PRELIMINARY SURVEY REPORT

of

CONTROL TECHNOLOGY FOR MICROELECTRONICS INDUSTRY AT AIRCO CORPORATION PHOENIX, ARIZONA

to

U.S. ENVIRONMENTAL PROTECTION AGENCY
Industrial Environmental Research Laboratory
Cincinnati, Ohio 45268

and

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
Division of Physical Sciences and Engineering
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by

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PLANT SURVEYED:	AIRCO Corporation 1122 North 52nd Street Phoenix, Arizona 85008
SURVEY DATE:	November 2, 1981
SURVEY CONDUCTED BY:	Ralph I. Mitchell, Battelle Columbus Laboratories Russell K. Smith, Battelle Columbus Laboratories Leslie J. Ungers, PEDCo Environmental James H. Jones, NIOSH
EMPLOYER REPRESENTATIVES:	Frank Dux, Corporate Safety Manager Richard Robbins, Laboratory Supervisor
EMPLOYEE REPRESENTATIVES:	None

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1.0 ABSTRACT

As part of a U.S. EPA and NIOSH assessment of control practices in the microelectronics industry, Battelle Columbus Laboratories conducted a walk-through survey of an AIRCO, Inc., Phoenix, Arizona, facility. This facility supplies high-purity, compressed gas mixtures to manufacturers of semiconductor devices. The purpose of the walk-through was to determine if the control technology used in gas bottle filling was applicable to the rest of the electronics industry.

Filling stations for AsH_3 and PH_3 gas mixtures and for other gases such as H_2 were observed. Control technology consists primarily of walk-in hoods in which virtually all gas transfer operations are conducted. The controls found were determined to not be applicable to the production of semiconductor devices because operations are in a sealed system which does not have particulate control problems. A detailed survey is not recommended.

2.0 INTRODUCTION

A walk-through survey was conducted at AIRCO, Phoenix, Arizona, on November 2, 1981, as part of a control technology assessment of the semiconductor manufacturing industry. The assessment is being performed by Battelle Columbus Laboratories under U.S. Environmental Protection Agency (EPA) Contract 68-03-3026. The study is being coordinated by EPA with the National Institute for Occupational Safety and Health (NIOSH) through interagency agreement number AR 75-FO-142-0.

This facility does not produce silicon semiconductor devices. However, it supplies high purity AsH_3 and PH_3 gas mixtures to parts of the industry which do produce semiconductor devices. The walk-through survey was conducted to determine if the control technology used in filling lines for these gases could be applied to the semiconductor fabrication industry.

This facility does some gas purification which was not observed. Its major products are repackaged HCl and blends of AsH_3 and PH_3 with a balance gas of H_2 or N_2.

3.0 GENERAL

This facility is a large fenced area with substantial paved area on which full and empty bottles of gases are stored. Liquid H_2 is available in a tank remote from the single building on the site. The building is a concrete block structure, about 15 years old. Both offices and filling areas are adjacent to each other in the process building, but are separated by a concrete block wall. The process area is ventilated by air being pulled through walk-in hoods. The hoods are operated at a face velocity of 50 linear ft/minute during normal processing, and at 150 linear ft/minute during purge and when a leakage occurs in the hood. The air is drawn through an induced-draft fan, and exhausted to the atmosphere.

This plant is staffed by 21 employees, including truck drivers which are on-site only part of the day. Filling is conducted in a two shift operation by seven gas technicians and two foremen. Corporate offices provide scheduled medical monitoring of all employees.

4.0 PROCESS DESCRIPTION

The two major processes are HCl repackaging and preparation of ppm to low percent doping gases (AsH_3 and PH_3) in H_2 and N_2 filled containers. Process operations for HCl repackaging are done in a walk-in hood. Operations for mixing AsH_3, and PH_3 doping gases in H_2 and N_2 are conducted in four walk-in hoods in the building.

Three bottles to be filled, one source bottle, and a balance gas bottle are all connected to a gas manifold in a hood. The bottles to be filled are pressurized with N_2 and allowed to stand. Pressure decay is monitored in the manifold to determine leakage. Additionally, an aqueous soap solution is sprayed on all cylinder valves and manifold connections to insure leak tight conditions.

After pressure testing, a vacuum is drawn on all three tanks to be filled by a vacuum pump. The pump is exhausted into a purge line which leads to a $KMnO_4$ and water scrubber.

The AsH_3 and PH_3 doping gas tanks are filled to a predetermined pressure from cylinders containing the pure doping gases. The balance gas (H_2 or N_2) is added to pressure from an H_2 or N_2 bottle also connected to the manifold system.

The manifold is then purged to a scrubber. In AsH_3 and PH_3 filling hoods the gases are purged by N_2 through a packed tower scrubber which has $KMnO_4$ solution flowing countercurrently to the gas flow. The spent liquor is analyzed prior to disposal and handled as a "hazardous waste" if so warranted.

The three filled cylinders are disconnected from the manifold, and plugs are inserted while the bottles are still in the hood. They are then soap-bubble tested for leakage, removed from the hood, and transported to the storage yard outside the building. The bottles are not chained to supports, but are stored in the yard in an upright position.

HCl cylinders are filled in a very similar fashion except that HCl cylinders are filled by weight because the gas condenses in the bottle as it is filled. The HCl manifold is purged to a venturi-type water scrubber.

H_2 cylinders are filled from H_2 vapor piped into the filling area from a liquid H_2 tank stored in the outside yard. O_2 is also filled in the building from a liquid O_2 tank. Tanks of both of these gases are filled after evacuation and N_2 pressure check of the bottle. No scrubbing is performed on these exhaust gases.

5.0 INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

Only a medical surveillance program is used at this facility. Minimal safety or evacuation training is available; this is being upgraded.

5.1 Process Monitoring

Draeger tube sampling for AsH_3, PH_3, or HCl is done when process changes are made, or when an employee complaint is registered. Periodic monitoring is not performed.

No current program exists for monitoring ventilation hood flow. A flow rate monitoring program is being considered.

5.2 Protective Equipment

Street clothes are worn by employees. Two SCBA respirators are available in the event that rapid entry is required. An acid gas entry suit is also available in the event that an HCl leak occurs.

6.0 CONTROL STRATEGY FOR PROCESSES OF INTEREST

All industrial hygiene controls are oriented toward ventilation and enclosures. Each of the toxic gas hoods has a gas flow which is selectable at 50 linear ft/minute or 150 linear ft/minute. The higher flow rate is used when tanks are being vented, or when a leak develops in the hood.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on this survey, further evaluation of this facility under this study is not recommended. Neither the process nor the controls used require further study as an exemplary control strategy.

Periodic monitoring of air flow across hood faces is recommended. Dosimetry and area monitoring should also be introduced to quantify worker exposure to AsH_3.

Enclosure of the cylinders in the yards should be considered. There is a resultant potential risk of multiple cylinders being knocked over, and a resultant chain reaction of cylinders falling, and possibly rupturing. A method of securing upright should be investigated.