the failure to control hazardous energy was cited. Hence, in approximately 10 percent of all inspections which resulted in the issuance of at least one General Duty clause citation, herein referred to as a 5(a)(1) citation, failure to lockout or tagout was identified. [Ex. 3-8]

The following is a tabulation of the breakdown of lockout citations by industry division.

TABLE XIV. -- INDUSTRY PROFILE, OSHA 5(a)(1) LOCKOUT CITATIONS

Industry divisions	Number of citations	Percent
Total	376	100
A -- Agriculture, forestry and fishing	2	.5
B -- Mining	4	1.1
C -- Construction	18	4.8
D -- Manufacturing	310	82.4
E -- Transportation and public utilities	11	2.9
F -- Wholesale trades	14	3.7
G -- Retail trades	5	1.3
H -- Finance, insurance and real estate	0	0
I -- Services	12	3.2
J -- Public administration	0	0
K -- Not otherwise classified	0	0
Unknown	0	0

Note. -- Due to rounding, percentages may not add to 100.

At the hearing, the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America (UAW) testified that there were 74 fatalities which it referred to as "lockout fatalities," which had occurred to its members between 1973 and 1988 (Tr. H253). In response to requests at the hearing, the UAW provided additional information on these fatalities (Ex. 49E). (The number of "lockout fatalities" was revised to 72 in the post-hearing submission.) The post-hearing data reinforce OSHA's determination that fatalities from hazardous energy sources involve more than simply a failure to "lock out" machines or equipment. Of the 72 fatalities, UAW reported that there had been "inadequate training" in 49 cases (68%); "inadequate procedures" in 50 cases (69%); and "adequate, but unenforced procedures" in 19 cases (26%). Although OSHA agrees that lockout provides more security against reenergization of equipment than tagout, the Agency is convinced more than ever that there is much more to energy control than the question of lockout vs. tagout. The UAW data make a strong case for the need for OSHA to provide for proper energy control procedures and adequate training in those procedures.

In the proposal, OSHA estimated, based on BLS data, that lockout or tagout related fatalities represented 7% of the total number of occupational fatalities. In their post-hearing comment, the UAW indicated that for their workers, this figure is estimated to be 26%, and that OSHA should take this larger estimated percentage into account in its projections. The UAW also argued that its data base is larger than that used by OSHA, and that it is more reliable because of its national scope and inclusion of both large and small facilities. (Ex. 49A). OSHA appreciates the time and effort taken by the UAW in compiling such data and in submitting it to the rulemaking record. At the time of the proposal, the Agency acknowledged that its injury and fatality figures were likely to be understated for

various reasons. Regardless of whose figures are used, there is little doubt that the failure to control hazardous energy sources exposes employees to a significant risk, and that this standard is necessary to reduce those risks.

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