

Naval Facilities Engineering Command Ergonomic Risk Assessment for Ground Electronics Operation

Introduction

An ergonomics risk assessment was conducted on November 14th, 2007. The Ground Electronics operation was observed in order to determine sources of ergonomics stress and recommend improvements. This assessment is based upon interviews with employees and safety personnel as well as an evaluation by a Certified Professional Ergonomist with the Naval Facilities Engineering Command (NAVFACENGCOM) Mishap Prevention and Hazard Abatement (MPHA) program.

The operation reviewed presents opportunities to reduce the risk of work-related musculoskeletal disorders (WMSDs). Musculoskeletal Disorders (MSDs) are injuries and illnesses that affect muscles, nerves, tendons, ligaments, joints, spinal discs, skin, subcutaneous tissues, blood vessels, and bones. Work-Related Musculoskeletal Disorders (WMSDs) are:

- ∞ Musculoskeletal disorders to which the work environment and the performance of work contribute significantly or
- ∞ Musculoskeletal disorders that are aggravated or prolonged by working conditions.

Recommendations for the command to reduce the probability of injury include equipment purchaseⁱ, process redesign, and implementation of administrative controlsⁱⁱ. Representative vendor information is included in the recommendations to assist in the evaluation of products and servicesⁱⁱⁱ. Recommendations for the command include gathering input from the workers, safety specialists, and other personnel to evaluate equipment before purchasing. This process will increase product acceptance, test product usability, and durability, and takes advantage of employee experience.

Naval Facilities Engineering Command (NAVFACENGCOM) manages the Chief of Naval Operations (CNO) Hazard Abatement and Mishap Prevention Program, which is a centrally managed fund to correct safety and health deficiencies beyond the funding capabilities of the activity. The submission deadline for FY09 is March 31st, 2008.

GROUND ELECTRONICS

Purpose of the Operation

Maintain and repair communications and radar equipment electronic components for the airfield and air traffic control tower.

Population

Twenty to thirty active duty electronics technicians (ETs) and two civilian employees. The ETs work eight-hour weekdays as well as four to five 14.5 hour “duty days” a month.

Injury Data

None provided

Description of the Operation

Micro-miniature (2M) Workbench:

Employees are responsible for removing, repairing, testing, and replacing electronics components. The electronics operations facility has one 2M workbench that is shared between five employees. Workers can spend up to eight hours a day at the workbench shown in figure 1. The most frequent task is soldering circuit boards as shown in figure 2. Fixtures to hold and orientate the circuit boards are available for use, but are not utilized by everyone.

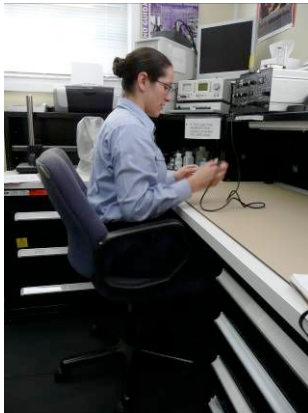


Figure 1: 2M Workbench

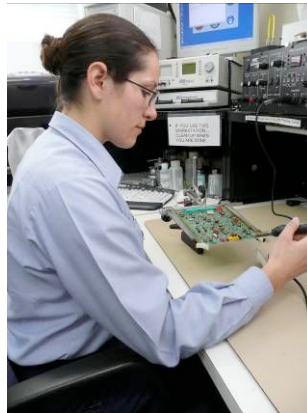


Figure 2: Soldering a circuit board using a fixture

The “L-shaped” 2M workbench contains one station for soldering and repairs, and another with a microscope. The computer workstation in the corner connects the two workbenches. Microscope use is of low frequency and duration since most of the work is visible to the naked eye. Computer use is also infrequent but is expected to increase in the future due to added testing processes. Figure 3 demonstrates the computerized screening process for circuit boards. For the sailor being interviewed, the keyboard was

located 3.5” higher than her seated elbow height and the monitor was 15” above her seated eye height.



Figure 3: Computerized screening process

Ergonomics Issue Description

Repair work and testing requires sustained awkward postures of the back, neck, hand and shoulders as well as repetitive hand and arm manipulations when using hand tools. Employees are also experiencing sustained contact stress to the forearms from the front edge of the workstation. Ergonomics risk factors occurring in combination (e.g. awkward posture, repetitive motions, and duration) increase the risk of WMSD development.

Repetitive Motions and Awkward Postures: Employees routinely maintain awkward postures of the neck, back, and upper extremities while working at the 2M bench. The sustained postures restrict blood flow and can cause muscle fatigue as well as place the workers at risk of developing WMSDs.

The workstation configuration encourages awkward postures. Employees have to continually look up to view the monitor and the storage unit under the microscope station causes employees to work with their torsos twisted. The current seating doesn't provide adequate adjustability or lumbar support so the employees tend to sit at the edge of the seat without utilizing the backrest. Employees are also performing repairs above the recommended work heights. Ergonomics guidelines for hand position when performing precision tasks such as electronics repair, are 2-4” above the seated elbow height. The employee interviewed was working at 11” above her seated elbow height. The muscles must apply considerably more contraction force to maintain an awkward posture especially when performing precision tasks. As the duration of the contraction increases, stress on the muscles also rise. The continuous stress on these muscles can lead to fatigue and discomfort which are precursors to injury. Static awkward postures impede the flow of blood needed by the muscles to supply nutrients and remove the waste products of muscle metabolism. Reduced blood flow also slows delivery of oxygen to the muscles resulting in a longer recovery time. Waste products, such as lactic acid, can build up in the muscle and cause fatigue. The longer or more frequently static loading occurs, the greater the risk of injury due to overuse of muscles, joints, and other tissues.

Workers perform extended reaches to operate the scanning equipment and access the soldering iron and extractor tool. Extended reaches are examples of awkward postures that require the body to deviate from the neutral in the arms, shoulders, and back. Repeatedly reaching for components, figures 3 and 4, can impose increased stress on the muscles and joints.



Figure 4: Reaching for soldering iron


Awkward postures combined with high repetition, as seen in the electronics repair operation, can fatigue muscles and cause the employee to exert more force than is necessary. The majority of the tasks involve repetitive hand, arm, and wrist motions which utilize the same muscle groups and reduce muscle recovery. Inadequate muscle recovery leads to muscle fatigue and possible overuse injuries.



Contact Stress: Contact stress results from a compression of the soft tissue by a hard object. A concentrated force can reduce blood flow and nerve transmission and may cause damage to tendons and tendon sheaths. The work station edge causes compression to the forearm as shown in figure 2. Due to the height of the workstation, some employees are not able to sit with their feet resting comfortably on the floor. Sitting with feet unsupported can cause compression to the underside of the thighs from the chair's seat pan. Sitting too high encourages employees to rest their feet on the legs of the chair which can create biomechanical stress or compression to the knees.

Environmental Concerns: Sailors noted low light levels when working at night while standing duty. A lack of task lighting can increase eye strain and induce awkward postures as workers lean forward to view the task. The task lighting has been repaired since the site visit.

Recommendations

- ∞ In order to promote a neutral posture while using the computer, the wrists and forearms should be kept level and parallel to the floor with approximately a 90° angle between forearm and upper arm, shoulders relaxed and upper arms close to the body with no contact stress to the forearm or hands. The keyboard and mouse heights should be equivalent to the user's seated elbow height. Elbow height is measured from the floor to the bony point of the elbow with the user's hand sitting in the lap. Keyboard height is measured from the floor to the middle row of characters on the keyboard. The monitor should be about arm's length away and directly in front of the user at the same height or slightly below eye level. By removing the shelf the computer sits on and moving the items under the shelf to another work surface, the monitor height and extended forward reaches can be reduced. Alternatively, removing one of the storage units and moving the computer from the corner unit to one of the workbenches on the side would eliminate reaching for the keyboard and promote a neutral working posture. In the meantime, the chairs should be adjusted to promote a neutral working posture and a footrest should be used if the employee's feet are not resting comfortably on the floor. A temporary footrest can be made from a box or similar square object.
- ∞ The employees mostly commonly reach for the keyboard, circuit scanning equipment, soldering iron and extractor. Locating these items close to the user is recommended to reduce reaching.
- ∞ An adjustable corner workstation and chair are recommended to reduce ergonomics stressors. The workstation should have a pedestal base, height adjustable ESD surface, electrical outlets and task lighting. Please refer to vendor table 1.

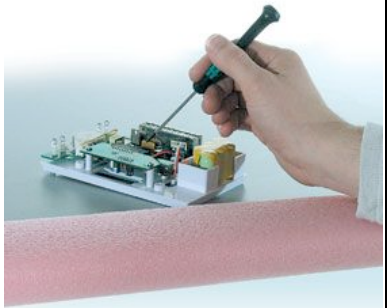
Vendor	Description	Estimated Cost	Figure
Peak Logix 703-819-6061	1 Pro-line Heavy Duty Pedestal Workstations with ESD Laminate Top and electrical outlets and overhead lighting	Price depends on configuration	
Ergosource 952-404-1969 www.ergosource.com	Levitech workstation- pricing done to spec		

Grainger 904-636-8896 www.grainger.com	Pro-Line Workstations- pricing done to spec		 <p>Dimension Next Biotech / Assembly Series Pro-Line 1 800-739-9067</p>
Global Industrial 1-800-645-1232	Effortless Stool- completely adjustable XF252374 Casters optional	\$252	
C&H 1-800-558-9966	Workspace, Bevco, and Krueger Stools	\$226-\$243	
Lab Safety and Supply 1-800-356-0783	Biofit and Bevco	\$206-322	

- ∞ Encourage workers to take stretch breaks during the day to relieve discomfort and encourage muscle movement². Micro-breaks taken throughout the day can aide in muscle recovery. The following web sites include exercises that can be printed and posted. Sources should be cited when reproducing information. Web site links updated November 2007.

<http://www.steelcase.com/na/knowledgedesign.aspx?f=10250&c=10213>
<http://www.safety.duke.edu/Ergonomics/Stretch/90Seconds.htm>
www.shelterpub.com/fitness/office_fitness_clinic/OFC_online_stretches.html

- ∞ In order to reduce contact stress, workstations should have an edge protector. Please refer to vendor table 2 for more information.

Table 2: Microscope Recommendations			
Vendor	Description	Estimated Cost	Figure
Alimed 1-800-225-2610	ESD edge protector	\$21-\$35	

- ∞ The current chair does not roll easily on the matting which makes it hard to move. ESD floor matting is recommended to reduce the force required to move the chair. Refer to vendor table 3.


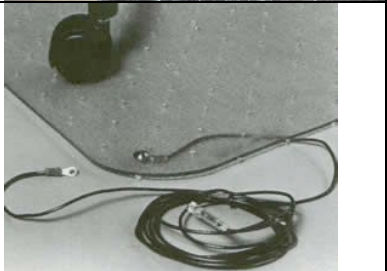

Table 3: ESD Matting			
Vendor	Description	Estimated Cost	Figure
United ESD 719.676.3928	ESD chair mats	\$310-\$810 depending on size	
Ground Zero 1-877-GND-ZERO	ESD chair mats	Pricing depends on size	

Table 3: ESD Matting			
Vendor	Description	Estimated Cost	Figure
e-mat 877-511-3628	Heavy duty anti-static floor mat	\$1035- \$2070	

OUTLYING FACILITIES:

Electronics technicians also maintain components at four outlying facilities. The ASR-8 facility is one such post that contains radar equipment. When a problem occurs, sailors can work 12 hours a day until the problem has been solved. Sailors either sit on the floor or a bucket, kneel, or squat while trouble-shooting circuit boards at various heights ranging from 8" to 46" above the deck, figures 5 and 6.



Figures 5 and 6: Troubleshooting circuit boards

Electronics technicians also maintain and inspect outdoor antennas. Sailors frequently carry a 10 lb. bag of desiccant in one hand while climbing outdoor ladders to access outdoor antennas, figure 7.



Figure 7: Transporting desiccant to antenna

Ergonomics Issue Description



Employees perform trouble shooting and repair operations in sustained awkward postures and carry heavy loads in an unsupported manner that could contribute to injury.

Awkward Postures: Technicians assume sustained awkward postures of the back, hips, knees and ankles while squatting or kneeling during repair and trouble-shooting operations. Hyper-flexing the knees in a squatting or kneeling position can result in pressure on the back of the knees which may reduce circulation in the lower extremities and can lead to fatigue and discomfort. Kneeling on the deck can also cause compression on the knees.




Carrying desiccant up to the antenna causes employees to climb with one hand which is an awkward and unsafe practice. The desiccant is contained in plastic garbage bags which are difficult to grab and carry.

Recommendations

- ∞ Tool stools are recommended to support employees working at low heights (e.g. trouble shooting circuit boards in outlying facilities). Five tool stools are recommended for all of the outlying facilities and to accommodate people working in teams. Tool stools should be permanently assigned to each facility and visibly marked to reduce movement between buildings. Refer to vendor table 4.

Table 4: Tool stools			
Vendor	Description	Estimated Cost	Figure
Lab Safety 1-800-356-0783	Adjustable height tool stools (with and without backrests)	\$199	
C&H 1-800-558-9966		\$156	
Grainger		\$203	
Alimed 1-800-225-2610		\$19-\$40	

- ∞ An outdoor pulley system could be used to raise and lower material up the antennas. One point of contact for a pulley system that can withstand the elements is Michael Gualandi with Fastenal at 407-557-5969.
- ∞ Desiccant should be stored in plastic bags inside of transport bags to facilitate movement to the antennas. Refer to vendor table 4.

Vendor Table 4: Transport Bag			
Vendor	Description	Estimated Cost	Figure
ArmyGear.net	This bag is perfect for float trips. Protect food, cameras and electronics from the damaging effects of water. Has lock down closures to keep the bag sealed and shoulder straps for easy carry. 43" x 25" x 9" and is made of vinyl coated nylon.	\$35	
Local Army/Navy surplus store	Alice Pack	\$50-\$100	
Local Army/Navy surplus store	Rucksack	\$20-\$50	

Notes

End Notes:

ⁱ Equipment purchase without proper and repeated training will not mitigate risk and may in fact increase hazards.

ⁱⁱ Administrative controls are management-controlled work practices and policies designed to reduce exposures to work-related musculoskeletal disorders (WMSDs) hazards by changing the way work is assigned or scheduled. Administrative controls reduce the exposure to ergonomic stressors and thus reduce the cumulative dose to any one worker. Examples of administrative controls that are used in the ergonomics context are employee rotation, employer-authorized changes in the pace of work and team lifting.

ⁱⁱⁱ This report does not constitute an endorsement of any particular product. Rather, it is a recitation of how Navy personnel have addressed a particular work place safety issue. Neither the Navy nor its employees and agents, warrant any product described in this report for any use, either general or particular.