Docket S030
Ex. 47

The cost implications of the mandatory use of insulating links on cranes

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1. Summary

This report will demonstrate, and reference data, to conclude the following points:

1.1 Accurate and consistent research shows that at least 100 crane power line contacts occur per year.

1.2 Government and independent data agree that such crane power line contacts are consistently the largest single 'event' of crane fatalities over the last 25 years.

1.3 The Federal regulations[1,2] expressly prohibits a crane from contacting power lines.

1.4 Operator training can modify the rate of fatalities but cannot stop the underlying causes of crane power line contacts.

1.5 Insulating links have been available since the 1950's but only from 1997 have there been insulating links which meet the requirements specified by experts for the crane industry.

1.6 Even the most pessimistic estimates show that the US crane industry could save at least $63 million per year if every crane were fitted with insulating links.

1.7 The most optimistic estimates show that the US crane industry would have to pay out as a minimum $85 million per year if insulating links are not fitted to every crane.

1.8 The payback time of the implementation costs range between 11 months and 4 years 11 months when measured against costs. (These calculations do not include any strict liability or punitive damages.)

1.9 Re wording the law to mandate the use of insulating links "only on jobsites

which include power lines" could reduce the retrofit costs, and hence also the payback time, by 40%.

1.10 The implementation cost in fitting insulating links is at a 'safety ratio' of 2.5% of the price of a new crane. This cost is also equivalent to 1 ¾ week's rental earned by an existing crane.

1.11 It confirms that the popular opinion claiming "safety devices encourage reckless behaviour" is unfounded and confirms the obvious fact that safety devices reduce accident rates.

1.12 The average age of those electrocuted is 33 years. The 32 years of lost labor and life place a heavy cost on industry, society and family which we must not forget.

2. Incident rate

2.1 Over the last twenty years crane power line fatalities have been the number one killer in the construction crane industry. Those recorded by Occupational Safety and Health Administration (OSHA)[17,35] confirm a steady rate of 20 fatalities per year. The US Department of Labor - Census of Fatal Occupational Injuries (CFOI)[10] was set up in 1992. The CFOI show a steady rate of 19 fatalities per year over 11 years.

2.2 OSHA performs many tasks which are primarily regulatory and statistics are only a bye product. OSHA statistics are therefore filtered may only include data:

2.2.1. when 1 fatality occurs

2.2.2. when 3 or more injured go to hospital. (Pre 1990 5 or more hospitalised).

2.2.3. when it does not involve a self-employed person.

2.2.4. when the injured/killed does not involve a relative of the owner of the business.

2.2.5. If there are sufficient staff to investigate.

2.2.6. If staff record sufficient information for the incident to be classified as a crane power line incident. (Staff are enforcement officers not statistical agents for Washington.)

2.2.7. when violations occur. (If no violation it may not be recorded).

2.2.8. If the scene has not sufficiently changed since the incident.

2.2.9. when the incident is recent. (When too much time, say 8 months, has passed since incident occurred it might not be recorded).

2.3 Morgan[21], an expert defence witness for 10 crane companies, has testified that about 100 power line contacts occur per year. This is a reliable statistic as Morgan, as a defendant expert, is privy to claims against crane companies and able to confirm this number under oath. It would be reasonable to conclude that the crane manufacturer's data is a base line as they would be subject to notification of incidents resulting in litigation or crane damage and replacement.

2.4 MacCollum[14] a well cross referenced safety campaigner, and expert prosecution witness, suggests 155 are killed or crippled and 450 serious injuries each year are contributable to crane power line contact.

2.5 Burrell's[22] survey of press cuttings in 1998 has shown about 17 injuries and

21 fatalities occur per year and that the ratio of fatalities to injuries is 8:10 or 80%. When these fatalities were cross-referenced to OSHA data only 13 or 34% of incidents were logged by OSHA. This puts paid to the suggestion that OSHA usually investigates 'media' events. It thus follows and would be reasonable to conclude that OSHA data under due to its filtering process underestimates by 66% so therefore that the incidents should be increased from 20 to 58 fatalities per year.

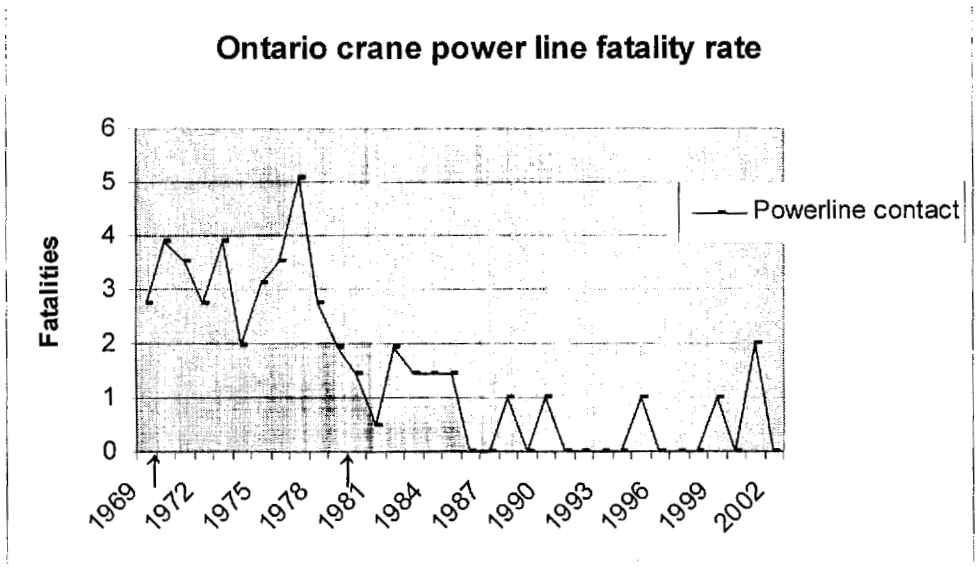
2.6 It is extremely unlikely that three or more are injured in crane power line contact due to the number of personnel operating with or near the crane and thus most injuries are not investigated by OSHA. Burrells[22] survey showed that there were no OSHA investigations when no fatality had occurred. It thus follows and would be reasonable to conclude that using the 80% rule the adjusted OSHA fatality rate of 58 would anticipate a further 47 injuries.

2.7 Ten years of data from the Texas Workers Compensation[31] show that 66% of crane fatalities are due to crane power line contact.

2.8 Fifteen years of recent data from Construction Safety Association of Ontario[30], (CSAO), show that 35% of crane fatalities are crane power line contact. Dickie[34] quotes prior CSAO data with 39% between 1969 and 1978 and 48% between 1978 and 1985.

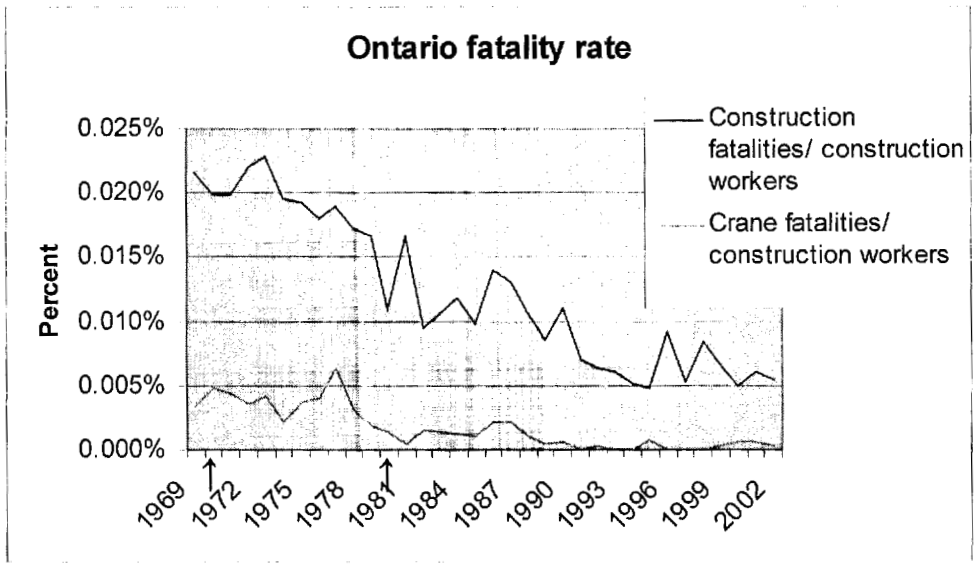
2.9 TCR NewsFlash[36,37] reports that Ontario initiated in 1972 and made mandatory crane operator training from 1982. Graph 1 shows that the rate dropped during the introduction and mandating of operator training from 3.5 crane power line fatalities per year to 2 crane power line fatalities per year

in 1982. Since 1982 the rate is stable.



Graph 1 – Fatality rate from crane power line contact in Ontario

2.10 The question remains whether the number of fatalities reflects the number of cranes in operation. There is no independent record of crane man hours in Ontario but there is a record of the number of construction workers.



Graph 2 – Fatality rate with cranes and for construction workers in Ontario

2.11 Graph 2 shows when the crane fatalities figures are tabulated against the number of construction workers a similar trend is observed. Training reduces fatalities but does not remove the underlying cause of crane power line contacts.

2.12 Research Committee, Public Utilities Section[39] in a voluntary survey of 273 utilities over a five year period had 185 fatal and 820 non fatal crane or boom power line contacts. This is equivalent to 37 fatalities and 164 non fatalities per year respectively. Just one company, Monongahela[38], admitted seven fatalities in fifteen years caused by crane power line contact.

2.13 It would be expected that the electric utilities would notice the power surges and resulting damage more often than the press, crane manufacturers or OSHA.

2.14 Since the survey was conducted there has been a great deal of rationalising in the electric utility industry. It would be hard to estimate the National figures extrapolated from the 273 who volunteered this information.

2.15 The expert estimation by Morgan[21] of 100 power line incidents is consistent with the resulting 58 fatalities and 47 injuries per year as computed from cross-referenced data.

3. Crane population

3.1. Off Highway research[23] have estimated that 2,000 new mobile cranes are added to the US fleet each year of which 7% are crawler lattice. Based upon the assumption that a hydraulic crane has a 10 year life and rough

terrain 25 years they estimate 27,500 hydraulic cranes and 6000 lattice boom are currently used in the USA.

3.2. Table 1 shows the new crane market from a survey by Yengst[26] in 1999. A weighted average is tabulated based on estimated number of each type of crane.

	All terrain	Rough terrain	Truck	Crawler lattice	TOTAL#	
0-25t	16	375	65	0	456	22%
25-60t	120	450	163	12	744	35%
60-100t	24	645	81	92	842	40%
100t+	0	30	16	12	58	3%
				Total	**2100**	**100%**

Table 1 – Crane capacity v. percentage of market

4. Cost per incident

4.1 There are several layers of cost which are borne by the industry directly or indirectly:

4.1.1. Damage to equipment – cranes and utility equipment. ASME[8] specify that the wire rope must be replaced after power line contact. if it is not replaced it can shed its load. A wire rope may cost up to $20,000 for a 100t crane.

4.1.2. Damage to people – fatality or debilitating injury.

4.1.3. Family bereavement

4.1.4. Cost to society

4.1.5. Management costs - incident reports with key personnel unproductive.

4.1.6. Legal costs – defence for those directly and indirectly involved.

4.1.7. Government costs

4.1.7.1. OSHA investigations.

4.1.7.2. Medicaid.

4.1.7.3. Medicare.

4.1.7.4. State vocational rehabilitation.

4.1.8. Company costs - OSHA fines and increased insurance costs

4.2 All of the items listed above do not appear as a separate accounting item in industrial or Government statistics.

4.3 Publicly available litigation outcomes can be used but even these are not publicly recorded. Often litigation results are by purpose settled 'out of court'. In this way defendant companies are able to avoid setting precedents for future cases. In 'out of court' settlements documentation is often destroyed with substantial penalties placed on plaintiffs for disclosure of the level of settlement.

4.4 MacCollum[14] analysis confirmed that there have been comparatively few settlements in the public domain for personal injury.

4.5 Most crane power line electrocutions do not go to court because:

4.1.1. Willis[32] reported that until 1997 there was not an insulating link which would be acceptable by a court.

4.1.2. dependents were ignorant of the availability of such a product.

4.1.3. plaintiffs opted for the safe route of Worker's Compensation.

4.1.4. defendants wish to settle 'out of court'.

4.6 Sixel[25] recently reported a fatality settlement of $4.2m. Conlon[27], a claims

adjuster, settled for his employer an injury claim of $25m including a $12m medical bill. Estes[24] reports fines on the Terex crane company of $114m in a related incident.

4.7 Any incident can take years to come to court with anyone remotely connected with the incident being cited. Pittman[29] suggests that the following are legitimate plaintiff targets:

4.1.1. Crane operators.

4.1.2. Crane rental companies.

4.1.3. Subcontractors.

4.1.4. General contractor.

4.1.5. Power company.

4.1.6. Engineering companies.

4.1.7. State Department of Transportation.

4.1.8. Crane operator's training school.

4.1.9. Crane manufacturers under strict liability laws.

4.8 There is extensive independent[13,14,15], industry[16,18,20] and government funded [11,12,17,31] research on this subject. Some of the agreed conclusions are:

4.9 NIOSH[11] shows that the average age for electrocution is 33 years.

4.10 MacCollum[14] has reviewed 400 crane/power line injury lawsuits over 25 years before 1993:

4.1.1. 179 Fatalities and 167 permanent disabilities.

4.1.2. Defence recorded verdicts in only 5%.

4.1.3. Reported settlements average $600,000.

4.1.4. Reported plaintiff's verdict average $1.5m.

4.1.5. 36% included utilities as defendants.

4.1.6. Total judgements estimated $200 million.

5. Benefits of using insulating link

5.1 An insulating link is designed to save the rigger when the crane boom or wire touches the power line as shown in diagram 1.

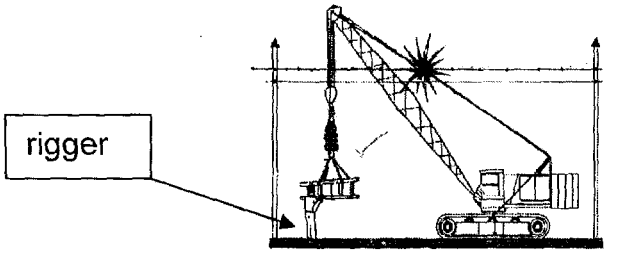


Diagram 1 – The use of insulating link on crane to stop electrocution of rigger.

5.2 The crane driver is safe so long as he does not panic and remains in his cab. The cab behaves as a 'Faraday cage' with the voltage flowing around it so he will be protected.

5.3 The 'oiler' and bystanders are not so fortunate. They are usually electrocuted should they touch the body of the crane or walk across the ground field to reach injured parties.

5.4 NIOSH[11] and MacCollum[14] estimate that 80% of all injuries and fatalities involve the rigger guiding the load. Burrell's[22] survey corroborates and sets this value at 85%.

6. Incident voltages

6. 1 There are various voltage levels on power line cables which might become entangled with a crane. These vary from domestic voltages of 110V to grid lines of 750 kV.

6. 2 Most roadside distribution voltages are below 34kV phase to phase producing 24kV phase to ground. NIOSH[11] estimate that 79% of the incidents occur with power line voltages below 20kV. MacCollum[14] considers that 80% of incidents occur below 16kV.

7. Insulating link costs.

7.1 International Cranes[39] produces regular surveys of average crane rental rates. Table 2 shows this rental rate compared with the lowest current list price of insulating links. An insulating link thus corresponds to about 1 ¾ weeks hire.

Capacity	Crane rental rate $ per week	Load Insulator OEM $	# weeks for cost
0-25t	2000	2960	1.5
25-60t	3500	4960	1.4
60-100t	5950	9920	1.7
100t+	8000	19040	2.4

Table 2 – The number of weeks of crane rental to cover cost of insulating link

7.2 In Table 3 similar data is presented to compare the cost of a new rough terrain crane and that of supplying an insulating link. The 'safety ratio' computed corresponds to about 3% of the cost. This is a similar rate to fitting an air bag on a truck. Both air bags and insulating links do not initiate

or stop accidents but mitigate the results of one. In one the driver is not facially disfigured, in the other the rigger retains his life and/or his limbs.

Capacity	Rough terrain crane	Insulating link OEM	Ratio
	$	$	%
0-10t	95000	2960	3
0-25t	265000	4960	2
25-55t	360000	9920	3
55-100t	643000	19040	3
	Pickup truck	Air bag	
	19100	640	3

Table 3 – The 'safety ratio' of cost of rough terrain crane to insulating link and pickup truck to air bag

7.3 It would be anticipated this 'safety ratio' would drop to 2.5% in OEM production volumes.

7.4 Stucki[33] notes that the use of airbags, a safety product, does not increase the rate of accidents nor do drivers become more reckless when air bags are fitted. This survey included all car accidents including night time, juvenile and alcoholic drivers. When professional drivers were analysed the accident rate reduced from 3% to 2% after the introduction of airbags. It is therefore reasonable to conclude:

7.4.1. that the introduction of insulating links, as a safety product, will reduce the accident rate

7.4.2. that the awareness of the insulating link being fitted to a crane will not encourage professional, sober, mature, day time operators to become more reckless.

7.4.3. that it would of course be illegal to call airbags or insulating links

safety products if they increased accidents.

8. Final calculations

8.1 We are now able to use some of the raw data identified in the previous sections and to calculate the implications. The cost of **not** implementing the mandatory use of insulating links is tabulated and contrasted with the cost of supplying links.

8.2 Table 4 shows the expected scenario for the annual settlement costs. It should be noted that these tabulated results are computed for injury costs only by cross referenced data.

	Incidents per year	Preventable %	Preventable per year	Settlements $m	Costs $m
Fatalities	58	80	46	5	232
Injuries	47	80	38	5	188
TOTAL			84		**420**
AVERAGE					**5**

Table 4 – The annual settlement costs for preventable personal injury – scenario 1

8.3. The settlement costs are linked to estimated casualty and fatality numbers in Table 4. In order to give some minimum measure of settlement costs the OSHA results actually recorded could be used. Table 5 shows the substantially reduced 2nd scenario using OSHA recorded data. These annual settlement costs for personal injury must be a bare minimum as,

noted previously, OSHA results are filtered.

	Incidents per year	Preventable %	Preventable per year	Settlements $m	Costs $m
Fatalities	21	80	17	4.2	71
Injuries	17	80	14	0.5	7
TOTAL			30		**77**
AVERAGE					**3**

Table 5 – The annual settlement costs for preventable personal injury using OSHA data– scenario 2

8.4. As we discussed in section 4 most costs are hidden. There is no measure of these costs but must be in proportion to the personal injury costs. In purely financial terms it would not be unreasonable to increase all loss totals by 10%. This would uplift the annual losses to range from $77m or $420m to $85m or $462m

8.5. Table 6 shows the cost of fitting every new crane with an insulating link at list prices. These results are tabulated from Tables 1 & 2.

Capacity	New units per year	Load Insulator OEM $	new units $m
0-25t	456	2960	1
25-60t	744	4960	4
60-100t	842	9920	8
100t+	58	19040	1
TOTAL	**2100**		**14**
AVERAGE		**6903**	

Table 6 – The number of cranes and computed cost to fit new cranes with insulating links

8.6. Table 7 shows the cost of retrofitting every crane. It is created from Tables 1 & 2 using the estimated crane population from section 3.1.

Capacity	Existing	Load Insulator	retrofit
	cranes	OEM $	$m
0-25t	4020	2960	12
25-60t	4355	4960	22
60-100t	9380	9920	93
100t+	15075	19040	287
TOTAL	32830		414
AVERAGE		12598	

Table 7 – The number of cranes and computed cost to retrofit cranes with insulating links

8.7. The most pessimistic annual saving to industry is the difference between Table 6, $14m the cost of fitting to new cranes and the settlement costs in Table 5 of $77m. The net benefit is thus $63m per year.

8.8. The pay back time to recover the retrofit costs of $414m in Table 7 depends on which annual cost scenario is used - $85m or $462m. This time would thus vary between 11 months and 4 years 11 months.

8.9. If OSHA mandates the use of insulating links only "on a job site which contained a power line" then cranes would not need insulating links:

8.9.1. for cities with buried power lines.

8.9.2. for green field sites with no power lines.

8.9.3. for job sites, (or the area under the control of the General contractor), with no power lines.

8.9. It would be difficult to estimate the proportion of cranes thus involved.

This proportion could be 40% of the crane population. It would not be unreasonable to suggest that the retrofit market cost could be reduced by 40% from $414m to £249m.

8.10. The crane manufacturers however may not be able to distinguish where their cranes were used and would follow prudent business to limit exposure of 'strict liability' and still fit insulating links as standard.

9. REFERENCES

1. Code of Federal Regulations [2002] *29 CER 1910- Labor* . U.S. Government Printing Office. Washington, D.C.
2. Code of Federal Regulations [2002] *29 CFR 1926- Labor* . U.S. Government Printing Office. Washington, D.C.
3. ISO Standard [1988] IEC 479 –1 Effects of current passing through the human body
4. Canadian Standards Association [1994] C22.1-94 Canadian Electrical Code part 1.
5. Institute of Electrical and Electronics Engineers [1995] *IEEE standard techniques for high-voltage testing IEEE Std 4.* 345 E 47 St. NY 100017
6. Institute of Electrical and Electronics Engineers [1984] *IEEE guide for in-service and electrical testing for live line tools.* 345 E 47 St. NY 100017
7. Institute of Electrical and Electronics Engineers [1997] *National electrical safety code ISBN 1-55937-715-1.* 345 E 47 St. NY 100017
8. The American Society of Mechanical Engineers [1989] *ASME B30.5 Mobile and locomotive cranes.* 345 E 47 St. NY 100017
9. The American Society of Mechanical Engineers [1994] *ASME B30.22a Articulating boom cranes.* 345 E 47 St. NY 100017

10. U.S. Department of Labor, Bureau of Labor Statistics and from 1992 the Census of Fatal Occupational Injuries, (CFOI).
11. NIOSH [1998] *Workers deaths by electrocution*, US Dept. of Health and Humàn Services.
12. NIOSH [1995] Prevention electrocutions of crane operators and crew members working near overhead power lines, US Dept. of Health and Human Services.
13. Construction Safety Council [2002] *Managing mobile crane hazards workbook.* 4415 W. Harrison Street, Illinois 60162
14. David V. MacCollum [1993] *Crane hazards and their prevention* ISBN 0-939874-95-4
15. ABH Partnership [1994] *Crane safety* , Winter Springs, Fl 32708
16. G. E. Bates & R. M. Hontz [1998] *Exxon crane guide* , SC&RA, Fairfax, VA 22031-4312
17. A. Suruda et al. [1997] *Crane related deaths in the US construction industry 1984-94* Center to Protect Workers' Rights, Washington DC 20001
18. Dr. D. Morgan & Dr. H. Hamilton [1982] *Evaluation of links for safety applications,* National Crane legal defence
19. Electric Power Research Unit [1982]Transmission line reference book 345kV and above Palo Alto, CA
20. Cranes Today [1991] Feb issue *The Battle Zone*
21. Dr. D. Morgan [1992] Deposition Muszynski v. Union Oil Company et al.
22. Burrell's press survey [1998]
23. Off Highway Research [1997] The *Construction equipment industry in North America - Equipment Analysis – Hydraulic cranes*
24. Estes. A [1999] *Jury socks co. with $114m verdict*, Associated press
25. L.M.Sixel [2003] State safety mandate little-known and less enforced Houston Chronicle
26. Yengst C. [1999] Yengst Associates Inc.
27. T.Conlon [1998]
28. International Cranes [2003] Jan. issue *Caution – rental rates*

29. W. Pittman [2000] Presentation to NALI conference.
30. M. McCusker P.Eng [2003] *Fatality data* Construction Safety Association of Ontario
31. Texas Workers Compensation Commission [2003] *Fatality Data*
32. Willis [2000] New safety procedure unveiled to prevent lifting electrocution accidents.
33. Stucki. S.L [2000] Estimate of Crash Involvement Rates for Passenger Vehicles with and without Air Bags in 1997
34. Dickie D.E. [1986] *Mobile Crane Accidents* Construction Safety Association of Ontario
35. Abramo V.J. [198?] *Case Studies 29 CFR Subpart N 1926-550-556 Cranes, Derricks, Hoists, Elevators and Conveyors* OSHA #41USC252C3-B9F3649F
36. TCR NewsFlash [1993] *Crane Study confirms downward trend, underlines importance of training.* ABH Partnership PO box 872, Merryfield VA22116
37. TCR NewsFlash [1993] *Lack of training a major contributory cause of crane deaths, new study suggests.* ABH Partnership PO box 872, Merryfield VA22116
38. Monongahela power company [1988] *Common pleas court of Washington County, Ohio.*
39. Research Committee, Public Utilities section & National Safety Council [1969]
40. Drudi.D [1997] *A century-long quest for meaningful and accurate occupational injury and illness statistics* Bureau of Labor Spastics.