

LEAD INDUSTRIES ASSOCIATION

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NEW YORK 17, N. Y.

RED LEAD DIVISION

July 8, 1948

To Members of the Red Lead Technical Committee:

SUBJECT: "THE INCIDENCE OF HEALTH HAZARDS FROM LEAD PAINT
AND ZINC CHROMATE PAINT IN MODERN CONSTRUCTION,
MAINTENANCE AND SCRAPPING OF SHIPS"

I am enclosing a draft of the paper entitled, "The Incidence Of Health Hazards From Lead Paint And Zinc Chromate Paint In Modern Construction, Maintenance And Scrapping Of Ships" by Dr. E. W. Brown, which it is proposed to submit to OCCUPATIONAL MEDICINE, published by the Council of Industrial Health of the American Medical Association.

May we please have your comments at your earliest opportunity?

As Dr. Brown is leaving on July 17 for six weeks, it is hoped to submit the paper to the publication prior to that date.

Very truly yours,

Robert L. Ziegler
Secretary



N2806

THE INCIDENCE OF HEALTH HAZARDS FROM LEAD PAINT
~~AND ZINC-CHROMATE PAINT IN MODERN CONSTRUCTION,~~
 MAINTENANCE AND SCRAPPING OF SHIPS

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 (July 1, 1968)

The chief objective of this paper is to present certain data on the incidence of lead intoxication and bodily disturbances ~~from zinc-chromate~~ resulting from the respective use of lead paint ^{and zinc-chromate paint} in the shipbuilding industry; this material reflecting in turn the extent of the health hazards which may be expected under existing environmental conditions of exposure and industrial hygiene measures of control.

The painting practices of ships have changed markedly in the last thirty years and practically all of the alterations have been in the direction of a decreased hazard in exposure to lead. ~~The use of zinc-chromate paint as a primer in ship construction is comparatively recent. In the interpretation of the statistical data in relation to the control of health hazards, the significance of these changes in occupational conditions is taken into account in the discussion to follow.~~

It should be emphasized that varying methods prevailed with respect to painting in the shipbuilding industry during the recent war. ~~For instance, zinc-chromate paint only was authorized as a steel primer in both United States Navy Government and Navy-Contract Shipyards. On the other hand, the United States Maritime Commission imposed no restriction on the use of red lead ^{as a lead primer made} ~~for this purpose~~ ^{as a lead primer made} ~~and it was applied widely in the United States Maritime Shipyards; while~~~~

• This study was conducted by the author as a consultant to the Lead Industries Association, New York, N.Y.

~~Under the Navy LIAA program, the data on lead exposure paint, the former was~~

~~separately presented.~~

The data contained in this paper fall under the following subdivisions as indicated:

- (a) Lead Intoxication in Personnel of the United States Navy and Marine Corps, 1922 to 1944;
- (b) Lead Intoxication in Civilian Employee Personnel in United States Naval Government Shipyards;
- (c) Efficiency of Control Measures in the Prevention of Lead Intoxication in the Scrapping of Naval Vessels in 1945 and 1946;
- (d) Lead Intoxication in United States Maritime Contract Shipyards During the Recent War;

~~(e) The Health Hazards of Zinc Chromate Paint in Shipbuilding.~~

LEAD INTOXICATION IN PERSONNEL OF THE UNITED STATES NAVY AND MARINE CORPS: 1922-1944.

These data were supplied by the Chief of the Medical Statistics Division of the Bureau of Medicine and Surgery of the Department of the Navy,¹ and publication was authorized by the Surgeon General². The data in this grouping refer to enlisted naval and marine painters, welders and burners engaged in maintenance work in naval vessels and subject to the following potential exposures:

- (a) Inhalation of lead fume by welders and burners while welding, burning or cutting lead paint-coated metal;
- (b) Both inhalation and ingestion of lead paint dust during chipping and wire-brushing in the removal of such paint from metallic surfaces;
- (c) Inhalation of lead paint spray;
- (d) Ingestion through contamination of food and drink from hand contact in both brush and spray painting.

¹ Personal communication to the author, Aug. 6, 1946.

² Personal communication to the author from the Surgeon General, Oct. 23, 1947.

LIMITATIONS IN ACCURACY OF REPORTING OF CASES: Certain of these data are accepted with considerable reservation. The following excerpts are quoted as examples of inadequate or fallacious reporting followed by the author's comment:

(a) "Caused by lead paint while painting shaft alley of ship." The record implies that the condition was due to exposure to paint fumes which necessarily could not contain lead; presumably due to some volatile component such as the thinner;

(b) "While chipping paint in poorly ventilated quarters was overcome by fumes." Under these circumstances dust from lead paint might have been inhaled but no fumes could have been involved. The symptoms recorded in this case could not be attributed to lead exposure although plumbism might have later developed.

(c) "For past four months has been using a lacquer spray daily without mask for protection." As lacquer paints ^{used daily} ~~are~~ not contain lead pigments, lead exposure was not a factor in this instance. *(Chrom yellow is sometimes used in lacquers.)*

It is evident from these examples that certain naval medical officers may not always be familiar with the composition of paints alleged to have caused lead intoxication or even may be under the erroneous impression that all paint contains lead pigment. This raises the question: should such doubtful cases be deducted from the total for any year recorded? This, however, poses another question, i.e., have not errors of omission also been a factor in that occasional cases of plumbism may have been reported under a mistaken diagnosis? Errors of omission would tend to effect mistakes of commission; consequently no alterations in the reported data have been made.

DISCUSSION OF DATA

(a) Number of Cases and Case Rates per 100,000.

The data are contained in Table 1 and accompanying semi-logarithmic graph. The annual frequency case rates per 100,000 are based on the average

TABLE I

STATISTICS OF LEAD INTOXICATION

U. S. Navy and Marine Corps: 1922-1944

Number of Cases and Frequency Case Rates per 100,000:

Calendar Year	Average Total Personnel	Number of Cases	Annual Frequency Rate per 100,000
1922	122,126	14	12
1923	116,565	33	28
1924	119,280	7	6
1925	115,391	9	8
1926	113,756	37	33
1927	115,316	34	29
1928	116,047	15	13
1929	117,308	23	20
1930	117,453	7	6
1931	112,767	6	5
1932	110,717	5	5
1933	108,183	22	20
1934	109,383	8	7
1935	114,188	4	4
1936	124,408	1	1
1937	132,855	4	3
1938	139,216	3	2
1939	149,618	2	2
1940	202,614	3	1
1941	348,926	0	0
1942	834,639	9	1
1943	2,108,379	19	0.9
1944	3,349,798	20	0.6

total personnel which is designated by the Navy as "average complement" and calculated for the calendar year by dividing the total number of daily rations issued by 365. All cases which existed prior to enlistment have been excluded.

It is realized that case rates from the comparative statistical standpoint should be calculated in terms of industrial personnel potentially exposed to the hazard of plumbism rather than on the basis of the total naval population. Such personnel would include the following groups: (1) painters, (2) welders, (3) burners, (4) men detailed to removal of paint from metal surfaces by means of chipping, wire-brushing and sandpapering, and (5) helpers assigned to the first three groups. It was found on inquiry that the Department of the Navy has no data segregated with respect to these classes of industrial workers. Comparisons of data for different calendar years must therefore relate to total personnel with the limitations inherent under such conditions.

It will be noted that the annual plumbism rate per 100,000 from 1922 to 1929 varied from 7 to 37 with an average of 21; from 1930 to 1939 from 1 to 7 (if 1931 is excluded with a rate of 20), the average for the entire period of the thirties being 6. From 1940 to 1944 the rate varied from 0 to 1. The markedly downward trend of the curve in the nineteen thirties and forties is striking.

(b) Sick or Absentee Days per Million Working Man-days per year. The data are presented in Table 2 and accompanying semi-logarithmic graph.

The following illustrates the method of computing: selecting the year 1922, the average total personnel was 122,855; this is multiplied by the factor 365, or total number of days of the calendar year, the result being 44,575,990 average working man-days. The total number of absentee sick days for this year charged to plumbism was 551; dividing the latter figure by the total number of million working man-days, the result is 12.4 absentee days per million working man-days. In view of the method of determining the average total personnel, the total average working man-days can be taken as approximately correct.

TABLE 2

LEAD INTOXICATION STATISTICS

U. S. Navy and Marine Corps: 1922-1944

Number of Sick Days per Million Working Man-Days per Year

Calendar Year	Average Total Personnel	Total Sick Days	Total Working Man-Days	Severity Rate Sick Days per Million Working Man-Days
1922	122,126	551	44,575,990	12.4
1923	116,565	857	42,546,225	20.1
1924	119,280	341	43,537,200	7.8
1925	115,391	390	42,117,715	9.2
1926	113,756	1,417	41,520,940	34.1
1927	115,316	1,498	42,090,340	35.6
1928	116,047	1,245	42,357,155	29.4
1929	117,308	569	42,846,620	13.3
1930	117,453	146	42,870,345	3.4
1931	112,767	194	41,159,955	4.7
1932	110,717	294	40,411,705	7.2
1933	108,183	975	39,436,795	24.7
1934	109,383	232	39,924,795	5.8
1935	114,188	50	41,678,620	1.2
1936	124,408	28	45,408,920	0.7
1937	132,855	91	48,492,075	1.9
1938	139,216	46	50,813,840	0.9
1939	149,618	17	54,610,570	0.3
1940	202,614	112	73,954,110	1.5
1941	348,926	None	127,357,990	0.0
1942	834,639	274	304,643,235	0.9
1943	2,108,379	1,016	769,558,335	1.3
1944	3,349,798	406	1,222,676,270	0.3

* The heading "Total Sick Days" denotes the total number resulting from plumbism for admissions, readmissions, and cases continued from the previous year.

Referring to Table 2 and accompanying graph, it will be observed that the variation in rate of sick days per million working man-days from 1922 to 1929 was 7.8 to 35.6, with an average of 20.2. From 1930 to 1939 the range was from 0.3 to 24.7 with an average of 5.1, and this is reduced to 2.9 if the year 1933 is omitted. The average rate for the period 1940 to 1944 is 0.8. The possible factors underlying the reduced incidence in the nineteen thirties and forties will now be discussed.

CHANGES IN NAVAL PAINTING PRACTICE: During the nineteen twenties red lead was in general use in shipbuilding by the Navy for the priming of steel until approximately 1929 when a change was effected, chiefly to conserve weight, as follows: the metal was pickled before construction and then covered with a coat of iron oxide paint. After the plates were fitted and construction was completed, an aluminum paint primer was applied in place of red lead, beginning at ten feet above the water line. However, red lead was still continued as a primer on the hull from ten feet above the water line beneath the underwater anti corrosive coat down to the keel. Lead paints for top coats were discontinued in the early part of this period both for outside and inside work.

In addition, during the nineteen thirties the red lead priming was retained for (1) submarine vessels in general, (2) for the so-called wet spaces in all vessels, as crew's washrooms, toilet rooms, double bottoms, tanks, pockets, etc. and (3) on metal underneath decks of wood planking. Putty with a high lead content was utilized between steel plates or other metallic structures secured to steel decks, thus producing an extremely heavy concentration of lead fume on cutting operations with the oxyacetylene flame.

Another shift of policy occurred when the Department of the Navy discontinued the use of red lead for priming steel in all types of vessels, replacing this by a zinc chromate formula.

When it was shifted from chromate to zinc chromate? (O. J. 1940)
that it was a general quantity of red lead was in existence.

As to the impact of these changes in painting technique on occupational exposure to lead, the considerable substitution of aluminum for red lead for steel priming in the nineteen thirties tended to reduce hazard in maintenance work in relatively new ships. However, lead exposure was still frequently entailed in paint removal operations and in welding in the older classes of vessels where red lead priming had been generally applied. An additional factor must also be taken into account, in that the red lead primer where used in the nineteen thirties, was not the pure red lead used at one time in naval construction, but contained only about $\frac{32.5}{100}$ of the pigment. This change-over occurred at some time in the nineteen twenties. The complete elimination of lead-bearing paint in the 1941-1945 period would of course postulate the disappearance of all plumbism relating to painting operations except in reference to repair work in older vessels.

It is concluded that the marked decline in plumbism rates for the nineteen thirties as compared with the nineteen twenties is correlated in part with the reduced use of red lead in the Navy, but due weight should be given to improved measures of medical and engineering control which developed during this period. Furthermore, the rates both for admissions to the sick list and absenteeism were so extremely low that plumbism cannot be considered as having presented an industrial health problem.

LEAD INTOXICATION IN CIVILIAN EMPLOYEES PERSONNEL IN UNITED STATES NAVAL GOVERNMENT SHIPYARDS.

It was hoped to obtain comparative statistical data on lead intoxication in civil employees of United States Naval Shipyards for the ten-year period 1930-1939 when red lead paint was still in use in naval construction and for the five-year period 1941-1945 when only non-lead paints were authorized. This material is contained in the files of the Bureau of Employees' Compensation, Federal Security Agency (formerly the United States Employees Compensation Commission) but plumbism was not individually coded until 1943. Prior to that

time this item was carried with other occupational diseases under the general listing of "Dusts, Gases and Fumes". The segregation of cases of plumbism would have involved the impractical task of manually going through all such listings for each year for all shipyards.

It was found however, that the number of cases of compensated lead intoxication in the entire Federal Industrial Establishment was available for the years 1935 to 1941 inclusive. These were originally collected by the U. S. Employees Compensation Commission on the request of the late Dr. Frederick L. Hoffman, an authority in the field of occupational disease statistics. Authority to publish the figures was given by Mr. E. P. Herges, Safety Director, Bureau of Employees Compensation, Federal Security Agency³, but with the reservation that while the data are approximately correct, absolute accuracy could not be guaranteed. The data follow:

<u>Calendar year</u>	<u>Number of Cases</u>
1935	5
1936	5
1937	5
1938	10
1939	6
1940	4
1941	<u>2</u>

Total 37

This represents an average of 5.4 cases per year distributed as follows: 4 fatal, 4 permanent total disability, 3 permanent partial disability and 26 temporary total disability. The compensation cost for the 37 cases, inclusive of both actual and future estimated figures, was \$173,691. ^B

The United States Naval Shipyards form only one segment of the Federal Industrial Establishment which is inclusive of all industrial activities under the jurisdiction of the Army, Navy, Air Force, Coast Guard, Maritime Commission,

³ Personal communication to the author, Aug. 8, 1947.

Department of the Interior, Treasury Department, etc. It would be reasonable to assume that industrial agencies other than naval shipyards have contributed to plumbism cases to the above total of 37. While the numerical distribution of cases is not known, it appears reasonable that only a certain fraction could be ascribed to occupational conditions in naval shipyards.

Moreover information as to the occupational conditions of exposure in the above 37 cases is not available. Not all of these can be related to health hazards associated with lead paint for the reason that entirely different types of occupational lead exposures may have been involved.

Information, therefore, with reference to the occurrence of lead intoxication among naval shipyard workers from 1935 to 1941 is entirely qualitative based on inference from data applying to the entire Federal Industrial Establishment. The conclusion appears justified that the incidence was minimal during this period. This situation reflects in part the effectiveness of preventive medical and engineering control procedures. Another factor may be the reduced use of red lead as a steel primer.

EFFICIENCY OF CONTROL MEASURES IN THE SCRAPPING OF NAVAL VESSELS IN 1945 AND 1946.

Immediately following the recent war, shipscrapping operations were set in motion in seven naval shipyards; these involving the usual burning and cutting operations. The writer is indebted to the Chief of the Ship Disposal Section, Bureau of Ships, Department of the Navy¹, for the following information as to the scope and location of these activities:

- (a) Portsmouth, N.H.: 3 pre-war submarines;
- (b) New York, N.Y.: 1 DD pre-war destroyer; 6 DE war-built destroyers and 2 mine layers converted from pre-war DE destroyers;
- (c) Philadelphia, Pa.: 4 CL pre-war light cruisers; 6 DD pre-war destroyers; 8 DE war-built destroyers and 3 AG pre-war auxiliaries;

¹ Personal communication, Feb. 13, 1946.

- (d) Norfolk, Va.: 1 DD pre-war destroyer;
- (e) Charleston, S.C.: 9 DE war-built destroyers;
- (f) Mare Island, Calif.: 1 PY pre-war vessel, 1 AO pre-war auxiliary, and 1 DD pre-war destroyer;
- (g) Terminal Island, Calif.: 2 DE war-built destroyers, 1 AO pre-war auxiliary, 1 AVD pre-war seaplane tender, and 1 DD pre-war destroyer.

Of the above vessels, the 25 DE types aggregating 28,800 tons, were war-built, involved the use of zinc chromate paint, and so presumably did not incur any health hazard from lead; the remaining 26, being of pre-war construction and totalling 59,848 tons, did present a potential risk. The tonnage in each group refers to standard displacement.

The data were collected through (1) interviews at the Brooklyn, Philadelphia, Norfolk and Charleston Shipyards with medical officers, industrial hygiene personnel, safety engineers and supervisors of scrapping operations, and (2) through a review of the Monthly Industrial Hygiene Reports of the various shipyards submitted during the course of the work. All naval industrial activities are required to include occupational diseases in making these reports to the Bureau of Medicine and Surgery. Authority for publication of the data contained was granted by the Surgeon General.⁵

The scrapping of old battleships after the London Conference in 1921 caused outbreaks of acute lead intoxication in many naval shipyards. For instance, the writer⁶ conducted a study of the situation at the Philadelphia Shipyard and found that 49.8% of the workers so employed for eight months, developed plumbism. Later, protective methods were adopted and conditions greatly improved. The recent shipscrapping operations afforded an opportunity to test the efficacy of the most modern procedures in controlling this type of occupational lead hazard.

⁵ Personal communication, Oct. 23, 1947.

⁶ Brown, E.W.: A Study of Lead Poisoning among Oxygen Acetylene Welders in the Scrapping of Naval Vessels. Journal Industrial Hygiene. 8:113, 1926

These activities in all shipyards were under the health supervision of Safety Engineers and Industrial Hygiene Units. The latter, first organized in 1940, are staffed by specialists and equipped with complete laboratory facilities including those for the analysis of lead concentration in air and in the urine. Physical and laboratory examinations of all chippers, burners, cutters and their helpers were conducted periodically for detection of increased lead absorption, thereby forestalling plumbism by removal from exposure. Standard types of lead-fume and air-line respirators were supplied and their use enforced. All men were instructed as to measures of personal hygiene.

The most extensive activity was conducted at the Philadelphia Shipyard, the number of workers potentially exposed reaching a peak of approximately 700. All such personnel were given the following laboratory procedures⁷: (a) blood hemoglobin, (b) examination of red blood cells for abnormal forms, (c) quantitative determination of basophilic stippling and (d) examination for lead line. Any case showing hemoglobin below 12 gms./100 c.c. was given a complete blood count. Any case showing abnormal red cell forms, significant basophilia or a lead line was subjected to the following: (1) complete blood count, (2) quantitative examination for urinary lead, (3) complete history and physical study and (4) other tests and disposition as indicated. No clinical cases of plumbism occurred at any time in this group. Four men were found to have borderline absorption sufficient to exclude them from further exposure.

As to air concentrations of lead fume encountered, the New York Shipyard⁸ reported a range of from below the standard maximum allowable limit of 1.5 milligrams of lead per 10 cubic meters of air for 8 hours exposure, up to as high as 38 times this allowable figure.

No cases of lead intoxication were reported from any of the seven shipyards during the work which ended in the fall of 1946 and a review of the Industrial Hygiene Reports, Philadelphia Shipyard to Bureau of Medicine and Surgery, Mar. and Apr. 1946.

⁸ Monthly Industrial Hygiene Reports from New York Shipyard to Bureau of Med. and Surg., May 1946 and June 1946.

Hygiene Reports, up to November 1947, showed that no claims referable to such exposure have been subsequently reported to the Surgeon General. Data were not available as to the approximate total of man-hours involved in these operations, but from the magnitude of ship tonnage scrapped it must have been relatively large. The conclusion is justified that the hazard of lead intoxication encountered in the demolition of naval vessels containing lead painted steel is readily controlled by the currently accepted standards of medical and engineering practice.

LEAD INTOXICATION IN UNITED STATES MARITIME CONTRACT SHIPYARDS DURING THE RECENT WAR.

As already stated, red lead was widely used in Maritime Contract Shipbuilding Yards during the recent war. A hazard was therefore present associated with the mixing of ~~red lead~~ ^{red lead paint}, lead spray painting, and the welding, burning and cutting of paint-coated metal. The United States Navy Department and the United States Maritime Commission jointly promulgated industrial health regulations⁹ in 1943 including instructions for the control of lead intoxication in contract shipyards.

It occurred to the writer that it would be of interest to collect data on the incidence of compensated plumbism in Maritime Contract Shipyards as an indication of the importance to be attached to this ^{potential} hazard. The following possible sources were consulted with respect to availability of data:

(a) U. S. Maritime Commission: Monthly Summary Injury Reports were submitted by all contract shipyards to the Commission but did not include a listing of individual occupational diseases. In general, these yards were surveyed annually or semi-annually by representatives of the U. S. Navy - U. S. Maritime Health and Safety Commission. Through the courtesy of the Director of Labor Relations of the Commission, permission was granted to review the various Industrial Health and Safety Survey Reports of 48 shipyards for possible statistical data on plumbism.

⁹ Minimum Requirements for Safety and Industrial Health in Contract Shipyards, U. S. Govt. Printing Office, Washington, 1943.

Mention of the occurrence of lead intoxication in shipyards is made in only three instances, but specific figures for rates are not recorded. Two of these reports state that cases of increased lead absorption were also found without actual clinical plumbism. Another report refers to three cases of excessive lead absorption without plumbism developing.

(b) The U. S. Bureau of Labor Statistics, Department of Labor: Interviews with key representatives of the Bureau disclosed that data on rates for lead intoxication in Maritime Shipyards during the war were not available. A systematic study of the subject was not conducted.

(c) Casualty Insurance Agencies: The various Maritime Contract Shipbuilding Companies were carried for workmen's compensation by (1) commercial casualty insurance companies, (2) official insurance agencies of certain states and (3) self-insurance procedure. The feasibility of obtaining records of the number of compensation plumbism cases, during specific periods of coverage approved for the various shipbuilding companies by their corresponding insurance carriers, was explored. Arrangements were made with the National Association of Casualty and Surety Executives through its Claims Bureau to enlist the cooperation of their company members to this end. The same procedure was followed with the National Association of Mutual Casualty Companies. In the case of state agencies underwriting shipbuilding concerns, and where the self-insurance system ~~was~~ obtained, requests for data were made direct. The information was available in most instances.

THE DATA OBTAINED

Data were supplied by 11 commercial casualty insurance companies, 5 state insurance agencies and 3 self-insured concerns covering 60 separate shipyards operated by 37 shipbuilding companies. These 60 shipyards made up approximately 85% of all such activities engaged in steel ship construction under contract with the Maritime Commission. In four instances, the same shipyard was reported on by two insurance agencies for different periods of coverage.

For this reason there were actually 14 reports. The material is listed in Table 3, publication of which has been authorized¹⁰. The headings of Table 3 are self-explanatory except for "Number of Employees" and "Number of Cases of Lead Intoxication". With respect to the former, these data were obtained from the Industrial Health and Safety Reports referred to above, but are of limited value in that they are restricted to the total for the designated month of the year. It was desired to procure the average total employee population in each instance for the entire period of insurance coverage. Such data had never been calculated by the shipbuilding companies and therefore were not available.

As to the number of cases of lead intoxication, only those for which compensation had been awarded are listed. Therefore, cases still in litigation—if any—are excluded. Moreover, certain limitations in these data demand mention. Information was not available pertaining to occupational history or criteria of diagnosis. Whether or not all of the 33 cases were true plumbism is therefore open to question. For example, the two cases from the Consolidated Steel Corporation were not voluntarily accepted by the insurance carrier on the ground of medical conflict. One of these was finally accepted for a nominal amount and the other allowed by the State Industrial Accident Commission.

Table 3 contains a total of 33 cases of plumbism occurring in ten shipyards distributed as follows:

	<u>Number of Shipyards</u>	<u>Cases per Shipyards</u>	<u>Period of Coverage—Years</u>
a)	3	1	3 to 5
b)	4	2	2 to 4.8
c)	2	3	4 to 5
d)	3	Combined total of 7	3.4 to 5
e)	1	9	1

It will be noted from the above tabulation that the number of cases per shipyard per year for each group was less than 1 for (a), did not

¹⁰ Personal communication from the U. S. Maritime Commission, June 23, 1946.

exceed 1 for (b), was less than 1 for (c) and 9 for (e). The number per year for (d) does not exceed 2, but this represents a combination of 3 shipyards, the average per shipyard being less than 1.

Comment is indicated relative to the 9 cases reported for the Marine Corporation of Sausalito, California by the State Compensation Fund of San Francisco for a coverage period of one year, although claims were made for a prior coverage of 1.6 years with a considerably higher employee strength, when carried by the Associated Indemnity Corporation of San Francisco. The occupations involved in the nine cases were spray painting and welding. Information relative to conditions of exposure or the status of medical and engineering control at this plant were not obtainable. Attention is invited to the fact that 27.3% of all cases reported in Table 3 are charged to a single shipyard.

The various shipyards listed in Table 3 were new construction activities with two exceptions, i.e., The Moore Dry Dock Company and the Repair Division of the Alabama Dry Dock and Shipbuilding Company; both being repair yards. For reasons requiring no discussion here, a greater exposure to lead intoxication tends to prevail in the reconditioning of ships in contrast to that in new construction, particularly in relation to welders, burners and their helpers. However, one case only is listed from the Moore Dry Dock Company over a period of three years and none from the Alabama Dry Dock and Shipbuilding Company for a five-year coverage.

The requisite data for computing frequency and severity rates of plumbism in the shipyards reporting such cases were not available. An accepted basis for the estimation of a frequency rate is the number of cases per million man-hours worked. The severity rate is the total time charged as a result of lost-time disability per one thousand man-hours of exposure. The systematic collection of such data was not required of Maritime Shipyards during the war and this could not be remedied subsequently.

Column four of Table 3 records, in general, the total number of employees for specified months of different years without allowing for variations

in labor turnover or absenteeism. If fluctuations from month to month are disregarded, and the totals are arbitrarily computed for each year on the basis of the month reported for each yard, the aggregates obviously will not be acceptable as indicating the combined population. However, it can be safely assumed that the latter reached several hundred thousand per year. A total of 33 cases of plumbism was reported for all shipyards for an average coverage period of 3.1 years, or 10.6 cases per year. When correlated with the industrial population, it can be justifiably stated that lead intoxication was rare in Maritime contract shipyards.

Apropos this finding, the following is quoted from Drinker¹¹, "Thousands of square feet of Liberty ships were paint sprayed by the Maritime Commission during the war. By specification most of this paint contained lead as the important pigment, especially for the priming coats on steel hulls. Working conditions were not perfect due to the great demand for ships and fast launchings, but lead poisoning among painters in our shipyards was virtually unknown." During the recent war, Professor Drinker was Chief Consultant to the U. S. Navy and Maritime Commission with respect to industrial health in all contract shipyards.

Also of related interest is a study of the health of arc welders in U. S. Navy and Maritime Contract Shipyards conducted during the recent war by Dreesen & Associates¹². This work comprised 814 men in Navy Contract and 2430 in Maritime Contract Yards. No instances of lead intoxication were found in either group. It is noteworthy that 150 welders were included from two repair yards where the hazard of inhalation exposure to lead was necessarily increased. Urinary examinations of 35 of these welders showed lead absorption to be within normal limits. This research and the above statement of Drinker emphasize the point that plumbism in Maritime Shipyards was minimal.

¹¹Drinker, Philip: Public Exposure to Lead, Occupational Medicine 3:145 (Feb., 1947)

¹²Dreesen, W.C. & Associates: Health of Arc Welders in Steel Ship Construction, Public Health Bulletin 290, U.S. Public Health Service, 1947.

THE HEALTH HAZARDS OF ZINC CHROMATE IN SHIPBUILDING.

It has already been pointed out that the U. S. Navy discontinued the use of red lead paint for steel priming in 1941 and adopted zinc chromate paint for this purpose. It therefore appeared of interest to inquire into the experience of the naval government shipyards regarding health hazards from this pigment. The Bureau of Employees' Compensation, Federal Security Agency, at the request of the writer, conducted an analysis of compensated injuries attributed to occupational exposure to all paints in the 12 shipyards directly operated by the Navy from 1943 to 1945 inclusive. These are not to be confused with the Navy Contract Shipyards to be considered later. The combined average numbers of employees carried by these yards for 1943, 1944 and 1945 were 335,585, 365,860 and 316,044 respectively.¹³ The results with authority for publication¹⁴ were as follows:

- 1) Total number of cases alleged to be due to inhalation of paint fumes: 21
- 2) Total number of cases of dermatitis ascribed to contact with paint: 16

While the precise nature of the paint was not specified in all instances, the bulk of the cases were reported as resulting from exposure to zinc chromate primer. The inhalation group occurred in confined spaces, were attributed to the volatile vapor of the thinner and resulted from failure to utilize protective measures, i.e., lack of adequate ventilation or neglect on the part of the worker in not wearing a respirator.

With respect to the dermatitis group, the exact number arising from contact with zinc chromate paint is undetermined for various reasons. For instance, some persons are not allergic to zinc chromate but do react to other constituents of the primer such as synthetic resins. Other workers are sensitive to zinc chromate alone, while some react to both zinc chromate and other

¹³ From "The Injured Employees of the Navy Department", Safety and Statistical Division, U.S. Compensation Commission, May 15, 1946.

¹⁴ Personal communication from Safety Director, Bureau of Employees' Compensation, Federal Security Agency, Oct. 3, 1946.

components of the paint. No mention is made of any cases of chrome ulcer of the nasal septum resulting from exposure in spray painting.

It is concluded that the occupational health hazards incident to the use of zinc chromate paint were minimal during the 1943-1945 period.

As zinc chromate paint was employed during the war in Navy Contract Yards to the exclusion of red lead paint, the question arises whether zinc chromate dermatitis was a factor among spray painters in those yards; also whether any health disturbances occurred among welders incident to exposure to the fumes from welding steel coated with zinc chromate paint.

On the authority of the Surgeon General of the Navy, the Industrial Health and Safety Survey Reports of 91 Navy Contract Shipyards were reviewed for data on this subject. This entailed a coverage of approximately four reports per shipyard, for different periods. No mention of dermatitis or chrome ulcer of the nasal septum associated with zinc chromate primer was found. Reference however is made in reports from four yards to the local highly irritative properties of the fumes generated on the welding or burning of steel coated with zinc chromate primer. The need for respiratory protection by means of an approved respirator is emphasized. One episode is described in which a group of 12 men were rendered ill by the irritation and were removed from the work shift as a result of such exposure.

It was the consensus of opinion that this irritation of the respiratory tract was due chiefly to phthalic anhydride, a constituent of the paint, which is given off when the zinc chromate primer is heated. The following comment of Drinker^{15,16} is pertinent, "No toxic trouble was experienced from zinc chromate whether we had a 2 inch unpainted margin or not. There was decided irritation from some of the ingredients in zinc chromate paint, notably phthalic anhydride.. Phthalic anhydride was a factor in shrinking plates of destroyers (zinc chromate

¹⁵ Letter from Professor Philip Drinker to Mr. R. Davidson, New Jersey Zinc Co., Dec. 6, 1945.

¹⁶ Authority to quote extract of letter contained in personal communication, June 29, 1948.

... painted) and other naval ships where the plates were warped in welding and had to be gotten back into place by heating with a large flame from a special torch ... There was no hint or trace of chromium poisoning or chrome ulcers among welders as far as was known¹⁷.

Fairhall and Sharpless^{17,18} conducted an unpublished series of tests for the Bureau of Ships, Department of the Navy, on the concentration of chromate at normal breathing level given off during the burning and welding of steel coated with zinc chromate paint. It was found that not over 1/10 the permissible working concentration established by the American Standards Association was produced. It appeared from this that the burning or welding of steel so painted, as carried out under normal working conditions, would not constitute a significant toxic hazard.

It is concluded that the health hazard of zinc chromate primer in Navy Contract Shipbuilding Yards was negligible as far as the chromate pigment was involved. The relative weighting of the factors which may have contributed to this result, such as degree of exposure and efficiency of hygienic measures of control, is undetermined.

¹⁷ Fairhall, L. T. and Sharpless, M. E. : The Health Hazard in the Burning and Welding of Steel Plates Painted with Zinc Chromate Pigments, Unpublished Report to Bureau of Ships, Department of the Navy, May 22, 1941.

¹⁸ Authority by personal communication to include data, June 29, 1948.

Zinc chromate paint was used exclusively for steel priming in the eleven Naval Government Shipyards and in all Navy Contract Yards subsequent to 1941. The average combined employee population in Naval Government Yards was 335,535, 365,260 and 316,044 for 1943, 1944 and 1945 respectively. The total number of cases of dermatitis in these yards during this three year period was below 16. No record was found of chronic ulcer of the nasal septum from exposure to spray painting; or toxic or irritative effects from chromate fumes generated in welding.

No toxic effects from zinc chromate were recorded by United States Navy Contract Shipyards, this finding being based on a review of the official Industrial Hygiene and Safety Reports of 91 yards. The fact, however, was brought out that under certain conditions of heating zinc chromate paint, severe respiratory irritation may result from the volatilization of one of the ingredients, namely, phthalic anhydride.

It is concluded from the data presented that the health hazards of both red lead paint and zinc chromate paint are minimal in shipbuilding and maintenance under modern conditions of control.

SUMMARY

Frequency and severity rates for lead intoxication in the United States Navy and Maritime Corps are presented for the calendar years 1922 to 1944 inclusive. A significant decline in rates occurred in the nineteen thirties and early nineteen forties. The possible factors involved in this trend are discussed.

Data on the prevalence of lead intoxication among civilian industrial workers in the nine United States Naval Government Shipyards were not available, but it was ascertained that 37 compensated cases were reported for the years 1935 to 1941 from the entire Federal Civil Establishment. Any claims originating in naval shipyards would have been included in this group of cases. The average number of civil employees in these shipyards increased from 30,325 in 1935 to 344,352 in 1941. It appears that plumbism was extremely rare in naval shipyards during this period.

Shipscrepping operations were conducted^{at} seven Naval Government Shipyards in 1945 and 1946, these involving the usual burning and cutting of steel coated in part with red lead paint. The vessels so disposed of were of pre-war construction, aggregating 59,848 tons. No cases of lead intoxication were reported from any of these activities during or subsequent to potential exposure.

Red lead paint was employed widely as a steel primer in United States Maritime Contract Shipyards during the recent war. An occupational risk of lead intoxication was therefor entailed to some degree with respect to paint sprayers and welders. The total number of compensated cases that were reported by 40 shipyards corresponding to employment periods of 2 to 5 years was 33. The average combined total employee population per year is undetermined, but fell somewhere within a range of several hundred thousand. This leads to the conclusion that lead intoxication was minimal in these contract shipyards.