PLAINTIFF'S EXHIBIT

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VENTILATION SURVEY

of

TODD-BATH AND SOUTH PORTLAND SHIPYARDS

EXHIBIT
Nelson #1
9A 11/11/85

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RECOMMENDATIONS

Welding:

1. Additional blowers should be provided in TEI so that at least five, and preferably seven, blowers may be placed on each hull and allowed to remain there until completion of all work requiring ventilation. In determining the total number of blowers necessary allowances should be made for repairs and miscellaneous uses.

2. The exact needs of the ventilation crews can best be determined by the ventilation foreman. However, it is recommended that the crews be enlarged and distributed so that one man is stationed on each hull on every shift. His duties should be to patrol the ship constantly to see that blowers are placed where needed, to keep the equipment in operation, and to see that exhaust lines are properly used.

3. All ventilation men should be provided with safety hats painted a conspicuous color and plainly marked "VENTILATION", so that they may be easily recognized when their services are needed.

4. Fan housings on blowers should be rotated so that discharge is upward into the air.

5. The tops of the deep tanks should be left off until all pick-up welding in the tanks is completed. The opening into a covered tank is too small to accommodate exhaust lines for welding fume removal and still permit men to enter. As each welder requires a local exhaust line, proper fume control will not be possible when more than one or two welders are at work in a tank unless a larger opening is available.

The same difficulty, that of lack of room for the passage of both men and ventilation lines, is found in the fore and after peaks. An additional

GENERAL DISCUSSION

Electric arc welding in shipbuilding results in welding fumes, the proper control of which is best accomplished by ventilation. Welding black iron generates a fume consisting almost totally of oxides of iron with traces of compounds from the combustion of the welding rod coatings plus minute quantities of nitric oxides. The welding fumes from iron do not cause any permanently harmful or cumulative effects.

Galvanized iron used for pipes in Liberty ships and generally in Navy vessels presents a much more serious problem, however. The zinc coating burns to zinc oxide and contaminates the air as a white fume or smoke. Inhalation of enough zinc oxide fume may cause the "Galvo", "shakes", or, more properly, metal fume fever. The ailment is characterized by chills and fever occurring some hours after leaving the job, general malaise, and by a high white blood cell count. Symptoms usually subside within 24 hours, but the "washed-out" feeling of the patient frequently causes lost time, and metal fume fever thus contributes directly to absenteeism.

The recommended limit of welding fumes from black iron is 50 milligrams of total fume per cubic meter of air. Control of fumes to keep below that concentration is desirable for two reasons: (1) to prevent any possible irritant effects of the fumes, and (2) to maintain comfortable working conditions for welders and others in the vicinity. Proper control also has the effect of bolstering the morale of welders inasmuch as it eliminates the starting of wild rumors and superstitious beliefs regarding the "poisonous" effects of the fumes. Most welders have heard tales of fellow workers who have coughed up blood after several hours of welding in the inner bottoms of ships.

The recommended limit for zinc oxide fumes has been set at 15 milligrams of zinc per cubic meter of air to prevent cases of metal fume fever. In view of the small percentage of welding done on galvanized iron in confined areas aboard Liberty ships it is unlikely that the permissible limit will be frequently exceeded. However, when such welding must be done in confined spaces, proper fume control is necessary.

Welding is often done on iron surfaces which have been painted with red lead. The heat of the arc causes volatilization of the lead pigment in the form of lead oxides, and, in confined spaces, presents a serious danger of lead poisoning due to inhalation of lead fumes. The recommended limit for lead fume in the air is 0.15 milligrams of Pb per cubic meter as compared with 15 milligrams of zinc oxide and 50 of iron.

RESULTS OF FUME TE TAKEN IN THE S.P.S.C. AND T.B. . SHIPYARDS DURING THE WEEK OF OCTOBER 18-22 BY MESSRS NELSON AND WOODMAN

Sample No.	Location, number welders, ventilation, number of other workers exposed.	Time of sampling	Fume mg./m³
1	Bos'n's stores, one welder, three exhaust lines hanging in chamber, eight other workers.	9:25-9:45 AM	25.2
2	Same conditions as sample No. 1.	10:10-10:30 AM	23.8
3	Dry stores, one welder on g.i. pipe, no ventilation, six other workers.	10:55-11:15 AM	51.2
4	Midship deep tank, one welder, two exhaust lines hanging in tank, two other workers.	1:20-1:32 PM	12.7
5	Sample taken above opening of drain well of deep tank, one welder in well, no exhaust lines, three others in tank.	2:05-2:10 PM	63.5
6	Engine room void, one welder, no exhaust lines, two others exposed.	5:00-5:16 PM	84.5
7	Same conditions as sample No. 6.	5:25-5:45 PM	56.9
8	Same conditions as sample No. 6.	5:55-6:15 PM	75.5
9	Above opening to drain well in deep tank, one pick-up welder in well, no exhaust lines, two tackers and five other workers in tank. Note; welder in well forced to come out seven of twenty minute sample period, hence sample 5 gives more accurate picture of concentrations reached in well.	9:45-10:06 AM	16.5
10	Above opening to drain well of deep tank, one welder in well using exhaust line properly, two tackers and five other workers in tank.	11:12-11:32 AM	9.4
11	Deep tank, two welders, sample taken at breathing level of one welder, two exhaust lines in tank.	4:02-4:22 PM	64.7
12	Same conditions as Sample No. 11.	4:27-4:42 PM	86.9
13	Same conditions as Sample No. 11, except welder using local exhaust properly, other welder not.	4:55-5:15 PM	17.6
14	No. 2 hold, open area, five welders working, sample taken near three welders, no forced ventilation	5:00-5:21 PM	6.7
15	Same conditions as Sample No. 14.	5:25-5:45 PM	8.2

Discussion of Results:

At the request of the management of SPSC and TBI the writers were sent to these yards by HC to investigate particularly air purity in welding operations. On Page 8 are shown the concentrations of fumes in various locations aboard ships under construction in the TBI and SPSC yards. In most cases, where samples were collected in confined spaces and when no attempt was made to change the ventilation already provided, fume concentrations were excessive. This was true in spite of the fact that samples were taken in places where only a very few welders were at work. It will be noted that when local exhaust was provided as in sample No. 10, the fume concentration as shown in sample 8 was reduced from 83.5 mgs/m^3, or twice the recommended limit, to 9.4. Again in the case of samples 11 and 12, where fume concentrations were 84.7 and 86.9 mgs/m^3, respectively, proper use of one of the exhaust hoses already hanging in the tank reduced the fume concentration at the breathing level of one of the welders to 17.6 mgs/m^3 (sample 13).

The various stages of construction of the ships were such that no large numbers of welders could be found working in any one confined area; however, we understand that such situations do occur often.

Ventilation Equipment:

There is really only one entirely satisfactory method of removing fumes from welding operations in confined spaces. This method is by the use of suction lines so placed as to act as local exhaust at the source of the fumes. The equipment now available at both the TBI and SPSC is especially designed for use as local exhaust and should be used in that manner only.

The principal difficulty with the present ventilation set-ups is the improper use of equipment. In all observed instances local exhaust lines or "suckers" were merely hung into compartments or placed in the vicinity of working welders. The objections to such arrangements are that each of the 3-inch lines exhausts approximately 200 cubic feet of air per minute, while the confined chambers are thousands of cubic feet in capacity. Obviously, it would take considerable time to achieve a single air change in the chamber and meanwhile the fumes would increase to excessive concentrations.

For proper fume control by local exhaust the open end of the exhaust line must be placed near enough to the arc so that the fumes are drawn into the hose. Measurements of air flow through the 50-foot lengths of flexible metal hose now in use showed that approximately 200 cubic feet of air per minute are exhausted through each line when four lines are attached to the Buffalo Forge Company GE blowers. The entrance of 200 cubic feet of air per minute into the 3-inch suction line creates a "safety zone" about the end of the line in which air movement is rapid enough to capture all welding fumes created in the zone. The zone extends 6 to 8 inches from the end of the hose with this air flow. The safety zone is enlarged when lines are laid adjacent to flat plates or in corners, due to the baffling effect of the plates. Fortunately, these positions will apply in most ship welding. The minimum of 200 cfm per hose is what is recommended for welding in confined spaces whether on black iron or galvanized iron.

The use of only three lines results in greater air flow and thus assures the recommended 200 cfm. Another advantage in the use of three lines is that the blower operates under a decreased load and will not overheat as

rapidly and shut off automatically. Thus, more uniform, dependable performance is gained. The screens at the inlet of the blowers must be kept free of debris if maximum efficiency is to be obtained, and the fan housings should be rotated 90° to discharge vertically into the air. At present, discharge is horizontally across the deck, often blowing dirt and fumes into workers' faces.

Instruction to Welders:

Each welder should be instructed in the proper use of local exhaust lines, that is, to place the open end within six to eight inches of the arc and to move the line along the weld when changing rods. As a beginning to the educational program that is necessary, brief talks were given by the writers to the following groups in both yards:

1. Welding foreman, ass't. foreman, lead-men on all three shifts.
2. Ventilation foreman and crews, all shifts.
3. Safety inspectors, all shifts.
4. Welding school instructors.

To be fully effective the educational program must be continued by the groups above until all welders use and continue to use properly the ventilation equipment provided.

Ventilation Crews:

Since welders require the most attention regarding ventilation, the distribution of ventilation men on the various shifts should closely follow the distribution of welders. In both yards it was found the welders are about equally divided over the three shifts and that most production

welding is done on the second and third shifts. In SFBC a ventilation crew is on the job only during the day shift, while TBI has 10 men on the first shift, 5 on the second, and 2 on the third. A re-distribution of the ventilation crews and their enlargement in both yards is desirable.

Spray-Painting:

While ventilation for welding operations is of primary importance, it is distinctly secondary, from an industrial health stand-point, to the hazards encountered in the spraying of red lead paints. This is clear from the fact that there have been thirteen cases of suspected lead poisoning among spray painters, three of which have definitely been confirmed.

Inhalation of lead pigment during spray-painting presents greater possibilities of lead poisoning than by eating or drinking, but the dangers of eating food contaminated with lead through lack of personal cleanliness must not be overlooked. Prevention of the inhalation of lead compounds is accomplished by the use of proper personal protective equipment in the form of air-line respirators, air-line hoods, and filter type respirators. The supply of protective equipment at the SFBC is entirely inadequate, while a small increase in the present stock is necessary at the TBI. Air-line hoods appear to satisfy the needs most satisfactorily for work in confined areas. For open work Bureau of Mines approved respirators offer sufficient protection.

Spray painters usually neglect to wear their respirators when working in the open, being unaware of the dangers of breathing the fine mist of red lead which often envelopes them. To impress upon the men the necessity of wearing proper respirators or hoods while spraying red lead, short talks on the subject were given the foremen and lead-men painters on all shifts

in both yards.

The procurement of adequate respiratory protective equipment, and the assignment of a worker in each paint shop, preferably a woman, to the tasks of cleaning, repairing, and fitting respirators routinely would help matters greatly. Losses on respirators due to poor maintenance are unnecessarily high at the present time.

Solvent vapors in freshly-painted confined chambers aboard ship can be diluted to tolerable concentrations by the forceful introduction of large volumes of air. Neither yard has enough high capacity fans to achieve ideal conditions, but much can be done to relieve the situation by the proper use of the few Coppus blowers now available. When it is necessary to send anyone into high concentrations of solvent vapors, he should be provided with an air-line respirator.

Carbon Monoxide:

Tests conducted in a steering gear room of a ship where riveting work was in progress showed amounts of carbon monoxide in the air approaching the maximum allowable limit. The source of the carbon monoxide was the rivet heating pot in the room, producing excessive room temperatures in addition to toxic carbon monoxide.

Carbon monoxide concentrations at the breathing level of a crane operator working above the forges of the blacksmith shop were determined to be less than the allowable limit. At the time of the tests, however, all doors in the large shop were open, and it is possible that under certain conditions harmful concentrations might be reached. Plans are in progress to extend the stacks of the forges to discharge outside the building.