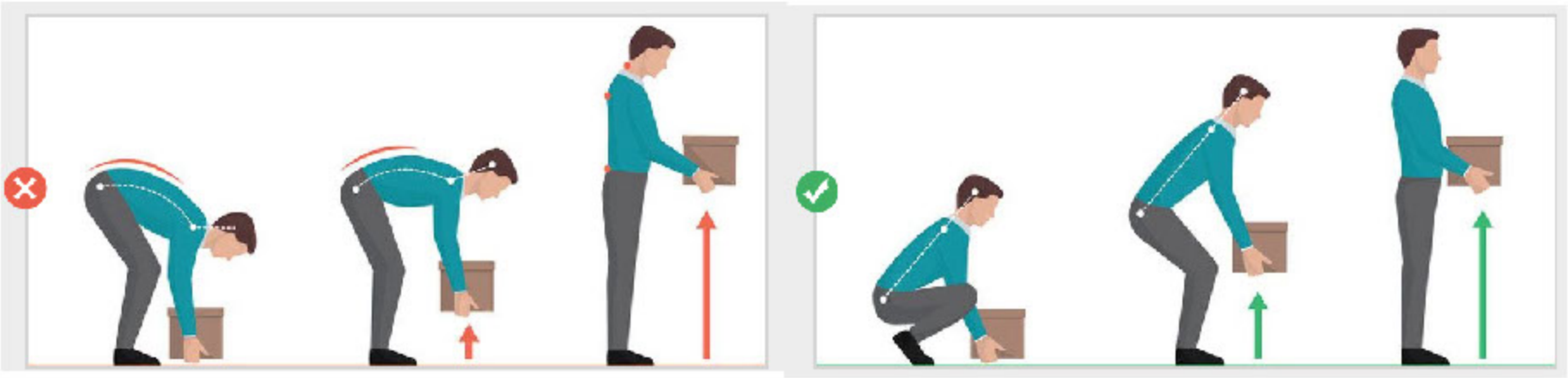
1.0 Introduction to Ergonomics



Think about the angle of your computer monitor, or the height of your workstation. Think about whether your eyes are strained by the end of the day or if your wrists hurt from completing repetitive tasks. A sound understanding of ergonomics can prevent most workplace injuries by adjusting tools to the user, putting an emphasis on proper posture to reduce the impact of repetitive movements.

The use of computers and rapidly changing technology in the modern workplace has greatly increased the need for ergonomics. Desks, chairs, monitors, and lighting all need to be assessed when creating a workspace. With all the changes and complexities to consider, managing the modern workplace is indeed a challenge. At the center of the challenge is the need for organizations to maintain stimulating and healthy environments for their employees. As the physical workstation and work tasks continue to evolve, we also must continue to evaluate the working environment and adjust it accordingly to make sure employees are willing and able to come to work every day.

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1.1 Ergonomics Defined

Ergonomics is defined as the science of matching the physical job or task requirements to human capabilities and limitations. It is an “applied” science, whereby scientific knowledge in such areas as anatomy, anthropometry, and kinesiology are utilized to develop and design processes to interact safely and efficiently on the job. The term ergonomics was coined in the mid-1800s from the Greek roots, ergo (work) and nomics (natural law or study), otherwise known as the “study of work.”

The best approach to studying ergonomics is to consider “how to work according to nature,” rather than to work in contradiction to the laws of human nature. While it is oftentimes described as the “fit” between the employee and their tools, tasks, and environment, it is important to note that the intent of ergonomics is to design the job to fit the employee, rather than to physically force the employee’s body to fit the job. When there is a “mismatch” between the physical requirements of the job and the physical capabilities of the employee, a high probability for injury results.

1.2 Injuries Associated with Ergonomics

If work tasks, equipment, and general working conditions do not incorporate ergonomic principles in their design, employees may have exposure to undue physical stress on their bodies. Employees who must repeat the same motion throughout their workday, who must perform their work in an awkward position, or who must use a great deal of force to perform a task are most likely to develop serious injuries.

Ergonomic injuries are those that are caused by hazardous activities which affect the human body's movement relative to the musculoskeletal system and are referred to as musculoskeletal disorders (MSDs) or biomechanical injuries. These painful and often disabling injuries generally develop gradually over weeks, months, and years and typically result from exposure to multiple risk factors inherent in the work itself or the work environment that can cause or exacerbate the injuries. An added challenge for employers associated with MSDs is that these types of injuries can also occur as a result of an employee's off-the-job activities which then can be aggravated by their daily performance of their job.

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1.2 Injuries Associated with Ergonomics

MSD injuries are categorized under the following generic titles:

- ***Cumulative Trauma Disorders (CTD):*** a group of disorders which are generally accepted to be work-related that are developed over time by repetition, force, and improper postures.
- ***Repetitive Motion Injuries (RMI):*** injuries that are caused by performing the same motion continuously over time.
- ***Repetitive Strain Injuries (RSI):*** injuries that are caused by straining parts of the musculoskeletal structure in a repeated "strain and heal" cycle.

The parts of the body typically affected by physical stressors resulting in MSDs are the arms, back, hands, wrists, fingers, legs, neck, and shoulders. Several obvious symptoms associated with MSDs are soreness, aches, numbness, cramping, swelling, burning sensation, tingling, or significant pain. These symptoms may result in a relatively minor issue for the employee, such as a reduction of an employee's grip strength or range of motion, or they may result in a permanent and debilitating injury for the employee over time whereby they may no longer be able to perform their job in an effective and safe manner.

1.3 The Significance of MSD Injuries

Based on recent data reported by the Bureau of Labor Statistics, work-related MSD injuries account for over 32% of all recorded employee injury and illness cases, with these numbers increasing steadily over time. Employers report nearly 600,000 MSD injuries requiring time away from work every year, with over 40% more days away from work than the average injury or illness. Low back pain is the most prevalent and costly work-related MSD in the nation, with an estimated one million employees affected in the US every year. Back pain is responsible for more days away from work than any other MSD recorded.

MSD injuries account for $1 of every $3 spent on workers' compensation by employers which, when added to other direct costs such as medical provider expenses, is estimated to equal more than $20 billion over the period of just one year. While these direct employer costs are significant, the indirect costs such as lost productivity, employee absenteeism, and retraining costs, can easily add up to five times as much as direct costs.

1.3 The Significance of MSD Injuries

Employees with severe MSD injuries may face a permanent disability that prevents them from being able to perform or return to their jobs or even handling simple, everyday tasks at work or at home. The toll on an injured employee can be significant, as an MSD injury may not only affect the employee's ability to perform the job, but also may have a significant impact on a family's emotional and financial security over time.

Preventing and controlling ergonomic risk factors in the workplace may cost only a fraction of some of these direct and indirect costs. Oftentimes, MSDs may be prevented by implementing simple and inexpensive changes in the workplace. As numerous case studies have concluded, an investment in an effective ergonomics program over time can result in a significant return, not only in its prevention of injuries and illnesses, but also in the advancement of the safety and health of employees.

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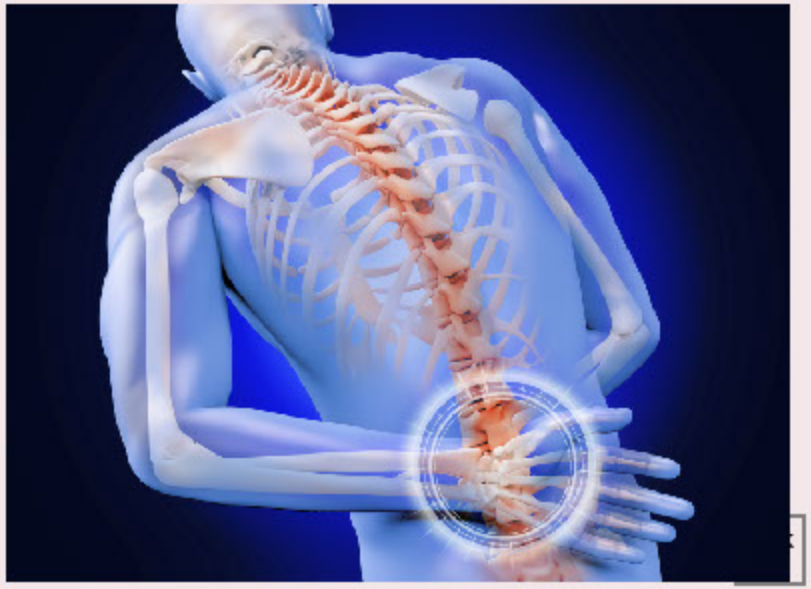
1.5 The Significant Impact of Ergonomics

Injuries resulting from musculoskeletal disorders present an ongoing challenge for both the employee and the employer. While OSHA has yet to publish a specific standard for ergonomics, employers have understood that compliance to the generally accepted principles set forth by the agency, as well as other organizations previously mentioned, does reap significant benefits for their company and its ongoing business goals. The benefits of an effective ergonomics program are far-reaching and may include the following:

- **Increase productivity** since a job designed to allow for good posture, less exertion, fewer motions, and better heights and reaches, becomes more efficient, making jobs easier and more comfortable for employees. OSHA, in its "Ergonomics Survey of General Industry Employers", found that 30% of those employers who had implemented ergonomics controls reported that their ergonomics programs had created measurable positive impacts on productivity.

- **Improve product quality** because fewer errors will be made when using automated processes that demand less physical effort. If the job task is taxing on the body, an employee may not necessarily perform the tasks as trained. Poor ergonomic designs lead to frustrated and fatigued employees who may not perform at an optimal level.



1.5 The Significant Impact of Ergonomics

- **Lower injury rates** as MSD injuries are minimized once risk factor controls are in place, combined with ongoing evaluation and management support.
- **Prevent other injuries** since employees who experience discomfort on the job may find shortcuts or workarounds that could result in other injuries.
- **Reduce absences** as employees are less likely to take time off to recover from muscle soreness, fatigue, and MSD-related problems. Lost time and transfers to jobs that put less stress on the employee result in lost productivity and efficiency due to training and retraining of replacements and new hires.
- **Reduce turnover** as new hires and current employees are more likely to be placed into a job designed with ergonomic principles in place to match their physical capacity.
- **Lower costs** over time as compensation and medical payments for injury and illnesses and replacement employee costs are reduced.
- **Reduce workers' compensation and health insurance costs** as ergonomic-related injuries tend to be long term with lengthy recovery periods, creating an ongoing drain on workers' compensation and medical costs.

1.5 The Significant Impact of Ergonomics

- **Increased employee comfort** since controls designed to reduce risks and exposure can result in improved methods and processes for them.
- **Reduce the rate of mistakes** and create less scrap considering employees working in awkward and uncomfortable postures or performing tasks that put them at risk for physical stress commonly make mistakes.
- **Identify waste** as an ergonomics task analysis assesses operations step-by-step with an intent to improve efficiencies in tandem with the performance of tasks in a safe manner.
- **Offset** the limitations of an aging workforce by making ergonomic adaptations for older employees to be as productive as those for younger ones. Many employers find that accommodations made for older employees, such as anti-fatigue mats and height-adjustable work surfaces, benefit employees of all ages.

1.5 The Significant Impact of Ergonomics

- **Reduce employee fatigue** which has been known to result in lost productivity given that it adds stress on the human body.
- **Improve employee engagement** because employees take notice when the company is putting forth their best efforts to ensure their health and safety. Investment in ergonomics shows employees that they are valued, resulting in higher job satisfaction that will lead them to be more productive and easier to manage.
- **Improve labor and employee relations** as redesigning the workplace using ergonomic principles provides an opportunity for collaboration in problem-solving that extends to other aspects of the work environment.
- **Improve the company safety culture** since applying ergonomic principles shows the employer's commitment to safety and health and the employee's value as an important resource. When a company invests in ergonomics, it demonstrates to employees their commitment to do their part to ensure, safe and healthy working conditions, such that the employees will be more inclined to do their part as well.

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1.5 The Significant Impact of Ergonomics

The new and important trend in ergonomics is a move away from a strict emphasis on reductions in musculoskeletal injuries and compliance with any regulatory requirements and toward the diverse business benefits that come from ergonomic changes. Once a company integrates ergonomics into their safety management systems and makes it an important component in the processes used to manage quality or continuous improvement, the result can be considered a potential success for the ongoing value of the business.

With this in mind, implementing a thorough ergonomics program can be considered a sound investment over time, not necessarily as an expenditure, given that human resources are typically the most valuable asset contributing to the financial well-being of the organization.

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2.0 The Identification of Ergonomic Risks Factors

Recognizing the many ergonomic risk factors in the workplace is an essential first step in being able to reduce or eliminate them with the proper controls, thereby preventing further injuries or illnesses. While this section is organized by employee, job, and work environment factors, it is important to note that more times than not, these factors interact with one another and ultimately create the opportunity for an MSD injury or illness to occur in the workplace.

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2.1 Inherent in the Employee

Employees come in all shapes and sizes, each with unique attributes that present certain ergonomic risk factors to a given job or workplace. To design for only the "average" person in one area may cause problems for everyone else who does not fit into that group. It is important to understand that each employee's ability to respond to external factors that exist at work is different and unique. Given that ergonomics is the science of the “fit” between the job demands and the employee capabilities, it is considered the solution to the problem of matching the variety of risk factors that employees bring to work to the conditions that exist in the job and in the workplace.

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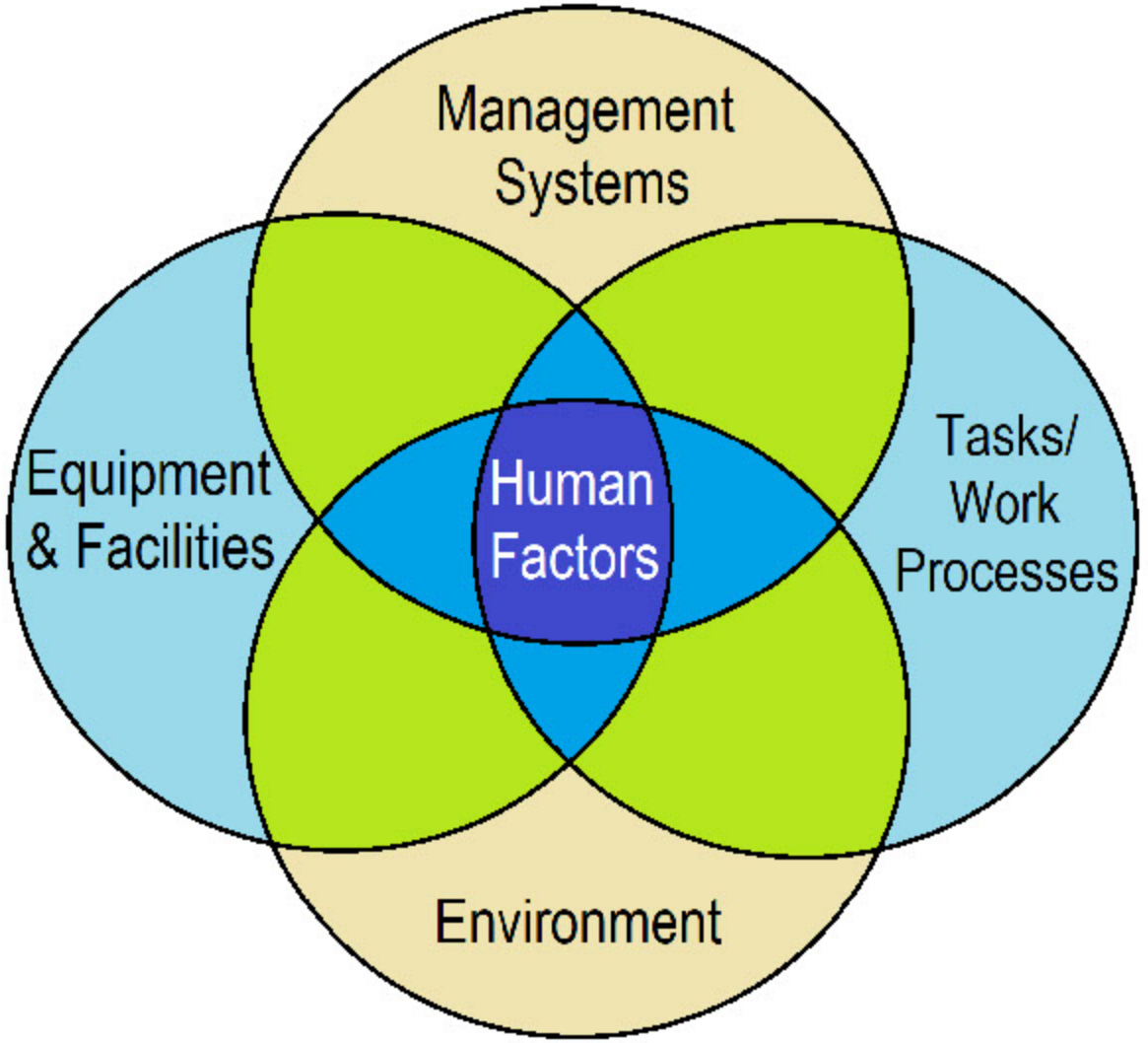
2.1.1 Human Factor Sciences

The study of “Human Factors” is concerned with the application of what we know about employees, their abilities, characteristics, and limitations to the design of job, equipment, and environments in which they function to promote safe, comfortable, and effective human performance. It is a multidisciplinary effort which generates and compiles information and research about human capabilities and limitations. The following is a review of these associated sciences accompanied by a detailed description of the human body system most closely aligned with ergonomics so that a foundation for the consistent application of important ergonomic principles can be established.



2.1.2 Human Anatomy and Physiology

The musculoskeletal system combines both the muscular and skeletal systems to allow for optimal body movements in employee performance on the job. Each of the system components work together to allow for the many human body parts that are utilized in work performance to function properly. When one of these system parts is stressed, an injury can occur that affects multiple areas. For example, if an employee incurs a sprain injury, the ligaments are stretched or torn that connect the bones together at a joint, thereby resulting in pain at the joint, while a strain injury stretches or tears a muscle or tendon that connects muscles to bones which will create pain at the bone.

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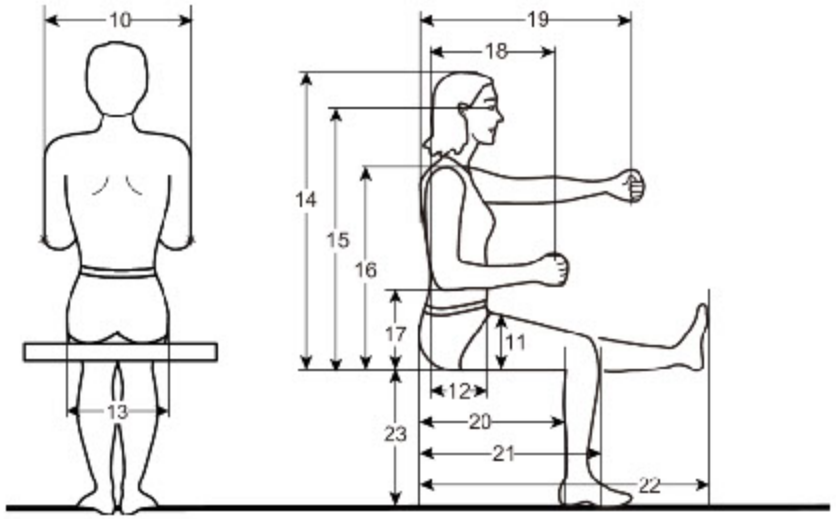
2.1.2 Human Anatomy and Physiology



WEIGHT lbs	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215
kgs	45.5	47.7	50.0	52.3	54.5	56.8	59.1	61.4	63.6	65.9	68.2	70.5	72.7	75.0	77.3	79.5	81.8	84.1	86.4	88.6	90.9	93.2	95.5	97.7
HEIGHT in/cm	Underweight					Healthy						Overweight					Obese						Extremely Obese	
5'0" - 152.4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
5'1" - 154.9	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	36	37	38	39	40
5'2" - 157.4	18	19	20	21	22	22	23	24	25	26	27	28	29	30	31	32	33	33	34	35	36	37	38	39
5'3" - 160.0	17	18	19	20	21	22	23	24	24	25	26	27	28	29	30	31	32	32	33	34	35	36	37	38
5'4" - 162.5	17	18	18	19	20	21	22	23	24	24	25	26	27	28	29	30	31	31	32	33	34	35	36	37
5'5" - 165.1	16	17	18	19	20	20	21	22	23	24	25	25	26	27	28	29	30	30	31	32	33	34	35	35
5'6" - 167.6	16	17	17	18	19	20	21	21	22	23	24	25	25	26	27	28	29	29	30	31	32	33	34	34
5'7" - 170.1	15	16	17	18	18	19	20	21	22	22	23	24	25	25	26	27	28	29	29	30	31	32	33	33
5'8" - 172.7	15	16	16	17	18	19	19	20	21	22	22	23	24	25	25	26	27	28	28	29	30	31	32	32
5'9" - 175.2	14	15	16	17	17	18	19	20	20	21	22	22	23	24	25	25	26	27	28	28	29	30	31	31
5'10" - 177.8	14	15	15	16	17	18	18	19	20	20	21	22	23	23	24	25	25	26	27	28	28	29	30	30
5'11" - 180.3	14	14	15	16	16	17	18	18	19	20	21	21	22	23	23	24	25	25	26	27	28	28	29	30
6'0" - 182.8	13	14	14	15	16	17	17	18	19	19	20	21	21	22	23	23	24	25	25	26	27	27	28	29
6'1" - 185.4	13	13	14	15	15	16	17	17	18	19	19	20	21	21	22	23	23	24	25	25	26	27	27	28
6'2" - 187.9	12	13	14	14	15	16	16	17	18	18	19	19	20	21	21	22	23	23	24	25	25	26	27	27
6'3" - 190.5	12	13	13	14	15	15	16	16	17	18	18	19	20	20	21	21	22	23	23	24	25	25	26	26
6'4" - 193.0	12	12	13	14	14	15	15	16	17	17	18	18	19	20	20	21	22	22	23	23	24	25	25	26

Kinesiology (Greek: study of movement) is the scientific study of the interrelationship between the principles of mechanics and anatomy to human movement. Adaptation through movement is a key principle relating to improved health and wellness and is a simple and established intervention for musculoskeletal conditions.

Anthropometry (Greek: human measurement) is the study of systematic measurement of the physical properties of the body, such as size, shape, weight, and physical range of mobility. Data about employee body dimensions is then used to design tools, equipment, and workstations for the promotion of optimal performance efficiency for individual employees. Measurements such as body mass index (BMI) have been identified in studies as potential risk factors for certain MSDs.

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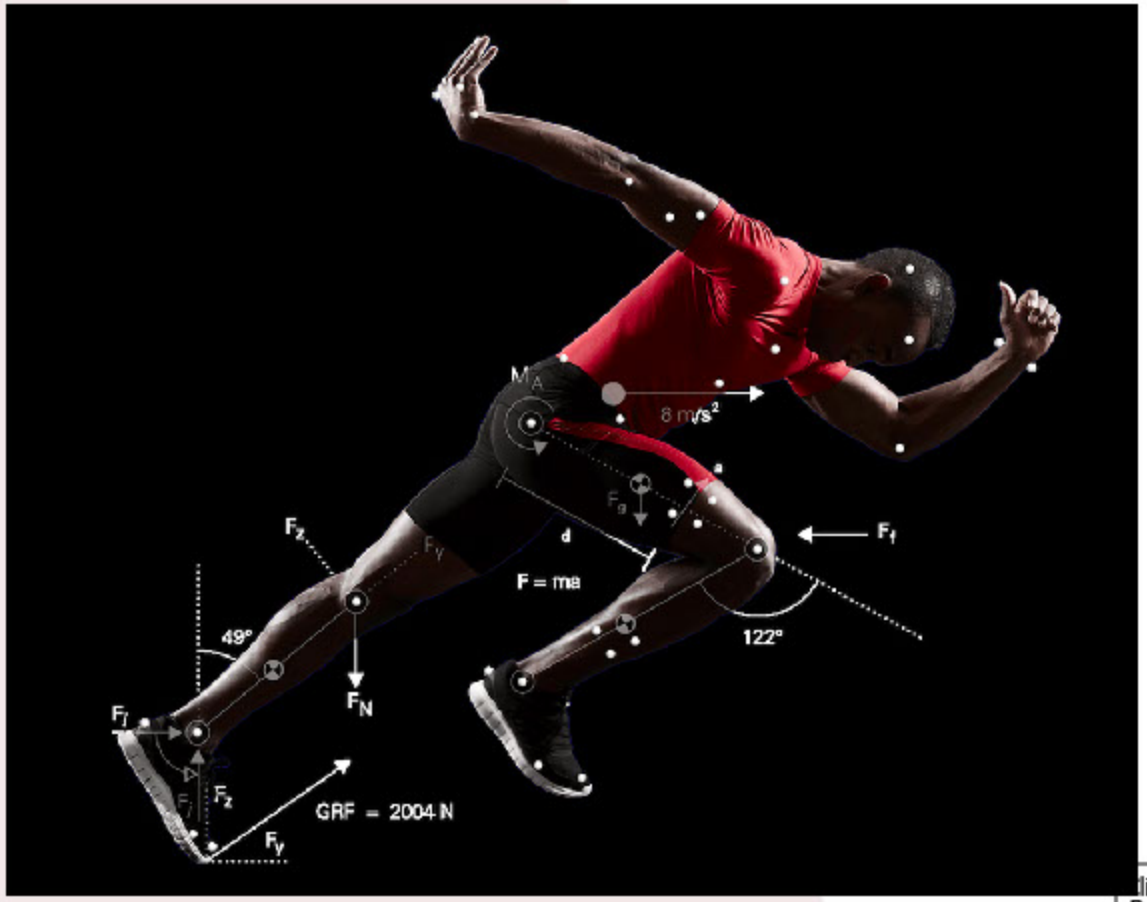
2.1.2 Human Anatomy and Physiology

Biometrics (Greek: life measurement) is the measurement and analysis of people's physical and behavioral characteristics. With regards to ergonomics, it measures the physical characteristics based upon a person's actions such as walking gait, gestures, and voice.

Biomechanics (Greek: life mechanics) is the study of the action of external and internal forces on the human body, especially on the skeletal system. The science is closely related to engineering, as it uses engineering concepts to study biological systems. MSDs are caused by a biomechanical load, the force applied to do tasks, the duration of the force applied, and the frequency with which tasks are performed.

Psychology (Greek: study of the soul) is the study of behavior and the mind. Stress is a key component in the study of ergonomics, as added stress can directly influence an employee's performance. Examples of psychological stress is that emotional stress that arises from poor design of a workstation, such as a display screen that makes it difficult to interpret information or as the stress of meeting quotas with piecework production.



2.2 Inherent in the Job

Risk factors are inherent in every workplace job and associated tasks. OSHA has referenced a large body of evidence supporting the finding that exposure to ergonomic risk factors inherent in the job itself causes or contributes to the risk of developing MSDs. While the types of jobs and their associated tasks are numerous and varied, this evidence, which includes thousands of epidemiological studies, laboratory studies, and extensive research, demonstrates that there are several ergonomic risk factors that are most likely to cause or contribute to MSDs common in most workplaces. It should be noted that combining these risk factors or prolonging the exposure to them will exponentially increase their effect on MSD injuries. Also, while some of the risk factors are easy to identify and to understand the reason that they may be likely to create hazardous exposures, others are not as apparent or observable.

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2.2.1 Contributing Risk Factors: Frequency/Repetition (How Often?)

Frequency is the rate by which a given exertion occurs or is repeated over a particular period of time. Jobs or tasks that involve repetition of the same body movement again and again are obvious, such as assembly line jobs where motions are repeated every few seconds. Repetitive motion jobs not only include performance of identical motions over and over, but also include repetitive multiple tasks where the motions of each task are very similar and involve the same muscles and tissues. Typically, a task cycle time of less than 30 seconds has been considered as "repetitive"; however, estimates vary on rates of repetition that may pose a hazard, since other factors such as force and posture may also affect this determination. When conducting ergonomic related audits, frequency and repetition are the most common reasons for citation by OSHA under the General Duty Clause.

There is much evidence to show a strong association between the occurrence of MSDs and jobs involving exposure to repetitive motions. The joints are most susceptible to repetitive motion injuries, especially the wrists, fingers, shoulders, and elbows. Repetitive work that is done with the foot or knees, such as climbing ladders or using a carpet kicker may also result in injury. While repetition alone is not an accurate predictor of injury, NIOSH studies conclude that high repetitiveness when combined with high external forces and extreme postures represents the highest risk for MSD injuries.

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2.2.2 Contributing Risk Factors: Duration (How Long?)

Duration is a measure of length of exposure time to an ergonomic risk factor. The assumption is that the longer the duration of exposure, the greater the risk of localized and general fatigue, thereby increasing the risk of injury. Furthermore, the longer the exposure to sustained work that fatigues the muscles, the longer the recovery period required for the employee. Duration may be measured in seconds, minutes, hours, days, weeks, months, and even years. As with most risk factors, duration should be considered in combination with other ergonomic risk factors, with repetitive motion factors being the most commonly combined and assessed.

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2.2.3 Contributing Risk Factors: Force and Exertion (How Much?)

Force and exertion are considered the amount of energy and/or effort the employee uses to perform each task. Performing forceful exertions requires an application of considerable contraction forces by the muscles, which causes them to fatigue rapidly. The more force that must be applied in the exertion, the more quickly the muscles will fatigue or become strained. Excessive or prolonged exposure to forceful exertions also leads to overuse of muscles and may result in muscle strain, soreness, and damage. Performing forceful exertions can also irritate tendons, joints, and discs, which leads to inflammation, fluid build-up, and constriction of blood vessels and nerves in the area. Increased compression of nerves from the pressure imposed by inflamed tendons or muscle contractions may create an opportunity for an MSD injury.

Many job or task forces can be viewed as the effect of an exertion on internal body tissues such as compression on a spinal disc from lifting, or the physical characteristics associated with an object external to the body such as the weight of a box. Other risk factors such as posture, velocity, repetition, and duration in conjunction with force, should be considered to accurately estimate the degree of risk for injury. For instance, the likelihood of injury from pushing a cart weighing 100 pounds would increase depending on the employee's posture as the cart is pushed, as well as the frequency by which the pushing occurs. Common locations of injury due to exerting excessive force are the neck/shoulder, foot/ankle, wrist/hand, and lower back.

2.2.3 Contributing Risk Factors: Force and Exertion (How Much?)

Contact Trauma

When any part of the body presses against an external object, the resulting sustained force may cause stress on tissues in the body. Repeated contact with hard objects such as tool handles may create pressure that eventually will inhibit blood flow or nerve function.

Grip

A grip is the conformity of the hand to an object accompanied by the application of exertion usually to manipulate an object. The manner in which an employee grasps a tool or piece of equipment can result in damage to the hand and wrist, with the exertion of force and the posture assumed contributing to a possible injury. Two basic grips are used when handling tools, equipment, or materials:

- ***The "Pinch Grip"*** depends on the fingers to exert the force and manipulate the object. This grip strategy requires much greater muscle strength, so it is more likely to cause an injury.
- ***The "Power Grip"*** where the object fits in the palm of the hand, uses the muscles of the entire hand to apply force and manipulate objects. Consequently, it's the most effective and safest grip to use.

2.2.3 Contributing Risk Factors: Force and Exertion (How Much?)

Static Exertion

This type of force is generally defined as the performance of a task from one postural position for an extended duration. Standing, sitting, or otherwise remaining in one posture for a long time can increase the likelihood of injury. Static exertion combines force, posture, and duration to create a condition that quickly fatigues the muscles. The greater the force, more awkward the posture, and longer the duration, the greater the risk for injury.

While sitting for extended periods of time has been shown to induce changes in the biological metabolism of the body, standing in one posture for a long time uses more muscles, thereby creating fatigue and an impact on the circulatory system, particularly in the legs. Ergonomists have recommended that for either of these static postures, a break in the release of exertion while retaining these postures is recommended.

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2.2.3 Contributing Risk Factors: Force and Exertion (How Much?)

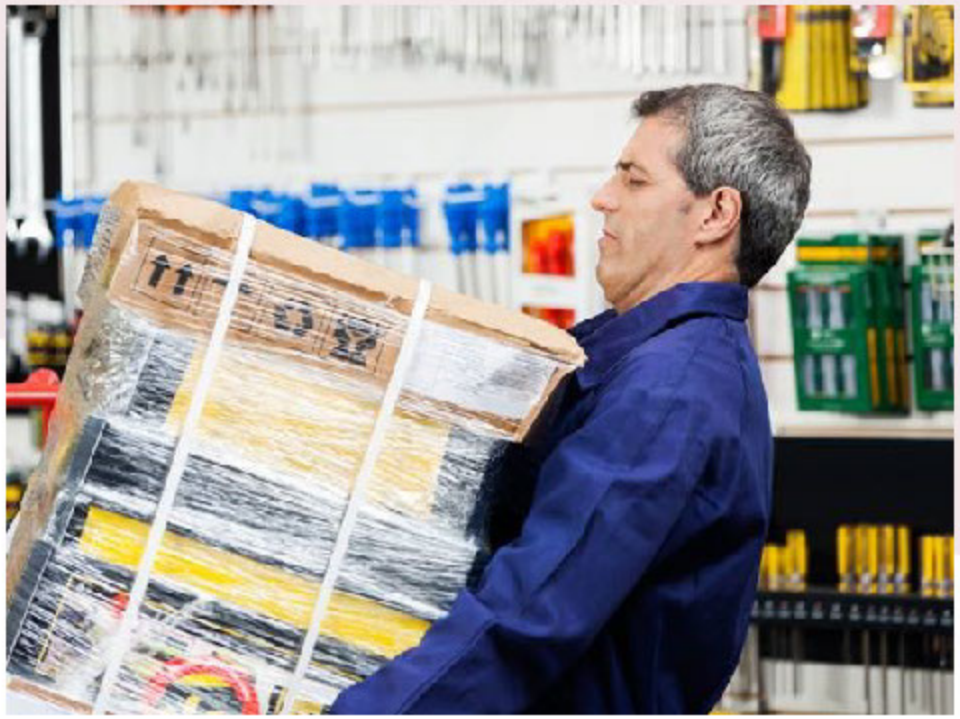
Examples of symptoms and possible ergonomic risks for this type of force are:

- ***Feet, or leg pain:*** Standing in one place too long
- ***Lower back pain:*** Torso curved forward while standing or sitting
- ***Wrist:*** Repetitive hand or finger motion
- ***Arm pain:*** Arms outstretched, sideways, forward, or upwards
- ***Shoulder pain:*** Shoulders forced up due to position of work
- ***Neck pain:*** Head inclined too much backwards or forward
- ***Forearm/wrist pain:*** Static grip too forceful

2.2.3 Contributing Risk Factors: Force and Exertion (How Much?)

Heavy Dynamic Exertion

Tasks requiring heavy physical exertion place a greater demand on the body's cardiovascular system. As physical activity increases, muscles demand more oxygen and metabolites. When muscle demand for metabolites is not met, physical fatigue occurs. When this happens in a specific area of the body, it is termed localized fatigue and is characterized by tired or sore muscles. When this happens to the body from long-term heavy carrying or lifting, it is termed whole body fatigue.



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2.2.3 Contributing Risk Factors: Force and Exertion (How Much?)

Gloves

Whenever gloves are worn, more grip force is required to perform a task. With the need for more force, increased risk of injury occurs. Gloves can make grasping an object or trying to accomplish intricate manipulations more difficult by changing the friction, decreasing dexterity, and interfering with sensory feedback. This often leads to using more muscle force than would be required without gloves. Additionally, gloves can fold, wrinkle, and bunch so that pressure points are created that result in contact stress. Gloves that fit properly or are less bulky may help to relieve these problems. Consideration of the employee's needs while performing a task is of utmost importance when gloves are purchased.

Bulky Clothes

Wearing bulky clothes, like heavy weather gear or protective clothing for removing hazardous waste, will increase the effort required by muscles to perform the task. Anytime the required force is increased to complete a task, such as shoveling materials while wearing heavy apparel, risk of injury also increases.

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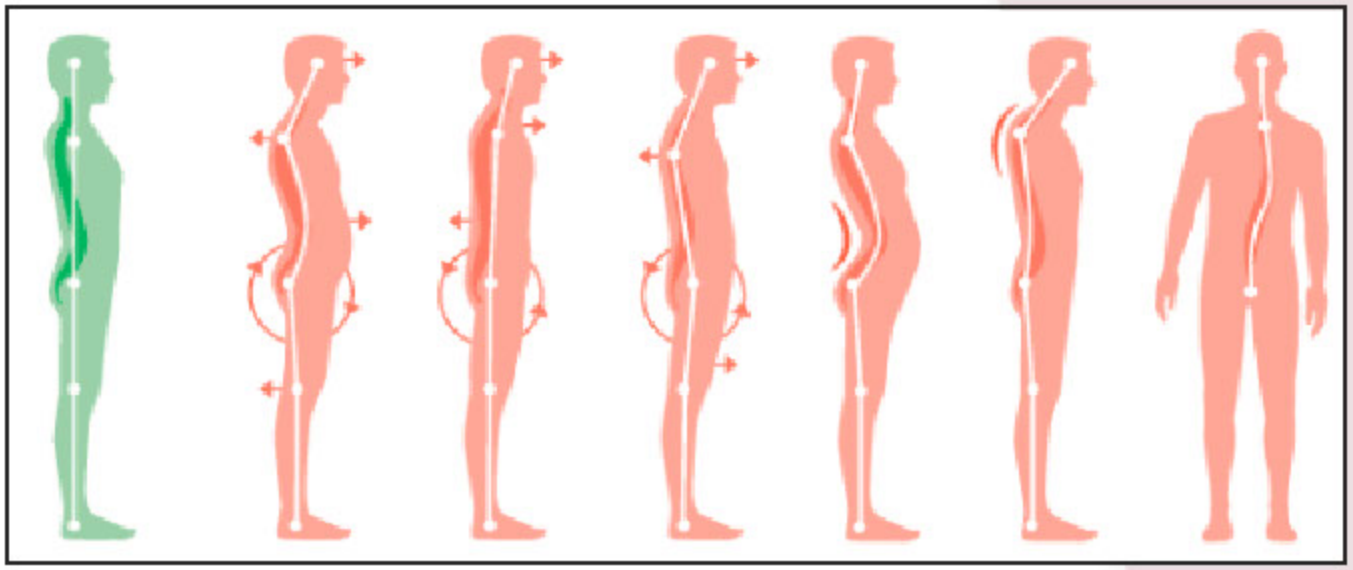
2.2.4 Contributing Risk Factors: Postures



A posture is the position of the body while performing work tasks. It is generally understood that the more a joint deviates from the neutral, or natural, position in such areas as the back, wrist, and arms, the greater the risk of injury. Neutral postures occur when the body is aligned and balanced, placing minimal stress on the muscles, tendons, nerves, and bones and keeping joints aligned naturally.

The opposite of a neutral posture is an “awkward posture.” Awkward postures move away from the neutral posture and toward the extremes in range of motion. This puts more force and stress on the musculoskeletal system, particularly on joints, thereby overloading the muscles and tendons around it. Joints are most efficient when they operate closest to the mid-range motion of a neutral posture. Risk of injury is increased when joints are worked outside of this mid-range repetitively or for sustained periods of time without adequate recovery time.

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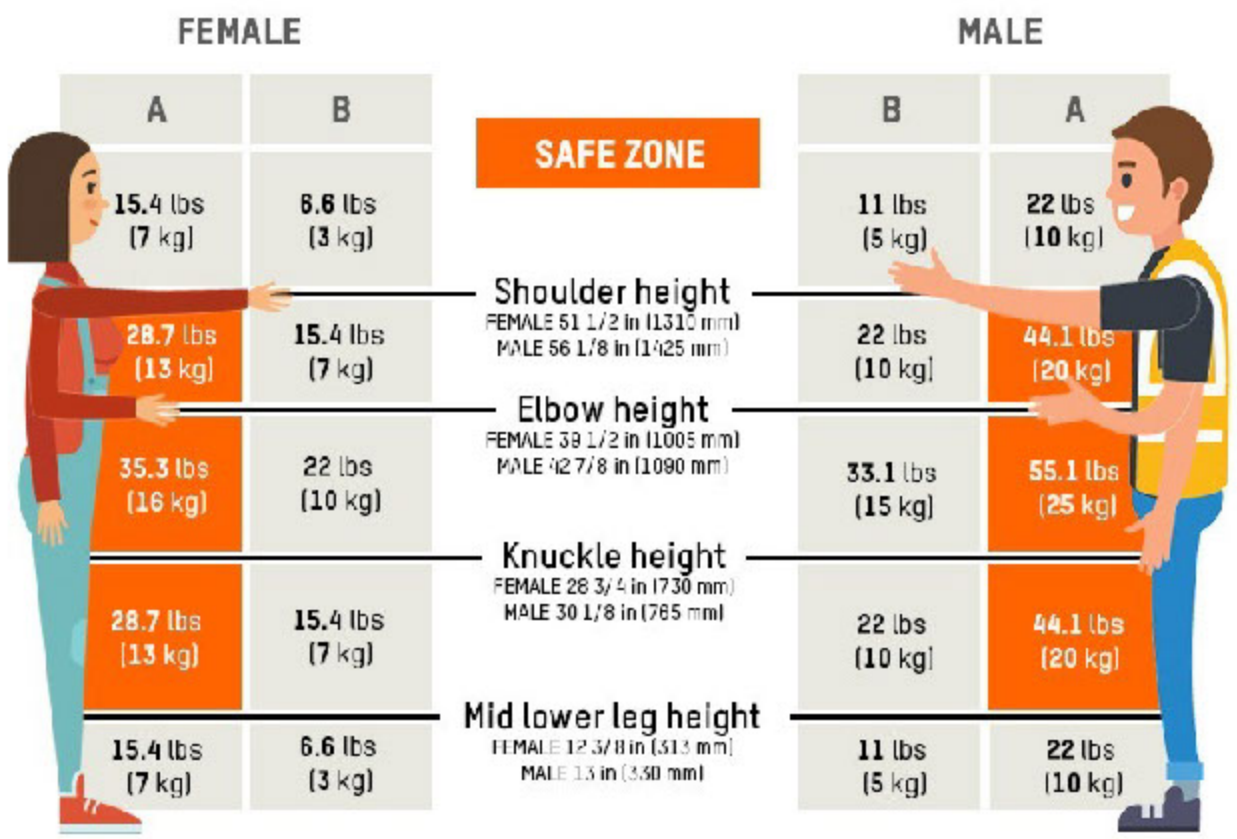
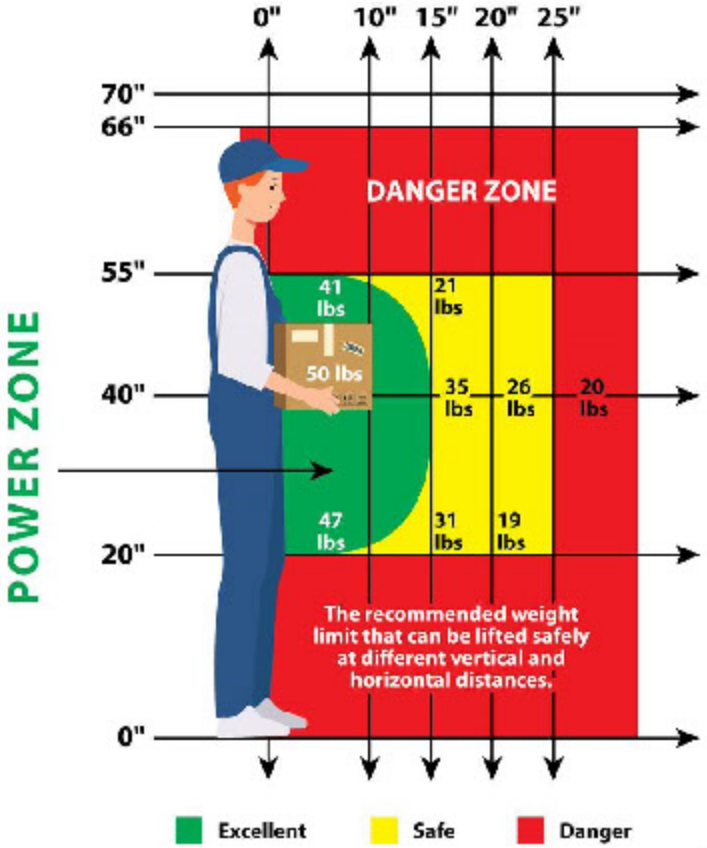
2.2.4 Contributing Risk Factors: Postures

Awkward posture issues generally result from work methods such as bending and twisting to pick up a box or tasks that require an extended reach to obtain material from an elevated location. This may also include postures that require working overhead with the arms. Specific postures such as those listed below have been associated with most MSD injuries:

- ***Wrist:*** bending up, down or sideways
- ***Shoulder:*** positioning the upper arm to the side or above shoulder level, rounding the shoulder
- ***Hands:*** positioning them at or above shoulder height
- ***Arms:*** prolonged extensions, over-reaching
- ***Neck:*** bending the neck forward and to the back, or side bending
- ***Low back:*** bending at the waist or twisting, prolonged standing, lack of back support when sitting, leaning forward
- ***Knees:*** locking when standing

2.2.4 Contributing Risk Factors: Postures





Special consideration should be given to a form of a neutral posture called the “power zone” for lifting as defined by OSHA. This zone is close to the body, between mid-thigh and mid-chest height such that the arms and back can lift the most with the least amount of effort. It is also referred to as the “handshake zone,” “comfort zone,” or the “baseball strike zone.” Using this zone when lifting heavy loads ensures that the employee works from proper heights and reaches, which reduces a variety of risk factors and allows for more efficient and pain-free work.

Click Box

2.2.4 Contributing Risk Factors: Postures

Velocity/Acceleration

Angular velocity is the *speed* of the employee's body part motion. Acceleration is the *rate of change* of the speed of that body part motion. Either one or the combination of both can contribute to an MSD injury. Consider, for example, an assembly line that alters the rate of production during any given period of time, with the speed of the tasks performed requiring a repetitive hand/wrist motion to move faster, then slower, increasing the risk of injury to both the hand and wrist. Other factors such as the weight of the object being moved may also increase risk.

Contact Stress

Contact stress results from continuous contact or rubbing between hard or sharp objects and surfaces against sensitive body tissue, such as the soft tissue of the fingers, palms, thighs, and feet. This contact creates localized pressure, which can inhibit blood, nerve function, or the movement of tendons and muscles. Examples of contact stress include resting wrists on the sharp edge of a workstation while performing tasks, pressing tool handles into the palms, hand hammering, and sitting without adequate space for the knees.

Click Box

2.2.4 Contributing Risk Factors: Postures

Vibration

Regular and frequent exposure to vibration can lead to permanent adverse health effects, which are most likely to occur when contact with a vibrating tool or work process is aregular and significant part of an employee's job.

Hand-arm or segmental vibration can cause a range of conditions collectively known as hand-arm vibration syndrome (HAVS), as well as specific diseases such as Raynaud's syndrome, carpel tunnel syndrome and tendinitis. Vibration has adverse circulatory and neural effects in the fingers and can also interfere with sensory receptor feedback leading to increased hand grip force to hold a tool. The signs and symptoms include numbness and pain in the affected areas.

Whole body vibration occurs with the exposure of the whole body to a vibration, such as the vibration that occurs through the feet and buttocks while driving a construction or heavy equipment vehicle. Back pain resulting in an MSD over time can be an effect of this type of exposure, with prolonged exposure to these vibration forces in high frequency ranges may create chronic stresses and sometimes even permanent damage to the affected body parts.

2.2.4 Contributing Risk Factors: Postures

Recovery Time

Recovery time is the measure of complete rest, performance of lower stress activity, or performance of an activity that allows a strained body area to rest. Recovery time is very important in preventing muscle fatigue as oxygen and other bodily functions can rejuvenate while waste materials are removed from the muscles. The recovery time needed to reduce the risk of injury increases as the duration of risk factor increases.

Jobs that do not provide short pauses or breaks between motions or task cycles are often a problem because there may not be adequate time for muscles to recover from the effects of the exertion before the motion must be repeated. If there are no pauses between motions or the pauses are too short, the muscles cannot recover to the rested condition. Thus, the effects of the forces on the muscles accumulates and the muscles become fatigued and strained. The lack of adequate recovery time often occurs in jobs involving highly repetitive tasks. This happens when task cycle lengths are very short, which also means that the job involves a high number of cycle repetitions per minute.

The longer motions or job tasks are performed, the less likely that there will be adequate recovery time. The accumulation of exposure leads to muscle fatigue or overuse. In addition, where the intensity of exposure is greater in repetitive motion jobs that involve exposure to additional risk factors such as an awkward posture, the increased forces required for the exertion also increase the amount of required recovery time.

Click Box

2.2.5 Common Workplace Tasks with Multiple Risk Factors

As noted in several research NIOSH publications, manual material handling (MMH) tasks contribute to a large percentage of the over half a million cases of work-related musculoskeletal disorder injuries reported annually in the U.S. These injuries most often involve strains and sprains to the lower back, shoulders, and upper limbs due to activities that include lifting and lowering, pushing, and pulling, and carrying materials. Exposure to job risk factors such as force, repetition and awkward postures in the job only contribute to the rate by which these injuries occur, as well as their severity. Obviously, jobs that present multiple contributing risk factors will result in a higher probability for an MSD injury to occur.

Inherent in these tasks are specific hazards, most of which can be addressed with effective control measures. In the Ergonomic Guidelines for Manual Material Handling, NIOSH depicts a variety of tasks associated with the handling of materials by employees and the recommended controls, either engineering or administrative, that can be adopted to prevent the occurrence of MSD injuries in the workplace. Many of these types of controls are depicted in the course section entitled, “Risk Factor Control for Injury Prevention” as well.

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2.2.5 Common Workplace Tasks with Multiple Risk Factors

Manual Lifting

The most common manual material handling task relative to the use of force is manual lifting. Manual lifting is typically the root cause for the development of many MSD injuries occurring in most any joint or tissue, with the costliest and possibly the most prevalent being back injuries. Low back pain is one of the most common reasons that people miss work, second only to the common cold. It has been estimated that over $100 billion dollars is spent in medical bills, disability payments and lost productivity from back injuries and illnesses a year.

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2.2.5 Common Workplace Tasks with Multiple Risk Factors

Each time an employee lifts an object, a lever action occurs that amplifies the compressive forces on the back and other body parts. Lifting heavy objects can result in injury to both muscles and connective tissues, such as tendonitis, and pulled or strained muscles. This task can also place significant stress on the spine beyond the level that the muscles can bear. If this occurs, pinched nerves, herniated disks and other spinal injuries can occur. When a heavy object is lifted, the abdominal cavity can be affected, as heavy weight can rupture or tear the tendons, resulting in a hernia. Lastly, heavy lifting can increase the heart rate, inducing exhaustion and fatigue, which may affect proper performance of the task and increase the opportunity for injury.

Three primary variables are considered when evaluating manual lifting tasks to determine how heavy a load can be safely and properly lifted by employees in the workplace: the horizontal distance from the load to the employee, the vertical distance through which the load is handled, and the frequency with which the load is handled. Other contributing variables include such things as floor traction, the need for twisting, size of load, and the ability to grip. NIOSH developed a scientific approach to evaluating a lifting task considering these primary variables, the result being a lifting formula that assists ergonomic practitioners in the determination of proper lifting loads. The tool is utilized extensively by safety professionals to assess the manual material handling risks associated with lifting and lowering tasks in the workplace.

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2.3 Inherent in the Environment

For most workplaces, there are several risk factors that can be identified that have a direct correlation to the rate of MSD injuries and illnesses.

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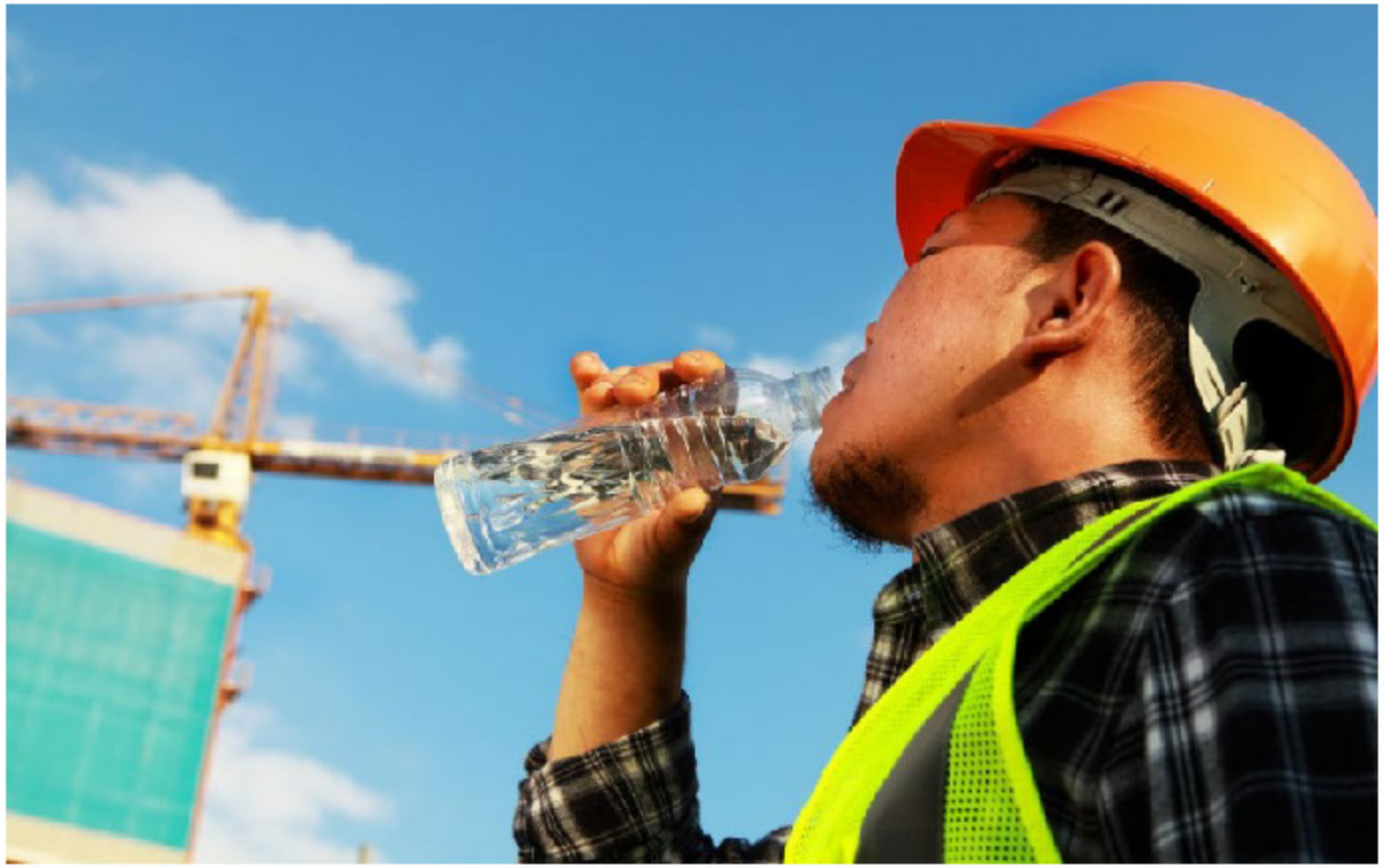
2.3.1 Heat



Externally generated heat in the workplace can cause excessive heat stress on the body, which can result in heat stroke, heat exhaustion, heat cramps, dehydration, and an electrolyte imbalance as the heart rate increases to cool the body down creating a loss of physical and/or mental work capacity. These conditions are made even more dangerous in the presence of high humidity as the body works harder to maintain the proper temperature. High temperature conditions may be brought on by summer or tropical heat, heat from engines or equipment, heat from chemical processes and reactions, as well as welding and friction.

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2.3.2 Cold

Work environments with low temperature conditions may be caused by winter cold weather, high altitudes, refrigerated surfaces and/or cryogenic lines and equipment. An environment in which the employee experiences cold temperatures can create stress symptoms such as body shivering, clouded consciousness, pain in the extremities, dilated pupils, and reduced grip strength and coordination. If the employee is exposed to an environment so cold that the body cannot maintain adequate deep core temperature, hypothermia may result which can be life-threatening.

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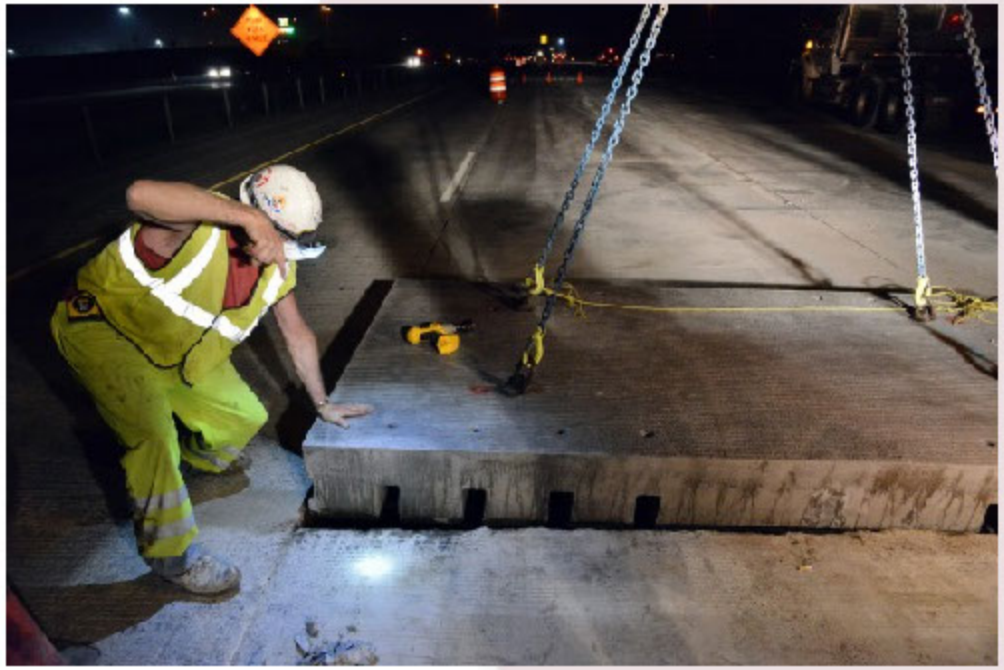
2.3.3 Lighting



For one employee, lighting for one workstation may be appropriate, whereas that same lighting may be potentially harmful to another. Poor lighting is a common problem in the workplace that can affect an employee's comfort level and performance. Too much or too little light can make work difficult, as dimly lit work areas and glare can cause eye fatigue and headaches and improperly lit areas place employees at greater risk for all types of injuries.

Adequate general and local lighting should be provided for rooms, buildings, and work areas during the time of use. Outside lighting is an important factor to consider as it should aid production and, at the same time, be at a level to ensure safety and security.

Click Box

2.3.4 Noise

Noise is any sound that is unwanted. In the industrial setting, it may be present in various forms such as the clatter of a pneumatic wrench or the whirl of an electric motor. It can be so powerful as to cause pain in the ears, or it may represent only a nuisance to an employee. Its pitch may be quite high or very low; its duration, continuous or intermittent; and its onset, sudden or gradual.

Headaches, increased blood pressure, muscle tension, and irritability are examples of the effects of noise for employees. Nuisance noise may interfere with an employee's ability to focus or concentrate on the work at hand, and therefore may be an indirect cause of an injury given the distraction. Prolonged exposure may lead to serious temporary or permanent deafness, tinnitus (ringing in the ears), and other hearing disorders. As with most other risk factors inherent in the environment, the louder the noise and the longer the duration, the greater the risk of injury.

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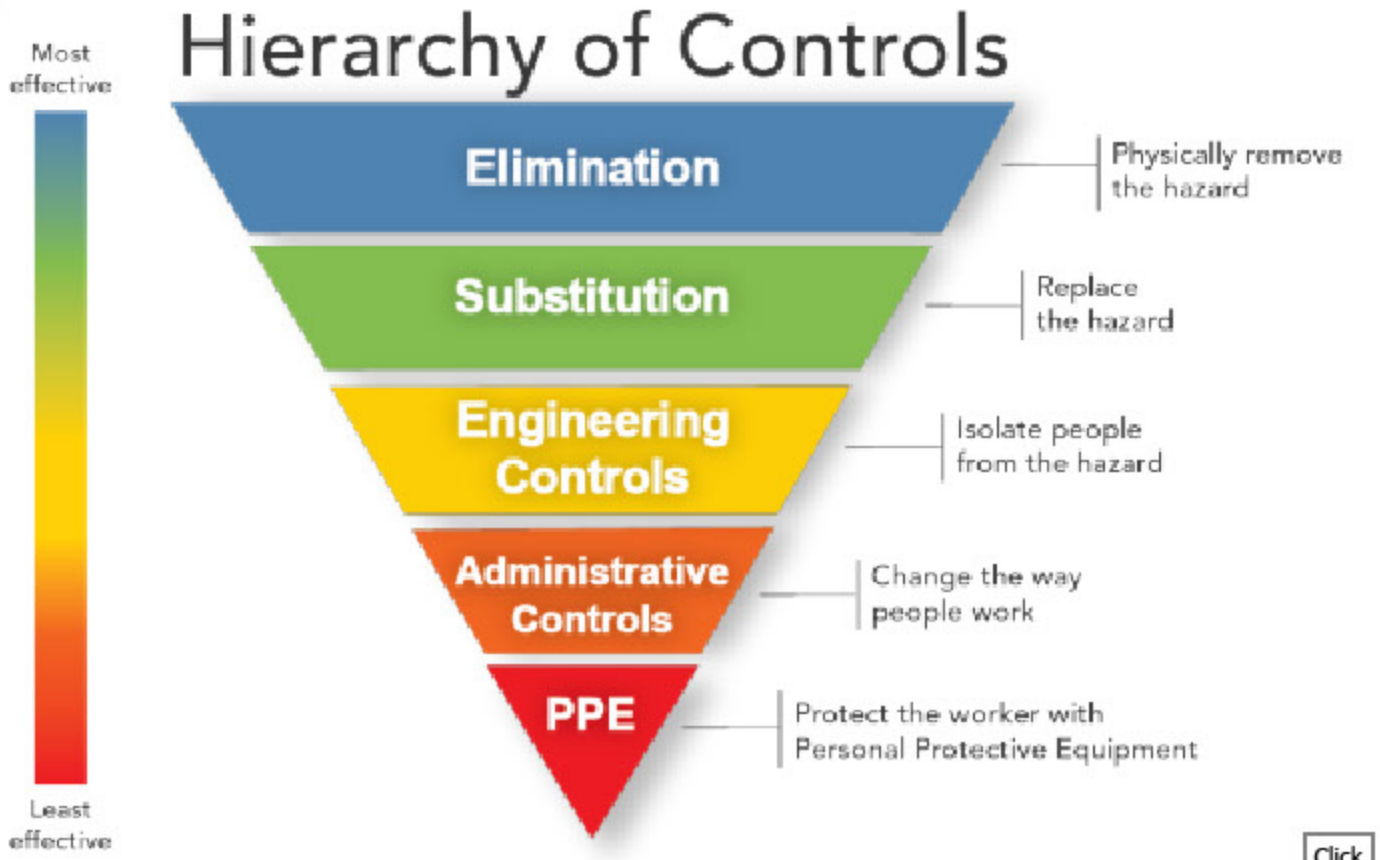
2.3.5 Psychosocial

The term psychosocial refers to the interrelation of social factors in the work environment and an employee's thought or behavior. A healthy ergonomic work environment depends a great deal on the general approach that employees may have to their role in the workplace. The manner in which the employer handles or responds to problems or concerns relating to ergonomics may determine the development and the severity of many problems in the workplace. To create a healthy work environment, everyone should understand his or her role in the overall work processes. That means end users should participate in the selection of their equipment and tools and that employers should provide the appropriate training on the tasks, risk factors and control measures for which employees are responsible.

Click Box

3.0 Risk Factor Control for Injury Prevention

Analyzing jobs to identify factors associated with risks for MSDs lays the groundwork for developing ways to reduce or eliminate ergonomic risk factors. A sound scientific evaluation of the workplace is imperative to evaluating the workplace to identify the tasks, controls, and equipment to fit the employee's individual capabilities and limitations. A good match, meaning that the job demands pose no undue stress and strain to the employee performing the job, helps to ensure safe work performance. A "hierarchy of controls" is widely accepted as an intervention strategy for controlling ergonomic workplace hazards:



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3.1 Engineering Controls

The most effective way to control ergonomic hazards to protect employees in the workplace is to eliminate or remove the risk factors altogether. Engineering controls are physical changes to a job that eliminate or materially reduce the presence of MSD hazards. These controls are preferred over all others since they usually require permanent changes that may eliminate hazards at their source.

As engineering controls are assessed, consideration should be given to the combination of all the ergonomic risk factors identified as inherent in the employee, the job, and the environment, since oftentimes they occur in combination with one another to create hazards that need to be addressed. The preferred approach to prevent and control MSD injuries in the workplace is to properly design the job and associated tasks with consideration to the layout of the workstation, the selection and use of tools and the work methods that acknowledge employee capabilities and limitations.

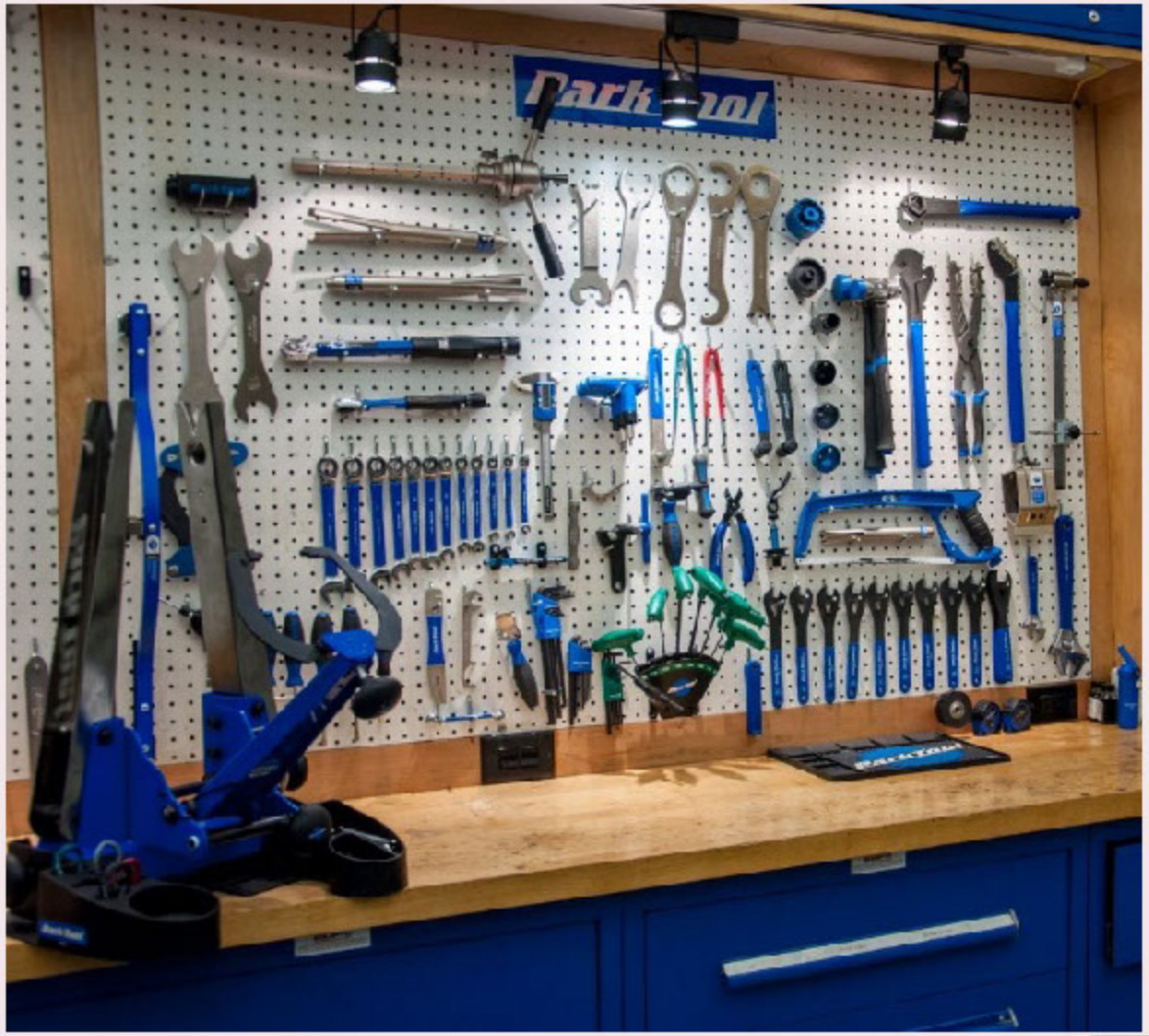
Click Box

3.1 Engineering Controls

Given that each job and associated tasks in the workplace may pose a variety of ergonomic risks, the following generic examples of effective strategies for job design changes using engineering controls are provided:

Change the workstation layout to address employee risk factors

- Use height-adjustable workbenches and seating options to adequately support the back, legs, and feet.
- Provide for a full range of motion with adequate leg room, as well as a variety of working positions, to avoid static postures.
- Provide floor surfaces designed to prevent slipping and provide adequate traction and comfort.
- Locate tools and materials within a short reaching distance.
- Allow for adequate space for convenient access to all necessary tools and equipment.



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3.1 Engineering Controls

Modify the way materials, parts, and products are transported

- Utilize powered equipment such as stackers, forklifts, lifters, and cranes as assist devices to relieve heavy load lifting and carrying tasks.
- Utilize alternatives to manual handling such as conveyor, slides, airball tables or chutes.
- Consider using handles or slotted hand holes in packages that require material handling.
- Consider the use of non-powered equipment such as a drum dolly, hand cart, platform cart, or portable scissor lift.

3.1 Engineering Controls

Change the process or product to reduce exposures to risk factors

- Isolate equipment or operations that produce loud or distracting noise.
- Reduce the weight of a load to limit force exertion.
- Isolate employees from excessive heat by providing adequate cooling and ventilation.
- Require the use of portable hoists, powered hand trucks, forklifts, or cranes as a standard part of the production process.
- Adjust lights to avoid creating glare and the resulting eye strain.

Click Box

3.1 Engineering Controls

Modify presentation of containers and parts

- Install height adjustable shelving and/or surfaces.
- Provide angled bins or tilt bins or containers to improve material handling.
- Organize storage areas such that heavy items are stored between knee and shoulder height.
- Provide height to the employee such as a step stool or catwalks to that items such that it can be grasped by the employee in the neutral posture or power zone.
- Remove or lower the sides of a receptacle for easier access by the employee.

Click Box

3.1 Engineering Controls

Change the way parts, tools, and materials are manipulated

- Use fixtures like clamps and vice grips to hold work pieces to relieve the need for awkward hand and arm positions.
- Use a device to lift and reposition heavy objects such as scissor lifts or pneumatic lifters to limit force exertion.
- Add extra handles to containers for better grip and control.
- Add padding to a container handle for comfort to minimize stress.
- Suspend tools to reduce their weight and allow for easier access.
- Provide carts for transporting material.
- Use a turntable to rotate containers or other objects closer to the employee.

3.1 Engineering Controls

Redesign tools

- Use tools that fit the hand, with consideration to those who have small hands or may be left-handed.
- Select tools that allow the wrist to be held straight and that minimize twisting of the arm and wrist, enabling a neutral posture.
- Avoid tools that place excessive pressure on any one area of the hand.
- Select tools that allow the employee to utilize a power grip.
- Select tools that dampen vibrations when possible.

Click Box

3.1 Engineering Controls

Change materials and fasteners

- Utilize lighter-weight packaging materials to reduce lifting loads.
- Consider the automation of installation of fasteners to minimize hi-risk dexterity hazards.

Change assembly access and sequence

- Remove physical and visual obstructions when assembling components to reduce awkward postures or static exertions.
- Install diverters on conveyors to direct materials toward the employee to eliminate excessive leaning or reaching.

- Install chutes, conveyors, or slides when possible to minimize lifting hazards.

Click Box

3.2 Administrative Controls

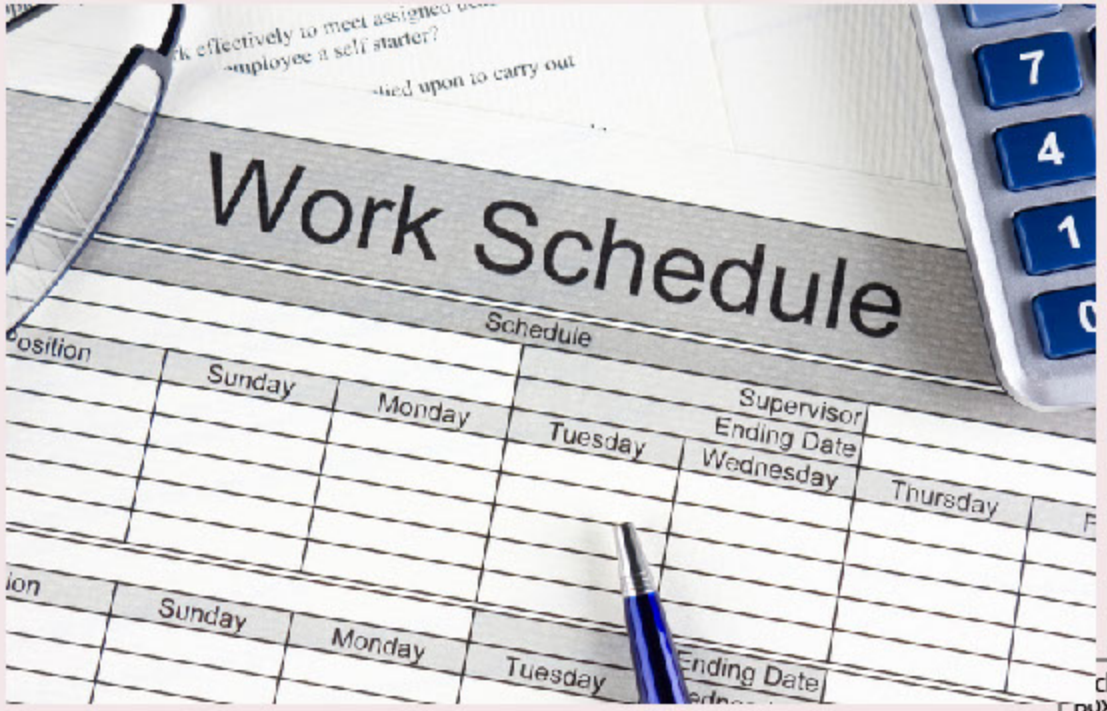
Work practice controls change the way employees perform their jobs while administrative controls address how the work is structured. Both are closely related attempts to change employee behaviors and are management-driven initiatives to reduce or prevent exposures to ergonomic risk factors. Although engineering controls are preferred, these controls can be effective as temporary measures until engineering controls can be implemented or when engineering controls are not technically feasible. Since these controls do not necessarily eliminate hazards, the employer must ensure that once these policies and practices are adopted that they are properly enforced.

Click Box

3.2 Administrative Controls

Work practice and administrative control strategies for reducing the risk of MSDs include:

- Utilizing automated processes whenever feasible to minimize employee interaction with a risk factor.
- Establishing reasonable production goals with the appropriate work rates that consider employee capabilities.
- Providing the appropriate incentive program for piecework so as not to create undue stress.
- Changing work schedules to minimize excessive overtime or lengthy shift work which may cause fatigue and muscle strain.
- Rotating employees through several different tasks to rest the various muscle groups of the body, reduce repetition, and ease mental demands.
- Scheduling additional breaks since adequate recovery time can reduce fatigue.
- Encouraging proper body mechanics and the use of safe lifting techniques through ongoing instruction and evaluation.



3.2 Administrative Controls

- Training in the recognition of risk factors and in the techniques for reducing the stress and strain while performing their job or tasks.
- Instruction in the appropriate work practices that can ease the task demands or burden whenever possible.
- Maintaining power tools properly to reduce vibration and their improper use.
- Following good housekeeping practices, keeping work areas free of hazards.
- Requiring the use of personal protective equipment when tasks are performed.

3.3 Personal Protective Equipment

Personal protective equipment (PPE) provides a barrier between the employee and the source of the hazard to protect against workplace hazards. It is the least effective control measure since its use acknowledges that all other types of controls have failed and that an employee needs some type of barrier to prevent them from being exposed to the hazard. Therefore, while more permanent controls are put in place or if the job cannot be designed differently to eliminate risks, personal protective equipment can and should be used. While equipment such as safety goggles, safety shoes, and hard hats are all standard examples of PPE, there are other types of PPE that can help to address ergonomic problems:

- ***Knee pads*** for kneeling tasks to reduce fatigue
- ***Ear plugs*** to eliminate the effect of noise on the musculoskeletal system
- ***Shoulder pads*** to cushion loads carried on the shoulder
- ***Clothing*** to reduce the risk of heat stress and exhaustion
- ***Gloves*** to protect against cold, vibration, or rough surfaces

Click Box

3.3 Personal Protective Equipment

Whether braces, wrist splints, back belts, and/or similar devices are regarded as offering personal protection against ergonomic hazards remains open to question. Although these devices may, in some situations, reduce the duration, frequency, or intensity of exposure, evidence of their effectiveness in injury reduction is inconclusive. In some instances, they may decrease one exposure but increase another because the employee may be required to "fight" the device to perform the job or tasks. An example of this is an employee's use of wrist splints while performing a task that requires wrist bending.

Of particular concern, are back belts (sometimes referred to as braces). Once very popular in the late '90s, research seems to indicate that the negative outweighs the positive concerning their use. Some studies show that the benefits of back belts include less stress and pressure on the spine during forceful exertions of the back, helping to maintain better posture while bending and lifting, and increased spinal support by stiffening the spine. However, much science indicate that the braces actually elicit a false sense of security, and accordingly, individuals tend to lift heavier loads than they would without the belt. By doing this, the possibility of new pains and injuries (in the mid-back, hips, legs and knees) may occur. Further, by use of belts, the muscles of the back weaken and, in turn, cause fatigue more quickly and wearers resort to bad posture. The end result is the spine becomes more prone to injury than if the belt had not been used. NASP is of the opinion that back belts are not a good option.

4.0 Effective Ergonomics Program

While a thorough understanding of key ergonomics principles and practices is important, their application in the workplace is the key to the reduction of MSD injuries and illnesses. Although there are several excellent resources for reference relative to the components that should be included in an effective ergonomics program, the basic standard elements remain constant. These important elements provide a strong foundation to build a program and to allow for it to be sustainable into the future.

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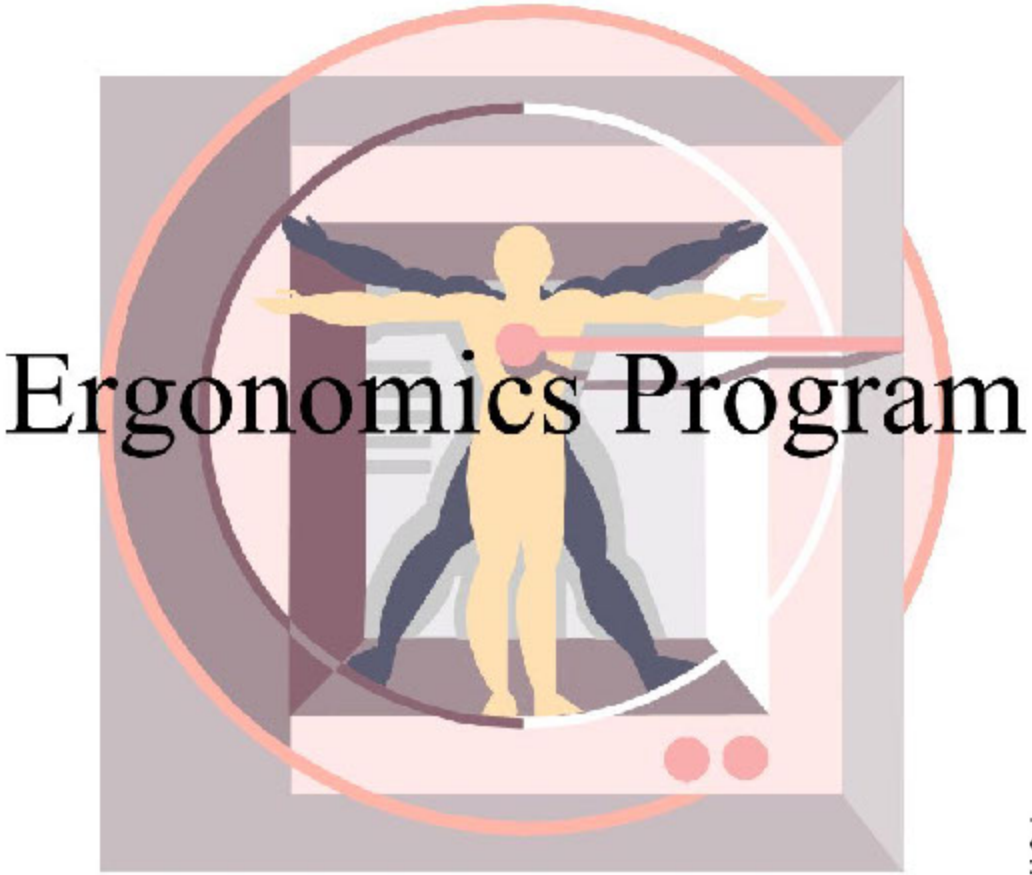

4.2 Workplace Analysis

Once a determination has been made to implement an ergonomics program, a critical first step in the process is to gather information about the workplace to determine the scope and characteristics of any problems or potential problems that may exist. This workplace analysis includes a collection and examination of MSD indicators to identify existing ergonomic hazards, conditions, and operations that create hazards, as well as areas where hazards may develop based upon patterns that are observed. A variety of techniques, tools and informational resources exist to provide the basis for developing solutions to identified existing and/or potential hazards in this step.

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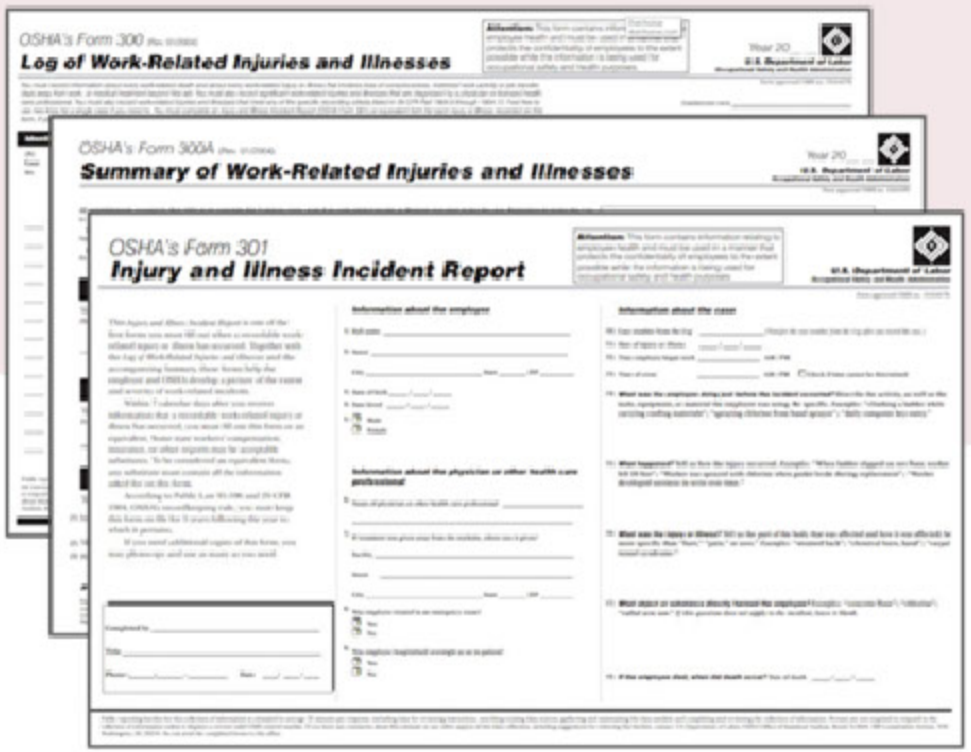
4.2.1 OSHA Logs

OSHA 300 Logs are valuable tools for employers to use in evaluating the types, frequency and severity of workplace injuries and illnesses. A review of this information includes the scrutiny and tracking of injury and illness records to identify patterns of traumas or strains that may indicate the development of MSDs. This information, in turn, can then be used to identify the location and nature of workplace hazards that should be eliminated or controlled. The data may reveal any apparent trends relating to specific departments, process units, job titles, operations, or workstations. Discovering employees in certain departments or operations experiencing more of these problems than others would suggest some immediate areas for study regarding possible risk factors.



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4.2.1 OSHA Logs

OSHA 300 Logs, however, do not provide a complete and accurate accounting of all the injuries and illnesses experienced in a workplace. Not all injuries and illnesses are required to be recorded, such as:

- An incident that results in first aid treatment
- An MSD that may not be acknowledged as work-related
- Early signs of MSDs reported or unreported
- “Near miss” incidents in which an employee may have been fatigued or in pain
- Work-related stress

Oftentimes, OSHA records contain nonspecific entries like "hand pain," which may be an indicator of a significant health problem associated with an MSD, for which further research might need to be conducted with other informational resources. This further demonstrates that while the OSHA 300 log may yield a great deal of data for a workplace analysis, it will be important to collect data from other resources in order to conduct a thorough analysis.

Click Box

4.2.2 Medical Exams

Since OSHA logs do not necessarily identify possible cases of MSDs, given their lack of specific or uniform medical information, their use may be limited in identifying existing or potential MSDs. A review of any periodic medical exams that have been conducted may overcome this limitation, especially for employees in high-risk jobs. Such exams typically include a history and a physical examination, with an assessment for range of motion, limb bending and stretching that includes an employee rating of the pain experienced by the maneuver. Obviously, such an approach is administered by a healthcare provider to ensure objectivity and health information confidentiality.

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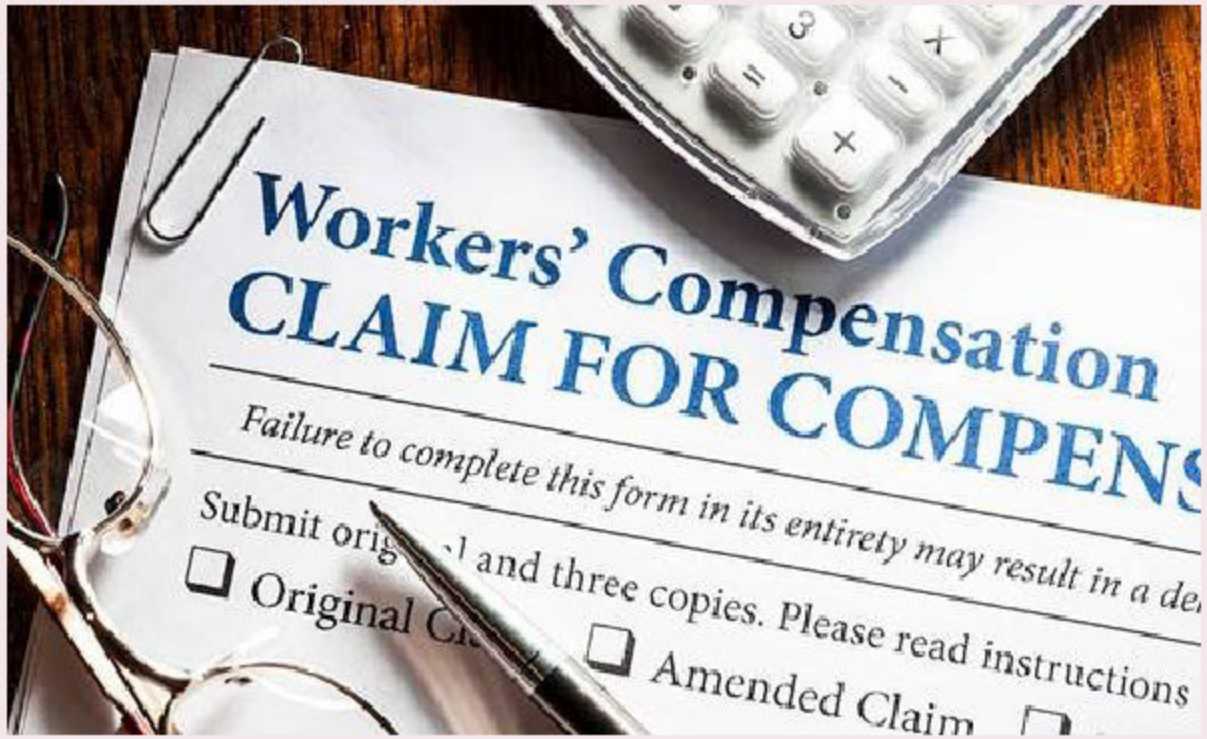
4.2.3 Insurance Records

Inspecting and analyzing workers' compensation claims and trends may yield information critical to the identification of the workplace hazards, since the injuries and illnesses captured in such records are well documented. Additionally, should the company have access to health insurance claim records, or at least be provided with general summaries of the types of chronic illnesses and disorders that have resulted in treatment under the plan, this data may also help to support in the gathering of information. Daily visit logs maintained at the medical clinic onsite may also reveal trends as employees visiting the clinic may make frequent references to physical aches and pains related to certain types of work assignments for which can be documented. Finally, there are numerous measurements utilized in company wellness programs that may reveal trends in the employee population such as BMI assessments.



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4.2.4 Employee Complaints and Reports

Certain jobs or work conditions may cause employee complaints of undue strain, localized fatigue, discomfort, or pain that does not go away after overnight rest. Assuring that employees feel free to report, as early as possible, any symptoms of physical stress is a key component of any ergonomics program. Additionally, a reliable communication system for employees should be in place to notify management or their representatives about conditions that appear to be ergonomic hazards in their workplace.

Click Box

4.2.5 Symptom Surveys

Symptom surveys can offer a means for detecting problems and identifying possible MSDs that might otherwise go unnoticed. A review of such surveys may reveal critical information for the workplace analysis. In this type of survey, employees are requested to complete a survey administered by the company that typically includes questions about the type, onset, and duration of any health symptoms that are believed to be associated with their performance of the job. Some surveys including a map of the human body whereby the employee is asked to locate and rate the level of discomfort experienced in different areas of his or her body. The intent is to uncover any discomfort or symptoms may be associated with an increased risk for MSDs.

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4.2.6 Industry Research and Trends

There are many other informational resources that could alert employers to potential problems. Company trade publications may reveal information relative to trends in the industry sector that have been observed relative to hazards associated with job design, equipment, or materials. Company insurance carriers typically create newsletters or other informational updates on trends that are observed with the clients that they represent. Information gathered from customers who have purchased equipment or tools from the same vendor as the company may also be an informational resource regarding hazards that have been observed. Lastly, information that is learned from competitors who provide similar products and services may be of value when it comes to identifying and controlling hazards.

Click Box

4.3 Identification and Documentation of Risk Factors

Once the MSD indicators are compiled and collected in the previous step, the data to be analyzed includes information that exists on file as either an injury or symptom that has already been documented, or activities that have already occurred. Health records or medical records may indicate the nature and extent of an existing MSD in the workplace. However, efforts now need to be taken to identify jobs or tasks that have known risk factors for MSDs which will provide the groundwork for changes and controls interventions to reduce the risk factors and control the identified hazards. This is the part of the program development where a change in direction is taken, as the next step is to move away from an analysis of existing data and move forward in taking steps to proactively address risk prevention and hazard identification.

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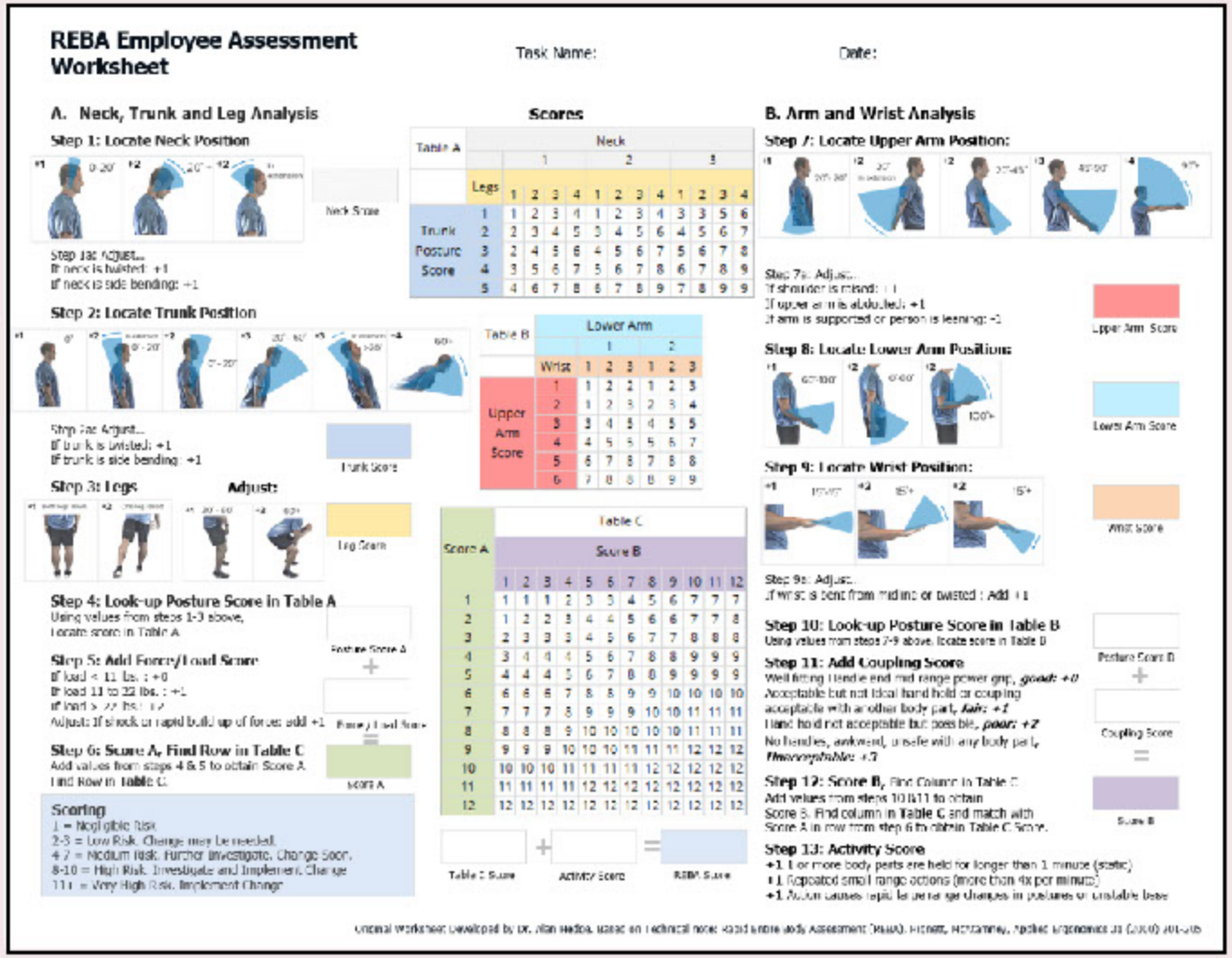
4.3.1 Selection and Screening for Jobs with Risk Factors



REBA Employee Assessment Worksheet

Task Name: Date:

A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position

Step 1a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Step 2: Locate Trunk Position

Step 2a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1

Step 3: Legs **Adjust:**

Step 4: Look-up Posture Score in Table A
Using values from steps 1-3 above, locate score in Table A

Step 5: Add Force/Load Score
If load < 11 lbs. : +0
If load 11 to 22 lbs. : +1
If load > 22 lbs. : +2
Adjust: If shock or rapid build up of force: add +1

Step 6: Score A, Find Row in Table C
Add values from steps 4 & 5 to obtain Score A. Find Row in Table C.

Scoring
1 = Negligible Risk
2-3 = Low Risk. Change may be needed.
4-7 = Medium Risk. Further investigate. Change soon.
8-10 = High Risk. Investigate and Implement Change
11+ = Very High Risk. Implement Change

Scores

Table A

Trunk Posture Score	Legs 1	Neck 1	Neck 2	Neck 3
1	1	1	2	3
	2	1	2	3
	3	1	2	3
	4	2	3	4
2	1	2	3	4
	2	2	3	4
	3	3	4	5
	4	4	5	6
3	1	3	3	5
	2	3	4	5
	3	4	5	6
	4	5	6	7
4	1	5	6	7
	2	5	6	7
	3	6	7	8
	4	7	8	9
5	1	7	8	9
	2	7	8	9
	3	8	9	9
	4	9	9	9

Table B

Upper Arm Score	Wrist	Lower Arm 1	Lower Arm 2
1	1	1	2
	2	2	3
	3	2	3
	4	3	4
2	1	1	2
	2	2	3
	3	3	4
	4	4	5
3	1	3	4
	2	3	4
	3	4	5
	4	5	5
4	1	4	5
	2	5	5
	3	5	6
	4	6	7
5	1	6	7
	2	7	8
	3	7	8
	4	8	8
6	1	7	8
	2	8	8
	3	8	9
	4	9	9

Table C

Score A	Score B 1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table C Score + Activity Score = REBA Score

B. Arm and Wrist Analysis

Step 7: Locate Upper Arm Position:

Step 7a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Step 8: Locate Lower Arm Position:

Step 9: Locate Wrist Position:

Step 9a: Adjust...
If wrist is bent from midline or twisted: Add +1

Step 10: Look-up Posture Score in Table B
Using values from steps 7-9 above, locate score in Table B

Step 11: Add Coupling Score
Well fitting handle and mid range power grip, *good: +0*
Acceptable but not ideal hand hold or coupling acceptable with another body part, *fair: +1*
Hand hold not acceptable but possible, *poor: +2*
No handles, awkward, unsafe with any body part, *Unacceptable: +3*

Step 12: Score B, Find Column in Table C
Add values from steps 10 & 11 to obtain Score B. Find column in Table C and match with Score A in row from step 6 to obtain Table C Score.

Step 13: Activity Score
+1 1 or more body parts are held for longer than 1 minute (static)
+1 Repeated small range actions (more than 4x per minute)
+1 Action causes rapid large range changes in postures or unstable base

Original Worksheet Developed by Dr. Alan Hedge, based on Technical Note: Rapid Entire Body Assessment (REBA). Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

Once the data is collected from the MSD indicators above, an analysis of the at-risk jobs with their associated hazards and risks factors can now be developed. Proactive screening can take place at this stage with the following activities:

- Walk-through observational surveys of the work facilities to detect obvious risk factors.
- A review of area safety inspections to assess any corrective actions yet to be taken.
- Interviews with employees and supervisors to obtain information such as time and workload pressures, length of rest breaks, and general internal work practices.

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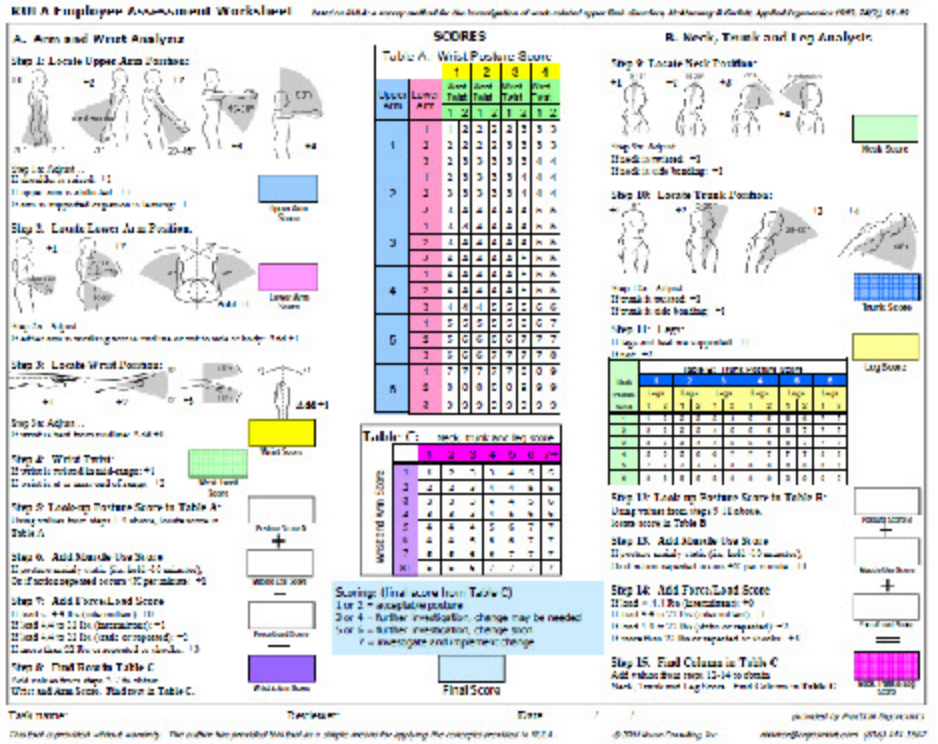
4.3.1 Selection and Screening for Jobs with Risk Factors

- Ergonomics risk assessments through the use of checklists that score job features against a list of risk factors. A checklist process provides the most formal and orderly procedure for screening jobs based on the type of risks. The following are examples:

  - **Rapid Entire Body Assessment (REBA):** Evaluates in one page the required body postures, forceful exertions, types of movement and other factors utilizing a scoring that follows body regions such as shoulders, back, legs and arms.

  - **Rapid Upper Limb Assessment (RULA):** Evaluates the biomechanical and postural load requirements of tasks in a single page format whereby scores are associated with arms, wrists, neck, and trunk.

  - **Ergonomic Hazard Identification Checklist:** Utilized as a general approach checklist to review all the jobs or tasks in a facility as a first means to localizing potential problems.



- The development of Job Hazard Analyses for each at-risk job.

- Given its level of importance in risk factor identification, the following section is devoted to this important tool for use in an effective ergonomics program.

Click Box

4.3.2 Job Hazard Analysis

Efforts to identify jobs or tasks having known risk factors for musculoskeletal problems can provide the groundwork for changes aimed at risk reduction. Even without clear medical evidence, screening jobs for musculoskeletal risk factors can offer a basis for early interventions and allow for a more proactive approach in injury prevention.

Job Safety Analysis

Risk Assessment Code Matrix

Severity	Likelihood of occurrence			
High to Low	A	B	C	D
I	1	1	2	4
II	1	2	3	4
III	2	3	4	5
IV	3	4	5	5

Task: Tripping Pipe in Hole

Location

Date:

Required PPE: Hardhat, Safety toe Boots, Safety Glasses

Reviewed by:

Tasks: Set up	Hazard:	RAC	Safety Precautions To Take:
Traveling block moving up derrick	Swinging blocks hitting sides of derrick.	1	Stabilize blocks and elevators. Do not put tongs on pipe too soon.
	Tong counterweight line getting hooked on blocks or elevators	2	Use spotter. Look up at load.

Click Box

4.3.2 Job Hazard Analysis

One of the most effective risk factor identification methods is the Job Hazard Analysis. This tool breaks a job down into its various elements or actions, describes them, measures and quantifies the risk factors inherent in the element, identifies conditions that contribute to the risk factors and determines corrective measures. While no "standard" protocol exists for conducting a job hazard analysis to specifically address ergonomic hazards, the following are suggested steps to follow in completing a Job Hazard Analysis:

JOB/TASK/EXPERIMENTAL PROCEDURE SAFETY AND HEALTH ANALYSIS

DEPARTMENT: **PI/SUPERVISOR:** Mr Supervisor	**TASK/EXPERIMENTAL PROCEDURE:** Using a Hand truck	
PREPARED BY: Ms. Driver		
REVIEWED BY:	**DATE APPROVED:**	**REVIEW/REVISION DATE:**
PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS (PPE). If appropriate attach PPE Assessment: Gloves if necessary		
TRAINING/COMPETENCY REQUIRED: Operation of a Hand Truck PPE		

Step #	TASK ①	POTENTIAL SAFETY AND HEALTH HAZARDS ②	CONTROLS ③
1	Pre-operation Safety Check	• Untrained operator	• Training on hand truck design, controls and instrumentation. • Training on the hand truck stability and the proper way to transport, load, and stack on the hand truck
2	Assembling a load	• Rolling the wheels off the edge of ramps and loading docks.	• Stay well back from the edge. • Never turn around on the slope. • When going down a ramp, keep the truck ahead of you. When going up, pull the truck behind you. • Make sure the chisel of the truck is all the way under the load.
3	Operating the Two-wheel Hand truck	• Slip/trip/fall	• Slow down for turns. • Make sure that you have enough overhead clearance.
4	Transporting the load	• Pinching hands between the truck and other objects.	• Be Alert • Wear gloves to protect your hands. • Strap bulky or dangerous cargo to the truck's frame. • When moving a stack of objects, put the heavier ones on the bottom.
5	Storing the hand truck	• Trip hazard	• Store in a safe out of the way area.

1. **Obtain** a copy of the complete job description. Inquire with the supervisor and employee if there were any major changes in the work processes or practices that may not have been reflected in the job description.

2. **Divide** the job into the several definitive tasks so that each task can be studied to determine the specific risk factors that exist as the employee is performing the job.

Click Box

4.3.2 Job Hazard Analysis

3. **Collect** additional information regarding each of the documented tasks that have been documented. A variety of methods to collect this data exist, some of which are:

- Observe employee(s) performing the tasks to furnish time-activity analysis and job or task cycle data.
- Take photos of work postures, workstation layouts, tools, etc., for job illustration.
- Take workstation measurements (e.g., work surface heights, reach distances).
- Measure tool handle sizes, weigh tools and parts, and measure tool vibration and part dimensions.

4.3.2 Job Hazard Analysis

- Determine characteristics of work surfaces such as slip resistance, hardness, and surface edges.
- Measure exposures to heat, cold, and whole body vibration.
- Take biomechanical calculations such as the muscle force required to accomplish a task or the pressure placed on a spinal disc based on the weight of a load lifted.
- Determine physiological measures where appropriate, such as heart rate or oxygen consumption.
- Complete special questionnaires, interviews, and subjective rating procedures to determine the amount of perceived exertion and the psychological factors influencing work performance.

4.3.2 Job Hazard Analysis

4. **Assess** and list the associated risks/hazards with each step or task, considering the contributing physical risk factors such as frequency, duration and force, as well as any other risk factors that are inherent in the job or in the environment.

While developing a JHA, special consideration should be given to those tasks associated with manual material handling, as they pose the greatest risk of hazard for an employee for an MSD. Such tasks that involve lifting of materials require even more scrutiny to be able to identify the hazard and the necessary controls to prevent these prevalent injuries. While documenting these types of tasks, the following contributing risk factors should be taken into consideration: awkward postures (i.e. bending, twisting), repetitive motions (i.e. frequent reaching, lifting, carrying), forceful exertions (i.e. carrying or lifting heavy loads), pressure points (i.e. grasping loads, leaning against parts or surfaces that are hard or have sharp edges), and static postures (i.e. maintaining fixed positions for a long time).

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4.3.2 Job Hazard Analysis

As a very basic JHA example, the following table provides a task, its associated risk factors, the consequence if the risk factor if not corrected and the recommended control measures to be put in place:

Job Hazard Analysis			
Job Title:		Employee Name:	
Department:		Supervisor	
Completed:		Date:	
Job Tasks	Potential Ergonomic Risk Factors	Potential Consequence	Recommended Risk Controls
1. Screw knob on cabinet door as required by the production schedule rate.	**Repetitive motion:** The production rate is 20 knobs per minute with little or no break. **Lighting:** Task lighting is not provided for work needing close attention. **Force exertion:** Force is applied utilizing a firm grip with one hand. **Awkward posture:** The assembly line is designed for sitting postures, but the twisting motion of the task does not provide for work in a neutral position while sitting.	Extended and repeated exposure to the repetitive motion, force and awkward postures may lead to injury of the wrist, forearm and back. Injury more likely to occur due to the fatigue and stress on the body. Extended exposure to improper illumination creates eye strain and fatigue.	**Engineering**: Assess for proper work surface height to ensure neutral posture. If the sitting posture remains as a requirement, provide adjustable chairs with wheels for rotational purposes. Provide task lighting. **Administrative:** Provide rest periods and breaks to reduce fatigue. **PPE:** Provide properly fitted gloves to reduce tension and stress on the hand.

4.3.3 Prioritization of Findings

Once all the MSD Indicators are collected and a review of the Job Hazard Analysis work is complete, it is now necessary to prioritize which jobs and work processes to first pursue in the implementation of the necessary corrective actions. The following are considerations in assessing the priorities:

- Jobs with the highest injury or illness rates for MSDs, with those jobs that have current MSD cases open receiving immediate attention. These are the jobs that have the most likelihood for reoccurrence and with the most detrimental consequences or severity.
- Hazardous jobs with the potential to cause MSDs, even if there is no previous history.
- New jobs to the operation or those that have undergone changes in processes and procedures for which ergonomic concerns can be addressed in the planning stages.
- Any jobs for which employee complaints of fatigue and discomfort have been reported.

4.3.3 Prioritization of Findings

- Consideration to those jobs in which the JHA reveals an unusually high likelihood of injury occurrences and with the most severe consequences.
- The technical and financial resources available to address the issues identified.
- The time frame allotted to make any revisions or improvement.

The identification and analysis of ergonomics hazards should be routinely performed and documented, with periodic assessment of the workplace analysis indicators and JHAs conducted at least annually, or whenever operations change. In that way, the identification of new or previously unnoticed risk factors and deficiencies or failures in work practices or engineering controls can be completed and an assessment of the effects of changes in the work processes can be considered.

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4.4 Development and Implementation of Risk Factor Controls

A follow-up evaluation is necessary to ensure that the controls reduced or eliminated the ergonomic risk factors and that new risk factors were not introduced as a result of the control measures that were put in place. This follow-up evaluation should use the same risk factor checklist or other method of job analysis that first documented the presence of ergonomic risk factors. If the hazards are not substantially reduced or eliminated, the problem-solving process is not finished. The follow-up may also include a symptom survey, which can be completed in conjunction with the other job analysis methods. The results of the follow-up symptom survey can then be compared with the results of the initial symptom survey assuming one was performed to determine the effectiveness of the implemented solutions in reducing symptoms. Because some changes in work methods and the resulting use of different muscle groups may make employees feel sore or tired for a few days, follow-up should not occur close to the time of implementation of the controls. Recognizing this fact may help to avoid discarding an otherwise good solution that was implemented.

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4.4 Development and Implementation of Risk Factor Controls

In addition to the short-term evaluations using such resources as job hazard analyses and symptom surveys, there are several long-term indicators of the success of the program, of which the following are a few:

- Reduction in the incidence rate of musculoskeletal disorders on record
- Reduction in the severity rate of musculoskeletal disorders that may occur
- Increase in productivity or the quality of products and services
- Reduction in job turnover or absenteeism
- Overall increase in employee job satisfaction
- Lower overall production costs due to increased efficiencies

A key element in sustaining an effective ergonomics improvement process and maintaining the momentum and effort is the ongoing evaluation of the program. Regular monitoring and tracking of ergonomic process measures is one of the indicators that differentiate an ineffective program from a successful one. Since most every business has processes for tracking performance such as throughput, quality, and profit, tracking ergonomic performance is most effective when it aligns with the same method used to track business performance. A comprehensive evaluation of the systems established in a workplace lends itself to a continuous improvement process that ensures that all elements are in place and operating effectively.

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4.5 Medical Management

Company healthcare management strategies, policies, and medical providers are an important part of the overall ergonomics program. In general, medical management emphasizes the prevention of impairment and disability through early detection, prompt treatment, and timely recovery. A medical management program, supervised by an individual professionally trained in the prevention of musculoskeletal disorders, is an important component in an effective program to manage the care of those injured. Typically, a program includes:

- Accurate injury and illness recording
- Early identification and treatment of injured employees
- "Light duty" or "no lifting" work restrictions during recovery periods
- Systematic monitoring of injured employees to determine when they are ready to return to regular duty

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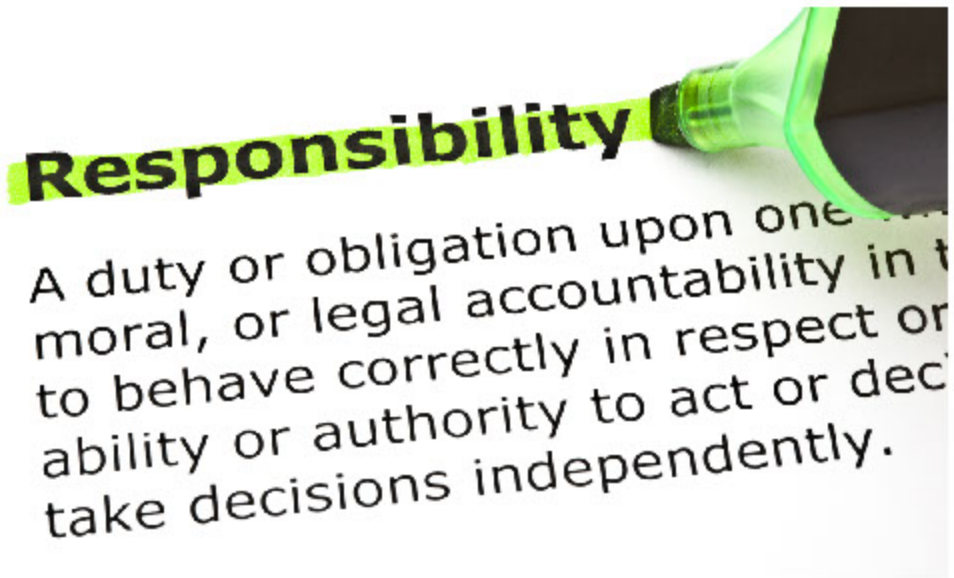
4.5.1 Employer Responsibilities

The role of the employer is critical for supporting the necessary processes to be put in place to prevent MSD injuries, with proactive prevention vs. reactive intervention being the key. To this end, employer responsibilities are numerous:

- Provide ergonomic awareness training to employees regarding the recognition of the symptoms and signs of MSDs
- Ensure appropriate employee selection and placement of employees to best match employees to job and their tasks
- Provide clear and concise workplace procedures for reporting MSDs
- Encourage employees to report symptoms early so prompt evaluation by an appropriate health care provider can be provided, ensuring that employees do not fear discipline or discrimination based on such reporting

4.5.1 Employer Responsibilities



- Give medical providers the opportunity to become familiar with jobs and job tasks
- Modify jobs or accommodate employees who have functional limitations as they relate to MSDs in collaboration with a healthcare provider
- Ensure, to the extent permitted by law, employee privacy and confidentiality regarding medical conditions identified during any assessments or exams
- Be cognizant of the fact that employees may be faced with conflicting job demands or requirements and that safe work practices or rules may conflict with pressures or incentives to be more productive for them

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4.5.2 Employee Responsibilities

Equally important is the role of employees with regards to the medical management process. They are responsible to:

- Follow applicable workplace safety and health rules
- Follow work practice procedures related to their jobs as defined by the employer
- Report early signs and symptoms of MSDs
- Engage in the process of identifying risks factors and implementing controls put in place to reduce or eliminate the hazards in the job

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4.5.3 Medical Provider Responsibilities

Lastly, the medical provider plays a key role in support of the employer's ergonomics program. These responsibilities include:

- Acquire experience and training in the evaluation and treatment of MSDs
- Seek information and review materials regarding employee job tasks
- Ensure employee privacy and confidentiality fully permitted by law
- Evaluate employees who have identified themselves as symptomatic to include:
  - Complete medical histories with a thorough description of symptoms
  - Thorough descriptions of work activities as reported by the employee
  - Specific physical examinations to evaluate symptoms as presented
  - Follow-up examinations to document symptom improvements or resolutions
  - Professional opinions as to whether documented risk factors caused, contributed to, or exacerbated the conditions

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4.5.4 Job Familiarity and Job Placement Evaluations

Medical providers who evaluate employees, determine their functional capabilities, and prepare opinions regarding work relatedness should be familiar with employee jobs and tasks. With specific knowledge of the physical demands involved in various jobs and the physical capabilities or limitations of employees, the medical provider can assist with the all-important ergonomic match between employees' capabilities to the appropriate jobs. Being familiar with employee jobs not only assists the medical provider in making informed case management decisions but also assists with the identification of ergonomic hazards and alternative job tasks.

To this end, medical providers should be encouraged to conduct periodic workplace walk-throughs or inspections, as well as review Job Hazard Analyses to learn about the various hazards and control measures that have been identified.

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4.5.5 Early Reporting and Access to Medical Providers

Employees reporting symptoms or signs of potential MSDs should have the opportunity for prompt evaluation by a medical provider, as it is now understood that the earlier that symptoms are identified and treatment is initiated, the less likely a more serious disorder will develop. Employers should not establish policies that discourage employees from reporting symptoms such as manager performance evaluations that tie number of recorded MSD symptoms with their compensation which may discourage them from allowing symptomatic employees to be evaluated by the medical provider.

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4.5.6 Treatment

Medical providers are responsible for determining the physical capabilities and work restrictions of the affected employees, and the employer is responsible for giving an employee a task consistent with these restrictions. Until effective controls are installed, employee exposure to ergonomic stressors can be reduced through such activities as restricted duty, job rotation, and/or temporary job transfer. Immobilization devices, such as splints or supports, can provide relief to the symptomatic area in some cases. These devices are especially effective off-the-job, particularly during sleep. However, they should not be used as PPE in the workplace to prevent the development of MSDs.

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4.6 Education and Training

Identifying and solving MSD problems in the workplace requires some level of ergonomic knowledge and skills, which makes training a critical element of a successful ergonomics program. The overall goal of ergonomics training is to enable managers, supervisors, and employees to identify aspects of job tasks that may increase an employees' risk of developing MSDs, recognize the signs and symptoms of the disorders, report early symptoms of MSDs whenever possible and participate in the development of strategies to control or prevent them. Since training can be one of the biggest investments an employer makes in implementing their ergonomics program, it should be well-planned, focused and coordinated.

The training should provide those that participate with the knowledge, skills, abilities, and tools to accomplish their designated responsibilities. Prior to any training effort, it is critical to plan for what is to be accomplished, such as defining the ergonomic continuous improvement process, or the establishment of the key roles and responsibilities in support of the process. Specific training objectives and the program content can then be developed to meet the goal(s) of the training identified.

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4.6 Education and Training

While all staff members and work groups play an important role in the total process, the order of training to support key roles has a major impact on the success and sustainability of the ergonomics process. It is suggested that awareness training for employees not be conducted initially, even though it may be the simple and fun activity to do. An effective ergonomic program cannot be sustained based solely on awareness, as it will not survive over the long term. Before training occurs, it is important to prepare each of the key players with skills training. The recommended sequence is as follows:

- Educate top management to obtain their sponsorship, guide them into leadership roles and establish direction and goals for the ergonomics process.
- Train the ergonomics leadership staff who are responsible for managing the ergonomics process, as they will coordinate and deploy all elements of the process.
- Develop the skills, abilities and confidence of ergonomic team members, engineering, medical management, and any other staff who have a responsibility to address ergonomic challenges brought to them by managers and supervisors.
- Provide managers and supervisors with awareness training and coaching to affect work practices and behaviors and to improve workplace conditions.
- Lastly, provide employees with awareness training to prepare and empower them to identify potential ergonomic issues in their workplace and to adjust the workplace to control the issues or escalate issues to their supervisors for assistance.

Click Box

4.6 Education and Training

Training content should focus on ensuring that employees are successful in performing their roles in support of the ergonomics process. This means that different roles require different topics and learning objectives. For each role defined in an ergonomics process, responsibilities need also be defined. The responsibilities become the basis for the learning objectives of each training class.

Click Box

4.6.1 Ergonomics Awareness

Typically, the learning objectives for ergonomics awareness training include the following:

- Understand ergonomic continuous improvement goals of the business.
- Ability to recognize workplace risk factors for musculoskeletal disorders and understand general methods for controlling them.
- Ability to identify the signs and symptoms of musculoskeletal disorders that may result from exposure to such risk factors.
- Be knowledgeable of the procedures for reporting risk factors and musculoskeletal disorders.

- Be knowledgeable of how the employer addresses and controls risk factors in the workplace and what the employee's role in the process.
- Understand safe work practices established to prevent an MSD injury and become aware of tasks that may lead to stress or pain.

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4.6.2 Job Hazard Analysis

Given the importance that the Job Hazard Analysis tool plays in the ergonomics program at any workplace, it is critical that this training be thorough and complete for those not only responsible for developing the analysis, but also for those who will operate within the confines of the analysis every day. The training should follow the awareness training objectives in the identification of the risk factors for MSDs, as well as in the process to implement and evaluate the control measures, which is the key to resolving any issues that are recorded relative to hazards and risks. Training in the use of the company-adopted JHA form that includes any codes or scoring, along with an opportunity to conduct practice exercises utilizing the JHA form while completing an analysis, are important to include in the course.

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4.6.3 Control Measures

With the hierarchy of recommended controls, typically it is desirable for most control measures to fall into the engineering control arena, as these are the most effective in eliminating and reducing risks factors. Thus, most of the training should be concentrated in these types of controls typically managed by engineering functions within the workplace. However, given that managers, supervisors, and employees alike are involved with everyday operations, they, too, can be trained in a more general method on how to consider various control measure options. The training objectives should consider the selection of not only the methods by which to implement control measures, but also to evaluate them on an ongoing basis.

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4.6.4 Problem-Solving Techniques

Given that control measures are resolutions to problems identified in the workplace, providing training that advances the skill level of all those that take part in the implementation and evaluation of controls is key.

Learning objectives for this type of training may include:

- Identify the jobs with high risk factors through the review of Job Hazard Analysis and other employer records
- Identify tools and techniques that can be used that address the controls that are identified in the Job Hazard Analysis
- Develop skills in teambuilding, consensus development, brainstorming and problem solving
- Recommend ways to control ergonomic hazards based on job analyses documents

4.6.5 Special Considerations

A word of caution when proceeding with the creation and implementation of an effective ergonomics program along with training; initially- especially when training hourly employees regarding the signs and symptoms of ergonomic stressors- the injury rate will go UP. Do not let this deter you! This is not uncommon. As individuals begin to realize that is not acceptable to have to work in pain, (and a culture has been created where they are not afraid to report this) then an increase in ergonomic injuries is to be expected. But as the root causes of these injuries are proactively attacked, there will be a gradual decrease of these types of injuries.

It is important to note that training objectives are not intended to have employees, supervisors, or managers diagnose or treat MSDs. Rather, the purpose is to instill an understanding of what type of ergonomic injuries occur in the workplace, as well as when and how to refer employees for medical evaluation. To this end, the training should include what is known about work and non-work causes of musculoskeletal disorders and the current limitations of scientific knowledge. Training should be understandable to the target audience, and the materials utilized should consider the participant's educational levels, literacy abilities, and languages skills.

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4.7 Resources

Both OSHA and NIOSH provide a variety of resources to enable you to create and maintain a successful ergonomics program. Click each link to learn more:

OSHA	NIOSH
Prevention of MSDs in the Workplace	Applications Manual for the Revised NIOSH Lifting Equation
Ergonomics: The Study of Work	Musculoskeletal Disorders and Workplace Factors
Materials Handling and Storage	Ergonomic Guidelines for Manual Material Handling
Easy Ergonomics: A Practical Approach for Improving the Workplace	Elements of Ergonomics Programs
	Practical Demonstrations of Ergonomic Principles

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