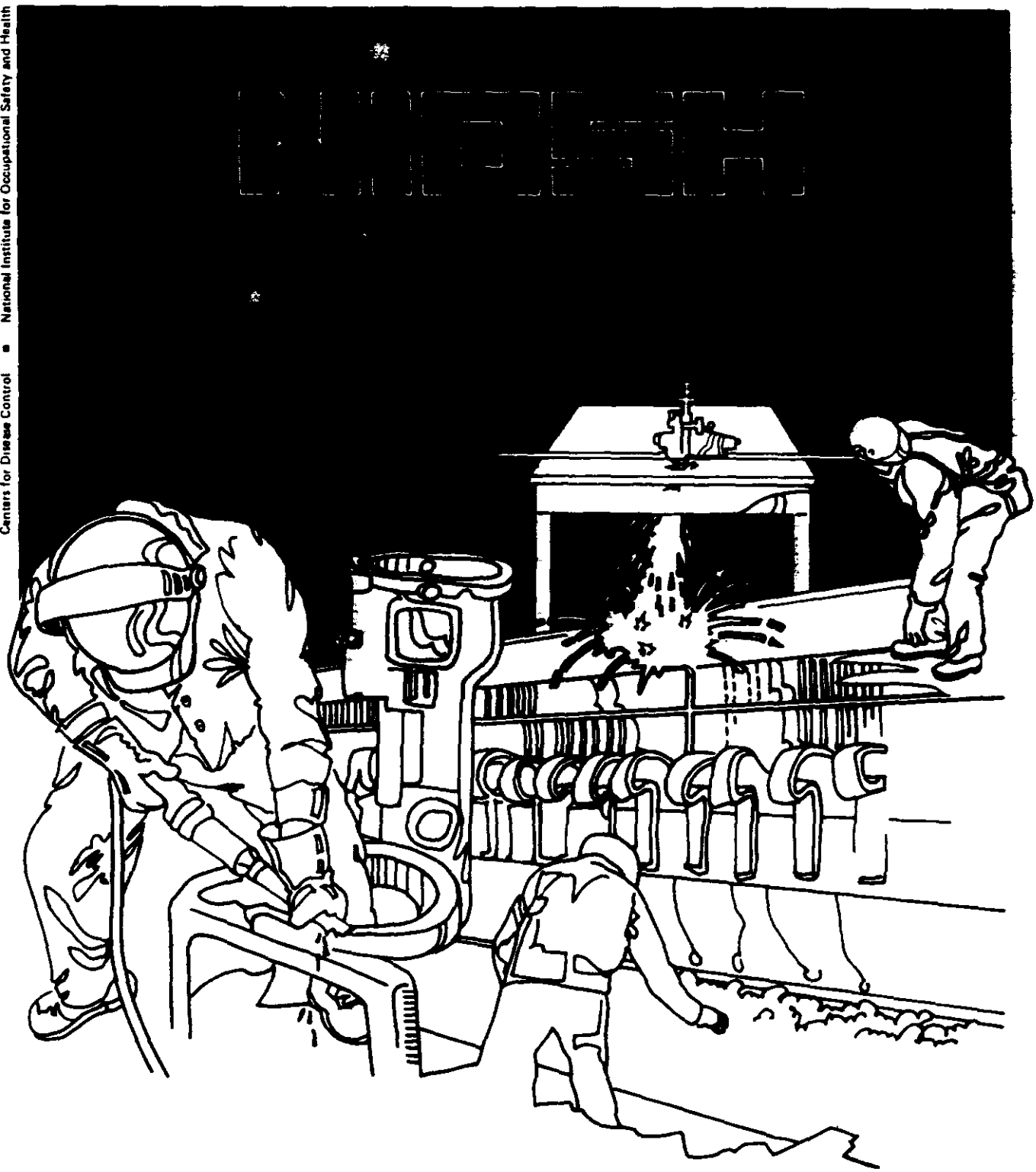
This Health Hazard Evaluation (HHE) report and any recommendations made herein are for the specific facility evaluated and may not be universally applicable. Any recommendations made are not to be considered as final statements of NIOSH policy or of any agency or individual involved. Additional HHE reports are available at http://www.cdc.gov/niosh/hhe/reports

U S DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 88-069, 88-070-1964

U.S. DEPARTMENT OF TRANSPORTATION
MARITIME ADMINISTRATION
BENICIA, CALIFORNIA
& FORT EUSTIS, VIRGINIA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 88-069, 88-070-1964
MAY 1989
U.S. DEPARTMENT OF TRANSPORTATION
MARITIME ADMINISTRATION
BENICIA, CALIFORNIA & FORT EUSTIS, VIRGINIA

NIOSH INVESTIGATORS:
Christopher M. Reh
James W. Collins
Allan K. Fleeger, M.S.P.H.

I. SUMMARY

On November 20, 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request from the U. S. Department of Transportation, Maritime Administration. The Occupational Safety and Health Administration's (OSHA) Federal Agency Targeting Program "targeted" these facilities because these worksites exceeded the Federal Government average of 2.4 lost time cases per 100 employees per year. The Suisun Bay incidence rate was 21.7 lost time cases per 100 employees per year, while the James River incidence rate was 20.6 lost time cases per 100 employees per year. According to the Bureau of Labor Statistics, the lost time incidence rate for a similar industry and operation was 10.5 in 1986[1]. On January 26-27, 1988, NIOSH conducted an initial site visit at the Maritime Administration's Suisan Bay Reserve Fleet in Benicia, California. On June 16-17, 1988, NIOSH conducted a follow-up survey at the Maritime Administration's James River Reserve Fleet in Fort Eustis, Virginia.

The most frequent injuries were back muscle strains/sprains, groin pulls and hernias. Other injuries that were not as prevalent, but surfaced in accident records and workers' compensation claims, included eye injuries due to foreign objects, nail punctures to the soles of the feet, and muscle strains/sprains. Potential exposure to asbestos was also noted on two worker compensation reports and was a concern of several workers at the Suisun Bay and James River facilities.

On the basis of observations and information collected during these investigations, the NIOSH investigators determined that a potential health hazard existed at the time of this evaluation from pulling steel cable and nylon rope, lifting and carrying marine batteries, nail punctures to the feet, slips and falls, vibrating handtools, and foreign objects in the eyes, as well as potential exposure to asbestos. Recommendations for reducing and/or preventing the occurrence of related musculoskeletal and other traumatic injuries, for reducing the risk of asbestos exposures, and for developing a formal occupational safety and health program, are contained in Section VII of this report.

KEYWORDS: SIC 4469 (Water Transportation Services, Not Elsewhere Classified), Mothballed Cargo Ships, Musculoskelatal Injuries, Manual Material Handling Techniques, Lost Time Accidents.

II. INTRODUCTION

On November 20, 1987, NIOSH received a request from the U.S. Department of Transportation, Maritime Administration, to conduct a health hazard evaluation at their large facilities in Benicia, California and Fort Eustis, Virginia. The request was submitted after these facilities were identified as high-risk worksites by OSHA's Federal Agency Targeting Program. NIOSH was requested to provide health and safety recommendations aimed at reducing lost time injuries due to musculoskeletal and traumatic injuries. On January 26 and 27, 1988, the NIOSH investigators conducted a baseline safety and health survey at the Suisun Bay Reserve Fleet, Benicia, California. On June 15-17, 1988, the NIOSH investigators conducted a similar survey at the James River Reserve Fleet, Fort Eustis, Virginia.

III. BACKGROUND

The type of work performed at the Suisun Bay and James River worksites can be generally characterized as that associated with the mooring, preservation, and maintenance of ships in the National Defense Reserve Fleet. There are between 75 to 100 "mothballed" cargo ships at both locations. These ships are divided into three categories: Ready Reserve Fleet, National Defense Reserve Fleet, and Scrap Fleet. The differences between these designations, with the Scrap Fleet being an exception, is in the number of days required to activate these ships for duty. Ships in the Scrap Fleet are stripped of all useful parts and sold to foreign businesses or governments. The salvable parts are stored either on other ships or in shore facilities.

The majority of work activities involve various types of manual materials handling tasks associated with the movement of ships in and out of the fleet. These tasks include the handling of anchors, anchor chains, mooring lines and wires, and gangways. Other tasks include inspecting and maintaining the engine room, cargo holds, and deck machinery; welding, metal-working, painting, etc.

As previously mentioned, these facilities were targeted for inspection under OSHA's Federal Agency Targeting Program. The James River Reserve Fleet has a lost time incidence rate of 20.7 lost time cases per 100 employees; the Suisun Bay Reserve Fleet has a lost time incident rate of 21.7. These levels far exceed the U.S. Government's average of 2.4. From the most recent injury incidence rates published by the Bureau of Labor Statistics, the lost time incidence rates for the water transportation services industry, SIC 4469 (which includes establishments engaged in ship storage, ship dismantling, and ship cleaning), were 9.4 in 1985, and 10.5 in 1986[1].

IV. EVALUATION DESIGN AND METHODS

During the surveys, the NIOSH investigators observed and photographed the many work activities performed at these facilities. Suisun Bay and James River accident records were reviewed for the years 1981-1987 to identify frequent and severe lost-time traumatic and musculoskeletal injuries that were amenable to prevention. Workers' compensation forms and internal accident reports were examined to determine trends in tasks which are most commonly associated with lost time injuries. Lifting tasks were evaluated using criteria found in the NIOSH Work Practices Guide (WPG)[2].

V. EVALUATION CRITERIA

The WPG takes into account the following aspects of lifting a load, which have been identified as physically hazardous to the musculoskeletal system:

1. weight of the item lifted,
2. location of the center of gravity of the load with respect to the worker,
3. frequency/duration of the task,
4. stability of the location of the center of gravity of the item,
5. workplace geometry in terms of movement, distance, directions and postural constraints, and
6. environmental factors.

The NIOSH WPG used medical, scientific, and engineering resources to develop quantitative recommendations regarding the safe load which can be lifted based on workplace geometry and various task conditions. The recommendations in the WPG assume that:

1. the lift is smooth,
2. the lift is two-handed and symmetric in the sagittal plane (directly in front of the body with no twisting during the lift),
3. the load is of moderate width, i.e. 30 inches or less,
4. the lift is unrestricted,
5. the load has good couplings (handles, shoes, floor surface), and
6. the ambient environment is favorable.

It is further assumed that other material handling activities such as holding, carrying, pushing, and pulling are minimal; that the individual performing the lifting activities is at rest when not lifting; and that those involved in lifting are physically fit and accustomed to labor.

The following formula was used to analyze lifting tasks:

$$\text{Action Limit (AL, in lbs.)} = 90\,(6/H)(1 - .01[V-30])(.7 + [3/D])(1 - [F/F_{max}])$$

Maximum Permissible Lift (MPL)= 3(AL)

where H = horizontal location forward of midpoint between ankles at origin of lift (inches)

V = vertical location at origin of lift (inches)

D = vertical travel distance between origin and destination of lift (inches)

F = average frequency of lifts (lifts/minute)

Fmax = maximum frequency which can be sustained (table of values provided in the Work Practices Guide)

Tasks analyzed in this manner are divided into three categories:

1. those below the AL which are believed to represent nominal risk to most industrial workforces,

2. those between the AL and MPL which are unacceptable without administrative or engineering controls, and

3. those above the MPL which are considered unacceptable and require engineering controls.

The AL represents loads which would be acceptable to over 75% of the female workforce and over 99% of the male workforce. Musculoskeletal injury incidence and severity rates increase moderately in populations exposed to lifting conditions between the AL and the MPL.

The MPL represents loads which only about 25% of the male workforce and less than 1% of the female workforce are capable of performing. Musculoskeletal injury rates and severity rates have been shown to increase significantly in populations when work is performed above the MPL.

VI. RESULTS AND DISCUSSION

The following summarizes the NIOSH investigators' observations from inspections of the Suisun Bay and James River Reserve Fleets:

1. Work activities performed at the Suisun Bay and James River Reserve Fleets were rigorous and strenuous, and were often performed under less than optimal conditions.

2. Recently, there has been no formal occupational safety and health program at these facilities. This neglect is demonstrated by the following observations: fire extinguishers with no inspection/maintenance tags and in need of repair, no written respirator program, gangways made of wood that appeared to be rotting, poor housekeeping on ships and in onshore work areas, etc. Also, the workers frequently lift heavy objects (e.g. batteries, anchor chains) while wearing street shoes or athletic shoes. If one of these heavy objects were dropped on a workers foot, it could inflict serious injury.

3. The lost time incidence rates for the Maritime Administration and the Federal Government are not comparable. The work activities performed at these facilities are very rigorous and are frequently performed under adverse weather conditions. Whereas, it is our opinion that the majority of the work performed in the Federal Government is less vigorous in nature, and does not involve the many hazards that the fleet workers face on a daily basis. Nevertheless, the lost time incidence rates at the James River and Suisun Bay facilities are twice those for similar operations and/or industries.

Along with these general observations, some of the more specialized activities and hazardous tasks performed on the fleet were evaluated:

Pulling Cable

The single most common task associated with back strain/sprains, hernias, and groin pulls was the pulling of wire cable and nylon rope. The task of pulling wire cable is done when a ship is to be moved in or out of one of the anchored rows. Nine 600 foot sections of 1 inch diameter steel cable are used to tie two anchored ships side by side at nine independent points along the length of the ship to minimize ship movement in the water. The one inch steel cable weighs 1.42 lbs./ft.

Each 600 foot cable is placed on the deck of one ship in an S-configuration, so as not to overlap the cable. The cable winds back and forth in approximately eight or nine 70 foot sections. Three or four men are then positioned on this ship and neighboring ships, passing sections of the cable back and forth around capstans and/or anchoring points on each ship, until the entire length of the cable has been used. Suisun Bay employees and supervisors stated that it was not practical to perform the task of pulling cable in any other manner,

since no external sources of power are available on the fleet. Steel cable is used over nylon because of its greater strength, lower cost, and ease of handling.

Lifting

Another task which was identified in two workers' compensation reports of overexertion injuries was the lifting of marine batteries. These batteries provide power to tug boats. They weigh 125 lbs. and are 12 inches wide, 20 inches long, and 10 inches high.

These marine batteries are occasionally lifted when they need to be recharged or replaced. To determine if this task presents a lifting hazard, an analysis was performed using the previously discussed WPG.[1] Geometric data, load weights, lifting heights, frequency of lifts, and work posture data were collected.

For the case of lifting the battery from the floor to waist height, which is the worst case scenario, the values for input to the WPG are as follows:

H = 12 inches
V = 0 inches
D = 20 inches
F = 0

Therefore:

$$(AL) = 90(6/12)(1 - .01(30))(.7 + 3/20)(1 - 0)$$

$$AL = 26.8 \text{ lbs.}$$

Maximum Permissible Limit = 3 (AL)

$$MPL = 3(26.8 \text{ lbs.}) = 80.4 \text{ lbs.}$$

For the case of handling marine batteries, the AL = 27 lbs. and the MPL = 80 lbs. Therefore, the 125 lb. weight of the marine battery substantially exceeds the MPL and lifting it should be considered hazardous.

Slips and Nail Punctures

Nail punctures to the feet accounted for two compensation claims. Three injuries were attributed to slips on oil, grease, and rain-slick ship decks. These types of injuries could have been prevented if better housekeeping procedures would have been followed to clean up oil and grease and remove boards with exposed nails from the work area.

Vibrating Hand Tools

Two injury reports described itchy, swollen hands associated with the use of vibrating hand tools. Vibrating hand tools have been known to induced a condition called vibration white fingers (Raynaud's Phenomenon) in shipyard workers[3].

Foreign Objects in Eyes

The tasks of sandblasting and paint scraping were associated with lost time injuries because of foreign objects in the eyes. Silica, razor-sharp metal chips and paint fragments can pose serious hazards to the eyes if proper eye protection is not worn. Silica is also a known respiratory hazard, producing a progressive and disabling lung disease called silicosis[4].

Asbestos

During the surveys, the NIOSH investigators observed large quantities of exposed insulation on many of the ships. The exposed insulation was assumed to be asbestos-containing, since many of the ships were constructed in the 1940's, when Navy shipyards used large amounts of asbestos as a building material. When considering the activities that employees perform on these ships, there is a definite potential for exposure to asbestos fibers. A review of the safety and health records revealed that neither an asbestos identification survey, nor an environmental exposure survey have been conducted at these sites.

VII. RECOMMENDATIONS

The following recommendations are provided to reduce the risk of injury to workers at the Maritime Admininistration's Suisun Bay and James River Reserve Fleets:

1. When practical, provide mechanical devices to assist workers when lifting, pulling, and/or handling heavy loads, e.g., such as a hoist to lift and maneuver marine batteries. If mechanical lifting devices are available, supervisory personnel should ensure that this equipment is used when lifting heavy loads. If workers do not have access to pneumatic, hydraulic, or electric power sources, supervisors should ensure that adequate manpower is available when such tasks are performed.

2. Provide worker training on the proper techniques for lifting. Stress the concept of biomechanics in any such training. Examples of good biomechanical principles include:

a. keep the load as close to the body as possible.
b. keep the lower back in a stable position during the lift.
c. lift with the legs rather than the back.
d. lift smoothly - don't jerk the load.
e. avoid twisting the torso during the lift.

3. Worker rotation and work-rest procedures should be developed to reduce exposure to vibrating hand tools, especially during long work periods. When purchasing new hand tools, only tools which are equipped with anti-vibration devices such as rubber grips or other vibration absorbing materials should be considered for procurement. Existing hand tools should be retrofitted with anti-vibration devices such as rubber grips or other vibration absorbing materials. The wearing of gloves also helps reduce the intensity of mechanical energy reaching the hand.

4. When scraping paint or sandblasting, eye, face, and respiratory protection that conforms with OSHA and ANSI regulations should be used. This protection should be provided by the Maritime Administration, and wearing of this equipment should be strictly enforced.

5. An asbestos identification survey should be performed on each ship in the fleet, including the shore facilities and the tugboats. Following identification of the asbestos-containing materials, those areas that tested positive should be properly labeled to warn any employee of the hazard prior to conducting any maintenance activities.

6. An employee awareness program should be implemented for those employees who are expected to be exposed to asbestos fibers. The training program should include, as a minimum, the following components:

   a. The health effects associated with asbestos exposure.

   b. Procedures to protect the employees from exposure to asbestos.

   c. Proper usage and purpose of respiratory protection.

   d. The components of a medical surveillance program.

7. It is recommended that industrial hygiene monitoring be conducted on those employees who are expected to be exposed to asbestos fibers. The exposure monitoring should be representative 8 hour time-weighted average samples, consisting of one or more consecutive samples representing the full-shift exposures for each job classification. Following collection of the initial samples, a

determination can be made for the selection of appropriate respiratory protection and engineering controls as necessary. NIOSH currently recommends an asbestos exposure limit of 0.1 fibers per cubic centimeter of air. Should asbestos exposures exceed this limit, then one of the following types of respiratory protection should be utilized:

a. A self-contained breathing apparatus (SCBA) with full facepiece operated in the pressure-demand mode.

b. A combination Type C supplied air respirator with full facepiece operated in the pressure-demand mode, and with an emergency backup SCBA operated in the pressure demand mode.

8. Formal occupational safety and health programs should be implemented at the James River and Suisun Bay Reserve Fleets. At each facility, at least one full-time employee should be charged with developing and maintaining the program. The NIOSH investigators believe this person should be someone with experience in such areas as personal protective equipment, material handling and lifting techniques, asbestos control technology, hearing conservation, hazard communication programs, etc.

This program should include, but not be limited to, the following components:

a. Safety Shoe Policy - safety shoes with slip-resistant soles and metatarsal guards should be mandatory for all non-office personnel.

b. Respirator Policy - requirements for a minimum acceptable program can be found in the OSHA Safety and Health Standards, 29 CFR 1910.134. Only NIOSH-approved respirators should be used, and each worker should be periodically trained on respirator usage and fit-tested according to protocols in the OSHA standards.

c. As recommended above, periodic training in proper lifting techniques.

d. Onshore and offshore housekeeping program - housekeeping at these facilities was lacking, with the areas being littered with trash, dead birds, old machinery and parts, and other potential safety and health hazards.

e. Eye and face protection programs for workers performing hazardous activities, i.e. sand blasting, paint scraping and welding.

f. Periodic safety audits - an inspection program which should include representatives of management and the workers.

g. A formalized recordkeeping program.

h. A review and sign-off on all purchases of equipment, machinery, and chemicals.

Finally, in the Federal Register (Vol. 53, No. 136, pp 26790-26797, July 15, 1988), OSHA published proposed rulemaking on the development and promulgation of an occupational safety and health guideline for general industry, shipyards and longshoring. The purpose of this guideline is to assist employers in using management methods in obtaining a workplace free of hazards. The NIOSH investigators recommend reviewing this rulemaking before implementing a safety and health program.

VIII. REFERENCES

1. U.S. Department of Labor, Bureau of Labor Statistics: The BLS Work Injury Report. U.S. Government Printing Office: Stock No. 202-109--84971, 1988.

2. NIOSH: Work Practices for Manual Lifting, U.S. Department of Health and Human Services Publication No. 81-122, March 1981.

3. NIOSH: Vibration White Finger Disease in U.S. Workers Using Pneumatic Chipping and Grinding Hand Tools, I. Epidemiology. U.S. Department of Health and Human Services Publication No. 82-118, September 1982.

4. Proctor, N.H., Hughes, J.P., Fischman, M.L.: Chemical Hazards of the Workplace. Second Edition. Philadelphia: J.B. Lippincott Company, 1988.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:

Christopher M. Reh,
Industrial Hygienist
Industrial Hygiene Section

Allan K. Fleeger, M.S.P.H.
Industrial Hygienist
Industrial Hygiene Section

James W. Collins, Research Mechanical Engineer, Division of Safety Research

Originating Office: Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies

Report Typed By: Sharon Jenkins
Clerk (Typing)
Industrial Hygiene Section

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Director, Office of Management Services, Maritime Administration.
2. Program Analyst, Maritime Administration.
3. Fleet Superintendent, James River Reserve Fleet.
4. Fleet Superintendent, Suisun Bay Reserve Fleet.
5. NIOSH Boston Region
6. NIOSH Denver Region
7. OSHA Region III
8. OSHA Region IX

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.