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FACILITIES AND ENVIRONMENTAL EFFECTS  
SURFACE PREPARATION AND COATINGS  
DESIGN/PRODUCTION INTEGRATION  
HUMAN RESOURCE INNOVATION  
MARINE INDUSTRY STANDARDS  
WELDING  
INDUSTRIAL ENGINEERING  
EDUCATION AND TRAINING

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# **THE NATIONAL SHIPBUILDING RESEARCH PROGRAM**

## **Application of Industrial Engineering Techniques to Reduce Workers' Compensation and Environmental Costs - Deliverable C**

U.S. DEPARTMENT OF THE NAVY  
CARDEROCK DIVISION,  
NAVAL SURFACE WARFARE CENTER

in cooperation with  
National Steel and Shipbuilding Company  
San Diego, California

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## DELIVERABLE C

### BLAST AND PAINT DEPARTMENT EYE INJURIES

## **BACKGROUND**

During 1996 and 1997, the Blast and Paint Department incurred 118 eye injuries, 99 first aid injuries and 19 recordable, 15 in 1996 and 4 in 1997. The types of eye injuries were abrasions, infections, irritations, rust rings, embedded foreign bodies and loose foreign bodies. Eye injuries have always been difficult to prevent in Blast and Paint due to the nature of work which includes painting, solvent washing, grinding, sanding, abrasive blasting and mechanical cleaning.

Due to the decrease in abrasive blasting, it was now standard operating procedure to mechanical clean and solvent wipe fabricated units in the on-block area. With the increase in mechanical cleaning and solvent wiping, dirt, sand and other debris embedded in the workers clothing became a source of problems. When a worker is mechanical cleaning in the overhead areas of an fabricated unit, for instance, dust particles fall downward and collect on clothing, safety glasses, respiratory protection, hands and face. The dust can only be removed by air blowdown hoses, vacuum hoses and by the workers dusting themselves after completion of work tasks. This procedure tends to be a problem because of, dust particles remaining in the atmosphere or settled dust on eye or respiratory equipment. When the employee removes Personal Protective Equipment from their face, loosened particles fall into the eyes causing a variety of first aid injuries, such as loose foreign body or embedded foreign body injuries.

The process of mechanical cleaning in an enclosed area, such as inside a closed compartment or isolated compartment outside, poses a threat to eye safety due to particles flying in the atmosphere or the air discharged from power tools dislodging loose particles from clothing and machinery. The employees are equipped with safety goggles and face shields to prevent eye injuries, but this process has not been totally effective in reducing eye injuries. Part of the problem has been the equipment, but much of the problem can be attributed to the employee.

Paint and Blast employees from several areas such as On board, On block and Paint pit areas were observed for several weeks. The observations were done to note tendencies, problems with existing Personal Protective Equipment, possible non-compliance and opportunities to change or modify current eye protection equipment. Employees were observed on several occasions, either not wearing eye protection, blowing air across their clothing to remove sanding/grinding debris or not taking the extra effort to thoroughly remove loose debris from personal protective equipment before removal. During these observations, some other issues arose such as current safety glasses fitting loosely, safety hazards with air feed respirator lines and injuries resulting from removing safety glasses and goggles from the employee's face.

## PARTICIPANTS

This project is concurrent with the Blast and Paint department goal of reducing hand, wrist and arm injuries within stages of construction Three and Five due to mechanical cleaning.

NAME	JOB TITLE	DEPARTMENT
**Andre Dorais	Facilitator	Training
**Indy Parra	Production Supervisor	Paint & Blast
**Bobby Flores	Production Supervisor	Paint & Blast
Jim Ferguson	Industrial Hygienist	Safety
**Arthur Green	Production Supervisor	Paint & Blast
Tony Robinson	Corrosion Control Specialist	Paint & Blast
Mario Cosio	Ass't Superintendent	Paint & Blast
Judie Blakey	Superintendent	Paint & Blast
Jim Paulson	Manager Safety	Safety
Craig Williams	Staff Engineer	Paint & Blast
Manuel Faria	Painter	Paint & Blast
Jorge Hernandez	Working Foreman	Paint & Blast
**Freddie Hogan	Project Engineer	Human Resources

**Note: \*\* Denotes current Team Members.**

## EYE PROTECTION

More than 90,000 eye injuries occur each year in the United States resulting in lost production time, medical expenses and workers compensation. No dollar figure can adequately reflect the personal toll these accidents take on the injured workers. Many of these could have been prevented with proper protective eyewear.

The Occupational Safety and Health Administration and the 25 states and territories operating their own job safety and health programs are helping to reduce eye injuries nationwide. Cal/OSHA requires that protective eyewear be worn wherever there is the potential for injury from flying particles, hazardous substances, or dangerous light. The eyewear must meet the standards put forth by the American National Standards Institute. Safety wear that meets this standard has "Z87.1 imprinted on the frame or lens.

### 1. Types of Protective Eyewear

- a. Safety Glasses: Safety glasses with side shields are designed to protect the eye from particles, projections, and , to a certain degree, hazardous chemicals. (Safety glasses must have side shields to meet the ANSI standard. Removing the shields voids the ANSI approval.) The lenses are impact resistant, and the frames are much stronger than those found on fashion eyewear.

Most safety glass lenses are made of polycarbonate, although some are made of glass. Glass lenses are more resistant to chemicals and cleaning solvents and may be a better choice in situations where the glasses will require frequent cleaning. Safety glasses are available with either plano (non-corrective) or prescription lenses.

- b. Goggles: Goggles provide more protection than safety glasses and should be worn wherever there is a potential for hazardous liquids to splash. In general they provide much better protection from smaller particles and liquids because they seal against the face. Also, they can be worn over normal prescription lenses if needed.
- c. Face Shields: Face shields protect both eyes and face when working with strongly corrosive chemicals that pose a splash hazard. Because face shields do not seal against the face, goggles should be worn under a face shield when handling strong corrosives.

- d. Welding/Chipping Goggles: Welding goggles are designed to protect your eyes from both hazardous light and hot particles. Among its other hazards, welding can generate infrared (IR) light. IR- safe lenses have special IR-absorbing dyes molded into them. Their degree of protection is rated on a "shade" scale. The higher the shade number, the higher the protection from IR. Be sure the glasses, goggles, or shields you pick have a high enough shade factor for your kind of work. Tint alone doesn't guarantee protection. Chipping goggles are untinted and should be used where flying chips or flakes of material are a problem.

## **2. Contributors to Eye Injury at Work**

- a. Not wearing eye protection. The Bureau of Labor Statistics reports that nearly three out of every five workers injured were not wearing eye protection at the time of injury.
- b. Wearing the wrong kind of eye protection. Usually injured workers were wearing some form of eye protection when the accident occurred. These workers were most likely to be wearing protective eyeglasses with no side shields, though injuries among employees wearing full-cup or flat-fold shields occurred, as well.

## **3. Causes of Eye Injuries**

- a. Flying particles. BLS found that almost 70% of the accidents studies resulted from flying or falling objects or sparks striking the eye. Injured workers estimated that nearly three-fifths of the objects were smaller than a pin head. Most of the particles were said to be traveling faster than a hand-thrown object when the accident occurred.
- b. Contact with chemicals caused one-fifth of the injuries. Other accidents were caused by objects swinging from a fixed or attached position, like tree limbs, ropes, chains, or tools which were pulled into the eye while the worker was using them.



#### **4. How Can Eye Injuries Be Prevented?**

- a. Always wear effective eye protection. To be effective, the eyewear must be of the appropriate type for the hazard encountered and properly fitted. When an employee is injured wearing eye protection, it is because objects have gone around or under the protector. Eye protective devices should allow for air to circulate between the eye and the lens.
- b. Use goggle as much as possible. Goggles generally provide better eye protection with face shield than safety glasses.
- c. Better training and education. Workers injured while not wearing protective eyewear most often said they believed it was not required by the situation. Make sure all employees have proper information on where and what kind of eyewear should be used.
- d. Maintenance. Eye protection devices must be properly maintained. Scratched and dirty devices reduce vision, cause glare and may contribute to accidents.

## **CONTACT LENSES IN THE WORK ENVIRONMENT**

The use of contact lenses in the chemical/dust environment complicates eye safety. Contact lenses have the potential to trap dusts or chemicals (gases or vapors) behind the lens and cause irritation, excessive eye watering and /or damage to the cornea; also, a chemical splash may be relatively more injurious when contact lenses are worn because the removal of the lenses may be delayed, restricting first aid and prolonging the exposure time. There are some who feel contact lenses give added eye protection and help to minimize injury; the scientific information on this issue continues to be sketchy and is controversial.

It is generally accepted that contact lenses are not, in themselves protective devices; it is strongly recommended that contact lenses not be worn where:

- gases, vapors or other materials are present which, when absorbed by contact lenses, may harm the eyes;
- dust or other materials are present which may harm the eyes or cause distraction which may expose the worker to other injury;
- there is significant potential for chemical splashing to the eyes from injurious chemicals such as acids and alkalis.

## RESULTS

Paint and Blast personnel were observed for several weeks to determine the causes of eye injuries in the production areas. In addition to the sheer volume of mechanical cleaning, an additional safety hazard was noted. This safety hazard was the abundance of airlines to power tools and air supplied respirators. During the workday, employees were observed performing work area cleanup, personal cleanup, and restowage of equipment.

It was noted that the employees did use low pressure air to remove loose debris, sand and grit from their coveralls. Many were noted pointing the nozzle directly to their face shields and/or goggles, instead of at an angle. When pointing the nozzle at an angle, air forces loose dust away from facial areas and not onto or under protective equipment. Many of the painters, after blowing down, would immediately wipe their face with a clean cloth to remove particles that had become embedded into facial areas. It was at this point that the potential for eye injury increased, because the safety glasses or goggles were removed prior to wiping.

Taking note of the employees actions, coupled with the numerous amount of lines in the immediate work areas, the Project Engineer recommended the use of full face cartridge respirators to eliminate the number of airlines in a work area, provide workers with an environment to breathe clean air, and eliminate the potential for eye injuries during blowing down or performing mechanical cleaning. Full face cartridge respirators provide the user with clean air (providing the filters are not clogged from contaminants) while mechanical cleaning and eliminate dust from getting under safety glasses, face shields or goggles. Additionally, the bulkiness of goggles and face shields will no longer be a burden for the worker.

The decision was made by Mario Cosio, Paint & Blast Ass't Superintendent, to purchase full face cartridge respirators for testing in the on block and on board areas. Each employee was fitted with a respirator and allowed to continue his or her regular duties. After a few more weeks of observation, it was noted that setup and breakdown time for the painters and blasters decreased an average of thirty minutes per employee. Not only were differences noted with setup and breakdown times but eye injuries began to decrease in the Paint & Blast areas.

In 1997, the injury rate for Blast and Paint declined to four workers compensation cases and in 1998, there are no recorded worker compensation cases for the Paint and Blast department (as of June 1998). **(Figure 1.)** Though, a small adjustment was made in the processes to reduce or eliminate eye injuries, daily followup on your employees is vital for continued success.

## **RECOMMENDATIONS**

Before selecting personal protective equipment, evaluate the level of protection required by your operations. The eye protection and respirators suggested for usage in atmospheres where airborne particulates pose potential health and safety concerns are only basic recommendations. When using cartridge type respirators, the following information should be considered for maximum efficiency:

### **1. Respirators**

#### **Particulate Filters**

The selection and use of particulate respirators are on the basis of service times. Use and reuse of the P-series filters would be subject only to considerations of hygiene, damage, and increased breathing resistance. Recent studies indicate the efficiency of P-series filters may be significantly reduced with long term use in the presence of oil aerosols. In some workplace situations, this reduction in filter efficiency may not always be accompanied by an increase in breathing resistance that would signal the user to replace filter or filter element. Different levels of reductions vary from model to model, therefore selection, evaluation and testing should be thorough.

- a. R-series filters should be used only for a single shift (or for 8 hours of continuous or intermittent use) when oil is present. The determination would need to be applied when conditions change or modifications are made to processes that could change the type of particulate generated in the user's facility.
- b. P-series should be used and reused in accordance with the manufacture's time-use limitation recommendations when oil aerosols are present. P-series filters should be used and reused subject only to considerations of hygiene, damage, and increased breathing resistance if oil aerosols are not present.
- c. 30CFR part 11 filters should be replaced at least daily or more often if breathing resistance becomes excessive or if the filter suffers physical damage (tears, holes, etc.) Filter elements designed to be cleaned and reused should be cleaned at least daily in accordance with the manufacture's instructions. Between uses, filters should be packaged to reduce exposure to conditions which causes filter degradation, such as high humidity.

## **2. Respirators**

Air-Line Respirators (Air Supplying) supply clean air through a small diameter hose from a compressor or compressed air cylinders. The wearer must be attached to the hose at all times, which limits mobility. Use of these respirators is subject to the manufactures guidelines.

Full-Face Respirators operate under the same principles and requirements as the half-face type, however, they offer a better facepiece fit and also protect the wearer's eyes from particularly irritating gases, vapors and dust particles.

## **3. Eye Safety**

- a. Observe eye safety signs and procedures.
- b. Always wear appropriate ANSI Z87 approved eye protection in clean and serviceable condition for mechanical, chemical, biological or radiant energy levels.
- c. Never wear contact lenses where smoke, dust, and chemical fumes exist.
- d. Know where the eye wash fountain is and know how to use and maintain it.
- e. Know basic first aid for eye injury so you may help yourself and your fellow worker.
- f. Have an eye examination by your eye doctor every two or three years, or sooner as directed, to ensure you have good vision to do your job safely and efficiently.
- g. Report to your supervisor hazards and unsafe practices that may cause eye injury.
- h. Encourage your fellow worker to practice eye safety and receive annual eye safety training.
- i. Use common sense in all activities potentially hazardous to the eye.

**APPENDIX 1.**

**1996 and 1997 Blast and Paint Worker's  
Compensation Costs**

**Actual Incurred Costs of Eye Injuries**

<b>Year</b>	<b>Total Blast and Paint Employees</b>	<b>Number of Injuries</b>	<b>Total Cost</b>	<b>Injury Rate</b>
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<b>1996</b>	<b>250</b>	<b>15</b>	<b>\$2,214.00</b>	<b>6.00%</b>
<b>1997</b>	<b>283</b>	<b>4</b>	<b>\$1,059.14</b>	<b>1.41%</b>

**1997 Blast and Paint Eye Injury Cost Savings at 1996  
Injury Rate**

<b>1996 Injury Rate</b>	<b>1997 Employees</b>	<b>1997 Per Injury Rate</b>	<b>1997 Cost Savings</b>
<b>6.00%</b>	<b>283</b>	<b>\$264.88</b>	<b>\$4,497.66</b>

<b>1997 Injury Rate</b>	<b>1997 Employees</b>	<b>1997 Per Injury Rate</b>	<b>1997 Cost Savings</b>
<b>1.41%</b>	<b>283</b>	<b>\$264.88</b>	<b>\$1,059.14</b>

			<b>***\$3,438.52***</b>
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**\*\*\*\*\* Annualized Cost Savings\*\*\*\*\***