Naval Facilities Engineering Command

Ergonomics Risk Assessment

Introduction

This report summarizes the ergonomics risk assessment conducted on June 15th, 2006. The Model Fabrication Facility was observed in order to determine sources of ergonomic stress and recommend improvements. This assessment is based upon interviews with employees, supervisors, and industrial hygienist as well as an evaluation by the Naval Facilities Engineering Command (NAVFACENGCOM) Hazard Abatement and Mishap Prevention (HAMP) occupational ergonomist. The ergonomist could not bring a camera into NSWC; therefore, photos from similar operations were substituted.

The risk assessment was conducted in conjunction with the Job Requirements and Physical Demands Survey (JR/PD). The JR/PD is an ergonomics survey designed to assess ergonomic risk in the workplace. The results of the JR/PD indicate the Model Fabrication Facility is an ergonomic problem area with a score of **9** on a scale of 1 to 9 where 9 is a maximum value. The JR/PD assesses five distinct body regions: shoulder/neck, hand/wrist/arm, back/torso, legs/feet, and head/eyes. All the body regions except for head/eye were found to have significant ergonomic risk. Ergonomic risk is based upon ergonomic stressors associated with the task and employee discomfort. A significant number of employees reported experiencing work-related pain or discomfort that does not improve when away from work. Sixty-four percent of the survey respondents have seen a health care provider within the last twelve months for pain or discomfort that he feels is related to the job. A significant number of employees also reported pre-existing Musculoskeletal Disorders (MSDs) as well as illnesses recognized as contributing factors, which places them at a higher risk of additional or more severe Work-Related Musculoskeletal Disorders (WMSDs). Appendix I contains a summary of the JR/PD results as well as a description of the methodology.

The operations reviewed present the opportunity to reduce the risk of WMSDs. Recommendations to the command to reduce the probability of injury include equipment purchase[1], process redesign, and implementation of administrative controls[2].

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.

Representative vendor information is included in the recommendations to assist in the evaluation of products and services[3]. Recommendations to 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. This activity is eligible to apply for funding. The application deadline for FY08 funding is February 28th, 2007.

Model Fabrication Facility (MFF)

Purpose of the operation: The MFF fabricates small scale models or mock-ups of ship and submarine components for testing and evaluation. The shop typically builds one-of-a-kind products with very specific design requirements. The shop also supports Public Works and Facilities at the activity. The MFF primarily performs welding and sheet metal operations.

Population: Twelve to thirteen civilian employees including welders, sheet metal workers and a rigger. Workers can spend up to 14 hours working per day during periods of heavy production.

Injury Data: Employees mentioned carpal tunnel syndrome, torn shoulder ligament, tendonitis in the shoulder and elbow, herniated disc, and back injuries. Sixty-four percent of the JR/PD survey respondents have seen a health care provider within the last twelve months for pain or discomfort that he feels is related to the job.

According to the command, back injuries are the most frequently occurring injury for this shop. Most back injuries were related to heavy lifting between 50 and 100 lbs. Between 1998 and 2002 there were 9 ergonomics related injuries in this shop including 6 back strains, 2 instances of right shoulder pain and 1 reported elbow strain.

Description of the Welding Operation: The shop fabricates prototypes which can be up to 600 feet long using steel, aluminum, and stainless steel. The entire construction process is completed using welding and sheet metal fabrication. There are usually 7 welders including 2 in training.

Welding is the most common way of permanently joining metal parts. In this process, heat is applied to metal pieces, melting and fusing them to form a permanent bond. The welding shop performs welding operations inside the shop and outdoors. In addition to sustained awkward postures, welding requires frequent heavy lifting and carrying. Employees weld on fixed height tables in the shop or for larger pieces they weld directly onto the structure. For larger structures the welders carry 100 lb. gas cylinders, figure 1, on top of the unit they are working on in order to weld. Workers can spend 2-3 days at a time working on a large structure with multiple welders working simultaneously. The welding shop doesn't have enough room for the large structures so work is performed outdoors.

Figure 1: Bottles of compressed gas (photo from SERMC)

Ergonomics Issue Description: Welders are exposed to a number of hazards, including the intense light created during welding, poisonous fumes, and very hot materials. The major ergonomic risk factors associated with welding are awkward posture and heavy lifting. Workers sustain awkward postures while performing welding operations. Moving parts and supplies for welding requires heavy lifting. The chances of developing WMSDs are increased when risk factors (e.g. awkward posture and force) occur in combination, especially for significant frequency and duration.

Sustained Awkward Postures: Workers assume sustained awkward postures during welding operations. Welding on the floor causes workers to squat or kneel which places biomechanical stress on the knees which can lead to fatigue and discomfort, figure 2. 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.

Workers perform shop welding on fixed height work surfaces. When the work item can not be raised and angled towards the worker, the worker has to adjust his or her body to view and reach the work. Ergonomics related stressors associated with welding include neck inclinations, bent back postures, non-neutral arm positions, wrist deviations, and contact stress to the lower extremities, figure 3. Working on top of and inside models also forces employees to maintain awkward postures in order to perform repairs in constrained spaces. The muscles must apply considerably more contraction force to maintain awkward postures. 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 can be 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. Awkward postures increase the muscular effort required

to do the task. The longer or more frequently static loading occurs, the greater the risk of injury due to overuse of muscles, joints, and other tissues.

Figures 2 and 3: awkward postures during welding
(Photos from MCLB Barstow)

Workers who use traditional welding hoods have a tendency to lower the shield with a jerking motion of the neck to snap it shut. Frequent, abrupt neck motions can put stress on the neck and spine.

Excessive Lifting: The workers risk injury from forceful exertions caused by handling components and moving materials such as gas cylinders. Forceful exertions can place high loads on the muscles, tendons, ligaments, and joints being used. Increasing the force required to lift a load also means increasing body demands (i.e. greater muscle exertion is necessary to sustain the increased effort) and imposing greater compressive forces on the spine. As force increases, muscles fatigue more quickly. Prolonged or frequent exertions of this type can lead to WMSDs when there is not adequate time for rest or recovery.

Prolonged Standing: Workers stand for most of the day on concrete. Standing for long periods of time can be a strenuous activity that promotes blood pooling in the legs and feet and has been known to produce discomfort and fatigue. Prolonged standing may have contributed to the leg/foot discomfort in the JR/PD results.

Compression: Workers weld while kneeling on concrete, which places biomechanical stress / compression on the knees that can lead to fatigue and discomfort. 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. Worker also rest their elbows while welding which can place stress on nerves and elbow joint.

Vibration: Welders use pneumatic and electric grinders which expose the worker to vibration. The National Institute of Occupational Safety and Health conducted a critical review of epidemiological evidence for work-related musculoskeletal disorders of the

neck, upper extremity, and low back. The review found strong evidence of a positive association between high level exposure to hand-arm vibration and vascular symptoms of hand-arm vibration syndrome (HAVS). For example, vibration can result from bad design, poor maintenance, and age of powered hand tools. New powered hand tools can still expose employees to excessive vibration if they do not include devices to dampen the vibration or shield the operator from it. There is substantial scientific evidence that as intensity and duration of exposure to vibrating tools increases so does the risk of developing HAVS.

Temperature Extreme: The space constraints in the welding shop forces work on large structures to be performed outdoors. Temperature extremes are considered a contributing factor that do not cause WMSDs but can increase the risk of developing one when combined with physical job-related factors. Average area temperatures range from 24° to 89° F (according to weather.com). Working in cold temperatures can affect a worker's coordination and manual dexterity and cause a worker to use more force than is required to perform the task. Warm temperatures can increase physical demands on the worker and can lead to heat-related illness. Personal protective equipment such as welding helmets and protective clothing can trap perspiration, increase internal temperatures, and contribute to dehydration.

Recommendations:

- ∞ Auto-darkening welding helmets will reduce awkward neck motions associated with lowering traditional hoods. The auto-darkening feature also reduces the likelihood of welding without proper eye protection. Refer to vendor table 1.
- ∞ Tool stools or a welding creeper will allow workers to weld at or near floor level in a more neutral posture. Tool stools used in the welding area need to be non-flammable and OSHA approved. Height adjustable chairs can also improve comfort at seated welding stations. Refer to vendor table 1.
- ∞ Adjustable ergonomic welding creepers and/or adjustable workstation will promote neutral working postures. Refer to vendor table 1.
- ∞ Cylinder carts could be used for moving heavy gas cylinders. Refer to vendor table 1.
- ∞ Non-flammable anti-fatigue mats can improve comfort levels for workers that stand in one area. Inner soles can help workers moving throughout the shop. Refer to vendor table 1.
- ∞ Knee pads and elbow pads can help reduce contact stress while kneeling or leaning to weld. Refer to vendor table 1.
- ∞ Safety glasses with light emitting diodes will help promote neutral posture while reading permits and doing layouts. Refer to table 1. Contact Public Works regarding light levels in the welding shop.
- ∞ A crane or lift device may help employees reach the top of the large structures they work on and help transport heavy gas cylinders. Refer to vendor table 1.

- ∞ Lower vibration tooling and vibration lowering gloves can help reduce vibration exposure. Only full-fingered gloves that conform to ISO 10819 Standard should be considered. Refer to vendor table 1.
- ∞ During extreme weather conditions outside work should be performed in a protected area whenever possible to reduce the effects of the sun and the wind. Work rest cycles and hydration breaks should be strongly encouraged as well as trying to avoid the hottest or coldest times of the day.

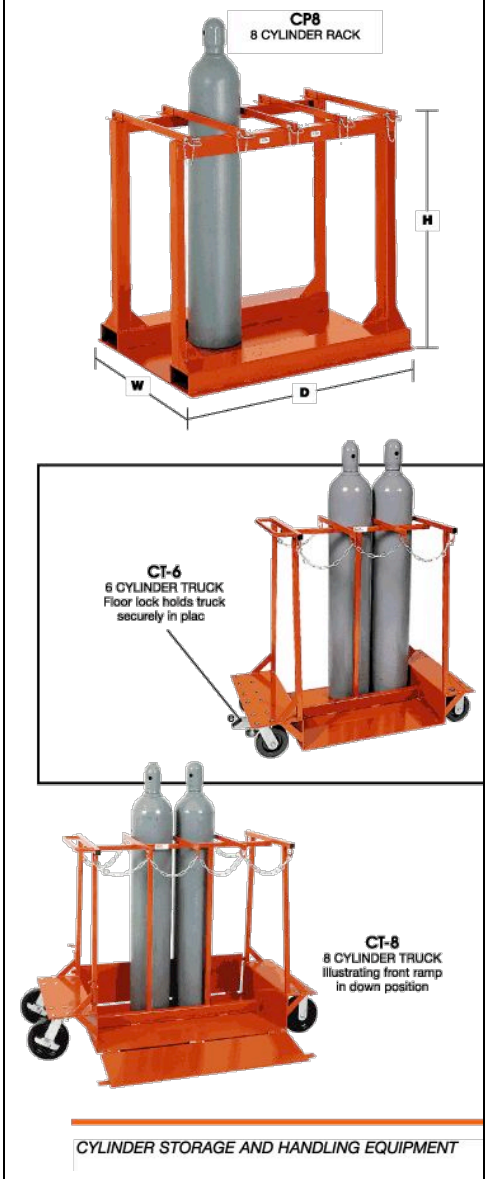
<table>
<tr><td colspan="4">Vendor Table 1- Welding Operation</td></tr>
<tr><td>Product</td><td>Vendor</td><td>Estimated Cost</td><td>Figure</td></tr>
<tr><td rowspan="3">Auto-darkening helmets</td><td>Grainger</td><td>$148- $263</td><td rowspan="3">  </td></tr>
<tr><td>Peaklogix

703-819-6061</td><td>$164</td></tr>
<tr><td>Lab Safety

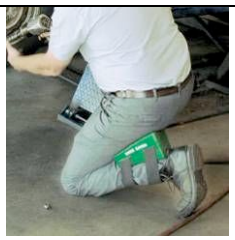
1-800-356-0786</td><td>$447-$486</td></tr>
<tr><td>Welding Creeper</td><td>Eidos Corp
800 210 9666
Model # 110</td><td>$170</td><td>  </td></tr>
</table>

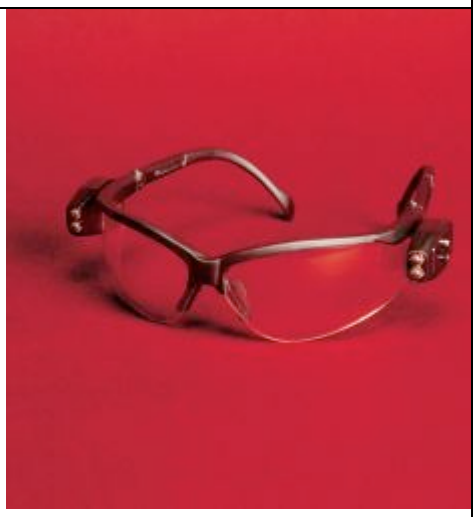
Vendor Table 1- Welding Operation			
Product	Vendor	Estimated Cost	Figure
Height and angle adjustable welding tables http://www.plasmasouth.com/forster/Ergonomic_Solutions.htm	Plasma South, Inc 1-256-314-1314	*Call for product pricing	  

Vendor Table 1- Welding Operation			
Product	Vendor	Estimated Cost	Figure
Gas Cylinder handling equipment	Grainger Cylinder Carts	$150-$300	
	C& H 1-800-558-9966 Double cylinder truck with hand break	$800-$963	
	Lab Safety 1-800-356-0786 Poly-cylinder Dollies	$141-$294	
	Wesco Industrial products 215-699-7031 Capacity 300 lbs Foot operated hydraulic pump or manual winch with auto-brake available	Call for pricing	

Vendor Table 1- Welding Operation			
Product	Vendor	Estimated Cost	Figure
	Peaklogix 703-819-6061 6 cylinder truck with 1500 lb. capacity.	$593	

Vendor Table 1- Welding Operation			
Product	Vendor	Estimated Cost	Figure
	Vestil Manufacturing 1-800-348-0868 Cylinder Caddy	Pricing depends on 4 cylinder or 6 cylinder	
Anti-fatigue matting for welding area	Peaklogix 703-819-6061 Flame retardant "Weldsafe Mat" 2' x 3' with beveled edge	$39	
Inner-soles	Guard Industries *Recommended by NADEP Jax 1-314-534-6952	Body Cushion #3059 Hiker/casual insoles $5.21	
	Alimed 1-800-225-2610	$19 a pair	
	Polymer Dynamics 1-800-287-4466	$10 a pair	
Angle adjustable creepers	Eidos Corp 1-800-210-9666	Price depends on features	
	Northern Tool & Equipment Co 800-221-0516	$60	

Vendor Table 1- Welding Operation			
Product	Vendor	Estimated Cost	Figure
	Whiteside 470 363 1179	$147	
	Lab Safety 1-800-356-0783	$114	
High Lift Elevating Creeper	Eidos 1-800-210-9666	$600	
	Grainger 4,000 lb. capacity 14' wide	$1311	
	Global Industrial 1-800-645-1232 8,000 lb capacity 15' wide (14' usable)	$1731	
Knee pads	Lab Safety 1-800-356-0783	$16	
	Grainger	$10-$36	
	Alimed 1-800-225-2610	Industrial Knee Saver	

Vendor Table 1- Welding Operation			
Product	Vendor	Estimated Cost	Figure
Elbow Pads	Lab Safety 1-800-356-0783	$14-$25	
Safety glasses with LED lights	Sears Craftsman	$20	
Tool Stools	Lab Safety 1-800-356-0783	$199	
	C&H 1-800-558-9966	$156	
	Grainger	$203	
	Alimed 1-800-225-2610	$19-$40	

Vendor Table 1- Welding Operation			
Product	Vendor	Estimated Cost	Figure
Chairs	Lab Safety 1-800-356-0783	$200-$300	
	Grainger	$200-$400	
Universal Lift	Peaklogix 1-703-819-6061	$35,000	
Reverse Counterweight Floor Crane	Lab Safety 1-800-356-0783 Up to a 2,000 lb. capacity	$1523-3025	

Vendor Table 1- Welding Operation			
Product	Vendor	Estimated Cost	Figure
	Ballymore 1-800-762-8327 Tank top lift	Pricing depends on features.	
Vibration Reducing Gloves	Impacto Air Glove 1-888-232-0031 Ergodyne Proflex 1-800-225-8238 Chase Ergonomics Decase 1-800-621-5436	Pricing depends on quantity	
Lower vibration tools	Atlas Copco 800 654 5965 Dynabrade 716 631 0110	Price depends on tool	

Description of the Sheet Metal Operation:
Workers perform a variety of machining operations in order to fabricate models and prototypes which require precision and attention to detail. Shop personnel are highly skilled in machine and tool operations. The employees reported the most difficult tasks are lifting and carrying materials. Employees also reported fatigue after standing at machines for extended periods.

Ergonomic issue description:
Heavy Lifting: Workers perform heavy lifting while retrieving heavy stock and loading it into machines. Workers also change the dies hundreds of times a month because their production is all unique projects. Dies can weigh up to 300 lbs. and are 5-10 feet long. Workers load the dies by hand. The workers risk injury from forceful exertions caused by lifting and holding the heavy dies in awkward postures. Personnel also risk injury from handling large, heavy sheet metal.

Forceful exertions can place high loads on the muscles, tendons, ligaments, and joints being used which results in increased body demands and imposes compressive forces on the spine. As force increases, muscles fatigue more quickly, especially when combined with awkward postures. Prolonged or frequent exertions of this type can lead to WMSDs when there is not adequate time for rest or recovery.

The Department of Defense Design Criteria Standard for Human Engineering (MIL-STD-1472F) addresses lifting objects. According to MIL-STD1472F, one male worker can safely lift an object up to 87 pounds from the floor and place it on a surface not greater than 36" from the floor. This recommended weight is reduced to 44 pounds for a female worker. Two male workers can lift 174 pounds under the same circumstances. The recommended weight limit is reduced to 88 pounds if one or both of the workers are female. The recommended weight limit is exceeded for dies weighing up to 300 pounds. Exceeding the recommended weight limit places the workers at increased risk of back injury.

Static and Awkward Postures: Employees frequently support the sheets of metal for cutting or bending as shown in figure 4. Supporting heavy metal in a static and awkward posture can cause the muscles to fatigue. Static sustained postures reduces blood flow which supplies the muscles with nutrients and carries away waste products Without adequate rest to re-oxygenate the muscles, lactic acid will build up and result in muscle fatigue. Muscle fatigue can be a precursor to WMSDs.

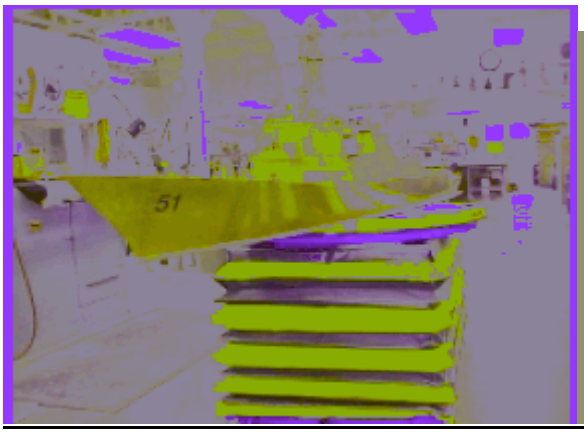
Prolonged Standing: Workers stand for most of the day on concrete. Standing for long periods can be a strenuous activity that promotes blood pooling in the legs and feet and has been know to produce discomfort and fatigue. Prolonged standing may have contributed to the leg/foot discomfort in the JR/PD results.

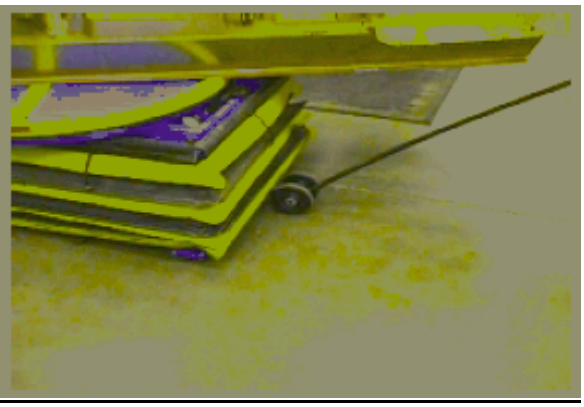
Figure 4: Holding metal stock (photo from USNO)

Vibration: Workers are exposed to high levels of vibration while using the planeshing machine to create compound curves. The planesher shapes metal through repeated impact. To create a cone shape from sheet metal, employees spend weeks pounding metal using a bowl shaped attachment on the planesher. Although infrequent, this job is very physically demanding.

Recommendations:

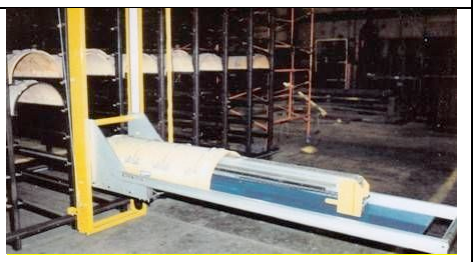
- Anti-fatigue mats can improve comfort levels for workers that stand in one area. Inner soles can help workers moving throughout the shop. Refer to vendor table 1.
- A height adjustable table could be used to support the weight of the metal sheets while loading machines. An optional roller top table would help assist with loading sheet metal. See table 2.
  Refer to success story from the model shop at Point Loma.
  http://safetycenter.navy.mil/success/stories/0-50/0048.pdf





- In order to reduce the ergonomics related stressors associated with loading heavy dies into machines, MCLB Barstow cut the dies in half (max. weight 150 lbs.). If space permits, a die retrieval system could be used to load the machine. Refer to vendor table 2.
- Mobile sheet metal carts and pull-out sheet metal storage will help facilitate the movement and storage of sheet metal through the shop. Refer to vendor table 2.
- A small English wheel may reduce vibration exposure by allowing workers to perform light work on a wheel instead of the planesher.
- In order to remove excess metal (1/4" and 1/8" steel) that falls behind the shear a mobile gantry is recommended. The shop will need to arrange for the electrical and air lines to be relocated. A sheer conveyor and stacker may also address this issue if space permits. Refer to vendor table 2. A reverse floor crane (vendor table 1) may help pick up blanks from the sheer or other heavy items in the shop.
- New magnets/suction cups or a vacuum lift device may help move sheets of metal. Refer to vendor table 2.

Vendor Table 2 – Sheet metal			
Product	Vendor	Estimated Cost	Figure
Scissors Lift Table	Grainger 1,000 lb. capacity 63"x32" platform Height adjustable from 11" to 36"	$785	

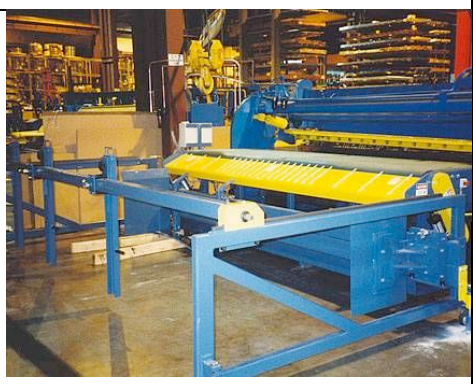
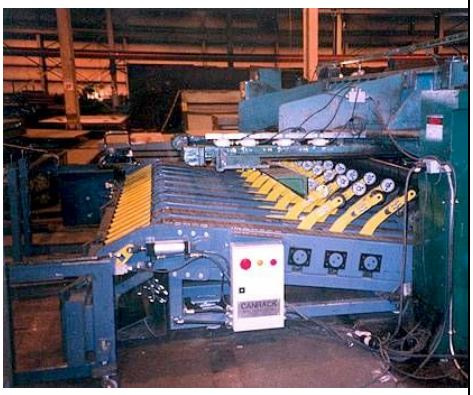
Vendor Table 2 – Sheet metal			
Product	Vendor	Estimated Cost	Figure
	Lab Safety 1-800-356-0783 1650 lb. capacity 20.5” x 39.75” platform	$1089	
	Peaklogix Scissor lift cart with roller top 1-703-819-6061	Price depends on size and capacity	
Die handling	Green Line Manufacturing Company (440) 439-2900 http://www.allcorrugated.com/automated_corrugated_die_stora.html Smedberg machine corp. 773-734-3064 http://www.smedbergmachine.com/htm/qick_die.htm	Price depends on system	

Vendor Table 2 – Sheet metal			
Product	Vendor	Estimated Cost	Figure
	Atlas Technologies 810-629-6663 www.atlastechnologies.com/		
Panel Mover/Sheet truck	Grainger Panel truck 4000 Pounds, Caster 5 x 2 Inches Polyurethane, Length 36 Inches, Height 34 Inches, Width 29 1/2 Inches	$476	
	C&H 1-800-558-9966 Price depends on capacity, size and number of uprights.	$335-$555	
	Lab Safety Panel Truck 1-800-356-0783	$267-$376	
Sheet Metal Storage	Rack America 484 224 3058 http://www.rackinternational.com/sheetmaster.html	Price depends on system	

Vendor Table 2 – Sheet metal			
Product	Vendor	Estimated Cost	Figure
	Warehouse rack and shelf (2) http://www.rackandshelf.com/SheetStorageRack.aspx		
	TEC Saw http://www.tecsaw.com/sheetmetal.html		
	FMG http://www.fmg.ch/sheet-metal-storage-systems-compact-tower.asp		 (NADEP Jax photo)

Vendor Table 2 – Sheet metal			
Product	Vendor	Estimated Cost	Figure
Angled sheet metal storage	Southworth (800) 743 - 1000 http://www.southworthproducts.com/Display/ProdSeriesCombo.asp?Seriesid=32&t=Upenders+and+Tilters	Call for pricing	
	Peaklogix 1-703-819-6061 Cantilever storage racks	Call for pricing	

Vendor Table 2 – Sheet metal			
Product	Vendor	Estimated Cost	Figure
Vacuum Lift devices	Vac-lift.com Capacity up to 22,500 lbs. **832-615-9110**	Pricing depends on system	 
Sheer Feeder	Metal Center Systems http://metalcentersystems.com/cnc_shear_feeders.asp# http://metalcentersystems.com/shear_conveyors_stackers.asp	Price depends on system	
Sheer Conveyor and stacker	Metal Center Systems http://metalcenterssystems.com/shear_conveyors_stackers.asp	Depends on configuration	

Vendor Table 2 – Sheet metal			
Product	Vendor	Estimated Cost	Figure
	Canrack Shear Conveyor http://www.canrack.com/ShearConveyor.htm		
	Met-fabrication Inc http://www.met-fabinc.com/m/fabrication5.html		
Magnets and Handles	Bunting Magnets http://www.buntingmagnetics.com/mag-main-sheet.cfm	Magnetic handle MH100 capacity 100 lbs. $182	
	Anver http://www.anver.com/document/vacuum%20handcups/hndcup-pump.htm	Hand vacuum cup $165	

Vendor Table 2 – Sheet metal			
Product	Vendor	Estimated Cost	Figure
Gantry Crane	Lab Safety 1-800-356-0786	Price depends on size and capacity	
	Grainger		
	Global Industrial 1-800-645-1232		
English Wheel	Westwood 1-800-544-5118	$549	
	Irvan Smith 1-800-221-RACE	$2600	

Vendor Table 2 – Sheet metal			
Product	Vendor	Estimated Cost	Figure
	Northern Tool 1-800-221-0516	$599	

Appendix I

Job Requirements and Physical Demands Survey Results

Model Fabrication Facility

Summary
The Job Requirements and Physical Demands Survey (JR/PD) was administered to the employees of the Model Fabrication Facility (MFF). Information regarding the development, instruction, and validation of the JR/PD can be found at http://www.brooks.af.mil/afioh/Health%20Programs/ergonomics_jrpd.htm. The JR/PD is an ergonomics assessment tool endorsed by the Department of Defense Ergonomic Working Group and used by the tri-services to collection occupational health data. The JR/PD is a survey used to assess ergonomics related risk in the workplace.

The results of the JR/PD indicate MFF is an Ergonomics Problem Area (EPRA). The pump shop scored an Overall or Survey Priority Rank of **nine** (on a scale of 1 to 9), where nine has the highest priority for intervention. A score of five or greater indicates an Ergonomics Problem Area. 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 ergonomics risk factors and employee reported discomfort. The shoulder/neck, hand/wrist/arm, back/torso, and leg/foot regions had significant priority scores. A significant number of employees reported experiencing work-related pain or discomfort that does not improve when away from work. Sixty-four percent of the survey respondents 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 also reported pre-existing Musculoskeletal Disorders (MSDs) as well as illnesses recognized as contributing factors, which places them at a higher risk of additional or more severe Work-Related Musculoskeletal Disorders (WMSDs).

Overall Priority Score

The results of the JR/PD indicate the pump shop is an ergonomics problem area with an overall score of **nine**. 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 are the hand/wrist/arm, back/torso, and leg/foot regions which all had maximum values of 9.

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

14 (workers/respondents) completed the JR/PD survey, resulting in a 82% response rate. The population demographics are contained in Table 1.

Table 1: Population Demographics

Gender:	Male: 100%	Female: 0%
Group:	Civilian: 100%	Military: 0%
Age:	29% between the ages of 21 and 30	
	21% between the ages of 41 and 50	
	50% over the age of 50	

Age is a contributing factor for the development of WMSDs. Totals may not sum to 100% due to under-reporting.

Priority Score

The JR/PD prioritizes five distinct body regions based upon a combination of ergonomics risk factors and discomfort. Workers indicate their duration of exposure for different ergonomics risk factors. Ergonomics 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 2 demonstrates the relationship between body region, discomfort, and risk.

Table 2 Body Region, Discomfort and Risk

		Body Regions				
		Shoulder/ Neck	Hand/Wrist/Arm	Back/ Torso	Leg/ Foot	Head/ Eye
Priority Score		5	9	9	9	2
Risk	Prevalence	50%	71%	71%	64%	43%
	Rating	Medium	High	High	High	Medium

Discomfort	Prevalence	43%	64%	64%	64%	21%
	Rating	Medium	High	High	High	Low

Risk Prevalence and Rating

The percentage of respondents exposed to specific ergonomics risk factors for a given body region, for longer than two hours per day, assesses the prevalence of risk. A low rating represents 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 hand/wrist/arm, back/torso and leg/foot regions have high levels of reported risk.

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 3. Low ratings represent less than 30% prevalence, medium 31% to 60% and high is greater 61%. The hand/wrist/arm, back/torso and leg/foot regions reported high levels of discomfort.

Table 3: Discomfort Matrix

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

The Priority matrix in Table 4 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 the MFF is equal to the highest body region priority value, which is a 9. All of the body regions except head/eye had significant scores.

Table 4 Priority Matrix

RISK FACTOR	**DISCOMFORT**		
	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 of minimal concern. 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 **9**. 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 8 is somewhat hard and a value of 10 is hard indicating a physically demanding task.

Health Care Provider Score

According to the health care provider score, **9 (64%)** of the respondents reported having been to a health care provider in the last 12 months for pain or discomfort that he or she thinks is related to his job.

Recovery Time Score

57% 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. Significant discomfort is apparent in the workers' inability to recover after the cessation of work.

Activity Interruption Score

50% 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	Ganglion Cyst
Trigger Finger,	Epicondylitis (Tennis Elbow)
Bursitis	Carpal Tunnel Syndrome
Thoracic Outlet Syndrome	Back Strain, Knee or Ankle Strain
Overuse Syndrome"	

64% 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.

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		

57% 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.

Process Improvement Opportunities

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.

1. Which tasks are the most awkward or require you to work in the most uncomfortable position?
   - ∞ overhead welding – grinding – changing bottles on welding carts

- ∞ reaching across tables to weld away from edges
- ∞ holding welding leads or torch at awkward positions.
- ∞ Working in confined spaces
- ∞ Climbing and working on and inside various types of models.
- ∞ Welding, grinding sweeping, computer usage, lifting extreme hot conditions.
- ∞ Working overhead position or lying downward
- ∞ Tight space
- ∞ Unseen area of location
- ∞ Kneeling or working under equipment on my back.
- ∞ Grinding
- ∞ sawing
- ∞ Grinding, welding.
- ∞ Dealing with the heat in summer time.
- ∞ Shearing heavy metal – lifting heavy metal
- ∞ Bending heavy metal.
- ∞ When welding being bent over or on knees and back
- ∞ Welding, grinding, burning or cutting metal in overhead position or awkward and reaching positions.

2. Which tasks take the most effort?
   - ∞ overhead welding – grinding – changing bottles on welding carts
   - ∞ reaching across tables to weld away from edges
   - ∞ holding welding leads or torch at awkward positions.
   - ∞ Confined space work.
   - ∞ Loading and unloading material on the waterjet.
   - ∞ Lifting material, grinding, standing on a hard floor for 9 or more hours.
   - ∞ Confined area
   - ∞ Small holes
   - ∞ ventilations
   - ∞ Sometimes I need to lift and move heavy plates of aluminum or steel – those are usually lifted with the assistance of a forklift or crane but sometimes certain pieces need to be moved by hand.
   - ∞ Typing
   - ∞ Grinding, welding.
   - ∞ Shearing heavy metal
   - ∞ Working with knees bent
   - ∞ Grinding, lifting, pushing, pulling.

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

- ∞ Most grinders with safety shields in place.
- ∞ Local ventilation in high does not always stay in position.
- ∞ Grinding, welding machines.
- ∞ Grinding
- ∞ Grinding by hands
- ∞ Grinders and drill motors especially heavy hand held types.

4. If you could make any suggestions that would help you do your job more easily or faster or better, what would you suggest.
   - ∞ Hire younger helpers – most of us are too old!
   - ∞ Air condition the building with a system that operates properly.
   - ∞ Reorganize welding machines in the high bay for more efficient use of space (maybe mounting on walls 8' off floor).
   - ∞ Overhead crane for waterjet;
   - ∞ more ergonomically friendly computer stations;
   - ∞ vibration absorbent gloves;
   - ∞ shorter welding tables;
   - ∞ air conditioning
   - ∞ Better gloves that fit to touch or control fingertip with thumb control, stronger fitting but comfortable too.
   - ∞ To have some sort of crane to run through the lowbay of Building #9
   - ∞ Maybe a central vacuum system.
   - ∞ Air conditioning
   - ∞ Softer materials for gloves and work gear.
   - ∞ Air conditioning the shops.
   - ∞ Crane over shears – more room in the work place
   - ∞ Get air conditioning in our building. It's too hot in the summer.
   - ∞ AC

End Notes:

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

[2] 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.

[3] 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.