Electrician's Job Demands – Heavy Cable Work

Heavy cable lifting is a main component of electrical work with distinct physical effects on the body. According to Hanna et al. (2005) in a research article about the factors affecting absenteeism in electrical construction, 52% [of electricians] reported they had a work-related injury sometime during their career that caused them to miss work.

During the month of April in 2005, the International Brotherhood of Electrical Workers (IBEW) local 353 commissioned the Toronto Clinic of the Occupational Health Clinics for Ontario Workers (OHCOW) to complete a musculoskeletal discomfort/ symptom survey of its membership. OHCOW found that in the last year (at the time of survey), an average of 50.35% of reporting union members experienced work related aches, pain, discomfort or numbness of the shoulder while 67% of reporting union members experienced work related aches, pain, discomfort or numbness of the low back. Of the reporting members, 31.4% had sought a health care professional's advice for shoulder pain while 37.8% had sought a health care professional's advice for low back pain.

Mechanisms of Injury

There are three main mechanisms of injury (McGill, 2002). Most individuals can identify the "specific incident" injury mechanism where a load greater than the individual's tissue tolerance is applied, resulting in an injury (Appendix). An injury may also occur from continuous load application resulting in an injury from the reduction in an individual's tissue tolerance over time. The final injury mechanism involves repeated loading, which decreases an individual's tissue tolerance over time until an injury finally occurs (McGill, 2002).

Potential Injuries

In certain sectors, electricians handle large cable, such as 500 MCM, which can weigh over 7.5 Kg a meter. Many electricians in Local 353 refer to working with 500 MCM tech cable as "wrestling a cobra." Working with heavy cable increases the risk for a low back or shoulder injury due to the unstable and unpredictable nature of the cable (Gallagher et al., 2002).

Musculoskeletal Disorders of the Low Back and Shoulder:

The National Institute of Occupational Health and Safety (NIOSH) (1997) defines musculoskeletal disorders (MSDs) as a condition that involves the nerves, tendons, muscles, and supporting structures of the body. An MSD may cause pain, inflammation, reduced mobility as well as other symptoms. Chengalur et al. (2004) reported that awkward posture is strongly associated with low back injuries, while static posture and compression are good risk factors for low back injuries. Workers who maintain static lumbar flexion for prolonged periods of time also experience high rates of low back disorders (Olson et al., 2004). The NIOSH action limit for the spine is 3400 N. A study by Gallagher et al. (2002) found that average compression values for tested heavy cable lifting tasks exceeded the NIOSH action limit, placing the spine at risk for a musculoskeletal injury.

NIOSH (1997) states that repeated or sustained shoulder flexion and abduction greater than 60 degrees from neutral is positively associated with shoulder MSDs and shoulder tendonitis. When the shoulder nears its end range of motion in overhead work settings, stretching and compression of tendons and nerves occurs limiting blood flow to the joint and damaging tissues. The longer a fixed or awkward body position is held, the greater the risk of developing MSDs (CCOHS, 2002).

Risk Factors for Injuries

There is great similarity in heavy cable work performed by electricians and miners. In both cases, electricians and miners often work with heavy cable in physical environments that prevent a neutral spine posture from being used. Therefore the workers usually adopt a stooped or kneeling posture, which greatly increases the risk of incurring a spinal injury (Gallagher et al., 2002; McGill, 2002). Researchers believe that workers may choose to adopt a stooped posture because it allows them to recruit muscular motor units in the leg, allowing the workers to create more physical force to support a load. Although the increase in muscular force allows an electrician to support a greater amount of weight, stooping involves deep trunk flexion, increasing the compressive and shear forces on the spine due to the increase in weight being handled (Gallagher et al., 1988). To decrease the risk of a low back injury, a single electrician should lift less cable or the work should be completed with two or more workers.

Gallagher et al. (1988, 1997, 2002) examined the effect of heavy cable lifting while in a kneeling posture. A kneeling posture limits the use of the leg musculature in the force production required to lift heavy cable. A kneeling posture also decreases mobility, causing workers to use spinal torsion (twisting) in order to accomplish tasks. Frequent torso motion and spinal deviations are low back injury risk factors. The spine’s load bearing is also reduced when in a twisted position further complicating the spine’s risk of injury (McGill, 2002).

With larger wiring jobs, an electrician is required to install and lift heavy cable in bigger quantities. The increase in weight associated with lifting more cable increases spinal musculature recruitment, increasing the risk of a low back MSD. Heavy cable is also unstable and prone to moving about. Therefore an electrician must also exert more force to stabilize him/herself and the cable, increasing muscular recruitment, which again, increases MSD risk (Gallagher et al., 2002).

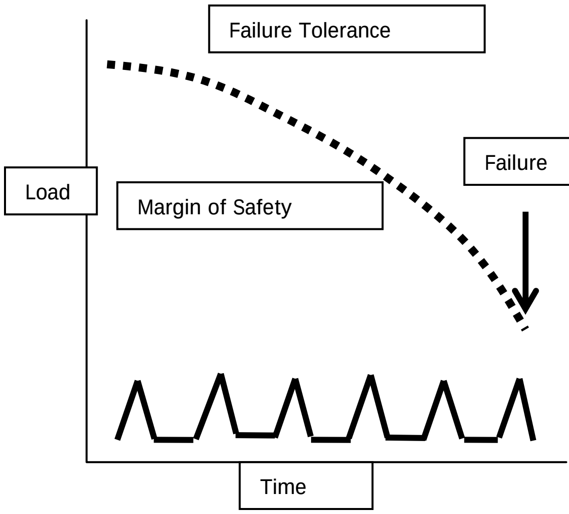
When installing heavy cable, an electrician will eventually need to hold the cable in place with one arm in order to secure it with the other causing asymmetry of movement (Kingma & Dieen, 2004). Asymmetrical lifting movement increases spinal compression, increasing the risk for a spinal injury and also places more load on the shoulder further increasing the shoulder’s risk of injury (Marras & Davis, 1998).

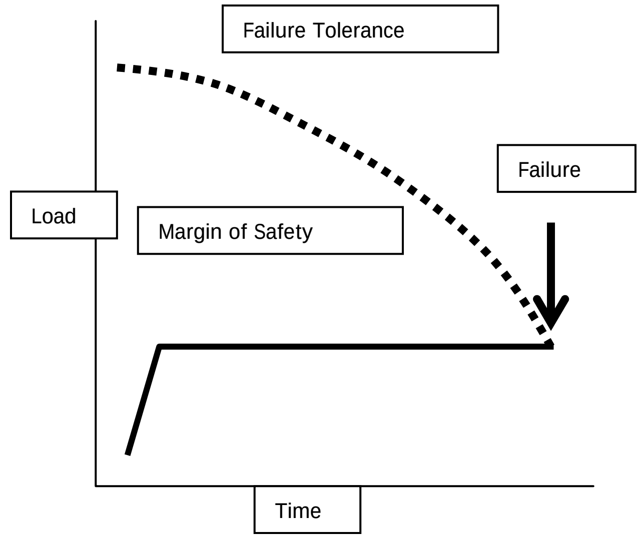
It is also important to note that the greater the force required to sustain a posture or lift heavy cable, the quicker an individual will become fatigued (Hagberg et al., 1995). Therefore, as the amount of heavy cable lifted increases, an individual may become more fatigued increasing the risk of a low back or shoulder injury. Hagberg et al. (1995) also noted that the longer a static posture is held, the greater the need for recovery time between work activities or work shifts.

Prepared by: Jennifer Yorke B. Sc. (Hon. Kin.)
Supervised by: Syed Naqvi – PhD CCPE CPE (Ergonomist, OHCOW Inc.), David Mijatovic – BSc MHSc (Ergonomist, OHCOW Inc.) & Gary Majesky (IBEW LU 353)

Appendix

Injury Mechanisms (McGill, 2002)





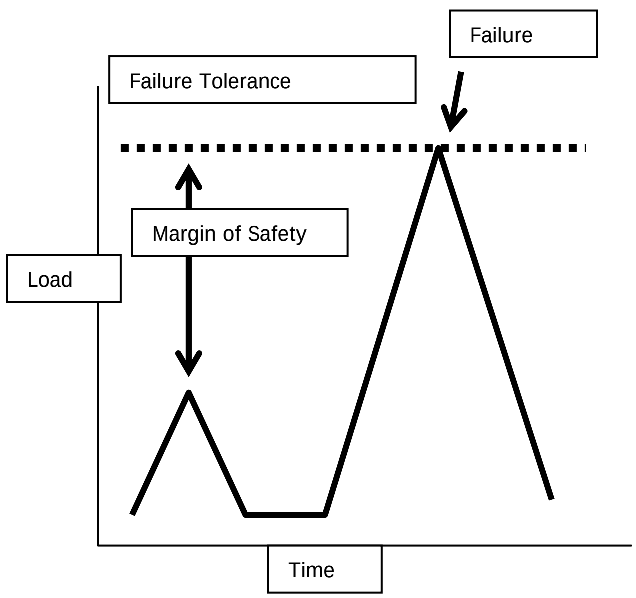


Table 1 (Chengalur et al., 2004)

Primary Job Risk Factors Considered in Major Reviews

Risk Factor	Low Back	Distal Upper Extremities	Neck and Shoulders
Force	Strong	Strong	Strong
Awkward Posture	Strong	Strong	Strong
Static Posture	Good	Good	Good
Repetition	Good	Strong	Strong
Dynamic Factors	Good	Weak	Weak
Compression	Good	Weak	Weak
Vibration	Strong	Strong	Weak
Combined	Good	Strong	Good

Strong = strongly correlated risk factor for MSDs in the low back/distal upper extremities/neck & shoulders
Good = strongly correlated risk factor for MSDs in the low back/distal upper extremities/neck & shoulders
Weak = weakly correlated risk factor for MSDs in the low back/distal upper extremities/neck & shoulders

Table 2: Static Work Duration as a Function of Intensity (Rodgers et al., 1986)

Percent of Maximum Static Strength	Maximum Endurance Time
100	6 seconds
75	21 seconds
50	1 minute
25	3.4 minutes
15	>4 minutes

Recovery Time Needs for Three Levels of Effort for Different Effort Durations (Rodgers 1998)

Effort time plus recovery time is the time before repeating to avoid accumulating fatigue on a task.

Continuous Effort Time (seconds)	Recovery Time Needed for Nonfatiguing Work (seconds)		
	Heavy	Moderate	Light Effort
1	1	1	0
2	3	2	1
3	4	2	1
4	9	3	1
5	14	3	1
6	18	4	1
7	27	5	1
8	35	8	1
9	49	11	1
10	57	14	2
11	62	17	2
12	74	20	3
13	97	24	3
14	111	28	3
15	135	32	3
16	149	36	3
17	158	43	3
18	167	48	4
19	186	53	4
20	220	57	5
21		62	5
22		67	5
23		73	5
24		79	5
25		86	5
30			11
35			13
40			15
45			17
50			20
55			25
60			40

Source: Chengalur et al., 2004

References

Canadian Center for Occupational Health and Safety (2005, December 12). *Work Related Musculoskeletal Disorders.* Retrieved August 1, 2006, from http://www.ccohs.ca/oshanswers/diseases/rmirsi.html

Chengalur, S.N., Rodgers, S. & Bernard, T. (2004). *Kodak's Ergonomic Design for People at Work*. New York: John Wiley & Sons, Inc.

Gallagher, S., Hamrick, C., Cornelius, K. & Redfern, M. (2001). The Effects of Restricted Workspace on Lumbar Spine Loading. *Occupational Ergonomics*, 2, 201-213.

Gallagher, S., Hamrick, C. & Love, A. (1997). Biomechanical Modelling of Asymmetric Lifting Tasks in Constrained Lifting Postures. *Ergonomics and Musculoskeletal Disorders: Research on Manual Materials Handling*, 86-90.

Gallagher, S., Marras, W. & Bobick, T. (1988). Lifting in Stooped and Kneeling Postures: Effects on Lifting Capacity, Metabolic Costs, and Electromyography of Eight Trunk Muscles. *International Journal of Industrial Ergonomics*, 3, 65-76.

Gallagher, S., Marras, W., Davis, K. & Kovacs, K. (2002). Effects of Posture on Dynamic Back Loading During a Cable Lifting Task. *Ergonomics*, 45, 380-398.

Hagberg, M., Silverstein, B., Wells, R., Smith, M., Hendrick, H., Carayon, P. & Perusse, M. (1995). *Work Related Musculoskeletal Disorders (WMSDs): A Reference Book for Prevention*. Great Britain: Taylor & Francis.

Hanna, A. S., Menches, C.L., Sullivan, K.T. & Sargent, J. (2005). Factors affecting absenteeism in electrical construction. *Journal of Construction Engineering and Management*, 131, 1212-1218.

Hagberg, M., Silverstein, B., Wells, R., Smith, M., Hendrick, H., Carayon, P. & Perusse, M. (1995). *Work Related Musculoskeletal Disorders (WMSDs): A Reference Book for Prevention*. Great Britain: Taylor & Francis.

Kingma, I. & Dieen, J. (2004). Lifting Over an Obstacle: Effects of One-Hand Lifting and Hand Support on Trunk Kinematics and Low Back Loading. *Journal of Biomechanics*, 37, 249-255.

Marras, W. & Davis, K. (1998). Spine Loading During Asymmetric Lifting Using One Versus Two Hands. *Ergonomics*, 41, 817-834.

McGill, S. (2002). *Low Back Disorders: Evidence-Based Prevention and Rehabilitation*. Ontario: Human Kinetics.

Musculoskeletal Disorders and Workplace Factors: *A Critical Review of Epidemiologic*

Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back, U.S. Department of Health and Human Services, 2nd printing. (1997).

Occupational Health Clinics for Ontario Workers (2006). *Discomfort Survey Results.* Retrieved August 3, 2006 from http://www.ibew353.org/survey%20results.pdf

Olson, M., Li, L. & Solomonow, M. (2004). Flexion-Relaxation Response to Cyclic Lumbar Flexion. *Clinical Biomechanics,* 19, 769-776.