U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTUE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 80-150-742

STAINLESS EQUIPMENT COMPANY
ENGLEWOOD, COLORADO

SEPTEMBER 1980

I. SUMMARY

In May 1980 the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate the potential exposure to titanium (in titanium sponge form) at Stainless Equipment Company, Englewood, Colorado. The titanium is annealed by two operators and the concern was that these, as well as other workers in the immediate area, were being exposed to titanium dioxide. The request originated out of one employee's medical problems which included occasional headaches and stomach disorders.

Personal time-weighted average (TWA) exposures were determined for two titanium operators over a two day period in June 1980. Area samples were taken on both days around the annealing machine and other areas associated with the operation. Bulk samples were collected of the raw unannealed material. These bulks included samples of unannealed material from previous batches, which were suspected of producing irritation.

Both personal and area samples were well below the American Conference of Governmental Industrial Hygienists (ACGIH) recommended exposure levels and the Occupational Safety and Health Administration (OSHA) standard of 10 mg/M^3 and 15 mg/M^3 respectively.

On the basis of the data obtained in this investigation, NIOSH determined that exposures to annealing operators at Stainless Equipment Company are below applicable exposure criteria for titanium. Therefore, based on the results of this investigation, no hazard to health is believed to have existed at the time of the survey. However, recommendations concerning medical problems and improved work practices to control potential hazards are included on page 5 of this report.

KEYWORDS: SIC 3490 (Miscellaneous Fabricated Metal Products), titanium, annealing machine, environmental control chambers.

II. INTRODUCTION

In May 1980 NIOSH received a request pursuant to Section 20(a)(6) of the Occupational Safety and Health Act of 1970[1] from a representative of Stainless Equipment Company, Englewood, Colorado. The request was to determine if there was a health hazard from exposures to titanium dioxide during the annealing operation. An environmental survey was conducted on June 16 and 18, 1980, to evaluate exposures to titanium; also, a review of the medical symptoms described were compared with existing toxicological information.

III. BACKGROUND

Stainless Equipment Company is a diversified operation which primarily produces chambers for control of rare environmental contaminants. The various contaminants include chemical, biological, and radiological materials and, therefore, the construction of these chambers requires a variety of skills and processes in order to meet the stringent specifications of the requestors. Included in the production of the chambers is annealed titanium which is used as a purifying-type filtering agent. The annealing operation occurs twice a week and each operation takes approximately 48 hours for a complete process. There are normally two operators involved in the process and the majority of time spent performing the job requires only the one operator. The following is a description of the process and the interface of the operators:

1. Two batches per week for 48 hours per batch.

2. Twenty pounds of raw material is pre-screened prior to loading into the annealing chamber. The screen is a 10 x 20 inch basket with a 1/4 inch mesh material. At this phase of the process some dust is generated and normally requires only one operator. However, if the raw material is at the end of a batch/barrel another operator will assist in removing the remaining portion of material from the bottom of the barrel.

3. The screened material is put into a container and then placed in the annealing chamber. This phase of the operation is very clean and requires only one operator.

4. Reflectors are then placed around the interior of the chamber for even heat distribution and the lid is placed on top of the machine. Only one operator is required here.

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[1]Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 19 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative to employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

5. A pressure vacuum is then created and the chamber is raised above 1000 degrees Fahrenheit for the 48 hour period.

   NOTE: At this phase and throughout the remainder of the operation, the entire process is confined in a closed system and all dust and fumes are filtered and/or scrubbed from the process. A filtering system removes all particulates for the initial phase of the annealing process and scrubbing diffusion unit removes fumes and/or gases during the remaining portions of the operation.

6. After the baking period the annealing machine is cooled and the finished material is placed into a finished materials box. Again this normally requires only one operator and takes approximately one hour to complete.

7. The next phase of the operation requires the operator to re-load the annealing machine as described earlier and the new batch begins.

8. The final step requires the operator to clean-up the area. Therefore, the total time spent by the main operator for a normal process, i.e., setting up and breaking down the process, is approximately two hours. The total time required for the second operator is about 15-20 minutes.

   There is one other intermittent process in this operation which requires both operators about once a month. This occurs when a new batch of raw material is transferred into another container. This is done to determine exact weight and requires two operators to transfer, via a shovel, the material until the exact weight is achieved in the receiving barrel. This is raw titanium and does produce a small amount of dust during the transfer. This process takes about 15 minutes and both operators wear disposable filter-type respirators during the operation.

   It should be noted that the main operator uses a disposable dust-type filter respirator during each of the phases described above.

IV. ENVIRONMENTAL DESIGN AND METHODS

Titanium dioxide breathing zone and general room air samples were collected on AA 0.8u pore density cellulose membrane filters at a flow rate of 1.5 liters per minute with vacuum pumps. The samples were analyzed by digesting and solubilizing the filter in sulfuric acid and ammonium sulfate and then analyzed by atomic absorption spectrophotometry (NIOSH Method P&CAM No. S-385).

V. EVALUATION CRITERIA

A. Environmental

Two sources of criteria were used to assess the workman concentrations: (1) ACGIH Threshold Limit Value, and (2) Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910), January 1979. These occupational health standards are established at levels designed to protect individuals occupationally exposed to toxic substances on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

Substance	Permissible Exposure Limits 8-Hour Time-Weighted Exposure mg/M^3
Titanium dioxide.....	15 mg/M^3 (OSHA) 10 mg/M^3 (ACGIH)

mg/M^3 = milligrams of substance per cubic meter of air.

B. Toxicological

Titanium Dioxide -- Titanium compounds are, for the most part, virtually inert and not highly toxic to man. At best it is considered a nuisance dust in large quantities, i.e., irritating to the eyes, nose, and throat at and above the standard for inert dusts.

VI. ENVIRONMENTAL RESULTS

A total of three personal and four area samples were taken during the sampling period. Each of the personal samples were well below both criteria (refer to Table 1). All of the area samples taken found non-detectable levels, i.e., levels below the limit of detection set during the analysis of these samples.

VII. DISCUSSIONS AND CONCLUSIONS

During this evaluation it was determined that no health hazard existed to those employees who performed the titanium annealing operation. This conclusion is based on the various air samples taken, evaluation of the work processes, and review of the toxicological information. In regards to the health problems of the one employee, it is difficult for NIOSH to evaluate past conditions and/or exposures, and thus, it is difficult to assume that conditions in the past may have produced the symptoms described. However, the worker in question has not experienced said symptoms since the cleaner raw titanium has been in use, and also, he is not working with this process as frequently as he did in the past. Therefore, at this time it can only be said that the combination of these two conditions are of benefit to the concerned employee and should be continued.

VIII. RECOMMENDATIONS

In view of the findings of NIOSH's environmental study, as well as personal communications with individuals at Stainless, the following recommendations are made to provide a better work environment for the concerned employees.

1. The present limited use of respirators in certain dusty operations is good work practice and, therefore, it is recommended that this be continued.

2. Any raw titanium material that appears to be dirty, i.e., abnormal shape, color, etc., should not be annealed if it is felt it could produce unusual gases or fumes.

3. Employees should be counseled about medical difficulties encountered while working with various metals, solvents, etc. If difficulties do occur employees should be adequately protected, e.g., engineering controls, personal protective devices, etc. However, before these practices are considered, additional environmental and/or medical evaluations should be performed.

4. Eating, drinking, and smoking should not be permitted in the working area.

IX. REFERENCES

1. Industrial Hygiene and Toxicology, second edition, Frank · Patty (editor), Interscience Publishers, 1967, Vol. II.

2. Industrial Toxicology, third edition, Hamilton and Hardy, Publishing Service Group, Inc., 1974.

3. "Threshold Limit Values for Chemical Substances in Workman Air", American Conference of Governmental Industrial Hygienist, (1978).

4. Encyclopedia of Occupational Health and Safety, International Labor Office, McGraw-Hill Book Company, New York.

5. Industrial Ventilation, A Manual of Recommended Practice, American Conference of Governmental Industrial Hygienists, 14th edition (1976).

6. U.S. Department of Health, Education, and Welfare. Occupational Diseases, A Guide to Their Recognition, Public Health Service Publication (NIOSH) No. 77-181.

IX. AUTHORSHIP AND ACKNOWLEDGMENTS

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XI. DISTRIBUTION AND AVAILABILITY

Copies of this determination report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Stainless Equipment Company.
2. U.S. Department of Labor/OSHA - Region VIII.
3. NIOSH - Region VIII.
4. Colorado Department of Health.
5. State Designated Agency.

For the purpose of informing affected employees, a copy of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE 1

BREATHING ZONE AND GENERAL ROOM AREA SAMPLING
FOR TITANIUM DIOXIDE

Stainless Equipment Company
Englewood, Colorado

Job/Area Description	Date	Sample Number	Sampling Time (minutes)	mg/M^3 Titanium Dioxide
Main Operator	6/16/80	21	150	0.48
Annealing Machine	6/16/80	15	150	N.D.
Diffusion Pump	6/16/80	20	150	N.D.
Assistant Operator	6/19/80	31	360	0.44
Main Operator	6/19/80	32	360	0.87
Annealing Machine	6/19/80	33	360	N.D.
Diffusion Pump	6/19/80	34	360	N.D.
EVALUATION CRITERIA				15 mg/M^3 (OSHA) 10 mg/M^3 (ACGIH)
NIOSH LIMIT OF DETECTION				3.0 mg/M^3

mg/M^3 = milligrams of substance per cubic meter of air.
N.D. = nondetectable/below laboratory limit of detection.