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Electrician's Job Demands Literature Review – Kneeling & Crouching

The requirement to kneel and crouch is a major component of electrical work. These postures are assumed approximately 50% of the working electrician's time during certain activities. With increased use, comes the potential for injury. 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), 67.6% of reporting union members experienced work related aches, pain, discomfort or numbness of the knees. Of the reporting members, 35.2% had sought a health care professional's advice for knee pain.

The knee experiences the most force during kneeling and crouching. As the knee is a weight bearing joint with high joint mobility it is susceptible to injury (Moore & Dalley, 1999). The knee, therefore, relies on ligaments and surrounding musculature to maintain its strength. Identifying potential mechanisms of injury within the job tasks of electrical work may lead to the reduction of work related injuries.

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

Due to the mobility of the knee joint, it is susceptible to a number of injuries, especially patellofemoral syndrome, bursitis, and meniscal wear and tear.

Patellofemoral syndrome:

Under normal circumstances the patella (knee cap) moves along a groove in the femur. Disruption of the patella's normal tracking pattern from a direct blow or from the wearing down of articular cartilage in the knee results in the patella sliding around, further damaging bone and cartilage (Moore & Dalley, 1999). Since crouching, climbing and kneeling are a required element of electrical work, and comprise a significant portion

of their working time, an electrician's risk of developing patellofemoral syndrome is increased.

Bursitis:

Bursitis in the knee is the inflammation of the bursa atop the patella. A bursa is a fluid-filled sac that reduces friction between body tissues (Medicinenet.com, 2003). The patellar bursa normally reduces friction that results from knee flexion and extension. Chronic compressive forces, such as continuous kneeling, or a direct blow to the patella can injure the bursa, causing it to swell and impede motion of the knee (Moore & Dalley, 1999; NIOSH, 1997). Compressive forces (contact stress) to the knee are further exacerbated when kneepads are not worn.

Meniscal Injuries:

The knee joint has lateral and medial menisci, which act as shock absorbers of the knee (Moore & Dalley, 1999). Repetitive motion and high levels of force can wear away the menisci, causing swelling and pain in the joint. The menisci also deepen the connection between the femur and tibia. When the menisci are worn down, knee joint instability can occur, increasing the risk of an injury occurring. As electricians employ kneeling and crouching on a daily basis, they are at increased risk of developing meniscal injuries.

Risk Factors for Injury

There are a number of factors that increase the risk of a knee injury. Dembe, et al. (2004) cited that a worker being exposed to six specific hazardous job activities – kneeling or crouching being one of the six, increases occupational injuries. A study by Bruchal in 1995 found that employees who work in a kneeling position experience more knee injuries than those that do not.

Kneeling and crouching also place high levels of force on the knee. High force, when combined with repetition of movement further increases the potential for a knee injury (NIOSH, 1997). Electrician's work requires continuous flexion and extension of the knee, which can lead to degeneration of the tissues and ligaments making the worker susceptible to injury. Awkward body postures further increase the potential for a knee injury by altering the biomechanics that protect the knee from injury (Bhattacharya et al, 1985).

Lastly, high levels of contact stress on the knee from hard or uneven surfaces such as the floor, or ladder rungs is correlated with injuries such as bursitis, fluid build up in the knee and other knee complaints (NIOSH, 1990). Kneepads can be used to reduce the potential for a knee injury from contact stress.

It is also important to note that the greater the force required to sustain a posture, the shorter the time it takes for an individual to become fatigued (Hagberg et al., 1995).

Therefore, as repetitions of knee flexion and extension increase, an individual may become more fatigued increasing the risk of a knee 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. It has also been noted that kneeling may reduce the ability to generate adequate hand forces, thus increasing the risk of injuries to the hand and forearm (Haslegrave et al., 1997).

The Spine

Although this paper has focused on the effects of kneeling and crouching on the knees, one must remember that the spine is also affected. Kneeling and crouching place the spine in a forward flexed position which decreases the ability of the spine to buttress itself from shear and compressive forces (McGill, 2002). As kneeling and crouching are frequently used working positions, the spine experiences cumulative repetitive force loading, increasing the risk of a spine injury (Marras, 2003).

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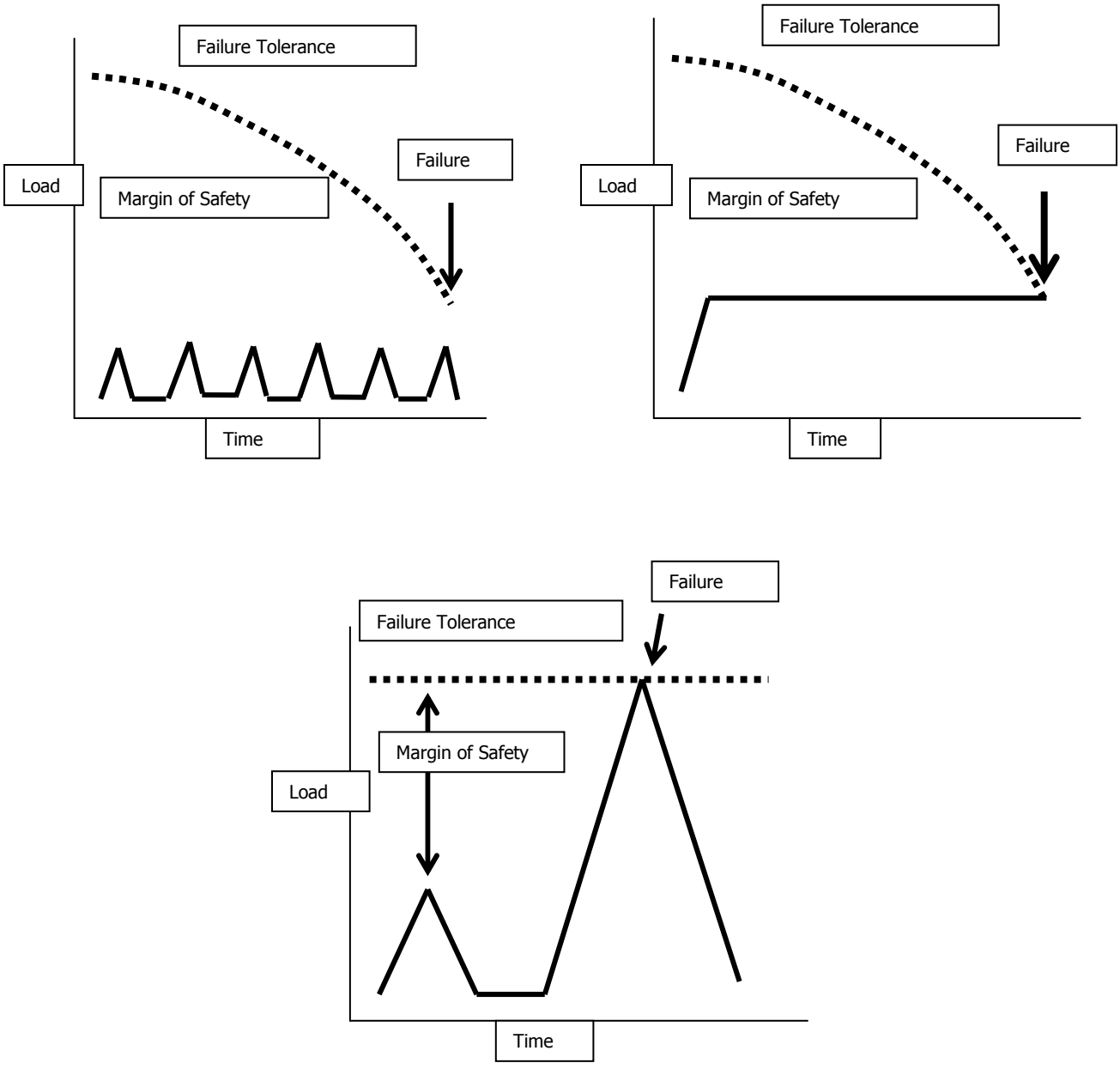
Appendix

Injury Mechanisms (McGill, 2002)



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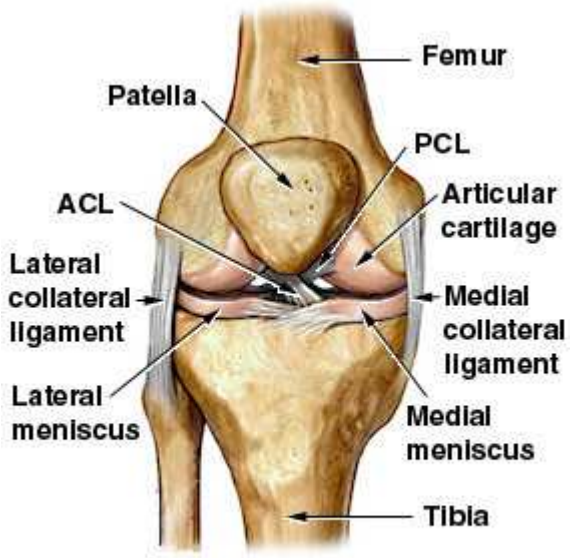
Tray 6–B. High Risk Repetition Rates by Different Body Parts

From Kilbom Å [1994]. Repetitive work of the upper extremity; Part II: The scientific basis for the guide. Int J Ind Erg 14:59–86.

Body Part	Repetitions Per Minute
Shoulder	More than 2½
Upper Arm/Elbow	More than 10
Forearm/Wrist	More than 10
Finger	More than 200

Diagram of the Knee Joint (www.wbcarrellclinic.com)



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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

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Kneeling & Crouching Photographs

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