FILE COPY

## U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE CENTER FOR DISEASE CONTROL NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH CINCINNATI, OHIO 45202

#### HEALTH HAZARD EVALUATION DETERMINATION REPORT NO. 74-16-272

#### MARATHON BATTERY COMPANY WACO, TEXAS

#### MARCH 1976

#### I. TOXICITY DETERMINATION

It was determined by NIOSH investigators that a potential health hazard exists to employees from exposure to nickel and cadmium dusts at the Marathon Battery Company. Workers in Departments 330A, 330B, 340A and 340B showed levels of cadmium and nickel in hair and urine above those found in the control group. Additionally, workers in Departments 330A and 340A showed excessive symptomatology and physical findings indicating upper respiratory irritation. Air samples also showed some excessive levels of cadmium and nickel particularly in these same two departments. However, medical evaluation of employees failed to demonstrate any apparent serious occupationally induced illness.

#### II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

- a) Marathon Battery Company, Waco, Texas
- b) Authorized Representative of Employees
- c) U.S. Department of Labor Region VI
- d) NIOSH Region VI

For the purposes of informing the "affected employees" the employer will promptly "post" the Determination Report in a prominent place(s) near where exposed employees work for a period of 30 calendar days.

#### III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by 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. Page 2 - Health Hazard Evaluation Determination 74-16

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees at the Marathon Battery Company. The request concerned exposure to dust and fumes in maintenance and production areas in the nickel-cadmium battery assembly factory. The presenting symptom was said to be nausea. The plant runs two shifts daily, five days per week with approximately 60 workers said to be exposed. The work force is predominantly female.

#### IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

This factory assembles nickel-cadmium batteries. The major exposures to nickel and cadmium are from the nickel containers (or nickel plated steel), nickel plates and the active material on the plates -  $Ni(OH)_2$  on the positive plates and  $Cd(OH)_2$  on the negative plates. There are additionally small amounts of  $Co(OH)_2$ . The components are shipped in from elsewhere, including the plates with active material already on them. Operations at this plant involve cutting the plates to size; resistance welding terminals (tabs) to the plates; interleafing the plates and putting them in appropriate containers; filling the cells with electrolyte (KOH); and closing, charging and testing the cells for satisfactory operation. Many cells are shipped at this point, others are assembled into batteries to the customer's order.

There are two major assembly "lines," one for vented cells and one for sealed cells. The sealed cells (Departments 330A and 330B) when completed look like standard flashlight cells. They are used in a great variety of small appliances containing rechargable batteries. The vented cells (Department 340A and 340B), when completed, resemble automobile batteries. They find their major use in aircraft. Each step in the process runs at its own speed, with more machines and more man-hours being devoted to those steps requiring more time.

The work area is one large building without any full partitions in the work area. Heating and cooling units are located under the roof. These units can be controlled from the work area. Only one vent through the roof was noted. This vent appeared to be unpowered. The ventilation units are primarily to heat or cool the room air for comfort and not to provide exchange with outside air. A few operations, such as phenol sealing, are enclosed within an exhaust hood.

The work force is characterized in Table IA. The total numbers are taken from the lists of workers as supplied by the company at the time of the follow-up visit and contain a few workers who were on leave on the day of the visit and a few who had been transferred to other departments. Of the 226 workers on the lists all except 10 were women. Page 3 - Health Hazard Evaluation Determination 74-16

This is a new plant. The maximum length of exposure for any worker at the time of the study was three and one-fourth years. Although workers are not usually transferred from one department to another, they are often reassigned to various jobs within each department. Parts of the plant work two shifts daily, others only one.

#### B. Evaluation Design and Methods

An initial visit to the plant by a NIOSH Industrial Hygienist suggested that health problems might be present. Therefore, on the initial medical visit the work area was toured, a sampling of the workers was interviewed to better pinpoint the problem, the OSHA Log was reviewed, and plans were made to collect urine and pubic hair specimens. For the individual interviews form HESB-IS-2 was utilized to obtain some identifying data, which included a brief occupational history and answers to the two questions "Do you have any health problems at work or you feel might be related to your work?" and "Do you have any other health problems?"

The follow-up study was designed to investigate the effects of exposure to nickel and cadmium dust and fumes. The study group consisted of workers with potentially high dust and welding fume exposure as suggested by questioning workers on the preliminary visit and by environmental findings from the initial survey. This included all workers in Departments 330A and 340A, and some of the workers in Departments 330B and 340B. In Department 330B the workers chosen were the Core Rollers (Core Winders), and the workers on the Reject Table. In Department 340B the workers with potentially high dust exposure were Stackers, Combers and the workers in Sorting and Repair. Workers who had spent at least a fourth of their time in the past three months in these jobs were to be included. A control group was to be drawn from Departments 350 and 360. These Departments were chosen as they are considerably further down the assembly line from the areas where dust was considered a problem. All active material is encased in nickel or plastic casings before reaching Departments 350 and 360. General air samples taken in these Departments confirmed that levels were considerably lower than in the study area and well below present Occupational Safety and Health Administration standards. However, they were above ambient air levels reported in Reference 5 for nickel and Reference 3 for cadmium.

1. The following steps were taken to obtain necessary data for all workers of either sex who participated in the study:

(a) Collection of a timed urine specimen for a semi-quantitative test for protein utilizing trichloroacetic acid or sulfosalicylic acid as precipitant; urine specific gravity, creatinine, cadmium, nickel, and zinc levels. Urines with 2 mg protein per 100 ml or more had an electrophoretic study. Page 5 - Health Hazard Evaluation Determination 74-16

A Quality Control Inspector who spent most of her time in the area was included for the shorter work-up. In all 62 workers were seen. They are characterized by job in Table IB and by age, sex, race, and length of service in Table II.

The OSHA Log recorded several cases of nickel dermatitis which had been referred to a local dermatologist for management. No particular effort was made to identify additional cases of nickel dermatitis since this is a well known sensitivity. It can occasionally occur from handling the outer cans with unprotected hands.

Although cancer of the lungs and nasal sinuses have been associated with industrial exposure to nickel, particularly refining of nickel, the current study did not attempt to screen for cancer as no worker had had more than three and one-fourth years of exposure. Most recent studies<sup>5</sup> suggest that it usually takes about 15 years or more for cancer to develop after exposure. This is discussed in more detail under Toxicological Effects.

C. Toxicological Effects of Cadmium and Nickel

1. Cadmium (Primarily Reference 3)

Cadmium toxicity can occur from either ingestion or inhalation of cadmium metal or cadmium oxide. Significant inhalation exposure from cadmium dust or fume is usually confined to occupational exposure at the work site, although significant exposure can also occur from silver soldering or heating metals with cadmium plating. Excessive cadmium exposure by ingestion can occur from eating food grown in an environment contaminated with cadmium. Environmental contamination may occur near a zinc or copper smelter, although contamination of the food chain has been reported only in Japan. Acid foods stored in cadmium plated containers can leach out cadmium and thus become contaminated.

Massive exposure to cadmium by inhalation can cause pneumonia or pulmonary edema. Acute exposure can also cause liver and kidney damage. Ingestion can cause nausea, vomiting, abdominal pain and diarrhea.

Also of importance are the chronic effects of low level exposure. Cadmium is poorly absorbed from the gut. (Absorption may be increased in calcium or protein deficiency.) Dietary cadmium accounts for an observed gradual rise in cadmium levels with age in the general population. Absorption through the lungs is somewhat greater than absorption through the gut and can be from either industrial exposure or to a lesser extent from cigarette smoking. It is unlikely, however, that ambient air levels of cadmium are a factor except as they get cadmium into the food chain. Page 6 - Health Hazard Evaluation Determination 74-16

Once within the body the cadmium is principally bound to a protein, metallothionein, with a molecular weight of about 10,000. This protein migrates with the  $\beta$  globulin fraction on electrophoresis. The cadmium-protein complex accumulates in the kidney, particularly in the renal cortex. Excretion of cadmium in the urine remains low, gradually rising with age, until the concentration of cadmium in the renal cortex reaches about 200 ug/g wet weight. Until cadmium levels in the kidney reach this critical level, there are no ill effects. Above this point the kidney begins to allow a low molecular weight protein to pass into the urine, the amount of cadmium in the urine increases dramatically, and permanent damage to the kidney occurs. This damage may progress even after exposure ceases. Emphysema has also been observed as a chronic effect of cadmium exposure.

2. Nickel (Primarily Reference 5 and 8)

Nickel is poorly absorbed from the gut and is rapidly excreted through the kidneys. Vegetarian diets are higher in nickel than diets with much animal protein. When absorbed, nickel is distributed in the body similarly to the blood volume and excreted in the urine.

Nickel tends to accumulate in the lungs if exposure is by inhalation. Except for acute poisoning by nickel carbonyl, acute toxicity is not a problem. Nickel does, however, cause an allergic dermatitis in many individuals.

Cancer has been recognized as a hazard of working with nickel. An increased rate of lung cancer and cancer of the nasal sinuses has been recorded, with the lungs being about three times more common than the nasal cancer. This danger has been largely confined to workers refining nickel. Major problems in this area occurred pre- and post-World War I these problems had greatly diminished by shortly after World War II. Inhalation exposure rather than ingestion or contact with the skin seemed to be associated with the cancers. As is typical of many industrial cancers, there was a long interval from first exposure until there was any evidence of cancer. Page 7 - Health Hazard Evaluation Determination 74-16

D. Evaluation Criteria

1. Environmental

	Substance	Federal Standard	ACGIH
Cadmium	Oxide fume	0.1 mg/m <sup>3</sup> *	0.05 mg/m <sup>3</sup> "C"
Cadmium	dust and soluble salts	$0.2 \text{ mg/m}^3$	0.2 $mg/m^3$
Nickel,	metal and soluble compounds	1.0 mg/m <sup>3</sup>	1.0 mg/m <sup>3</sup>

\*Approximate milligrams of particulate per cubic meter of air.

The Occupational Health Standards promulgated by the U.S. Department of Labor are taken from the Federal Register, June 27, 1974, Title 29, Chapter XVII, Subpart G, Tables G-1 and G-2.

The ACGIH Standards are taken from the tables of Adopted Values and Notice of Intended Changes (for 1975) appearing in Threshold Limit Values for Chemical Substances in Workroom Air Adopted by ACGIH for 1975. A "C" designation indicates a ceiling level which should never be exceeded even for short periods of time.

It should be noted that these Federal Standards refer to total concentrations in the atmosphere and make no distinction between respirable and non-respirable particulates.

The standards listed above refer to 8-hour time-weighted average exposures except for cadmium oxide fume for which the American Conference of Governmental Industrial Hygienists has recommended a ceiling value of 0.05 mg/m<sup>3</sup>.

2. Medical

Cadmium levels in blood, urine, and hair tend to rise gradually, but are of a considerably lower order than levels in the kidneys. The biological halflife of cadmium in the body is between 10 and 30 years. Blood levels are subject to fluctuation due to acute exposures and are not a good measure of the body burden of cadmium.

(a) Pubic hair was chosen as a medium to judge chronic exposure to cadmium and nickel for the following reasons:

(1) Metals in hair are inactive once deposited. The amount deposited reflects the levels in the body fluids at the time the hair is being formed. Thus the level in a strand of hair should reflect the average level in the body fluids over a number of months or years. This is thought to better reflect the amount of metal which has been available for storage in the body than can a one-time level on blood or urine. Page 8 - Health Hazard Evaluation Determination 74-16

(2) Pubic hair is unlikely to be cosmetically altered by dying or bleaching (although it is subject to spray deodorants) and is somewhat protected from contamination by workroom dust. As the workers to be tested were predominantly women, the likelihood of altered scalp hair color was appreciable.

(3) Of the various tissues which might reflect metal levels over time, hair is the one most readily obtainable in any quantity without risk or discomfort to the worker.

(b) Urine cadmium levels were chosen to judge more acute exposure as it was necessary to collect urine to test for the unique proteinuria caused by excessive cadmium. As blood levels did not offer any advantages in interpretation over urine levels, they were not obtained.

(c) Some reported normal values of metals and protein in urine and hair are included in Table III. As there are no well established "normal" levels for the metals, exposed workers were compared to the control group. A logarithmic scale was used for statistical analysis of metal levels as it gave better consistancy.

For urine, cadmium levels in relation to the amount of creatinine excreted gave the greatest consistancy in the control group and so were used for comparisons. For nickel and zinc levels timed excretion calculated to 24 hours were used. Again, comparisons were made to the control group.

For comparison of control levels with levels by department (as shown in Table IV), the following rough division of cadmium and nickel levels were made:

- (A) Not increased control mean value + 3 standard deviations.
- (B) Slightly increased greater than A up to the mean value of the higher departmental group.
- (C) Moderately increased greater than B up to + 3 standard deviations above the higher group mean value.
- (D) Considerably increased higher than C.

For zinc only groups A, not increased, and B, increased over control mean + 3 standard deviations, were used.

Cadmium and zinc have been shown to be metabolically antogonistic in animal studies<sup>3</sup> with evidence that excessive cadmium caused symptoms similar to zinc deficiency. Also increased levels of zinc intake could in part counter the effects of cadmium toxicity. In this study no correlations between zinc and cadmium levels could be demonstrated, probably because cadmium levels were much lower than those required to upset zinc metabolism in humans.

Page 9 - Health Hazard Evaluation Determination 74-16

E. Evaluation Results and Discussion

1. Environmental

As shown in Table X, airborne concentrations of cadmium and nickel dust were above existing Occupational Safety and Health Administration Standards of 0.2 mg/m<sup>3</sup> for cadmium metal dusts and 1.0 mg/m<sup>3</sup> for nickel dust for some job classifications. Although these are levels were not calculated as an 8-hour time-weighted average, they suggest that the potential for excessive exposure exists in these positions. If these same levels should persist for the full shift, exposure would be excessive. Eight(8) of the 12 air samples taken in the vicinity of the cracking machine (Department 330A) showed levels of cadmium above 0.2 mg/m<sup>3</sup> and one also showed a nickel level above 1.0 mg/m<sup>3</sup>. Three(3) of 7 air samples taken in the vicinity of Department 330A (Sealed Cell) Tab Welders showed both cadmium and nickel to be above these levels. For Department<sub>3</sub>40A (Vented Cell) Tab Welders 2 out of 13 air samples were above 0.2 mg/m<sup>3</sup> for cadmium and 2 out of 13 were above 1.0 mg/m<sup>3</sup> for nickel. Two(2) out of 3 air samples from the Tapers were above 0.2 mg/m<sup>4</sup> for cadmium.

Broken down by department of 21 samples taken in Department 330A twelve(12) showed excessive air levels of cadmium and 4 of nickel. In Department 330B one(1) air sample out of 10 showed excessive cadmium. There were 3 excessive cadmiums and 3 excessive nickels out of 14 air samples taken in Department 340A but only one excessive nickel among the 3 samples taken in Department. 340B. One sample was taken in each of Departments 350 and 360. Both showed levels of cadmium and nickel considerably lower than those found in Departments 330A, 330B, 340A or 340B.

It was noted during the surveys that compressed air was being used by some employees for cleaning purposes. This method of cleaning disperses the nickel and cadmium dust into the work environment in large quantities. Vacuuming is the preferred method of cleaning surfaces contaminated with toxic materials.

2. Medical

(a) Metal Levels in Hair and Urine (Table III, IV, V and VI)

Except for zinc levels in hair and urine, the control group showed higher metal levels than are reported in the literature for individuals not occupationally exposed to cadmium and nickel (Table III). This may be due to use of pubic hair instead of head hair, to low level exposure at work, or to regional variations. Page 10 - Health Hazard Evaluation Determination 74-16

For all three metals both mean hair levels and mean urine levels were higher in the exposed workers than in the control workers (Table IV). In the case of zinc these evaluations were not significant statistically. The departments were treated as units in the analysis. Departments were then grouped together if their means and variations were compatible. The groupings varied for the different substances, sometimes giving only one large group with levels higher than the control group and sometimes stratifying into two groups, both with higher levels than the control group, but one group having distinctly higher levels than the other group.

Department 330A was always in the high group for both hair and urine levels for both cadmium and nickel. If two groups with increased levels were appropriate for a specific substance, Department 340B was always in the lower group. Except for Department 330A, the increase of mean urine nickel was not statistically significant.

Table IV also divides metal levels in hair and urine into "not increased", "slightly increased", "moderately increased" and "considerably increased" as explained in the Evaluation Criteria Section of this report. No clinical significance can be attached to particular metal levels at this time.

Of all workers seen (Table V) 49 (80%) showed some increase in hair levels of cadmium or nickel as compared to the control group, and 24 (49%) (Table VI) showed some increase of cadmium or nickel in their urine. If workers with only slightly increased levels of the metals are excluded, 26 (42%) showed increased hair levels and 18 (36%) showed increased urine levels. The following table shows the hair and urine levels by department.

	NO INCREAS	SED LEVEL OR ONLY	MODERATELY OR CONSIDE					
DEPARTMENT	SLIGHTLY	INCREASED LEVELS	ABLY INCREASED LEVEI					
	No.	% of Dept.	No.	% of Dept.				
Hair levels(Cd and Ni)								
350 (Controls)	14	100	0	0				
330A	2	זב 7	10	83				
330B	3	43	4	57				
340A	3	38	5	62				
340в .	7	64	4	36*				
Total Including Other	35	58	26	42				
*None were consid	erably inc:	reased						
Urine Levels								
350 (Controls)	9	100	0	0				
330A	3	- 33	6	67				
330B	3	33	4	57*				
340A	6	67	3	33*				
340B	6	75	2	25*				
Total Including Other	31	64	18	36				

\*None were considerably increased

Page 11 - Health Hazard Evaluation Determination 74-16

When examined by specific job, the current tab welders showed three out of five with moderately or considerably increased urine nickel levels as compared to three out of 44 for the rest of the workers (the probability of this difference being due to chance is 0.012). The current and past tab welders together showed a greater proportion with increased cadmium and/or nickel in their hair samples (8 out of 10) compared with the rest of the workers (18 out of 51) (probability of this difference being due to chance is 0.044).

(b) Medical History and Physical Examination

Table VII details health problems felt to be related by the workers response to the question "Do you have any health problems you feel might be related to your work?" Workers from Departments 330A, 330B and 340A all complained about the dust from the plates as causing a variety of irritative symptoms.

Most workers felt they were in good health. It is of note, however, that Department 330A had less workers with no complaints than the workforce average. The higher proportion of workers in Department 330A and 340A who felt they were only in fair or poor health is also of interest. The finding of a similar increase in Department 350 probably related to the method of sample selection (volunteer rather than random sample). Metal levels in hair or urine did not correlate with symptoms on individual bases.

Tables VIII and IX tabulate responses to detailed questioning and findingson physical examination for 43 workers. Twenty-nine workers (67%) had current symptoms and 29 workers (not necessarily the same workers) had some findings on physical examination. Departments 330B and 340A and B had the greatest proportion (67%, 44%, and 57%) of workers with no current complaints and Department 350 had the greatest proportion (50%) with no physical findings. Most of the current problems concerned the upper respiratory tract with nasal irritation or stuffiness (35% of the workers) and sinus problems (28% of workers) reporting this. By history, headaches, light headedness and dizziness were the most frequent complaints (79% of the workers), but were considered non job-related twice as often as job-related. Nasal irritation (58% of the workers) and eye irritation (56%) were more likely to be considered job-related; and sinus problems (56%) were usually not considered job-related. Complaints of hay fever like reactions (40%) and dermatitis (42%) were felt to be job-related or not job-related in about equal proportions. In some cases either negative (cadmium) or positive (nickel) plates were specified, but usually no such designation was made.

Page 12 - Health Hazard Evaluation Determination 74-16

Physical findings were not particularly well correlated with symptomatology, especially history of symptoms. However, if all irritative and exudative findings in the nose and pharynx are considered together, they are predominantly found in Departments 330A and 340A (12 out of 17 workers had some findings) ( $X^2$  probability of this being due to chance was 0.011).

A number of workers complained of frequent cuts and wire punctures from handling the plates, sometimes adding that they healed poorly. The stackers (Department 340B) in particular (3 of 5) complained of frequent cuts in trying to align the plates properly. Physical findings were not remarkable.

(c) Urine Protein

Urine protein values were at levels which would not normally be detected on routine urine screening. The highest concentration may have just been detected but was not associated with an excessive 24 hour excretion. Three urine 24 hour creatinine projections were higher than might be expected, but concentrations were within the same range as the rest of the workforce. Elevated urine creatinine levels are not diagnostic of any disease entity, but do cast some doubt on the specifics of collection of the urine specimen.

(d) Summary of Medical Findings

In summary, the workers in Departments 330A, 330B, 340A and 340B showed higher levels of cadmium and nickel in their hair and urine than did the control group of workers drawn from Department 350. These differences were statistically significant for hair cadmium, hair nickel and urine cadmium. Only Department 330A showed a statistically significant increase of urine nickel levels.

Department 330A besides showing increased urine nickel was in the group with the higher urine cadmium levels; with the highest proportion of workers giving spontaneously reported health problems which were thought to be job-related; with the most current medical complaints; with a greater portion of workers feeling they were in less than good health; and with a significant proportion of workers showing upper respiratory irritation or exudation. Department 340A had findings similar to Department 330A except urine nickel levels were not significantly increased statistically, and there were less current complaints reported and less spontaneously reported health problems thought to be job-related.

Department 330B showed less increase in hair and urine metal levels and less medical problems than Departments 330A and 340A with no findings of upper respiratory irritation.

Department 340B showed some increase in hair and urine cadmium and hair nickel, but otherwise differed little from the control group.

Page 13 - Health Hazard Evaluation Determination 74-16

Department 350, as expected, had lesser proportions of reported problems and of physical findings. Hair and urine metal levels were lower than the study group. There were a larger proportion of workers claiming less than good health, and more current symptoms than the other departments (excepting 330A) but these were mostly considered related to something other than the job.

Of specific work groups the tab welders showed a larger proportion of workers with high metal levels (present tab welders for urine nickel and past and present for tab welders for hair cadmium and/or nickel).

(e) Conclusions

(1) Departments 330A and 340A show excessive symptomatology and physical findings indicative of upper respiratory irritation. These symptoms and physical findings are probably due to exposure to plate dust and tab welding fumes. It is impossible to determine whether it is due to the cadmium or nickel from the findings of this study. The tab welding fumes are particularly suspect as the tab welders as a group showed higher hair and urine metal levels than the other workers.

(2) All workers in Departments 330A, 330B, 340A, and 340B are exposed to levels of cadmium and nickel above those which they would encounter away from the job. Increased absorption of cadmium and nickel is shown by increased levels of cadmium and nickel in hair (storage) and of increased excretion of these metals in urine.

(3) The exposure is worse in Departments 330A and 340A with 330A being the worst as shown by both hair and urine cadmium and nickel levels and by air levels of these metals. The tab welders as a group appear to have the greatest exposure as judged by biological tests. The crackers had the worst exposure if judged by the relative number of air samples showing excessive levels of the metals.

(4) There is no evidence that exposure to cadmium and nickel in Department 340B is causing any illness. This is probably also true of Department 330B.

(5) No evidence of chronic toxic reaction to cadmium was found as evidenced by the lack of cadmium induced proteinuria. No emphysema related to cadmium was found by history or physical examination.

(6) According to the OHSA Log there has been some nickel dermatitis in this plant. This is a hazard associated with contact with nickel, and is not confined to an industrial setting in our society. (Nickel is found in coins and jewelry.) Page 14 - Health Hazard Evaluation Determination 74-16

#### V. RECOMMENDATIONS

1. Use of compressed air should be prohibited for cleaning purposes.

2. Sweeping should also be prohibited. Floors, equipment, and work areas should be cleaned by vacuuming.

3. The tab welding and cracker machines should be provided local exhaust ventilation unless other control methods are demonstrated to be effective in reducing cadmium and nickel exposures to safe levels.

4. The company should monitor all operations where nickel and cadmium exposures occur and reduce airborne and settled dust concentrations to safe levels. Better housekeeping is also essential if nickel and cadmium dust exposure are to be adequately controlled.

5. During the NIOSH survey on December 18, 1974, it was noted that the welder in the maintenance shop had been provided exhaust ventilation, but the exhaust system was still not adequate to control welding fumes. The exhaust system should be redesigned to capture fumes and gases produced during welding.

6. Periodic urine screening for low molecular weight proteinuria (using sulfosalicylic acid or trichloroacetic acid) should be instituted with prompt referral of workers showing proteinuria for further medical evaluation. This should be done quarterly for workers in Department 330A and 340A, annually for others.

7. Because proteinuria is apparently not found before some kidney damage has occurred, it is suggested that periodic surveys of metal hair levels might be done as a measure of body burden. Semi-annually or annually would be suitable. Workers with hair levels comparable to those found in Departments 330A and 340A should have urine tests for proteinuria on a quarterly bases.

8. Chest x-rays and pulmonary function tests for FVC and FEV should be part of the pre-employment physical examination.

9. Comments regarding restroom cleanliness and other matters not directly related to a health hazard evaluation were submitted to the Marathon Battery Company in a letter dated March 7, 1974.

Page 15 - Health Hazard Evaluation Determination 74-16

VI. REFERENCES

1. Baumslag, M; Yeager, D; Levin, L; and Petering, H.G. "Trace Metal Content of Maternal and Neanate Hair." Arch. Environ. Health 29:186 (1974).

2. Davidsohn, I. and Henry, J.B. <u>Clinical Diagnosis by Laboratory Methods</u> 15th ed., W.B. Saunders: Philadelphia, 1974.

3. Friberg, L; Piscator, M; Hordberg, G.F.; and Kjellstrom, T. <u>Cadmium</u> in the Environment 2nd ed., Cleveland, Ohio: CRC Press, 1974.

4. Fukushima, T. "Cadmium (Cd) (In Urine) How to Interpret the Values." Nippon Rinshe 29:245 (1971).

5. NICKEL: Medical and Biologic Effects of Environmental Pollutants. National Academy of Sciences, Washington, 1975.

6. Petering, H.G.; Yeager, D.W. and Witherup, S.O. "Trace Metal Content of Hair in Relation to Age and Sex." Arch. Environ. Health 27:327 (1973).

7. Schroeder, H.A., and Mason, A.P. "Trace Metals in Human Hair." J. Invest. Dermatol. 53:71 (1969).

8. Underwood, E.J. Trace Elements in Human and Animal Nutrition. Academic Press, New York, 1971.

#### VII. AUTHORISHIP AND ACKNOWLEDGEMENTS

Report Prepared By:

Theodore W. Thoburn, M.D. Medical Officer Medical Services Brnach Cincinnati, Ohio

Lee B. Larsen Industrial Hygienist Western Area Occupational Health Laboratory Salt Lake City, Utah

Originating Office:

Jerome P. Flesch Chief Hazard Evaluation Services Branch Cincinnati, Ohio Page 16 - Health Hazard Evaluation Determination 74-16

Acknowledgements:

Nursing assistance in this study was supplied by Eileen Philbin, R.N., Medical Services Branch, DTS, NIOSH and Laura Andersen, R.N., Medical Investigations Branch, DFSCI, NIOSH.

Industrial hygiene assistance was provided during the December 1974 survey by Harry Markel, Region VI Industrial Hygienist

## TABLE I

# DETAILED BREAKDOWN OF WORKFORCE

Α.	December	Workforce	and	Average	Numbers	Assigned	to	Certain	Specific	Jobs
----	----------	-----------	-----	---------	---------	----------	----	---------	----------	------

Departments	Job Titles	Days	Night		tals
330A - Sealed Cells	Total	24	0	24	
	Shearers Tab Welders Cracking Machin	1.5 3.5	6	) 2	1.5 3.5
	Operators	1.5	Ĺ	2	1.5
330B - Sealed Cells	Total	41	0	41	
	Core Rollers	17	C	2	17
340A - Vented Cells	Total	21	17	38	
	Shearers Tab Welders	5 6		5 7	11 13
340B - Vented Cells	Total	38	26	64	
	Stackers	11	1	5	16
350 - Sealed Cells - Charge	Totals	49	2	51	
360 - Vented Cells - Fill & Charge	Totals	8	0	8	
TOTALS		181	45	226	

# TABLE I

# DETAILED BREAKDOWN OF WORKFORCE

# B. Workers Interviewed

DEPT.	JOB TITLES	INITIAL INTERVIEWS			FOLLOW-UP STUDY						
		DAYS	EVEN	TOTAL	PARTIAL	COMPLETE	TOTAL	DAYS	EVEN		
330A											
	Shearers	0	0	0	0	4	4	4	0		
	Tab Welders	3	0	3	I	2	3	3	0		
	Cracking Mach-										
	ine Operator	2	0	2	0	2	2	2	0		
	Taping and										
	Repair	3	0	3	1	I	2	2	0		
	Sub-Total	8	0	8	2	9	11	11	0		
330B											
	Core Rollers	6	0	6	4	3	7	7	0		
	Tapers	I	0	l	0	0	0	0	0		
	Scorers	1	0	1	0	0	0	0	0		
	Seal & Load							1			
	Fillers	2	0	2	0	0	0	0	0		
	Cover Spinners	l	0	1	0	0	0	0	0		
	Cover Welders	2	0	2	0	0	0	0	0		
	Sub-Total	13	0	13	4	3	7	7	- 0		
330A&B											
	Group Leader	I	0	I	0	l	1	1	0		
	Repairman	0	0	0	1	0	1	1 1	0		
	Sub-Total	1	0	1	1	1	2	2	0		
340A					2						
	Shearers	3	I	4	3	3	6	2	4		
	Tab Welders	3	3	6	1	1	2	1 1	1		
	Sorting & Repair	r 0	0	0	1	5	6	3	3		
	Sub-Total	6	4	10	5	9	14	6	8		
340B											
	Stackers	1	0	l	4	5	9	9	0		
	Trimmers	0	0	0	0	1	1	0	1		
	Combers	1	0	l	1	1	2	2	0		
	Sorters	1	2	3	0	0	0	0	0		
	Terminal Welder:	s 1	I	2	0	0	0	0	0		
	Phenol Sealers	0	1	I	0	0	0	0	0		
	Cycle Charge										
	Operator	0	I	1	0	0	0	0	0		
	Sub-Total	4	5	9	5	7	12	77	7		

# TABLE I

# B. Workers Interviewed (Continued)

DEPT.	JOB TITLES	INITIAL INTERVIEWS			FOLLOW-UP STUDY							
-		DAYS	EVEN	TOTAL	PARTIAL	COMPLETE	TOTAL	DAYS	EVEN			
340a&1	3											
	Group Leader	1	0	1	0	0	0	0	0			
	Repairman	0	0	0	1	0	1	1	0			
	Sub-Total	1	0	l	1	0	1	1	0			
350	Total	0	0	0	0	14	14	14	0			
360	Total	0	0	0	о	0	o	0	0			
400	Quality Control •Inspector	0	0	0	I	0	1	1	0			
GRAND	TOTALS	33	9	42	19	43	62	53	9			

## TABLE II

1.14

# CHARACTERIZATION OF STUDY SAMPLE

* * *	STUDY G	ROUP	CONTROLS
	Females	Males	Females
Number	46	2	14
Race			
White	42	2	14
Black	4	0	0
Age			
Average	34.6	30.5	42.7
Range	20 - 59	30 - 31	25 - 61
Years with Company			
Average	2y 6 1/2m	Зу	2y 7 1/2m
Range	7m - 3y 6m	2y 6m - 3y 5m	8m - 3y 6m

#### TABLE III

SOME NORMAL VALUES AS REPORTED IN THE LITERATURE AND CONTROL VALUES AS FOUND AT MARATHON BATTERY COMPANY, WACO, TEXAS.

(95% confidence limits are given for means of control group)

SUBSTANCE	SPECIMEN	SEX	SAMPLE	MEAN	UNITS	REF	
			SIZE				
CADMIUM	Head Hair	Male	95	2.20 + 0.2	ug/g	6	
	Head Hair	Female	83	2.43 + 0.26	ug/g	6	
	Head Hair	Male	82	2.76 + 0.483	ug/g	7	
	Head Hair	Female (Age 1-3	24 0)	2.59 + 0.379	ug/g	7	
	Head Hair	Female (Age 40-	22 70)	$0.92 \pm 0.153$	ug/g	7	
CONTROL	GROUP	-					
	Pubic Hair	Female	14	15.22 (8.85 -26.17)	ug/g		+
						<del></del>	
CADMIUM	Urine		8	5.4	ug/day	4	
	Urine		?	10 (2-22)	ug/l	8	
	Urine		?	1-2	ug/l	3	
	Urine		?	1-2	ug/day	3	
	Urine		?	0.001-0.002	ug/mg creatin	- 3 line	
CONTROL	GROUP						
	Urine	Female	9	18.9 (14.7-24.3)	ug/l		
	Urine	Female	9	32.6 (20.2-52.9)	ug/day		
	Urine	Female	9	0.024 (0.015-0.036)	ug/mg		
					creatin	ine	-1-
In Japa 30 ug/2	an, screening . 24 hours. The	levels for refore a r	cadmium in andom urine,	urine assume a normal unless quite dilute,	of less t should ha	han we	
1855 CI.		Re1. 4/					
NICKEL	Head Hair	Male	79	0.97 + 0.147	ug/g	7	
	Head Hair	Female	25	3.96 + 1.055	ug/g	7	
CONTROL	GROUP						
CONTROL	Pubic Hair	Female	14	6.14 (4.01 -9.40)	ug/g		+

+ values to be used in this study.

# TABLE III (continued)

SUBSTANCE	SPECIMEN	SEX	SAMPLE SIZE	MEAN	UNITS	REF.
NICKEL	Urine Urine Urine	<sup>%</sup>	24 ? 154	20 <u>+</u> 2.6 Approx. 30 10 (range 1-81)	ug/l ug/day ug/l	8 8 8
CONTROL	GROUP		2	70.454.211		
	Urine	Female	9	10(54-91) 121(74-230)	ug/l va/dau	- <b>f</b> -
	Urine	Female	9	0.09 (0.05-0.14)	ug/mg ¢i	reatinine
ZINC	Head Hair	Female	50*	136 (133–138)	ug/g	1
	Pubic Hair	Female	51*	151 (148-154)	ug/g )	6
	Head Hair	Male	95	145 <u>+</u> 4	ug/g	6
	Head Hair	Female	83	152 <u>+</u> 6	ug/g	
		"San	ne person			
CONTROL	GROUP Pubic Hair	Female	14	104.02 (45.02 -204.35 )	ug/g	+
ZINC	Urine		?	300 (range 100-500)	ug/day	8
CONTROL	GROUP					
	Urine	Female	9	212 (132-340)	ug/l	
	Urine	Female	9	366 (255-526)	ug/day	+
	Urine	Female	9	0.26 (0.20-0.33)	ug/mg ci	reatinine
,			PUBLI	SHED NORMS		
PROTETN	Urine		10-100 Upp	er limit of pormal 150	maldan	2
LIOIDIN	Urine		20-80 At n	ormal flow rates	mg/dug mg/l	2
			Globulins total prot	usually account for 1/2 ein	to 2/3 c	of
Heavy Modera Minima	Proteinuria ate Proteinur al Proteinuria	ia a	Greater th 500-4000 Less than	an 4000 500	mg/day mg/day mg/day	2
CREATININE	Urine Urine	Male Female	1000-2000 800-1800		mg/day mg/day	2 2
			About 10% 29% variat	variation within an ind ion between individuals	ividual a •	and
			Healthy ma high prote	les may have up to 2500 in intake and intensive	-2700 mg, exercise	/day with e

.

+ values to be used in this study

TABLE IV

MEAN CADMIUM, NICKEL, AND ZINC LEVELS IN MARATHON BATTERY WORKERS BY DEPARTMENT

		s		PROBABIL ERENCE F MEAN & UNITS (95% BEING DU	ITY OF DIFF- ROM CONTROL E TO CHANCE
SUBSTANCE	SPECIMEN	GROUP	NUMBER	Confidence Limits) (inde	pendent t)
CADMIUM	Hair	Control(350) 340B	14 11	15.2 μg/g (8.85-26.17) 61.49 μg/g (32 04-118 01)	0.003
		330A,330B,340A	27	197.19 μg/g (129.18-301.01)	2x10 <sup>-8</sup>
		Not increased Slightly increase Moderately increa Considerably incr	ed ised reased	Up to 34.88 µg/g 34.89-197.19 197.20 376.75 Over 376.75	
	Urine	Control(350)	9	0.024 µg/mg creatinine (0.015-0.036)	
		330A&B,340A&B	33	0.052 µg/mg creatinine (0.038-0.074)	0,027
		Not increased Slightly increase Moderately increa Considerably incr	ed ised reased	Up to 0.045 µg/mg creat 0.046-0.052 0.053-0.088 Over 0.088	inine
NICKEL	Hair	Control(350) 330B,340B 330A,340A	14 18 20	6.14 μg/g (4.01-9.40) 21.36 μg/g (14.27-31.96) 43.38 μg/g (28.69-65.59)	6x10 <sup>-7</sup> 4x10 <sup>-7</sup>
		Not increased Slightly increase Moderately increa Considerably incr	ed ised reased	Up to 11.78 µg/g 11.79-43.38 43.39 81.68 Over 81.68	1
	Urine	Control(350) 330B,340A,340B 330A	9 24 9	121 μg/24 hr (74-230) 141 μg/24 hr (113-176) 418 μg/24 hr (252-696)	0.524* 0.003
		Not increased Slightly increase Moderately increa Considerably incr	ed ased reased	Up to 258 µg/24 hr 259-418 419-911 Over 911	

\*With this probability the difference between the means is not considered statistically significant.

TABLE IV (Continued)

		5.e.		PF EF MEAN & UNITS (95% BF	ROBABILITY OF DIFI RENCE FROM CONTROI EING DUE TO CHANCH		
SUBSTANCE	SPECIMEN	GROUP	NUMBER	Confidence Limits)	(independent t)		
ZĮNC	Hair	Control(350) All Other Workers Tested	14 47	104 µg/g (45-204) 166 µg/g (147-187)	0.072*		
		Not increased Increased		Up to 375 μg/g Over 375			
	Urine	Control(350) All Other Workers Tested	9 - 40	366 μg/24 hr (255-52 499 μg/24 hr (336-60	26) 00) 0.536		
		Not increased Increased		Up to 638 µg/24 hr Over 638			

\*With this probability the difference between the means is not considered statistically significant.

### TABLE V HAIR LEVELS (GROUPED) BY DEPARTMENT

(For hair levels, if a worker had spend an appreciable time in one department and was transferred to her current department no more than 2 months prior to the study, she was considered with her prior department.

METAL LEVEL GROUP	TC	TALS	3	350		330A		330B		340A		340B		Other	
	#	%	#	ġ6	#	de	#	36	#	%	#	%	#	*	
Total Workers	61	100	14	100	12	100	7	100	8	100	11	100	9	100	
Slightly Increased, Cd &/or Ni	23	38	5	36	1	8	3	43	3	38	5	45	6	67	
Moderately or Considerably Increased Cd, Ni Normal or Slightly Increased	10	16	0	0	5	42	2	29	l	12	l	9	1	11	
Moderately or Considerably Increased Ni, Cd Normal or Slightly Increased	8	13	0	0	3	25	0	0	2	25	3	27	0	0	
Both Cd and Ni Moderately or Considerably Increased		13	0	0	2	17	2	29	2	25	0	0	2	. 22	
Total with Increased Levels	49	80	5	36	11	92	7	100	8	100	9	82	9	100	
No Increased Levels of Cd or Ni	12	20	9	64	I	8	0	0	0	0	2	18	0	0	
INCREASED Cd LEVELS															4
Slightly	28	46	3	21	3	25	3	43	5	62	8	73	6	67	
Moderately	8	13	0	0	2	17	2	29	1	12	1	9	2	22	
Considerably	10	16	0	0	5	42	2	29	2	25	0	0	1	11	_
Total Increased Cd	46	75	3	21	10	83	7	100	8	100	9	82	9	100	
INCREASED NÍ LEVELS															
Slightly	26	43	4	29	6	50	3	43	4	50	5	45	4	44	
Moderately	10	16	0	0	3	25	2	29	0	0	3	27	2	22	
Considerably	5	8	0	0	2	17	0	0	3	38	0	0	0	0	
Total Increased Ni		67	4	29	11	92	5	71	7	88	8	73	6	67	

# TABLE VI URINE LEVELS (GROUPED) BY DEPARTMENT

METAL LEVEL GROUP		TO	TALS	3	50	33	30A	33	30B	,34	40A	34	40B	Oth	ner "
		₹F	76	ŦF	76	łF	76	ŦF	70	ŦF	74	ŦF	76	ŦF	74
Total Workers		+9	100	9	100	9	100	7	100	9	100	8	100	7	100
Slightly Increased Cd and/or Ni		6	12	1	11	2	22	0	0	1	11	2	25	0	0
Moderately or Considerably Increased Cd Ni Normal or Slightly Increased	, 1	L2	24	0	0	1	11	4	57	3	33	2	25	2	29
Moderately or Considerably Increased Ni Cd Normal or Slightly Increased	3	1	2	0	0	1	11	0	0	0	0	0	0	0	0
Both Cd and Ni Moderately or Considerably Increased		5	10	0	0	4	44	0	0	0	0	0	0	1	14
Total with Increased Levels Cd and/or Ni	2	24	49	1	11	8	89	4	57	4	44	4	50	3	43
(Total with associated increased .Zn levels)	(	8	16	1	11	5	56	1	14	1	11	0	0	0	0)
No Increased Levels of Cd or Ni	2	25	51	8	89	1	11	3	43	5	56	4	50	4	57
(Total with associated increased Zn levels)	(	9	18	1	11	1	11	1	14	3	33	0	0	3	43)
INCREASED Cd LEVELS						1000 - Filli	10.00	inners 2							***
Slightly		2	4	0	0	1	11	0	0	0	0	1	12	0	0
Moderately		6	4	0	0	1	11	3	43	0	0	0	0	2	29
Considerably	1	1	22	0	0	4	44	1	14	3	33	2	25	1	14
Total Increased Cd	1	19	39	0	0	6	67	4	57	3	33	3	38	3	43
(Total with associated increased Zn levels)	(	5	10	0	: 0	3	33	1	14	1	11	0	0	0	0)
INCREASED Ni LEVELS															
Slightly		6	12	1	11	1	11	0	0	2	22	2	25	0	0
Moderately		2	4	0	0	2	22	0	0	0	0	0	0	0	0
Considerably		4	8	. 0	0	3	33	0	0	0	0	0	00		14
Total Increased Ni	1	12	24	1	11	6	67	σ	0	2	22	2	25	1	14
(Total with associated increased Zn levels)	(	7	14	1	11	5	56	0	0	1	11	0	0	0	0)

TABLE VII HEALTH PROBLEMS FELT TO BE JOB RELATED BY WORKERS IN RESPONSE TO NON-DIRECTED QUESTION (Combined from both visits)

	3.	30A	3.	30B	3	40A	3	40B	3:	50	OTHER	TO	TAL
COMPLAINTS	#	*	#	%	#	%	#	%	#	%	#	#	20
Number Interviewed	15	100	15	100	18	100	15	100	14	100	I	78	100
Dust, usually with complaints such as respir- atory or eye irritation, sinus problems, headache	8	53	5	33	7	39	1	7	2	14	0	23	29
Dermatitis or itching	3	20	l	7	I	6	0	0	1	7	0	6	8
Acnelform rash	3	20	0	0	0	0	0	0	0	0	0	3	4
Frequent cuts, possibly difficult healing	l	7	l	7	0	0	4	27	0	0	0	6	8
Solvent Fumes	0	0	0	0	l	6	2	13	0	0	0	3	4
Safety Glasses	1	7	l	7	0	0	2	13	0	0	0	4	5
Other Headaches	0	0	0	0	2	11	0	0	0	0	0	2	3
Other Miscellaneous	2	13	2	13	2	11	0	0	0	0	0	6	8
No Complaints	4	27	6	40	7	39	10	67	11	79	1	39	50
WORKERS ASSESSMENT OF THEIR GENERAL STATE OF HE	ALTH												
Number	9	-	3		9		7		14		1	43	
Good	5	56	3	100	7	78	7	100	10	71	I	33	77
Fair	4	44	0	0	1	11	0	0	4	29	0	9	21
Poor	0	0	0	0	l	11	0	0	0	0	0	1	2

CURRENT AND HISTORICAL SYMPTOMS AS ELICITED ON DIRECTED QUESTIONNAIRE (Total number of workers interviewed = 43)

-

				1	PAST HIS	STORY		
			JC	)B	NOT	JOB	TOT	TAL
SYMPTOM	CUR	RENT	RELA	TED	REL	ATED	NUM	IBER
	#	%	#	de de	#	%	#	00
None	15	35	N.A.	-	N.A.	-	1	2
UPPER RESPIRATORY PROBLEMS			and all a state of the second second					
Throat Irritation	6	14	6	14	12	28	18	42
Eye Irritation	4	9	17	40	7	16	24	56
Nasal Irritation or Stuffiness	15	35	19	44	9	21	25	58
Sinus Problems	12	28	6	14	18	42	24	56
Hay Fever & Similar Allergies	-	-	9	21	10	23	17	40
Problems With Taste or Smell	1	2	I	2	0	0	l	2
Total Upper Respiratory	22	51	27	63	28	65	37	86
LOWER RESPIRATORY PROBLEMS	Construction of the							anti dere dell
Cough	8	19	3	7	11	26	14	33
Chest Discomfort	3	7	0	0	10	23	10	23
Wheezing or Whistling	0	0	1	2	4	9	5	12
Shortness of Breath	1	2	3	7	11	26	14	33
Asthma	-	-	0	0	2	5	2	5
Total Lower Respiratory	11	26	7	16	19	44	25	58
SKIN PROBLEMS	and the second							
Acne-like Rash	-	-	3	7	5	12	8	19
Dermatitis, Rash or Skin Allergy	-	-	5	12	14	33	18	42
Frequent Cuts	-	-	8	19	0	0	8	19
Total Skin	-	-	14	33	17	40	27	63
OTHER PROBLEMS								
Headaches, Lightheadedness or	9	21	10	23	24	56	33	77
Heart Blood Pressure or Anemia	_	_	0	0	15	35	15	35
Stomach		_	7	2	20	19	10	21
Kidney & Other Uninary	_	-	0	0	12	20	12	29
Fevers Fatime or Weight Loss			1	0	15	20	10	12
Other	0	0	1	2	13	30	13	30
TOTAL WITH SYMPTOMS	29	67	28	65	38	88	42	98

TABLE IX

SYMPTOM GROUPS AND PHYSICAL FINDINGS BY DEPARTMENT

SYMPTOMS OR FINDINGS	TOTA #	۱L %	330 #	)A %	330B #	340 #	A %	340 #	DB %	350 #	%	OTHER #
Total Examined	43	100	9	100	3	9	100	7	100	14	100	1
No Current Symptoms	15	35	1	11	2	4	44	4	57	3	21	1
No Symptoms by History	1	2	0	0	0	1	11	0	0	0	0	0
No Physical Findings	14	33	2	22	1	2	22	2	29	7	50	0
UPPER RESPIRATORY PROBLEMS												
Current Symptoms	22	51	7	78	1	4	44	1	14	9	64	0
History of Symptoms	37	86	7	78	3	6	66	7	100	13	93	1
FINDINGS: Slight Eye Irritation	1	2	1	11	0	0	0	0	0	0	0	0
Nasal Inflamation	7	16	3	33	0	2	22	0	0	2	14	0
Bluish Nasal Exudate	2	5	0	0	0	2	22	0	0	0	0	0
Throat Inflamation	8	19	1	11	0	4	44	٦	14	2	14	0
Grayish Ulceration in Throat	1	2	0	0	0	0	0	0	0	1	7	0
Total inflamatory & exudative findings	17	40	5	55	0	7	77	1	14	4	29	0
Enlarged Tonsils	1	2	0	0	0	0	0	1	14	0	0	0
LOWER RESPIRATORY PROBLEMS												
Current Symptoms	11	26	2	22	1	2	22	0	0	6	43	0
History of Symptoms	25	58	5	56	3	6	67	2	29	9	64	0
FINDINGS: Altered Chest Sounds	7	16	0	0	2	2	22	2	29	1	7	0
Increased AP Diameter	1	2	0	0	0	0	0	0	0	1	7	0

1

# TABLE IX Continued

	TOTA		330A		330B	340	Ą	340	)B	350		OTHER
SYMPTOMS OR FINDINGS	#	%	#	0/ /U	#	#	%	#	%	#	%	#
											1	
SKIN PROBLEMS												
History of Symptoms	27	63	7	78	2	4	44	7	100	7	50	0
FINDINGS: Acne-like Rash	2	5	1	11	0	0	0	0	0	0	0	1
Drying or Cracking (particularly about nails) or Loss of Skin Detail	5	12	1	11	0	1	11	1.	14	2	14	0
Other Rashes	1	2	1	11	0	0	0	0	0	0	0	0
Discolorations	3	7	0	0	0	2	22	0	0	1	7	0
SYMPTOMS OF HEADACHES, LIGHTHEADEDNESS (	OR DIZ	ZINESS	<u>s</u>									
Current Symptoms	9	21	2	22	1	0	0	2	29	4	29	0
History of Symptoms	33	77	8	89	3	6	67	6	86	10	71	0
OTHER FINDINGS	5	12	3	33	0	0	0	0	0	2	14	0

# TABLE X. AIR CONCENTRATIONS OF CADUIUM AND NICKEL

# A. CRACKER OPERATIONS - Department 330A

# 1. Samples Collected February 27-28, 1974:

			C.	oncentrat	ion Mg/MJ	
	Air Volume		C	d	1	N <u>1</u>
Location	MЗ		(Total)	(Resp.)	(Total)	(Resp.)
Cracker Operator Sample 1	.838		0.19		0.75	
Cracker Operator Sample #2	.830		0.25		1.3	
Area Sample About Four Feet Above Cracker Machine	.291		0.55		0.35	
2. Samples Coll	ected December	17, 19	74:			
Cracker Operator Sample #3	.789	ł.	0.40	0.01	0.16	0.02
Cracker Operator Sample #4	.828		0.03	0.01	0.14	0.05
Cracker Area During Cleanup (Same Emp. as Sample #3)	.036		2.1		0.78	
Area Sample about Four Feet Above Cracker Machine	.803		0.08		0.57	
3. Samples Coll	ected December	: 18, 19	74:			
Cracker Operator Sample #4	.745		0.05	0.01	9.11	<0.01
Cracker Operator Sample #5	.743		0,62	0.02	0.19	<0.01
During Cleanup (Same Emp. as Sample #4)	.048		0.29		0.23	
During Cleanup (Same Emp. as Sample #5)	-041		0.43		0.20	
Area Sample About Four Feet Above Cracker Machine	.768		0.35	0.01	0.85	0.07

# Page 2

# B. TAB WELDERS: - Sealed Cell - Department 330A Vented Cell - Department 340A 1. Samples Collected February 27-28, 1974

			Co	oncentrat	ion Mg/M3	
Location	Air Vo M3	lume	(Total)	(Rasp.)	(Total)	(Pace)
LOCALION			(IULAI)	(resp.)	(IOLAL)	(vean')
Tab Welder Sample Sealed Cell	#1 .760		0.11		0.67	
Tab Welder Sample Sealed Cell	#2 ,746		2.23		1.91	
Tab Welder Sample Vented Cell	#3 .433		0.04		0.15	
Tab Welder Sample Vented Cell	#4 <b>.</b> 668		0.08		0.40	
Tab Welder Sample Vented Cell	#5 ,304		0.49		2.42	
Tab Welder Sample Vented Cell	#6 .304		0.17	•	0.16	
Tab Welder Sample Vented Cell	<b>#7</b> .332		0.38		0.18	
Tab Welder Sample Vented Cell	#8 .314		0.05		1.08	
2. Samples	Collected De	cember 17, 1	974:			
Tab Welder Sample Sealed Cell	<b>#9 .801</b>		0.52		18.3	
Tab Welder Sample Sealed Cell	<b>#10 .758</b>		0.56	-	53.3	
Area Sample Sealed Cell	.838		0.06	0.01	0.06	0,02
Area Sample Vented Cell	.806		0.06	0.02	0.09	0.03
Tab Welder Sample Vented Cell	#10A .818		0.03	0.01	0.06	0.01

Page 3.

	Vie Williams	Co	ncentrat	ion Mg/M3	
Location	M3	(Total)	(Resp.)	(Total)	(Resp.)
3. Samples Collec	ted December 18, 1	.974:			
Tab Welder Sample #11 Sealed Cell	.544	0.02		0.07	
Area Sample Sealed Cell Area	.784	0.07	0.01	0.06	0.01
Tab Welder Sample #12 Vented Cell	.751	0.11		0.14	
Tab Welder Sample #13 Vented Cell	.723	0.16		0.39	
Tab Welder Sample #14 Vented Cell	.719	0.08		0.20	
Tab Welder Sample #15 Vented Cell	.711	0.08		0.16	
Tab Welder Sample #16 Vented Cell	.700	0.08		0.06	1715
C. CORE ROLLERS - Dep	partment 330B				
1. Samples Collec	ted February 27-28	3, 1974:			
Core Roller Sample #1	.247	0.05		0.11	
Core Roller Sample #2	.758	0.10		0.14	
2. Samples Collec	ted December 17, 1	L974:			
Core Roller Sample #3	.706	0.07	0.01	0.11	0.02
Core Roller Sample #4	.728	0.09		0.07	
Area Sample Core Rollin	ng.690	0.04		0.05	
Area Sample Core Rollin	ng.284	0.08		0.10	

Page 4

D. TAPERS

1. Samples Collected February 27-28, 1974:

1.1

		C	oncentrat	ion Mg/M <sup>3</sup>	
Location Dent	Air Volume	(Total)	(Peen)	(Total)	(Resp.)
Dept.	110	(total)	(11050),7	(10041)	(Resp.)
Taper Sample #1 -	.476	0.25		0.45	~~
Taper Sample #2 -	.804	0.16		0.27	
2. Samples Coll	ected December 17, 19	74:			
Taper Sample #3 330B	.801	0.38	0.06	0.20	0.03
E. OPERATIONS NOT S	PECIFIED ELSEWHERE				
1. Samples Coll	ected February 27-28,	1974:			
Shearer Sample #1 330A	.401	0,18		0.40	
Taping Plax Operator #1	261	0.06		0.13	
Stacker Sample #1 340A	.314	0.05		1.08	~
2. Samples Coll	ected December 17, 19	74 <b>:</b>			
Shearer Sample #2 330A	.768	0.22		0,27	
Shearer Sample #3 340A	.770	0.29		5.32	
Negative Welder 330B Sample #1	.751	0.02		0.02	
Scoring Sample #1 330B	.721	0.02		0.02	
Cover Assembly Sample #1 330B	.753	0.03		0.05	
Area Sample — Putting in Nylon Separators	.794 340B	0.04		0.05	
Area Sample Dept. 360	706	0.006	0.005	0,005	0.003
Area Sample Dept. 350	702	0.006	0.005	0.009	0.004
Area Sample Terminal ( Welder	340в.539	0.03		0.04	

### APPENDIX A

1. Questionnaire A was used, when necessary, to determine which workers from Departments 330B and 340B should be included in the study group. If they had spent less than 15 work days out of the last 60 work days in high risk jobs they were not included.

2. Consent Form and Questionnaire B. These were obtained on everyone included in the study and from whom hair and urine specimens were obtained.

3. Questionnaire C was obtained on a sample of women in the study group and on the controls. This related to medical history.

4. Questionnaire D and Physical Examination was obtained on a sample of women in the study group and on the controls. This asked for current symptoms to correlate with medical findings.

## QUESTIONNAIRE A

SCREENING QUESTIONNAIRE - DEPT. 330B & 340B

Identifying Data:

1. NAME\_\_\_\_\_\_2. DEPT.\_\_\_\_\_

3. JOB TITLE \_\_\_\_\_ 4. SHIFT \_\_\_\_\_

5. ASSIGNMENT TODAY

IN THE PAST 3 MONTHS ABOUT HOW MANY DAYS HAVE YOU SPENT IN THE FOLLOWING ASSIGNMENTS: (Total workdays equals about 60)

6.	Core Rolling (Dept. 330B)	
7.	Reject Table (Sept. 330B)	
8.	Comber (Dept. 340B)	
9.	Stacker (Dept. 340B)	
10.	Sorting and Repair (Dept. 340B)	
	TOTAL	

(If the Total equals 15 or greater, include in high risk group.)

RHE 74-16

## U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE PUBLIC HEALTH SERVICE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH 518 POST OFFICE BUILDING CINCINNATI, OHTO 45202

#### CONSENT

I voluntarily agree to participate in a study at the Marathon Battery Company. Waco, Texas, conducted by the Public Health Service, to evaluate the sealed and vented Nickel-Cadmium Storage Cell assembly operations for possible undue exposure to these metals. I understand that the medical evaluation will consist of my answering questions about my health, a limited physical examination of head, chest, and skin, if deemed necessary by the examining physician, and the taking of a specimen of my urine and of a small sample of puble hair for analysis.

I understand that my participation in this study is voluntary and that all information obtained will be considered confidential in accordance with U.S. Public Health Service Regulation (42 CFR Part 1). The information will be utilized statistically, but I will not be identified as an individual without my expressed consent. I am free to withdraw from the study at any time.

DAT	E	SIGNATURE		na fan mei an fan fan fan fan fan fan fan fan fan
	A	UTHORITY TO GIVE	MEDICAL REPORT	-
In I a	addition to notifying gree to allow the Pub	me whether my te lic Health Servic	sts are normal or e to inform:	need further study,
Å.	My Personal Physicia	n Yes	No	
	Name			
	Address		κ.	
	City			Signature
В,	Plant Physician	Yes	No	
	Address			
	City		and the spectrum of the state	Signature

of any significant results of this study.

Information obtained in this study will be kept confidential in accordance with U.S. Public Health Service Regulation (42 CFR Park 1).

RHE 74-16

# QUESTIONNAIRE B

# U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE PUBLIC HEALTH SERVICE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH CINCINNATI, OHIO 45202

DATE

	Last			First			Mi	.ddle	2	
CURRENT	ADDRESS:	(Numb Stat	er, St e, Zip	reet or Code)	Rural	Route	, City	or	Town,	Count
	- N									
PHONE NU	MBER					4. SO	CIAL S	ECUE	RITY N	0.
PHONE NU BIRTHDAY	MBER	Day, Y	ear)		2	4. SO	CIAL S	ECUF	RITY N	0
PHONE NU BIRTHDAY AGE LASI	MBER (Month, BIRTHDAY	Day, Y	'ear)	7. SEX	^ ;	4. SO Male	CIAL S	ECUF	RITY N Femal	0

# URINE DATA SHEET

TIME OF LAST VOIDING	·
TIME OF SAMPLE COLLECTION	
TIME SPAN COVERED BY SAMPLE	Hr.
TOTAL VOLUME OF VOIDING	cc

CUESTIONNAIRE B

JOB HISTORY

9.	DEPARTMENT	10. SH	<u>[F']</u>
11.	JOB TITLE	و مع الوجر ، و مع هو معاصر مو الم الموجر ، و معامل و الموجور ، و معامل الموجر ، و مع	
12.	CURRENT ASSIGNMENT		
13.	YEARS WITH COMPANY		Montus
		Years	Plottens
14.	TIME IN DEPT. 330A	Years	Months
15.	IN SHEARING	%	
16.	IN TAB WELDING	<u> </u>	
17.	IN CRACKING	<u> </u>	
18.	IN TAPING & REPAIR	%	
19.	TIME IN DEPT. 330B	Years	Months
20.	IN CORE ROLLING	%	
21.	ON REJECT TABLE	70	
22.	TIME IN DEPT. 340A	Years	Months
23.	IN SHEARING	76	
24.	IN TAB WELDING	%	
25.	TIME IN DEPT 340B	Years	Months
26.	IN STACKING	%	
27,	IN COMBING	%	
28.	IN SORTING & REPAIR	%	
29.	TIME IN DEPT. 350	Years	Months
30	TIME IN DPET, 360	Years	Months
	CIGAR	TTE SMOKING	
31.	DO YOU NOW SMCKE CIGARETTES?	YES	NO
	IF "YE3" GO RIGHT TO QUESTION :	34.	
32.	HAVE YOU EVER SMOKED CIGARETTES	S? YES	NO NA

IF "NO" GO RIGHT TO QUESTION 39.

- 33. HAVE YOU SMOKED AT LEAST AS MANY AS FIVE PACKS OF CIGARETTES, THAT IS, 100 CIGARETTES DURING YOUR ENTIRE LIFE? YES NO NA IF "YES" GO ON TO QUESTION 34. IF "NO" GO TO QUESTION 39.
- 34. HOW OLD WERE YOU WHEN YOU STARTED SMOKING CIGARETTES REGULARLY?

IF AN EX-CIGARETTE SMOKER, ASK:

QUESTIONNAIRE B

35.	HOW OLD WERE YOU WHEN YOU LAST GAVE UP SMOK CTGARETTES?	LING	Age in years
36,	DURING THE YEARS YOU WERE SMOKING CIGARETTE OR MORE?YESNO	S, DID YOU	EVER QUIT FOR A YEAR
37.	IF "YES" HOW MANY YEARS?	YEARS	
38.	HOW MUCH DO/DID YOU SMOKE ON THE AVERAGE? (1 pack = 20 cigarettes) (Use "did" only for ex-smokers)		Cigarettes per day
39.	DO YOU OR DID YOU SMOKE CIGARS?	YES	NO
	A PIPE?	YES	NO
40.	IF "YES" HOW MANY YEARS?	YEARS	
41.	ARE YOU STILL SMOKING A PIPE OR CIGARS?	YES	NO

QUESTIONNAIRE C

Deteiled Ouestimpedre	
	2

D	2	-	0						
D	2	2	<b>–</b>						

	INDUSTRY & LOCATION	YRS OF EMP	LOY.	SPECIFIC JOB	ANY MEDICAL PROBLEM
		From	То		RESULTING FROM THE JOB
2.	1 		ware		
3.					
4.	p				
5.					
б.			and the second second		
7.					
8.					
9.					
10,	HOW WOULD YOU DESCRIBE	YOUR GENERA	L HEALT	TH: Poor	
11.	DO YOU HAVE ANY HEALTH If so, describe.	PROBLEMS WH	IICH YOU	J BELIEVE ARE REI	LATED TO YOUR WORK?