

Ergonomic Risk Assessment Navy Facilities (NAVFAC) East Division

An ergonomic risk assessment was conducted on May 25 and 26, 2000. The money counting operation and drug screening laboratory were observed in order to determine sources of ergonomic stress. This assessment is based upon interviews with employees, supervisors, and safety personnel as well as evaluation by the Hazard Abatement East Coast occupational ergonomist. The Job Requirements and Physical Demands Survey (JRPD), an ergonomic survey, was also administered to the employees. The results of the JRPD indicate that the money counting operation and drug screening laboratory are Ergonomic Problem Areas. Recommendations are included with as much vendor information as possible to assist in the evaluation of products and services.

Money Counting Operation

The money counting facility is responsible for calculating the income from vending machines across the activity and supplying change for the change machines. The money counting facility also provides a banking service where recruits can withdraw cash from a cash card. There are currently three full-time employees in this area, although personnel can number up to five. Employee responsibilities include counting money, completing paperwork, and acting as bank tellers. The most taxing operation is counting money, which can consume up to four hours a day. Personal protective equipment includes foam earplugs and steel-toed shoes. There are no recorded injuries for this area, which may be related to the young and transitory work force. During the evaluation, the employees mentioned pain and discomfort in their back, wrists, and legs and stated that lifting is the most stressful part of the job.

The JRPD indicates that this is an Ergonomic Problem Area (EPRA) with an overall priority score of 9 (on a scale of 1-9, where 9 has the greatest priority). Significant amounts of discomfort and ergonomic risk were found in the shoulder/neck, back/torso, hand/wrist/arm, and head/eye regions. The money counting operation was assessed as a physically demanding task. JRPD results also indicate that employees are experiencing work related pain or discomfort, which doesn't improve away from work and has interfered with carrying out normal activities.

Process

A vendor brings money from vending and change machines to the money counting facility in plastic crates stacked on a hand truck. The money is contained in individual zippered bags. The vendor tosses the bags of money into crates either placed on the floor or on a low dolly, as shown in figures 1 and 2.



Figure 1: Vendor transferring money bags



Figure 2: Vendor sitting on plastic crate

Paper currency is hand sorted into different denominations (\$1, \$5, \$10, etc.). Each denomination is put through a bill counter for tabulating. The employee records the amount of money and secures a bundle of bills. A second employee breaks the binding and runs the bundle through a second bill counter for verification. The entry height of the bill counters are 40" and 46" at a distance of 24" and 28", which requires the operator to load bills with a raised and extended arm, as shown in figure 3. This posture places stress on the shoulder and arm.



Figure 3: Employee using bill counter

The coin currency is much more difficult to work with due to its weight and poor handling ability. The employees often work on the floor- squatting or sitting on milk cartons rather than lifting the coins to a proper working height, as shown in figure 4. While this method eliminates heavy and unnecessary lifting, it still places strain on the back and knees. Another reason for handling coins on the floor is that the plastic cartons often arrive in the work area on the floor and are slid between workstations. Money can also arrive by dolly, as shown in figure 5. Since the dolly is only 7" high, employees still sit at a low level or stand and pull moneybags from the dolly with bent backs. Lifting from a low height, as shown in figure 5, increases biomechanical stresses, particularly to the knees and back.



Figure 4: Employee sorting on floor



Figure 5: Emptying crates on dolly

Coins are processed through three coin counting machines: (1) a coin sorter, which sorts quarters, dimes, and nickels; (2) a coin bagger, which separates a specific dollar amount of coins, and (3) a coin roller. The machines are located around three sides of the room in a non-sequential order, which creates quite a bit of non-value added material handling. Moneybags are pulled from stacked milk cartons, as shown in figure 6, to load the machines. The machine load heights are about 42", which requires the operator to hold the end of the bag above shoulder height (about 47") to dump all of the coins into the machine, as shown in figure 7. The processed coins from the coin sorter and coin bagger end up in bags at the base of the machine. To unload these machines the operator has to lift full bags of coins from a height of about 20", as shown in figure 8, and take them to the load height of the next machine. Lifting a heavy, awkward money bag from a low height increases the stress to the back. The coin roller empties into a rolling tray, as shown in figure 9. Unloading the coin roller is performed with the operator squatting or sitting on milk crates. The operator empties the tray into a small bin that only holds a specific number of rolls.



Figure 6: Employee reaching for Money bag in carton



Figure 7: Employee emptying money bag to load machine



Figure 8: Employee unloading coin Sorter



Figure 9: Employee unloading coin roller

During the day, completed bags are stored in shelves that start at a height of 5" above the floor. A completed bag of money contains \$1,000 in quarters (50 lbs.), \$1,000 in dimes (50 lbs.), or \$200 in nickels (44.1 lbs.). These bags are often handled with a pinch grip which places stress throughout the upper extremities. According to the NIOSH Lifting Guide 75% of healthy females can repeatedly lift up to 51 lbs. under ideal circumstances. The employees of the money counting operation are lifting 50 pound loads repeatedly with poor handles to and from floor height and carrying the load across the room. These lifting conditions create a far less than ideal lifting scenario, which increases the biomechanical stress associated with the lift, thereby decreasing the amount that most healthy females can lift to well below 51 lbs. At the end of the day all money is placed in the safe, shown in figure 10. The safe contains shelves above shoulder height, which are difficult to access without placing stress on the shoulder and upper extremities.



Figure 10: Storing money in safe

The banking operation is not performed for extended periods of time. Employees spend up to 40 minutes at a time acting as a teller. Employees are able to sit while performing teller duties, but the chairs in this area are in disrepair and don't provide much support for the employees. Given the short duration and low frequency, the teller operation does not pose any major ergonomic stressor at this time.

Recommendations:

Coin and Bill Counting Machines

1. *Observations:* Lifting and carrying heavy, awkward bags of money from a low height at one machine to a level above shoulder height to load the next machine is stressful to the back, knees, and upper extremities.

Recommendations: New equipment is recommended to reduce ergonomic stress associated with loading and unloading machines and transporting money. The first two machines can be combined into a single machine that sorts and batches coins. It is suggested that this machine be purchased with a stand, rather than as a tabletop unit so that a cart can be slid under the bags for removal. A bill counting machines is recommended that is capable of sorting different bill denominations. A conveyor could be used to load the coin sorter and the coin roller.



Coin counter/sorter with stand



Bill sorter/counter



Conveyor

Table 1: Coin and Bill Counting Equipment

Vendor	Description	Price
LDSystems 972-929-9228	Scan Coin 900 Double Sort Coin Sorter with preset batches Noise Level 68 dBA Sorts 900 coins/minute	Sorter \$4,895 Stand \$495 Inspection tray \$395
DeLaRue 630-258-1186	6800 Mach 5 High Speed Coin Sorter- sorts and bags	\$6,768
DeLaRue 630-258-1186	Model 2800VB Document Recognition Currency Counter and Sorter	\$5,755
DeLaRue 630-258-1186	Vertical Loose Coin Conveyor	\$4,195
Cummins	Jetsort 6000 Series High	\$5216

847-647-1100	Speed Coin Sorter/Counter	
Cummins 847-647-1100	Two-pocket Jetscan Currency Counter	\$4,295
Scan Coin 1-800-336-3311	Scan Coin 900 Double Sorter	\$6,495
Scan Coin 1-800-336-3311	Scan Coin 88 Coin Conveyor	\$7,950
	SC 11 Coin Cart for conveyor	\$2,450

Layout

2. *Observations:* The current machine layout increases non-value added material handling, decreases productivity, and increases ergonomic stressors.

Recommendations: The money counting machines should be in a sequential manner, preferably in a U-shape or circle format to reduce travel distances. An engineering analysis along with employee input is recommended to design an optimal layout. A sort area near the incoming money area will reduce material flow. Locate machines close to the edge of the work surface to reduce reach distances and at a height to ensure a neutral load height. Heavy work, such as sorting full bags of change, should be conducted below elbow height.

Height Adjustable Cart

3. *Observations:* One of the most difficult tasks of this operation is lifting the bags of money from floor height to working heights. Carrying bags of money throughout the process is also stressful.

Recommendations: Incoming crates of money should be loaded onto a height adjustable cart. Any money transfers should be conducted on the cart. The cart could be raised to the height of all machines, sorting tables, or storage shelves to allow for easy transfer and reduced lifting. The carts can also be located perpendicular to the workstation to allow for efficient machine loading. This will eliminate twisting one's back to reach milk cartons. Some of the recommended machines have stands that a height adjustable cart could enter so that the bags of money can be lowered directly onto the cart.

Height Adjustable Tables		
Vendor	Product	Price
Alimed 1-800-225-2610	Hydraulic Elevating Carts and Lift Tables	\$449-\$800
C&H 1-800-558-9966	Scissor Lift Tables	\$560-\$1320
Lab Safety 1-800-543-9910	Scissor Lift Carts or Lift Tables	\$462-1352

Alzar GSA 260199, 272770, 260200	Mobile Scissor Lift Tables	\$298-\$468
Global Industrial 1-800-645-1232	Mobile Scissor Lifts or Hydraulic Lift Tables	\$329-\$1047
Vestil 1-800-348-0868	Deck Cart, Hydraulic Cart, or Post Table	\$250-1775

Anti-fatigue Matting

4. *Observations:* Standing at machines and walking on concrete floors can lead to discomfort and fatigue.

Recommendations: Each machine in the money counting area should have anti-fatigue matting in front of it to decrease discomfort and fatigue associated with standing for long periods of time. Anti-fatigue matting used in conjunction with carts should have beveled edges and not have any texture. Shoe inserts perform the same function without interfering with cart movement. Shoe inserts serve the employee throughout the day, but degrade much faster than matting.

Anti-fatigue Matting		
Vendor	Product	Price
Global Industrial 1-800-645-1232	Anti-fatigue matting	\$11-\$225
Alimed 1-800-225-2610	Anti-fatigue matting Shoe Inserts	\$17-\$100 \$15.95-\$17.95
C&H 1-800-558-9966	Anti-fatigue matting	\$15-\$255
Lab Safety 1-800-348-0869	Anti-fatigue matting	\$15-\$230
Matting World 1-800-257-8557	Anti-fatigue matting	\$15-\$200

Sit/Stand Chairs

5. *Observations:* Employees stand or sit on broken chairs in the banking area to conduct cash card transactions.

Recommendations: The employees would benefit from sit/stand chairs in the banking area to reduce discomfort and fatigue while still aiding in mobility. When used properly, sit stand chairs can aid in relieving pressure on the feet and lower back by enabling the worker to change positions frequently.

Sit/Stand Chairs		
Alimed 1-800-225-2610	Portable Sit/Stand	\$299
Alimed 1-800-225-2610	Stand Stool RA75195	\$243
Global Industrial 1-800-645-1233	Lyon Sit-Stand Stool XF244849	\$223
C&H 1-800-336-1331	Lyon Sit-Stand Stool 41-186D	\$219
C&H 1-800-336-1331	Workspace Sit/Stand Stool 41-340A	\$190
Lab Safety and Supply 1-800-356-0783	Lyon Sit-Stand Stool OM-27282	\$221
Lab Safety and Supply 1-800-356-0783	Large Prowork Chair OM-4729	\$177

Totes

6. *Observations:* The current milk crates have high sides, which require the operator to reach in to retrieve money. The crates are not light weight either.

Recommendations: It may be possible to work with the vendors to replace all existing crates with new lightweight totes with either drop down or low sides.

Totes		
Vendor	Product	Price
Lab Safety 1-800-356-0783	Low wall tote boxes OM-39375 (with handles) 6"x10"x15"	\$11.70
Global Industrial 1-800-645-1232	Low wall tote XF662119 8.25"x11.75"x15.75	\$8.08
C&H 1-800-558-9966	Low wall tote 47-960DA 7.5"x12"x15	\$9.40

Ergonomic Principles

7. All employees should be instructed in proper lifting techniques. Employees should also be instructed to cradle moneybags in their arms instead of using a pinch grip. Mid-shelf usage should be encouraged to reduce bending and reaching above shoulder height. Micro-breaks and stretching exercises promote blood flow and muscle activity.

Drug Screening Lab

The hospital houses one of five US laboratories used by the Navy for drug screening of urine samples. The drug screening lab receives 800 to 3,000 samples of urine each day. There are about 20 employees working 40 hours a week over two shifts. Overtime is occasional. There are currently 14 workstations in the laboratory. There have been a number of Carpal Tunnel Syndrome injuries. Employees mentioned back discomfort associated with sitting all day and shoulder discomfort from reaching. Personal protective equipment includes latex gloves.

The JRPD results indicate that this is an Ergonomic Problem Area (EPRA) with an overall priority score of 5 (on a scale of 1-9, where 9 has the greatest priority). The shoulder/neck and back/torso regions showed significant ergonomic stress and employee discomfort. Working in the drug screening laboratory is a repetitive job which requires awkward postures, extended reaches, and carrying awkward loads. The survey revealed that employees are experiencing work related pain or discomfort, which doesn't improve away from work and has interfered with carrying out normal activities.

Process

Urine samples arrive by mail each morning. Each box contains 12 urine samples in separate bottles. Employees open the boxes and take the samples for batching into trays. Large trashcans are kept near each workstation to discard packing materials. The trashcans remain at the workstation all day impeding traffic and preventing carts from being moved through the lab. Each tray measures 21" x 15" x 3.5" and contains 50 bottles. Trays are stored on carts, as shown in figure 1. Each employee transfers two trays at a time from the cart to their workstation. Two trays, without handles and weighing about 20-25 lbs., make for an awkward load. Dropping urine samples is a potential problem for the laboratory.



Figure 1: Trays stored on cart

Workstation layout is consistent throughout the lab. Each employee has an individual workstation consisting of a large flat table (36" high and 30" deep) and a laboratory

stool. The table has a lip, which prevents smaller employees from raising their chair to a height where they can work with a neutral posture. The chair has a foot ring which when used causes the operator to bend their knees, as shown in figure 2, creating biomechanical stress. Some employees let their feet hang unsupported, which can cause blood to pool in the feet and places stress on the knees. Other employees currently use step stools as footrests, although the stepstools are much higher than resting foot height. Most employees place their paperwork, test tube trays, and label dispenser in front of them. The tray of urine samples usually sits to one side of the employee; requiring extended reaches of up to 30", as shown in figure 3. Rotating the tray of samples is not an option since the employee accesses each sample in order going across the tray.



Figure 2: Employee using chair ring with bent knees



Figure 3: Employee reaching to samples in tray

Employees in the lab rotate tasks during the day. There are three predominant tasks after the mail is sorted. All bottles are first labeled. The employee checks the sample against the written record and removes two labels from the dispenser to be placed on the bottle top and the written record. Reading and placing labels on the written records requires repetitive neck motion and awkward neck postures, as shown in figure 4. The labels are on a roll in the dispenser. Some employees use a pinch grip to pull the label off while others use a pen as a tool, figures 5 and 6. The second major task is to pour a urine sample from the bottle into a test tube and remove the label on the bottle top and place it on the test tube, as demonstrated in figure 7. Pouring urine from a round bottle into a small test tube is difficult and leads to spillage. A third task is for quality assurance where all labels are checked against paperwork. Occasionally employees test urine samples from civilians, which requires a more complicated labeling and record process, but this task is diminishing.



Figure 4: Employee fixing label to record sheet



Figure 5: Employee pulling label out of dispenser with fingers



Figure 6: Employee using pen to affix label on bottle



Figure 7: Employee pouring sample into test tube

Recommendations:

Trays

1. *Observations:* Each written record contains information and labels for 12 urine samples. Each tray contains 50 bottles. Employees carry two trays at a time, weighing about 20-25 pounds. The trays have no handles and create an awkward load.

Recommendations: A new tray designed for 24 bottles of urine would be lighter and easier to handle than the current trays. A smaller tray would decrease reaching while pulling samples. The new trays could be obtained from the current manufacturer or possibly created by cutting the current trays.

Sample Containers

2. *Observations:* Pouring samples from the bottles into the test tubes is time consuming and creates spillage.

Recommendations: The lab should work with the actual testing sites to develop a better method. One option would be to send specimens in sterile vials with tops. Another possibility may be a lip in the specimen container to facilitate pouring. There may be legal issues associated with having medical professionals transferring the specimen from the original collection container to a separate mailing container.

Auto-Leveling carts

3. *Observations:* The large trashcans impede workflow and prevent carts from being used to transport trays.

Recommendations: Removing the large trashcans after the incoming mail is sorted would improve material flow. Smaller wastebaskets could be kept under each workstation for smaller items. Without the trashcans, small carts could be used to transport trays and eliminate carrying trays. Each cart should be capable of automatic height leveling to maintain a constant load and unload height. Carts should be placed perpendicular to the workstation to allow for sliding of trays onto the table. New carts would ideally be used for smaller trays.

Auto-Leveling Carts		
Vendor	Product	Price
Lab Safety and Supply 1-800-356-0783	Spring Elevating Table	\$754
Alimed 1-800-225-2610	Spring Counterbalanced Table	\$850
C&H 1-800-558-9966	Self-Elevating Lift Tables	\$740

C&H 1-800-558-9966	Self-Leveling Positioner	\$888
Vestil Manufacturing	Self-Elevating Table ETS-230	\$790

Label Dispenser

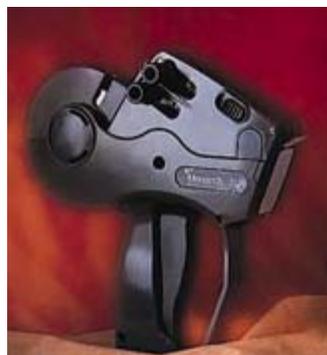
4. *Observations:* Employees currently peel labels off with their fingers or use a pen to grab the label. Grabbing labels with ones fingers requires repetitive pinch grips. Holding a narrow pen uses a sustained pinch grip.

Recommendations: An improved label dispenser would reduce ergonomic stressors associated with peeling labels. Employee input could be used to decide between a labeling gun or an automatic dispenser.

Employees should be strongly encouraged not to peel labels with their fingers. If they choose to use a pen or other tool it should have a wide gripping surface. A label scraper or possibly an ergonomic staple remover may aid in removing labels. Pen and pencil grippers can be purchased from your office supply store to increase the gripping surface and reduce the force required to hold the implement. Given the amount of writing required for keeping records the employees would benefit from grippers or wide body pens during all their activities.



Label Gun



Label Gun



Label Dispenser

Label Dispenser		
Vendor	Product	Price
Label-Depot 305-861-6636	Label Dispenser SLE-U45	Waiting quote
Label-Depot 305-861-6636	Trigger Action Applicator (label gun) THA-300	Waiting quote
Staples 800-333-3330	Pricing Labeler (label gun)	\$68-\$78
Quill 1-800-789-1331	2" Easy Grip Dispenser (label gun)	\$10.99
Alimed	Ergonomic Staple Remover	\$2.47-\$4.95

1-800-225-2610		
Mark-Rite 800-848-7279	Label Scraper	\$7.25 for 10

Sit/Stand Chair

5. *Observations:* Employees in this area are seated for most of the day. Being seated for extended periods of time can cause discomfort in the back and legs and inhibit mobility, which encourages extended reaches.

Recommendations: Employees could reduce fatigue and improve blood flow by using a sit/stand chair. A sit/stand chair reduces the fatigue and discomfort associated with sitting for extended periods. A sit/stand provides the support of a chair while giving the user the mobility and reach associated with standing. When used properly, sit stand chairs can aid in relieving pressure on the feet and lower back by enabling the worker to change positions frequently.

If employees use a sit/stand chair or spend any time standing at their workstation, anti-fatigue matting should be obtained to reduce discomfort and fatigue.

Sit/Stand Chairs		
Alimed 1-800-225-2610	Portable Sit/Stand	\$299
Alimed 1-800-225-2610	Stand Stool RA75195	\$243
Global Industrial 1-800-645-1233	Lyon Sit-Stand Stool XF244849	\$223
C&H 1-800-336-1331	Lyon Sit-Stand Stool 41-186D	\$219
C&H 1-800-336-1331	Workspace Sit/Stand Stool 41-340A	\$190
Lab Safety and Supply 1-800-356-0783	Lyon Sit-Stand Stool OM-27282	\$221
Lab Safety and Supply 1-800-356-0783	Large Prowork Chair OM-4729	\$177

Anti-fatigue Matting

Anti-fatigue Matting		
Vendor	Product	Price
Global Industrial 1-800-645-1232	Anti-fatigue matting	\$11-\$225
Alimed 1-800-225-2610	Anti-fatigue matting Shoe Inserts	\$17-\$100 \$15.95-\$17.95

C&H 1-800-558-9966	Anti-fatigue matting	\$15-\$255
Lab Safety 1-800-348-0869	Anti-fatigue matting	\$15-\$230
Matting World 1-800-257-8557	Anti-fatigue matting	\$15-\$200

Lab Chairs

6. *Observations:* The employees are experiencing discomfort associated with sitting all day.

Recommendations: If the employees prefer a lab stool to a sit/stand chair then they should try alternating between sitting and standing during the day. While sitting, employees would benefit from new lab stools. Lab stools should be height adjustable. Backrests should be height adjustable and provide lumbar support. Removing the lip on the edge of the table would allow for the employees to raise themselves to a neutral working height. Laboratory work of this nature should be performed at about elbow height. If the chair has an attached footrest, it should be height adjustable and wide enough to accommodate the both of the user's feet without having to bend their knees.

If employees stand at their workstation, they should have anti-fatigue matting to reduce fatigue and discomfort.

Lab Chairs		
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

Height Adjustable Tables

7. *Observations:* The current workstations are not appropriate for all of the workers.

Recommendations: Optimal workstation surfaces should be height adjustable to accommodate all employees. A height adjustable table would better accommodate a standing worker or employee using a sit/stand chair. Employees should be aware of how to adjust all furniture. Working height for light work should be about elbow height.

Vendor	Product	Price
Alimed 1-800-225-2610	Hand Crank Adjustable Height Work Tables	\$805-\$1,325
New Dominion 1-800-850-8559 X132	Hand Crank Adjustable Height Table	\$1,123-\$1,325
Lab Safety 1-800-356-0783	Adjustable Workbenches	\$1018-\$1190
Vestil 1-800-348-0868	Adjustable Work Benches	\$965 (30"x60")

Read/Write Stand

8. *Observations:* Alternating between the written records placed on the desk and the specimen bottles, induces repetitive neck motions.

Recommendations: In order to reduce neck strain, written records should be placed on read/write stands.



Read Write Stand

Read/Write Stand		
Vendor	Product	Price
Alimed 1-800-225-2610	Read/Write Stand RA73746	\$39.95
US Office Products 1-877-402-5655	Read/Write Stand RNG 94280)	\$34.95
Adams Marketing 1-800-322-6082	Vision Vu Document Holder VUR 14DC (14"x11") VUR 18DC (18"x11")	\$49 \$59

Footrest

9. *Observations:* The foot rings on the current chairs encourage employees to bend their knees or leave their feet hanging unsupported.

Recommendations: If the current lab stools are to be used then employees should be provided with a height adjustable footrest.

Footrest		
Vendor	Product	Price
C&H 1-800-558-9966	Lyon Industrial Footrest, tilts 10°-35°, adjust from 3” to 16” 41-338D	\$114
Lab Safety and Supply 1-800-356-0783	Biofit Industrial Footrests Adjusts from 3” to 11”	\$85-\$90
Alimed 1-800-225-2610	Factory Footrests RA7558 Adjusts from 3” to 11”	\$98-\$109

Incline Trays

10. *Observations:* The employees are employing extended reaches to access bottles across the trays.

Recommendations: The trays would also benefit from slight angling to reduce reaching when accessing the farthest samples. An adjustable incline that doesn't cause the samples to fall could be made in-house.

Air Quality

11. *Observations:* Some of the employees mentioned concern over air quality.

Recommendations: An industrial hygienist can be requested to survey the area.

Micro-breaks

12. All employees should be instructed on micro-breaks and exercises that can be performed at work to reduce ergonomic stress.

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