

## **Naval Facilities Engineering Command Ergonomic Risk Assessment for Aircraft Maintenance Department**

### **Introduction**

This report summarizes the ergonomic risk assessment conducted at the Aircraft Maintenance Department on February 6<sup>th</sup>, 2003. The Tire Shop and Squadron maintenance operations were observed in order to determine sources of ergonomic stress and recommend improvements. This assessment is based upon interviews with supervisor, safety officer, and employees as well as an evaluation by the Naval Facilities Engineering Command (NAVFACENGCOM) Hazard Abatement Ergonomist.

The Job Requirements Physical Demands Survey (JR/PD), an ergonomic survey, was also administered to the employees in both shops. The results of the JR/PDs indicate the tire shop as an ergonomic problem area with a score of 9 on a scale of 1 to 9 where 9 is a maximum value. The shoulder/neck and back torso regions were found to have significant ergonomic risk. Ergonomic risk is based upon ergonomic stressors associated with the task and employee discomfort. The squadron scored a three and is not considered an ergonomic problem area.

The Tire Shop and Squadron were observed in order to determine sources of ergonomics stress and make recommendations to reduce the risk of work-related musculoskeletal disorders (WMSDs) and improve safety, health and productivity. 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 work conditions.

Recommendations to the command to further reduce the probability of injury include new equipment<sup>i</sup> and administrative controls<sup>ii</sup>. Recommendations are included with as much vendor information<sup>iii</sup> as possible to assist in the evaluation of products and services. Input gathered from the workers, safety specialists, and other personnel to evaluate equipment before purchasing is recommended. This process will increase product acceptance, test product usability and durability, and take advantage of employee experience.

The command may request additional funds from the Chief of Naval Operations (CNO) Hazard Abatement (HA) Program to abate the risk of injury. Naval Facilities Engineering Command (NAVFACENGCOM) manages the CNO Hazard Abatement Program, which is a centrally managed fund to correct safety and health deficiencies beyond the funding capabilities of the activity. Information about the HA program can

be found on the Naval Facilities Engineering Command web site [www.navfac.navy.mil/safety](http://www.navfac.navy.mil/safety) and in OPNAVINST 5100.23F. Ch 12 Hazard Abatement.

## Tire Shop

Purpose of the Operation: Refurbish aircraft tires

Population: Eight active duty personnel working 40 hours a week.

Injury Data: No recorded injuries. According to the Job Requirements and Physical Demands Survey results, six employees have seen a health care provider for pain/discomfort that he feels is related to his job.

Description of the Operation: Workers repair approximately 3 aircraft tires per week. Tire refurbishing takes approximately 3 days per tire. Tires can weigh from 20 to 315 lbs and arrive in the tire shop flat on a pallet by a forklift. Workers roll the tires throughout the shop for repairs and back to the hangers when completed. If the employee loses control of the tire they may exert extreme force to keep it from falling or “getting away”. The heaviest tires require 2 or 3 employees to lift refer to figure 1.

Tires are disassembled by removing the lug nuts. One worker holds the nut, while the other uses a pneumatic impact wrench to turn the screw. In some cases the pneumatic tool is insufficient and the worker uses a breaker bar to forcibly loosen the lug as shown in figure 2. Workers then perform a variety of repair / maintenance tasks on the tires.



Figure 1: Lifting a tire



Figure 2: Using a breaker bar to loosen

The tires are rolled throughout the shop for different processes where they are manually loaded into machines. Workers lift the tires to place them in the machines. The tires. The power wash machines and paint stripper both have load/unload heights of 32". The inspection station has a load height of 4'. Results from the OPNAVINST 5100.23F Appendix A would consider these tasks a WMSD hazard associated with heavy lifting. The hazard level should be reduced to lower the risk of injury.

Ergonomic issue description:

**Forceful exertions and Heavy Lifting:** Handling 315 lb. tires requires heavy lifting and high forces to maneuver the tires throughout the repair process. Tires are manually lifted into machines for processing. Heavy lifting can strain the back and place the worker at risk of injury. Results from the OPNAVINST 5100.23F Appendix-A found the task of lifting the tires to be a WMSD hazard associated with heavy lifting. The hazard level should be reduced to lower the risk of injury. In addition, lifting tires in excess of 87lbs (for a strictly male population) exceeds the recommended maximum design weight limits in MIL-STD 1472F. For team lifting, tires in excess of 174lbs (for a strictly male population) exceeds the recommended maximum design weight limits in MIL-STD 1472F.

Using a breaker bar requires the worker to exert an extremely high level of force to loosen a lug nut. Exerting high forces can contract muscles to their maximum capability which can lead to fatigue and possible damage to the muscles and other tissues.

**Awkward Postures:** Workers spend a large percentage of their time in kneeling or stooping postures while removing the lug nuts from the rim, as shown in figure 3. Working on a hard surface places high forces on the knees. Since muscles operate less efficiently in awkward positions, more force is expended to do the task. Awkward postures may also put additional strain on the tendons, which can cause inflammation, swelling, restricted movement, and pressure on nearby nerves and if occurring often can lead to WMSDs.



Figure 3: Removing lug nuts (photo from AIMD SD)

Recommendations:




- Height adjustable carts are recommended for transporting the tires through the tire shop. Some tasks can be performed on the carts. The carts can also be adjusted to machine height for loading and unloading to reduce heavy lifting. In order to roll a cart into the disassembly area the matting needs to be replaced with a 1" mat with beveled edge. Refer to table 1.
- A light weight, low vibration impact wrench with sufficient torque to remove all lug nuts is recommended to eliminate use of the breaker bar, table 1.

- A seated lug nut removal station is recommended to reduce the need for workers to kneel and squat on the floor during disassembly. A prototype was manufactured at NAS Fallon, refer to figure 4. Alternatives and temporary solutions include tool stools and knee pads. A cost estimate is supplied in table 1.



Figure 4: NASFallon prototype seated lug nut station

Table 1: Tire Shop Recommendations				
Description	Vendor	Product	Estimated Cost	Figure
Height Adjustable Carts	Lab Safety 1-800-356-0783	Bishamon Mobile Scissor Lift Tables 1650 lb. Capacity 20.5"x40" platform Height adjustable 16.5" to 39"	\$1075	
	C&H 1-800-558-9966	Southworth Dandy Lift Mobile Lift Truck 1760 lb. capacity 23"x39" platform Height adjustable 13" to 40"	\$1228	
	PeakLogix 704-819-6061	Southworth Dandy Lift Mobile Lift Truck 1760 lb. capacity 23"x39" platform Height adjustable 13" to 40"	\$998	

Table 1: Tire Shop Recommendations				
Description	Vendor	Product	Estimated Cost	Figure
1" Matting custom made with beveled edge	PeakLogix 704-819-6061		\$2100	
Low Vibration Tools	Tool source 1-888-220- 8350	1" Impact Wrench by Ingersoll-Rand	\$700	
	Grainger	1" Impact Wrench by Ingersoll-Rand Torque Multiplier	\$700 \$400	
Knee Pads	Alimed 800-225-2610	Knee Saver	\$39.-72.	
Tool Stool	C&H Dist 800 558 9966	Mechanics Seat	\$132.	
	Whiteside 740 363 1179	Mechanics Seat	\$84	
Seated Lug Nut Station	Custom build		\$8.9k	Photo 4

## Squadron

Purpose of the operation: Maintain jets.

Population: Forty active duty personnel work 40 hours a week.

Injury Data: No recorded injury data. According to the results of the Job Requirements and Physical Demands Survey, seven workers have seen his/her health care provider for pain or discomfort that he/she feels is related to the job.

Description of the operation: Workers are responsible for maintaining squadron aircraft. The most difficult task performed by the maintenance personnel is cleaning the craft after it returns from a flight. Each aircraft has to be scrubbed clean and polished. Due to the importance of the passengers, the aircraft have to be polished to high shine.

Employees in have to wash and polish one or two planes per day. Four to five employees spend one to four hours washing and polishing each aircraft by hand with soft cloths. Polishing the underside of aircraft wings requires sustain awkward postures of the entire body combine with overhead reaching, as shown in figure 5. Employees also kneel and squat on rolling platforms with hard metal surfaces, as shown in figure 6.



Figure 5: Polishing an aircraft wing



Figure 6: Polishing from a platform

Employees also change aircraft tires about once a week. Each tire weighs about 90 lbs. and has to be rolled into the hanger. Rolling a heavy tires can be a safety hazard if the employee loses control of the tire and tries to stop it by force from getting away. Two or three employees raise the tire into place to attach to the aircraft. This operation was not available for photos.

Ergonomic issue description:



**Awkward Postures:** Polishing the aircraft requires workers to assume awkward postures of the entire body. Kneeling or squatting on a hard surface can restrict blood


flow and also place mechanical stress on the knees. Sustained awkward postures restrict blood flow and can cause muscle fatigue as well as place the employee at risk of developing Work-Related Musculoskeletal Disorders.

**Forceful exertions and Heavy Lifting:** Handling 90 lb. tires requires heavy lifting and high forces to change the aircraft tires and transport them. Exerting high forces can contract muscles to their maximum capability which can lead to fatigue and possible damage to the muscles and other tissues. Heavy lifting can strain the back and place the worker at risk of injury.

Recommendations:

- An elevated work positioner is recommended for employees polishing the underside of the aircraft wing. A positioner will support the employee's body, allowing him to work in a neutral posture with less reaching. Refer to table two for product recommendations.
- Anti-fatigue matting is recommended to cover the mobile work platforms (table 2) and give the workers a place to sit while cleaning and polishing.
- A wheel dolly is recommended for transporting and changing aircraft tires. Product details can be found in table 2.

Table 2: Product Recommendations			
Product	Vendor	Estimated Cost	Photo
Work Positioner	Eidos (402) 466-1119  Model 117	\$1145	
Anti-fatigue Matting	Alimed 1-800-225-2610	Price varies by size	
	Lab Safety 1-800-356-0783		
	C&H 1-800-558-9966		

<b>Table 2: Product Recommendations</b>			
<b>Product</b>	<b>Vendor</b>	<b>Estimated Cost</b>	<b>Photo</b>
¾ Ton Wheel dolly	Myers Tire Supply 1-800-321-2114	\$695	
Hydraulic Wheel Dolly	Grainger	\$553	



\*Some information has been removed from this report that is specific to the activity.

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

<sup>ii</sup> 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.

<sup>iii</sup> 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.