Naval Facilities Engineering Command
Ergonomic Risk Assessment – Fire Department

Introduction

This report summarizes the ergonomic risk assessment conducted at the Fire Department in August of 2004. This assessment is based upon interviews with supervisor, safety personnel, and employees as well as an evaluation by the Naval Facilities Engineering Command (NAVFACENGCOM) Hazard Abatement Ergonomist.

The Fire Department was 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.

The Job Requirements and Physical Demands Survey (JR/PD) was administered to two shifts in the Fire Department in March of 2004. The two shifts of Fire Department personnel are identical in work schedule and duties, each alternating 24-hour workdays and will be referred to as Shift A and B. The JR/PD results indicate that Shift A is an Ergonomic Problem Area, while Shift B was not. The scores were close enough to be caused by population variance.

The JR/PD is an ergonomic assessment tool endorsed by the Department of Defense Ergonomic Working Group and used by the tri-services to collect occupational health data. The results of the JR/PD indicate Shift A at the Fire Department is an Ergonomic Problem Area (EPRA). Shift A scored an Overall or Survey Priority Rank of **five** (on a scale of 1 to 9), where nine has the highest priority for intervention. A score of five or greater indicates an Ergonomic Problem Area. The back/torso region was associated with significant ergonomic risk. Shift B scored an overall survey priority rank of **four.** Shift B reported higher risk exposure but negligible discomfort which lowered their score below an ergonomic problem area. Although employees in Shift B did not report any discomfort for specific body regions they did reply in follow-up questions that work-related pain or discomfort does not improve when they leave work overnight or over the weekend. Ergonomic risk is based upon ergonomic stressors associated with the task and employee discomfort. Thirty-nine percent of survey respondents from both shifts have seen a health care provider within the last twelve months for pain or discomfort that he or she feels is related to the job. A significant number of employees from both shifts also reported pre-existing MSDs and conditions known to be contributing factors, which places them at a higher risk of additional or more severe MSDs. Refer to Appendix I for additional information regarding the survey results.

Recommendations for the command to further reduce the probability of injury include new equipment[i] and administrative controls[ii]. Recommendations are included with as much vendor information[iii] 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.

Hazard Abatement funding requests can be submitted for Fiscal Year 2006 consideration if received by February 28 2005. Naval Facilities Engineering Command (NAVFACENGCOM) manages the 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 and in OPNAVINST 5100.23F. Ch 12 Hazard Abatement.

Fire Department

Purpose of the Operation: Responsibilities include training exercises and manning crash trucks on the flight line as well as fire fighting.

Population: 50 civilian workers

Injury Data: No recorded injuries. Seventeen employees (39%) over both shifts who completed the Job Requirements and Physical Demands Surveys have seen a health care provider for pain or discomfort that he/she feels is related to the job.

Description of the Operation:
The two Fire Department shifts are identical in work schedule and duties, each alternating 24-hour workdays and will be referred to as Shift A and B. The firefighters work one day on and one day off. After 7 shifts on they receive a 3 day break. Each work week is 72 hours.

Recent ergonomic improvements, including new crash trucks, have addressed many of the stressors associated with the firefighting operation. According to the workers, the most difficult task involves handling hoses. The fire station contains a tall hose tower used for drying hoses. The hoses are hung from the top of the tower to drip dry. Two employees are required to raise the hoses. The employees have two pulleys (one per tower side) for raising the hoses to the top of the hose tower. Standard Operating Procedure requires that only two hoses are lifted at a time but there is a tendency to add more hoses to improve efficiency. One employee standing on the floor of the hose tower attaches the hoses to the pulley and hoists it by hand, figure 1. While the employee on the ground is raising the hoses, another employee is climbing a ladder attached to the wall of the tower, figure 2. The employee uses fall protection by tying off to the ladder in order to climb to the top of the hose tower. Once at the top of the hose tower, the employee releases the fall protection and transfers to a cat walk 30 feet above the ground. From the cat walk the worker can retrieve the hose from the pulley system and place the hose on a hook on the wall for drying, figure 3. There are two sides of the fire tower, each with 13 hooks. Each hook can hold 4 hoses. After the hoses are dried, they are spread out on the ground, hand rolled and carried to the firehouse, figures 4 and 5.

The fire station uses 50 foot long hoses. The hoses are a combination of cotton jacket hoses and new Darcon hoses. Hoses come in 1” to 3” diameters and can weigh up to 60 lbs. when wet. Every three months all the hoses are tested and hung to dry. The fire station has about 1500 feet of hose.

Figure 1: Using a pulley to raise hoses

Figure 2: Climbing the ladder

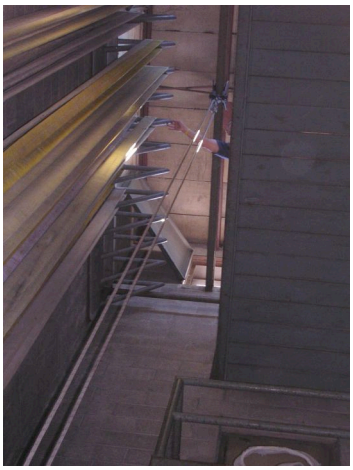

Figure 3: Placing a hose on the hook from the catwalk

Figure 4: Rolling hose

Figure 5: Carrying hose

Ergonomic issue description:

Standing on a catwalk 30 feet above ground without fall protection is a possible safety hazard. The ergonomic hazards associated with this task involve heavy and repetitive lifting.

Heavy and Repetitive Lifting: The pulley is used to raise two wet hoses weighing up to 120 lbs. According to Military Standard 1472F, vertical pull forces, using two hands, should not exceed 113 lbs. for men and 49 lbs. for women. Although using a pulley reduces the pull forces required for the lift below the actual weight of the load, adding more hoses than allowed by the SOP will exceed the recommended weight limit. The stress to the back and hand forces are magnified when lifting is being performed repetitively throughout the day. Carrying heavy loads such as hoses and ladders can also place stress on the back. According to Military Standard 1472F a male population shouldn't carry more than 82 lbs or 42 lbs. if the population is mixed male and female. Heavy, repetitive lifting and carrying may have contributed to the significant JR/PD score for the back and torso region.

Recommendations

- Installing an electric pulley in the hose tower will reduce the effort required to raise the hoses as well as increase productivity by improving the pulley capacity. Refer to table 1 for vendor information.

- A man lift will reduce the fall hazards associated with climbing the ladder and walking on a catwalk. From the lift, the worker can retrieve the hose from the pulley and place it on a hook. Refer to table 1 for vendor information.

- A hose dryer will help reduce the need for hanging hoses to dry. The dryer can also be used for turnout gear in under 3 hours. Hoses take up to 8 hours. Additional hose equipment can reduce material handling. Refer to table 1 for vendor information.

Table 1: Fire Department

Description	Vendor	Product	Estimated Cost	Figure
Electric Winch	Lab Safety 1-800-356-0783	Thern Portable Power Winch	$1621	
	Grainger	Electric Winch 1000 lb. capacity single line pull.	$391	
	Lab Safety 1-800-356-0783	Electric chain hoist 1000 lb. capacity	$1660	

Personnel Lift	Ballymore 610-696-3250	MRO Telescoping Hydraulic Maintenance Lifts 2 person 500 lbs. capacity 28' platform height http://www.ballymore.com/ldstep15.htm	$10,485 (AC) $10,670 (battery)	
	Grainger	Aerial Work Personnel Lift, Capacity 350 Pounds, Work Height 36 Feet, Power Source AC	$6235 (AC)	
	Lab Safety 1-800-356-0783	Hydraulic Maintenance Lift 30' platform height	$8215 (AC) $8385 (battery)	
Hose Accessories	American Airworks 1-800-523-7222	Hose dryer http://www.americanairworks.com/hosedry.html	$12,750	

	American Airworks 1-800-523-7222	Tilt Top Hose Turntable	$1525	

Appendix I
Naval Facilities Engineering Command
Job Requirements and Physical Demands Survey

Fire Department

Introduction

The Job Requirements and Physical Demands Survey (JR/PD) was administered to the Fire Department. The results of the JR/PD indicate that Shift A is an Ergonomic Problem Area (EPRA). The activity scored an Overall or Survey Priority Rank of **five** (on a scale of 1 to 9), where nine has the highest priority for intervention. The survey indicates the presence of both ergonomic risk factors and discomfort for a majority of the workers. The JR/PD assesses five distinct body regions: shoulder/neck, hand/wrist/arm, back/torso, leg/foot, and head/eye. The (body region) priority scores are a combination of identified ergonomic risk factors and employee reported discomfort. The **back/torso** region received the highest priority score. A significant number of employees also reported pre-existing MSDs as well as conditions recognized as contributing factors for MSDs, which places them at a higher risk of additional or more severe WMSDs.

Information regarding the development, instruction, and validation of the JR/PD can be found on the US Air Force web site at http://www.brooks.af.mil/afioh/Health%20Programs/ergonomics_jrpd.htm
The JR/PD is an ergonomic assessment tool endorsed by the Department of Defense Ergonomic Working Group and used by the tri-services to collection occupational health data.

Survey Analysis for Shift A

Overall Priority Score

The results of the JR/PD indicate the Shift A is an ergonomic problem area with an overall score of **five**. An Overall Job Priority score of five or greater establishes a task/job as an ergonomic problem area. The Overall Job Priority score is determined by selecting the highest Body Region Score for the job which in this case is the back/torso region.

The Overall Priority Rating Score is used to determine which jobs or areas are associated with the most significant ergonomic risk. It is important to note that a high Overall Priority Score (i.e. ergonomic problem area) does not necessarily mean that the risk of illness associated with a job or area is high. Rather a high rating indicates that the tasks expose workers to a considerable level of risk factors associated with WMSDs in comparison to jobs/tasks or areas that receive lower scores.

Demographics

19 (workers/respondents) from Shift A completed the JR/PD survey resulting in a **response rate of 76%**. The population is **95% male and 5% female,** and **100% civilian**. **11%** of the workers are between the ages of **21 and 30**, **47%** are between **31 and 40, 37%** are over 40. Age is a contributing factor for the development of WMSDs.

Priority Score

The JR/PD prioritizes five distinct body regions based upon a combination of ergonomic risk factors and discomfort. Workers indicate their duration of exposure to different ergonomic risk factors. Ergonomic risk factors include posture, force, frequency, repetition, vibration, contact stress, and restrictive personal protective equipment. The frequency and severity factors are combined to evaluate discomfort in each of the five body regions. Table 1 demonstrates the relationship between body region, discomfort, and risk. The back/torso region has a significant score.

Table 1 Body Region, Discomfort and Risk

		BODY REGIONS				
		Shoulder/ Neck	Hand/Wrist /Arm	Back/ Torso	Leg/ Foot	Head/ Eye
Priority Score		3	1	5	2	1
Risk	**Prevalence**	26%	21%	37%	42%	26%
	Rating	Low	Low	Medium	Medium	Low
Discomfort	**Prevalence**	37%	11%	32%	5%	5%
	Rating	Medium	Low	Medium	Low	Low

Risk Prevalence and Rating

The percentage of respondents exposed to specific ergonomic risk factors for a given body region, for longer than two hours per day, assesses the prevalence of risk. A low rating represent less than 30% prevalence, medium 31% to 60% and high is greater than 61% of the respondents have exposure greater than 2 hours per day. The back/torso and leg/foot body regions have medium risk prevalence.

Discomfort Prevalence and Rating

The terms fatigue, numbness, and pain categorize discomfort. The percentage of respondents and their discomfort ratings determine whether discomfort is prevalent among the workers. Combinations of frequency and severity that indicate significant discomfort prevalence are shown with asterisks in Table 2. Low ratings represent less than 30% prevalence, medium 31% to 60% and high is greater 61%. The back/torso and shoulder/neck have medium discomfort.

Table 2: Discomfort Matrix

		SEVERITY	
FREQUENCY	Mild	Moderate	Severe
Daily	*	*	*
Weekly		*	*
Monthly			*

The Priority matrix in Table 3 determines the overall prioritization of specific body regions. The relationship between discomfort and risk factors determines priority rating from 1 to 9 for each body region. A priority greater than four, indicated by an asterisk, is significant. The Overall Priority ranking for Shift A is equal to the highest body region priority value, which is five.

Table 3 Priority Matrix

	DISCOMFORT		
RISK FACTOR	High	Medium	Low
High	9*	7*	4
Medium	8*	5*	2
Low	6*	3	1

Organizational Information

Organizational factors contribute to ergonomic stressors. The organizational score for this area was **low**, which indicates job stress factors are not likely present. Survey respondents were asked if they understood their job responsibilities, if their workload was too heavy, if they are able to get pertinent information, if they received comments on performance, etc. Suggestions to improve stress associated with organizational

factors include providing workers with more autonomy and improving discussion and feedback between workers and supervisors.

Physical Effort

The survey resulted in a perceived physical exertion score of **10.6**. Respondents were asked to describe the physical effort required of their job on a scale of 1 to 15 where one is no exertion at all and fifteen is maximal exertion. The higher the score, the greater the level of perceived physiological exertion. A value of 10 is hard indicating a highly physically demanding task.

Health Care Provider Score

According to the health care provider score, **7 (37%)** of the employees reported visiting a health care provider in the last 12 months for pain or discomfort that he/she thinks is related to his or her job. In shift B, **10** workers **(40%)** have seen their health care provider.

Recovery Time Score

5.26% of the respondents reported experiencing work-related pain or discomfort that does not improve when away from work overnight or over the weekend. A score above 30% is of high importance. Lasting pain/discomfort is an indicator of inadequate recovery time for the muscles, tendons, and ligaments. Muscles, tendons, and ligaments that do not recover are more likely to be injured. A significant number of the employees in Shift B (**44**%) reported experiencing work-related pain or discomfort that does not improve when away from work overnight or over the weekend.

Activity Interruption Score

47.37% of the respondents indicated that in the past 12 months, work-related pain or discomfort has caused difficulty in carrying out normal activities (e.g. job, hobby, leisure, etc.). A score above 50% is of high importance.

Previous Diagnosis Score

The survey asks if “a health care provider ever told you that you have any of the following conditions which you think might be related to your work?

Tendonitis/Tenosynovitis
Trigger Finger
Bursitis
Thoracic Outlet Syndrome
Overuse Syndrome”
Ganglion Cyst
Epicondylitis (Tennis Elbow)
Carpal Tunnel Syndrome
Back Strain, Knee or Ankle Strain

26.32% of respondents indicated affirmatively. Pre-existing WMSDs can contribute to an employee's pain and discomfort levels; thereby affecting the overall priority score. Working conditions may exacerbate a pre-existing disorder. Workers with pre-existing WMSDs are likely to experience additional or more severe WMSDs if the environment is unchanged. Shift B also had a significant previous diagnosis score.

Contributing Factors

Respondents were asked if they had ever had one or more of the following conditions:

Wrist Fracture	Hypertension	Kidney Disorders
Thyroid Disorders	Diabetes	Gout
Rheumatoid Arthritis		

21.05% of the respondents indicated positively. These health conditions are contributing factors and may increase one's risk of developing a musculoskeletal disorder; thereby affecting overall priority. Shift B also had a significant contributing factors score.

Process Improvement Opportunities- Shift A & B

This section of the survey allows employees to write in responses to questions. All statements are included exactly as written by the employees with the exception of spelling errors and expletives. Responses were also taken from a discomfort survey, which was distributed to the population.

1. Which tasks are the most awkward or require you to work in the most uncomfortable position?
   - ∞ Inspections in crowded areas
   - ∞ Lifting hose up tower
   - ∞ Fire fighting
   - ∞ Crawling on floor in smoke filled environment. Firefighting activities.
   - ∞ HAZMAT incident wearing Level A suits in confined space
   - ∞ Entering structures and aircraft on fire and putting the fire out
   - ∞ Hazardous materials response and remediation fire extinguishment in structures, aircraft and wildlands
   - ∞ Going in to burning structures and putting [out] fire
   - ∞ Duty crew. Sitting in a crash truck up to 8 hours a day
   - ∞ Duty crew (sitting in a truck)
   - ∞ Sitting duty crew on ARFF vehicles (airport fire apparatus)
   - ∞ Wearing Hazmat suits
   - ∞ Overhead
   - ∞ Fire operation

- ∞ Ladder work or confined space areas
- ∞ Duty crew- need a job requirement and physical demand survey for that.
- ∞ Long periods of standing
- ∞ Duty crew
- ∞ Sitting in a crash truck for long periods of time on duty crew
- ∞ Sitting on duty crew in truck
- ∞ Removing ladders from trucks. Sitting for hours in truck (duty crew)
- ∞ Sitting in truck up to 3 hour covering flight line duty crew
- ∞ Firefighting
- ∞ Climbing hose tower ladder, reaching out to pull hose off rope and drape over holders
- ∞ Using my workstation
- ∞ Hose tower pulley and lifting hose by hand with pulley requires bending over a rail and stretching up my upper body to reach.
- ∞ Lifting cotton jacketed fire hose.
- ∞ General firefighting duties.
- ∞ Sitting in crash truck during duty crew.
- ∞ Hauling hose up in hose tower and hanging on hooks. Crawling in trainer- need knee pads.

2. Which tasks take the most effort
   - ∞ Turning valves, walking
   - ∞ Lifting hose
   - ∞ Fire fighting
   - ∞ Fire fighting activities.
   - ∞ Rescue, fire fighting, confined space rescue
   - ∞ Salvaged overhaul
   - ∞ Performance emergency operations while wearing firefighting PPE or fully encapsulated suites and breathing compressed air while performing strenuous tasks under stress
   - ∞ Rescue and firefighting
   - ∞ Overhaul- salvage
   - ∞ Fire suppression and wearing and operating in fully encapsulated Haz-mat gear
   - ∞ Fighting fires/Hazmat
   - ∞ Fire operations
   - ∞ Showing up here everyday
   - ∞ Hanging hose in the hose tower
   - ∞ Fire fighting in general
   - ∞ Working on back
   - ∞ Firefighting
   - ∞ Pull hose beds and re-loading hose bed.
   - ∞ Hose tower pulley and loading hose on trucks. Daily cleaning.
   - ∞ Lifting cotton and vinyl jacketed fire hoses (1.5” to 5”)
   - ∞ Active fire duties
   - ∞ Fighting fire

3. Are there any tools or pieces of equipment that are notoriously hard to work with?

- ∞ Winch
- ∞ Yes- hoist tool
- ∞ Amertex crash truck, MSA air pack
- ∞ Hoisting hose by hand for drying
- ∞ Communication while encapsulated in a Hazmat suit with a SCBA on.
- ∞ Hurst tool
- ∞ Electric winch for hose tower
- ∞ Crash trucks
- ∞ Vehicle extraction equipment
- ∞ Hose tower pulley and 4" hose and heavier generators.
- ∞ Hose tower hoisting system. Totally manual pull (rope block and tackle)
- ∞ There are no ergonomic equipment in the station. Should outfit entire station.
- ∞ Hose block and tackle in tower. Hose turn table.

4. If you could make any suggestions that would help you do your job more easily or faster or better, what would you suggest.
   - ∞ Electric winch for hose tower
   - ∞ New crash trucks, new air packs
   - ∞ New equipment
   - ∞ Electric winch to raise hose in the hose tower
   - ∞ Electric winch for hoisting gear
   - ∞ New equipment
   - ∞ Electric motorized winch for hose tower
   - ∞ Get rid of duty crew
   - ∞ Upgrading work-out equipment, for a more user friendly environment.
   - ∞ Electric winch in hose tower, hand trucks
   - ∞ To have a plan for the task.
   - ∞ Quit wasting my time with these things
   - ∞ Electric winch for hose tower, better trucks for duty crew, better station (fire station)
   - ∞ An electric winch in our hose tower
   - ∞ Put a crane in hose tower
   - ∞ Electric winch for hose drying tower
   - ∞ Hose tower crane
   - ∞ New apparatus which has pull out boards to place tools on with hyd. Hoses pull from back to hook-up to tools. Electro-mechanical winch for hose tower.
   - ∞ Ergonomic equipment. New working conditions
   - ∞ Electric pulley for hose tower.
   - ∞ Replace hose tower hoisting system (manual) to electrical hoist.
   - ∞ Need to update entire station so meet the most recent standards.
   - ∞ Power lifter in tower. Rebuild turn table. Provide knee pads in bunker or for trainer fires.

[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.