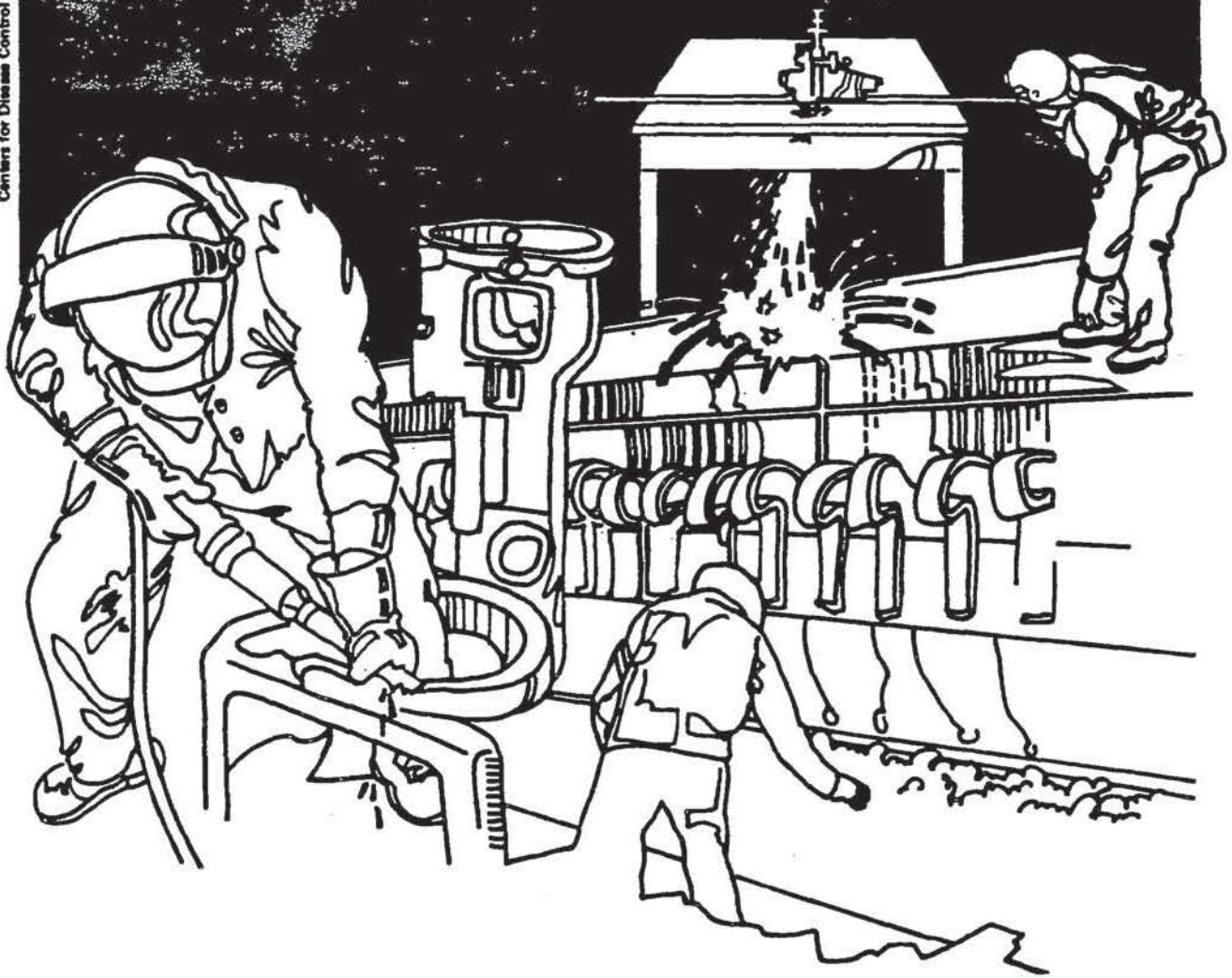


NIOSH



Health Hazard Evaluation Report

HETA 81-364-1080
GENERAL DYNAMICS SHIPYARD
QUINCY, MASSACHUSETTS

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.

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General Dynamics Shipyard
Quincy, Massachusetts

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I. SUMMARY

In June 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the Industrial Union of Marine Shipbuilding Workers of America, Local 5 at the General Dynamics Shipyard, Quincy, Massachusetts. Symptoms of eye irritation, burning throat, nasal and sinus congestion, chest tightness and pain, nausea, extreme fatigue, light headedness, and severe headaches were experienced by male and female burners, welders, and fitters who were doing hot repair work on an epoxy coated submarine.

To determine whether these symptoms were work-related, a health hazard evaluation was initiated by conducting a walk-through site visit. Plans for environmental and medical monitoring to be performed during a second site visit were discussed with both the Shipyard management and the Union representatives. A complete investigation of the health hazards associated with epoxy paint fumes was not possible at the General Dynamics Shipyard for two reasons: (1) no hot work was in operation during the walk-through; (2) investigators were informed by management that the practice of hot work on epoxy paint was not permitted in the Shipyard and so this process would never be observed by an evaluation team.

Although it is not a normal work practice, hot work on epoxy paint is reported to occur during repair work at the General Dynamics Shipyard. Epoxy paint fumes are potentially harmful to exposed workers and have been associated with some of the symptoms experienced by the Shipyard employees. Even if employees follow the work practices outlined by the company, we could not determine from this investigation that these employees are being effectively protected from epoxy paint fumes exposures.

A complete investigation resulting in a toxicity determination could not be made because full information concerning this complaint could not be obtained. Worker exposures to epoxy paint fumes should be investigated, but this problem cannot be studied under the conditions at the General Dynamics Shipyard.

Keywords: SIC 3731 (Shipbuilding and repairing), Epoxy paint

II. INTRODUCTION

On June 11, 1981 the Occupational Health Program, through the National Institute for Occupational Safety and Health (NIOSH) Cooperative Agreement, was assigned a request for a health hazard evaluation prepared by a steward and other members of the Industrial Union of Marine and Shipbuilding Workers of America, Local 5 at the General Dynamics Shipyard, Quincy, Massachusetts. The purpose of the investigation was to evaluate complaints of eye irritation, burning throat, nasal and sinus congestion, chest tightness and pain, nausea, extreme fatigue, light headedness, and severe headaches possibly associated with welding on epoxy paint in the 6 Basin of the General Dynamics Shipyard in Quincy, Massachusetts. After obtaining security clearance and an escort of the Master Chief of Shipbuilding, US Navy, a site visit was conducted on July 6, 1981 during which a walk-through of the 6 Basin area was made and the company medical records were reviewed. At a later date, a local physician who regularly sees employees from the shipyard was interviewed and the medical records of three shipyard employees who were exposed to epoxy paint fumes were obtained from a local hospital.

III. BACKGROUND

General Dynamics Shipyard employs approximately 2400 workers. There are three shifts with 1600 employees on the first shift, 700 on the second shift, and 100 on the third shift. The major employment at the Shipyard is the construction of new LNG tankers and submarines. Over the past year, however, the amount of repair work on older vessels has increased. This work is sporadic and depending on the size of the job, may last for a few weeks to several months. It is the hot repair work on old epoxy painted vessels which prompted this evaluation.

IV. METHODS AND MATERIALS

Personal interviews and medical records were obtained from exposed employees during the walk-through and during the weeks following the site visit.

V. Results

A. Environmental

The bow section of the submarine in 6 Basin is approximately 20 feet in diameter and 40 feet high. Welding is done on both the inside and outside of the vessel. During the time of the site visit the outside was unpainted. The inside was painted gray except where ground off at the seams for welding (approximately 3 inches wide).

A fan and flexible ductwork were in the area but not observed in use at the time. Several workers were observed with respirators around their necks.

At the time of the walk-through, no burning, grinding or welding was in progress. Most of the workers in 6 Basin had been transferred there from Newport, Rhode Island the morning of the walk-through. These workers knew nothing of the health complaints of other employees who had worked in 6 Basin before them. The new workers did not have any health complaints at the time of the walk-through.

B. Worker Reports

Three workers who were welding in 6 Basin immediately prior to the health hazard evaluation request were located and briefly interviewed. Five other workers were located and interviewed after the walk-through site visit. Several reports relating to the health hazard evaluation are summarized:

1. Although company work practices (Appendix A) stipulate that the epoxy paint be blasted or ground back (not burned) on both the front and back of the welding seam, several of the welders interviewed reported they regularly encountered seams to be welded that still had epoxy on either the front, back or both. In some cases the epoxy had been removed but not far enough back from the seam to prevent combustion.
2. Workers expressed concern that they would lose their jobs if they continuously refused to work on epoxy paint.
3. Workers reported they had not been informed which individual(s) had the ultimate responsibility to oversee the blasting and grinding of epoxy paint before welding or what to do when these work practices were not performed properly.
4. Welders who could not locate someone to grind back the epoxy paint or who were pressed for time to complete a job, would weld on the paint.
5. When welding did occur on epoxy paint, both male and female workers reported eye and upper respiratory irritation, chest tightness, chest pain and nausea. These verbal reports were similar to the symptoms reported in the medical records of three shipyard workers with epoxy paint fume exposures who were seen at a local occupational health clinic the month prior to the walk-through site visit. (See below.)
6. According to both the company and the workers, at least five welders and burners had been to the company medical services. Other workers reported that they attempted to treat the symptoms themselves. These workers did not see an independent physician because such visits are not paid for by their medical insurance.
7. The union steward for 6 Basin reported that he had complained on behalf of the workers he represented to the company and asked that the work practices be strictly enforced. As of the date of the site visit, the practices were still not always followed.

C. Management Reports

The manager of industrial hygiene and safety reported that he had written the work practices for hot work in wide open spaces and semi-enclosed/enclosed spaces. These practices are company policy and are to be followed at all times. Final responsibility for the enforcement of these practices belongs to the supervisor of each work area. The work practices are not given to the employees in written form nor are they posted in a conspicuous location at the work sites. When asked about further environmental sampling to determine the

composition of epoxy paint fumes in 6 Basin, the manager reported that the job under complaint would be completed within days and that the health hazard evaluation industrial hygienists would not sample epoxy paint fumes because work practice policy did not permit hot work on epoxy paint. He also said the company had evaluated the operation by sampling with Draeger detector tubes for ammonia, ozone, nitrous oxides, carbon monoxide, cyanide, ketones in direct proximity or welding in nose section of bow. All detector tubes were below the limit of detection of this method.

D. Union Leadership Reports

The vice-president of IUMSWA Local 5 officially represented the union for this evaluation. The union leadership stated that they were aware of the health complaints of the welders, burners and cutters. They said they had spoken with their members and told them if they had problems the workers should go to the company medical services and/or see an independent physician. Immediately after this earlier discussion, four welders reported to the company medical services.

E. Medical Report

The company physician stated that he was not aware of any unusual health problems particularly among the welders but noted that the medical logs are not kept by job category. Since the NIOSH evaluation team did not have the names of every individual who had sought medical aid, this organization of medical files made a satisfactory review of the records difficult.

The health hazard evaluation physician spoke with a local dermatologist who had seen some of the Shipyard employees including a number of welders with facial reactions since hot work on epoxy paint began and he stated that there was a medical problem. The dermatologist's investigation led to the conclusion that the irritant was a combustion product of the welding smoke (fume). He reported that the manager of industrial health and safety had analyzed the smoke and found that it had a very low pH and that it contained phenols. Three shipyard workers were seen by the local dermatologist with allergic contact dermatitis which he attributes to epoxy combustion products.

The medical records of three shipyard employees exposed to epoxy paint fumes were obtained from a local occupational health clinic. All three workers were seen in June 1981. The health complaints recorded were those of light headedness, extreme fatigue, decrease in libido, nausea, burning throat, nasal and sinus congestion, occasional wheezing mostly in the evenings, severe headaches, anterior chest tightness and pain and eye irritation. In all three workers the symptoms get progressively better on weekends. The symptoms occur even with the use of the respiratory protection supplied by the company, although they are less severe when a respirator is worn.

VI. TOXICOLOGICAL DATA

Epoxy resins are thermosetting plastics despite the fact that some of these resins utilize "cold curing" methods where the "heat" is generated by the chemical reaction itself.

Epoxy resins are basically the reaction product of two chemicals, epichlorohydrin and 2,2 bis(p-hydroxy phenyl) propane, (Bisphenol A). They form a condensation product, diglycidyl ether which has epoxy groups at both ends as well as pendant hydroxyl groups where reactions can occur. Both of these groups are potentially reactive physiologically as well as chemically.

Curing of the epoxy resin is brought about by splitting of the epoxy ring which leads to linkages being formed between the long chain molecules in such a way that a stable three-dimensional lattice is built up. The most commonly used curing agents are amines, followed by acids and acid anhydrides and sometimes polyamides. In general, the amines are considered strongly alkaline and highly reactive chemically and physiologically.

The paint used on the bow of a submarine is specified by the US Navy to be Mobil Chemical Company's "Sovapon". The curing agent used in this epoxy paint is Triethylene tetramine, a primary aliphatic amine commonly known to cause skin irritation and sensitization. A study by Bourne, Milner and Alberman showed the damp surface of a cured resin has a pH of 10-12 and the body of a cast resin contains 0.1-0.2% free amine. This means that when a resin-TTA ratio of 10:1 is used possibly 1% of the added amine remains unreacted in the resin. Ideal cross-linking does not occur. Free NH₂ and NH groups always remain present (1).

Very little has been done regarding the decomposition of cured epoxy resins. However, in 1956 Charles Bergtholdt of the Industrial Health Division of the US Naval Weapons Plant described complaints of welders and cutters working on epoxy resin coated steel in naval facilities. He reported complaints about the odor of fumes and in some cases inhalation of the fumes resulted in nausea. No attempt was made to characterize the exposure (2).

Joyner and Pegues (1961) reported six cases of illness characterized by upper respiratory irritation and abnormal urinary findings among workers engaged in destructive removal of epoxy resin-concrete (TTA and dimethylamine propylamine curing agents). They analyzed the dusts and vapors collected from drilling, grinding and pyrolyzing the samples in the lab and found no epichlorohydrin or other aromatic chlorinated compounds and no free amines. They did find xylene which was a resin precursor, other aromatics especially a $\text{C}_6\text{H}_5^\circ$ fragment and volatile nitrogen compounds (perhaps amine hydrochloride) (3).

A study with rats exposed to the pyrolysis products of epoxy resins (alkyl derivative of maleic anhydride as curing agent) concluded that "the pyrolysis products may constitute a hazard to human personnel" (4).

VII. CONCLUSIONS AND RECOMMENDATIONS

The most obvious way to avoid the potential effects of epoxy resin decomposition products is not to heat up the resin by welding or cutting on it.

A 1961 paper by Charles Bergtholdt on "Recent Welding Practices at Naval Facilities" the procedures for working with epoxy resin coated steel required that the section to be welded be ground back to bare metal (2).

General Dynamics' written policy of March 19, 1981 (Appendix A) specifies the conditions under which hot work should be done in wide open spaces and semi-enclosed/enclosed spaces. When working in open spaces the policy states that workers are to blast "as much as possible" to remove paint before cutting or welding. Provisions are made for circumstances where hot work is done directly on paint. Presumably this is done only when blasting "is not possible." The meaning of "as much as possible" should be clearly defined. The line of responsibility for enforcing the specific provisions (2-c) of the practices when hot work is done directly over paint should also be clarified and communicated to all parties at all times. Written work practice requirements do not specify exactly how much epoxy paint should be removed from the area to be welded. A verbal report from management indicated that epoxy paint was to be blasted or ground back 4 inches on both the front and back of the area to be welded. These provisions should be written specifically into the work practices.

In enclosed or semi-enclosed spaces the policy is vague. A strong statement on the need for removal of epoxy paint before welding or cutting should be included. Provisions for protection of blasters/grinders should be covered and should include mandatory use of forced ventilation located as close to source as possible, use of respiratory protection (MSA's GMC-H cartridge) and perhaps goggles.

The most important aspect of any policy no matter how appropriate is that it be well known and used. In light of this it would be useful to instruct each new employee in this policy and to periodically re-instruct workers once they are on the job. This should include a copy of the policy and, after discussions with the union, a procedure for assuring that work is blasted or ground down before welders are assigned and how to deal with and correct situations where this has not been done.

The medical records for this shipyard should be organized according to job category. This would provide early identification of illness or injury that occurred primarily in one department or group of employees.

Although it is not normal work practice, worker interviews and medical records obtained prior to this investigation have indicated that hot work on epoxy paint occurs during the course of repair work at the General Dynamic Shipyard. Epoxy paint fumes are potentially harmful to exposed workers and it is possible that these epoxy fumes are the source of many of the health

complaints described by the shipyard workers and local physicians. In order to determine whether the current work practices, if correctly employed, are effective in preventing health problems, a continuing systematic evaluation of workers performing hot repair work is indicated.

Worker exposures to epoxy paint fumes should be investigated, but this problem cannot be studied under the current conditions at the General Dynamics Shipyard.

VIII. REFERENCES

1. Bourne LB, FJM Milner, KB Alberman. Health problems of epoxy resins and amine-curing agents. Brit J Industr Med, 16:81, 1959.
2. Bergtholdt CPI. Recent welding practices at Naval facilities. Arch Environ Health, 2:257, 1961.
3. Joyner RE, WL Pegues. A health hazard associated with epoxy resin-concrete dust. J Occ Med, :211, 1961.
4. Leong KJ, HN MacFarland. Hazards from decomposition epoxy resins. Arch Environ Health, 7:61, 1963.
5. Bergtholdt CPI. Recent welding practices at Naval facilities. Arch Environ Health, 2:257, 1961.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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1. General Dynamic Shipyard
2. Industrial Union of Marine Shipbuilding Workers of America, Local 5
3. NIOSH, Region V
4. OSHA, Region V

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.

APPENDIX A

A. WORK IN WIDE OPEN SPACES

1. USE BLASTING AS MUCH AS POSSIBLE TO REMOVE PAINT BEFORE CUTTING/BURNING OR WELDING.
2. HOT WORK DIRECTLY OVER PAINT, BUT ONLY IN THE OPEN, IS PERMISSIBLE ONLY IF:
 - (a) ALL WORKERS WHO MAY BE AFFECTED BY ANY SMOKE FROM THE OPEN SPACE HOT WORK ARE PROTECTED BY RESPIRATORS WHICH USE THE GMC-H CARTRIDGE.
 - (b) NATURAL AND/OR FORCED VENTILATION EXISTS TO RAPIDLY DISSIPATE ANY SMOKE AND REMOVE IT AWAY FROM THE FACE OF ANY WELDER/BURNER.
 - (c) NO SMOKE IN TANKS IS GENERATED BY THE EXTERNAL (OPEN SPACE) HEATING WHICH AFFECTS WORKERS IN SUCH TANKS (WHEN SUCH WORK IS DONE, WORKERS SHOULD BE REMOVED/ABSENT).

B. ENCLOSED/SEMI-ENCLOSED SPACES

1. BLAST PAINT OR GRID PAINT--DO NOT BURN. BLASTING IS PREFERABLE TO GRINDING.
2. AVOID ALL UNNECESSARY ACTIONS WHICH CAUSE PAINT TO CHAR/DECOMPOSE.
3. EMPLOYEES WHO MAY BE AFFECTED BY ANY SMOKE OR GRINDING DUST WILL WEAR GMC-H CARTRIDGES WHICH WILL BE EXCHANGED DAILY.
4. EMPLOYEES MUST BE INSTRUCTED TO:
 - (a) NOT SMOKE ON BOAT
 - (b) WASH HANDS/FACE REGULARLY AND IF/WHEN ANY IRRITATION IS FELT
 - (c) WASH RESPIRATOR AT LEAST DAILY
 - (d) TEST FIT OF RESPIRATOR
 - (e) EXAMINE RESPIRATOR PARTS--VALVES, ETC.
 - (f) BE CLEAN SHAVEN WHEN USING RESPIRATOR
5. SAFETY DEPARTMENT WILL:
 - (a) CHECK USERS OF RESPIRATORS TO ASSURE PROPER USAGE/CORRECT FIT
 - (b) ASSURE PRACTICES/CONDITIONS ARE SATISFACTORY
 - (c) CONTROL CONDITIONS AND PRACTICES AS NECESSARY TO ASSURE WORK/WORKPLACE IS SAFE