FILE NAME: Allied Signal Bendix (ASB)

DATE: 1972

DOC#: ASB123

DOCUMENT DESCRIPTION: Unpublished Report of Inspections by Consultant

PLAINTIFF'S EXHIBIT 839 A
PENGAD 800-631-6989

1972
I.H. surveys of
Aexp. in plants:
Cleveland TN
Troy NY
South Bend

swanson environmental consultants, inc.

HWMURPHY18502

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HWMURPHY18503

SERVING INDUSTRY
IN THE
MEASUREMENT,
EVALUATION AND
CONTROL OF:

Air Pollution

Water Pollution

Radiation

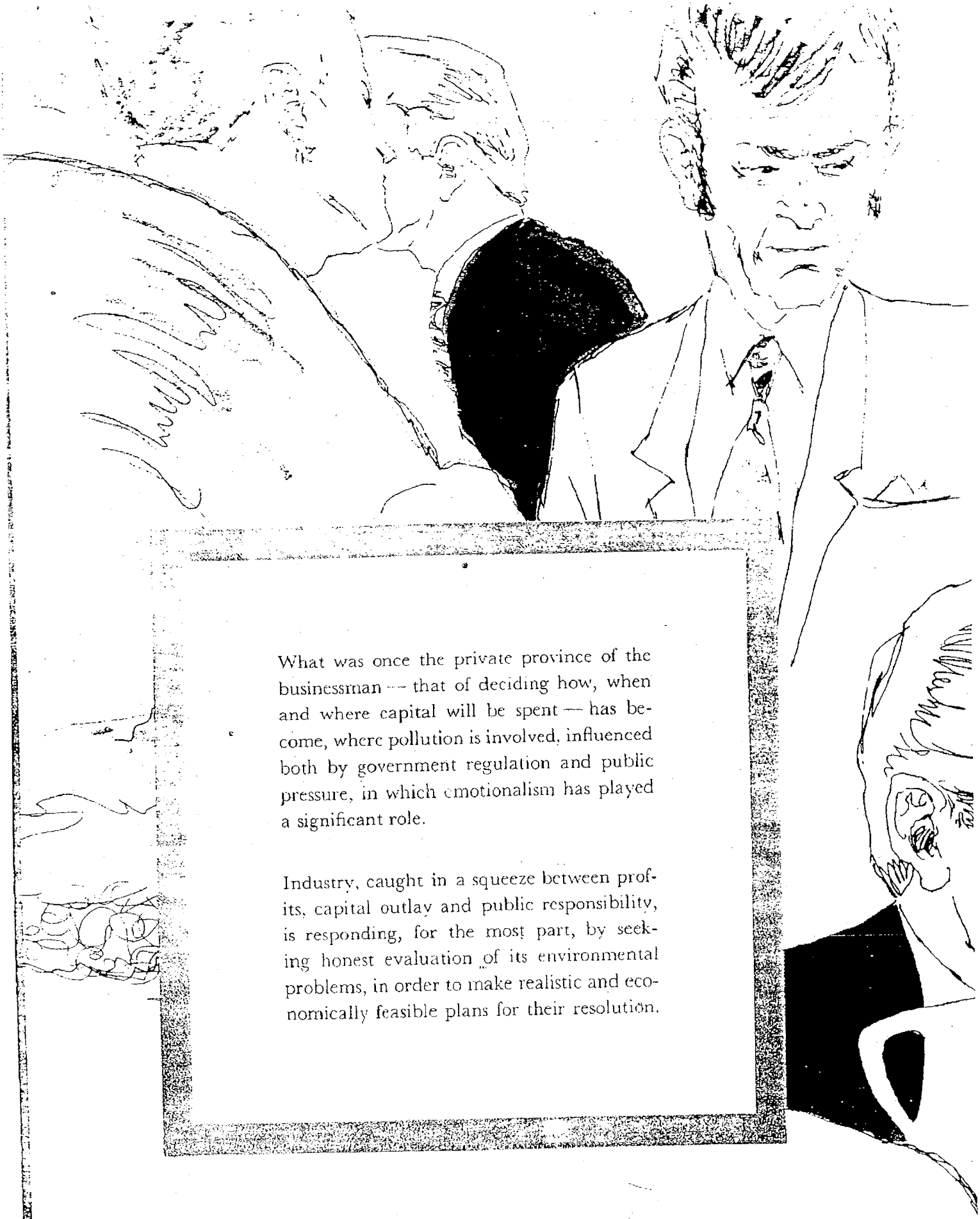
Solid Wastes

Noise

Occupational Safety and Health

Ecological and Environmental Impact

HWMURPHY18504



What was once the private province of the businessman — that of deciding how, when and where capital will be spent — has become, where pollution is involved, influenced both by government regulation and public pressure, in which emotionalism has played a significant role.

Industry, caught in a squeeze between profits, capital outlay and public responsibility, is responding, for the most part, by seeking honest evaluation of its environmental problems, in order to make realistic and economically feasible plans for their resolution.

HWMURPHY18505



HWMURPHY18506





swanson environmental consultants, inc., headquartered in two key mid-western industrial areas, is dedicated to the preparation of scientifically accurate, clearly presented, confidential environmental studies.

We consider our staff to be amply qualified and ideally experienced in both government and industry, ensuring not only meticulous evaluation of all types of environmental problems, but also a realistic assessment of their probable economic and regulatory effects.

HWMURPHY18507

Jon R. Swanson, who serves as director of ***swanson environmental consultants, inc.***, in Farmington, Michigan, received his Bachelor's Degree in Mechanical and Sanitary Engineering from the University of Iowa. During his enlistment in the United States Air Force, he functioned for 3 years as base Bio-Environmental Engineer at Keesler Air Force Base in Biloxi, Mississippi, later completing his Master of Science Degree in Air Pollution at the University of Minnesota. He was awarded his Ph.D. in Environmental Health and Preventive Medicine by the University of Iowa's College of Medicine.

Following 3 years in Geneva, Switzerland as an Environmental Engineering expert for the United Nations, Dr. Swanson became Chief of Environmental Projects for the consulting firm of George D. Clayton & Associates.

His affiliations include memberships in the Air Pollution Control Association, the American Industrial Hygiene Association, the British Occupational Hygiene Association, the Belgian Society of Industrial Physicians and Engineers and the American Society of Mechanical Engineers.

Raymond E. Kary, who directs the Chicago office of ***swanson environmental consultants, inc.***, holds a Bachelor's Degree in Physics and Mathematics from Jamestown College in Jamestown, North Dakota. He earned his Master of Science Degree in Radiological Health at the University of Minnesota, later receiving his Ph.D. in Environmental Health and Preventive Medicine from the University of Iowa's College of Medicine.

Dr. Kary spent 2½ years with the American Smelting & Refining Co. in Salt Lake City, Utah, working in the areas of industrial hygiene, air pollution, water pollution and toxicology. He has served most recently as supervisor of industrial hygiene, radiological health and air pollution activities for Industrial Bio-Test Laboratories in Northbrook, Illinois.

He is a member of the American Industrial Hygiene Association, the American Public Health Association and the Health Physics Society.

HWMURPHY18508



Air Pollution

swanson environmental consultants offers:

STACK TESTING (source testing)

Field teams are available to sample and measure particulate and gaseous emissions; gas flows, velocities and pressures; temperature profiles; and the efficiency of air pollution control equipment.

Typical measurements include sulphur compounds, nitrogen oxides, hydrocarbons, carbon monoxide, metals, organic solvent vapors, organic and inorganic particulates, and particle sizing.

Complete emission inventories for industry are also available.

AMBIENT AIR TESTING (surveys conducted in the general environs of an area)

Surveys are conducted around single or multiple sources of pollution. Investigation will disclose concentrations of gases, such as oxides of sulphur and nitrogen, hydrocarbons, vapors and dusts—both suspended and settled.

swanson environmental consultants is equipped to provide complete, automated, permanent-type surveillance, as well as short-term analyses.

Some pollutants, such as sulphur dioxide, can mark vegetation, causing economic loss to commercial crops. Careful analysis will determine 1) if an alleged fumigation has actually occurred, and 2) the economic loss, if any, from such an occurrence.

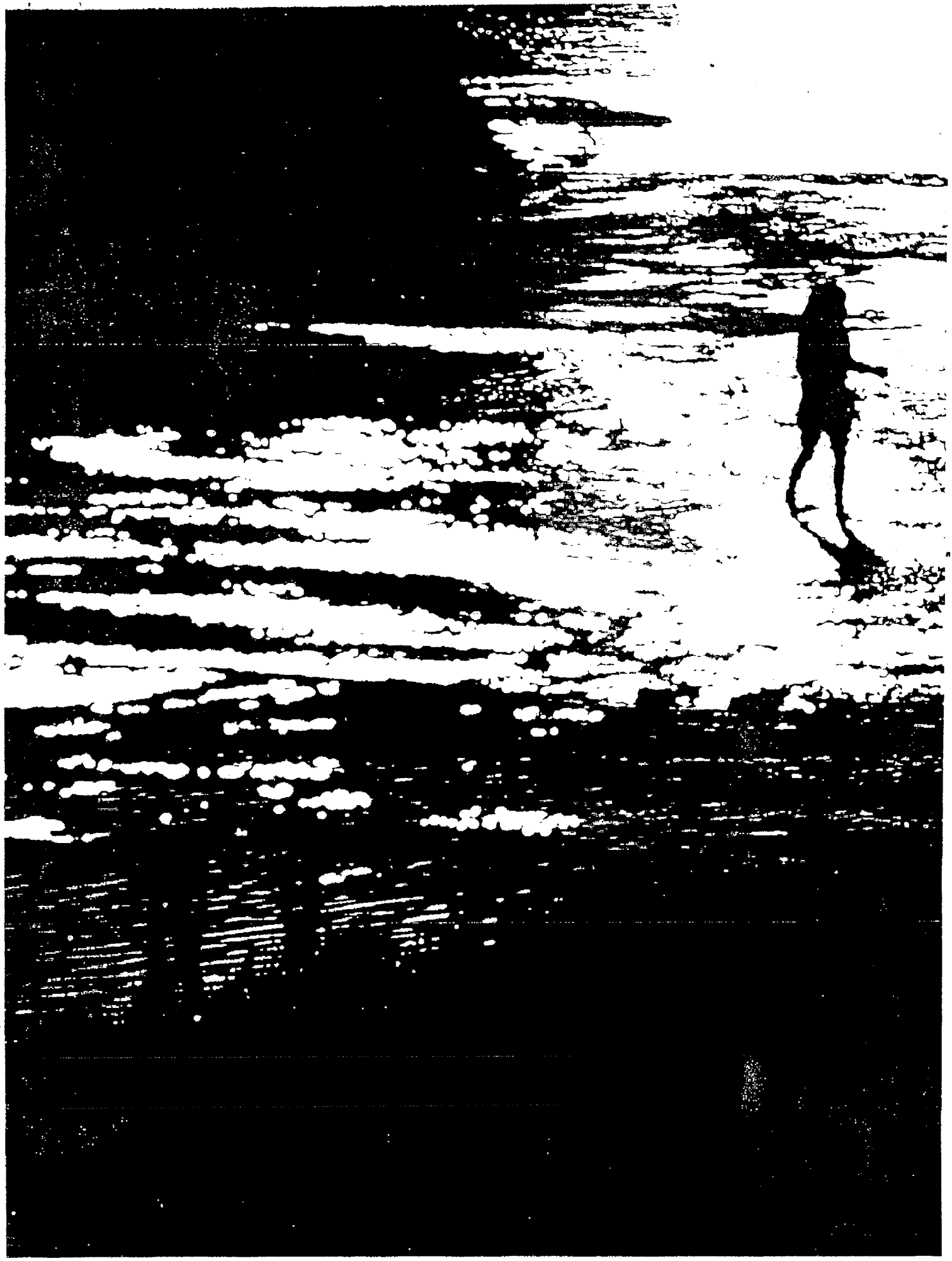
COMMUNITY SURVEYS

In undertaking a community survey, ***swanson environmental consultants*** contracts to measure and identify community pollution levels, pinpoint sources of pollution, and extend consultation services on rules and regulations. In addition, the community can be provided with complete, automated, permanent-type surveillance, as well as short-term analyses of gases, such as oxides of sulphur and nitrogen, carbon monoxides, hydrocarbons, vapors and dusts — both suspended and settled.

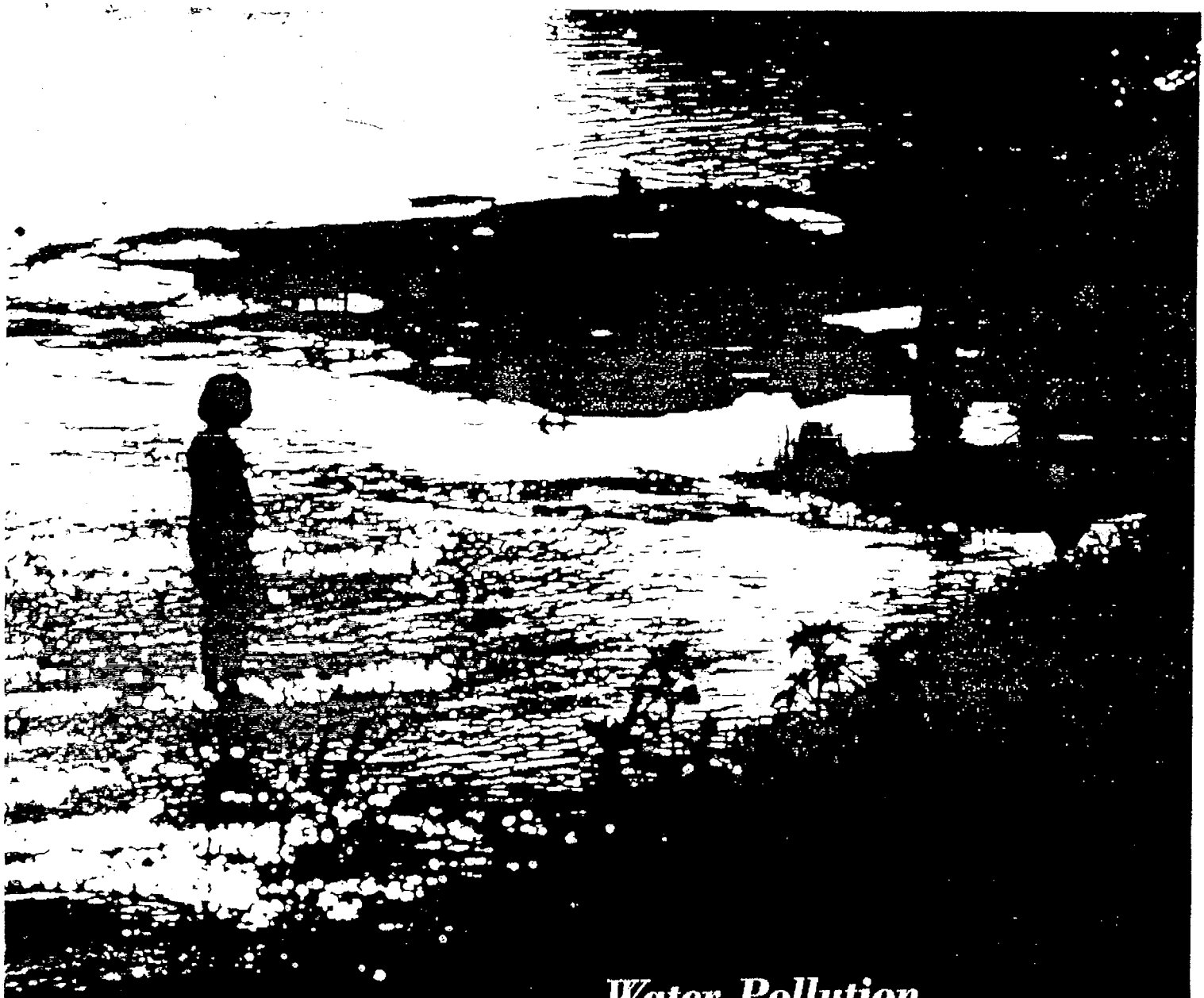
ENGINEERING

In the event that existing equipment is not available for use in solving a particular problem, ***swanson environmental consultants*** will provide consultation for the design and installation of effective devices.

HWMURPHY18510



HWMURPHY18511



Water Pollution

swanson environmental consultants will provide effluent and stream studies to identify water pollutants, and will conduct ecological studies of water bodies to define the character of the aquatic community — reviewing the effects of chemical, biological and physical (thermal) pollutants. Water quality evaluations, determining suitability for specific industrial use, are also available.

Typical samplings and measurements include: dissolved oxygen (DO), pH (acidity), turbidity, alkalinity, nitrogen compounds, temperature, hardness, phosphates, sulfates, chlorides, biochemical oxygen demand (BOD), chemical oxygen demand (COD) and metals.

In addition, ***swanson environmental consultants*** will provide identification and species population determination (taxonomy) of phytoplankton, zooplankton, necton, and benthic and littoral plants and organisms.

HWMURPHY18512

Radiation

swanson environmental consultants offers:

ENVIRONMENTAL IMPACT EVALUATION

Evaluation of the environmental impact of nuclear reactors — by studying radiation in: air (suspended and settled dust fall, and ambient gamma rays); soil (native and cultured vegetation, the ecological food web or chain, and miscellaneous food products); and water (suspended and dissolved solids, bottom sediments and organisms, and aquatic organisms).

A complete evaluation involves:

preparation of the required environmental impact volume for the Preliminary Safety Analysis Report (PSAR) to the Atomic Energy Commission, encompassing: radiation, air pollution, water pollution, ecology, demography, geology, hydrology and meteorology.

establishment of a pre-operational environmental monitoring program (based on the PSAR), defining pre-existing conditions as related to: radiation, air pollution, water pollution and ecology.

preparation of the environmental impact volume for the Final Safety Analysis Report (FSAR) to the AEC.

establishment and maintenance of an operational monitoring program — a continuation of the pre-operational program — to determine changes in environmental conditions.

program presentation at hearings and before regulatory agencies.

ENVIRONMENTAL MONITORING

Radiation monitoring generally involves low-level measurement of ambient gamma radiation, and the determination of gross alpha and beta activity, as well as specific isotopic analysis in various environmental media.

RADIATION MEASUREMENT AND DECONTAMINATION

Radiation measurement and decontamination services are available for medical and industrial installations.

HWMURPHY18513

Solid Wastes

The volume of solid waste material generated today is of such proportions that the cost of its handling and disposal staggers the imagination. Archaic methods are frequently adapted to the problem, providing uneconomical and impractical stop-gap solutions, and often merely prolonging the discovery of efficient, ultimate answers.

swanson environmental consultants will appraise your solid waste problem, with particular attention given to:

- the effectiveness of existing systems for handling and disposal.
- feasibility of reclamation or recycling.
- disposal site selection, considering ecological as well as economic factors.
- incinerator design, with an eye to incorporation of recent engineering advances — effectively disposing of wastes without adding to air or water pollution.

HWMURPHY18514

Noise

swanson environmental consultants offers:

INDUSTRIAL NOISE SURVEYS

Personnel and equipment are available to assess noise through general sound surveys and octave band analyses.

Typical measurements include a determination of the noise level (in decibels) being emitted from a sound source. This measurement may include an analysis of the noise to identify noise levels at specific frequencies and their exposure duration.

Noise data is normally interpreted to determine compliance with state and federal regulations and to assess the risk of permanent hearing damage.

HEARING CONSERVATION PROGRAM

swanson environmental consultants will install a hearing conservation program through training, providing advice on the purchase, installation and operation of equipment, audiometric testing programs, evaluating employee protection, proper use and maintenance of personnel protective equipment, engineering control and proper acoustical design.

CERTIFICATION TESTING

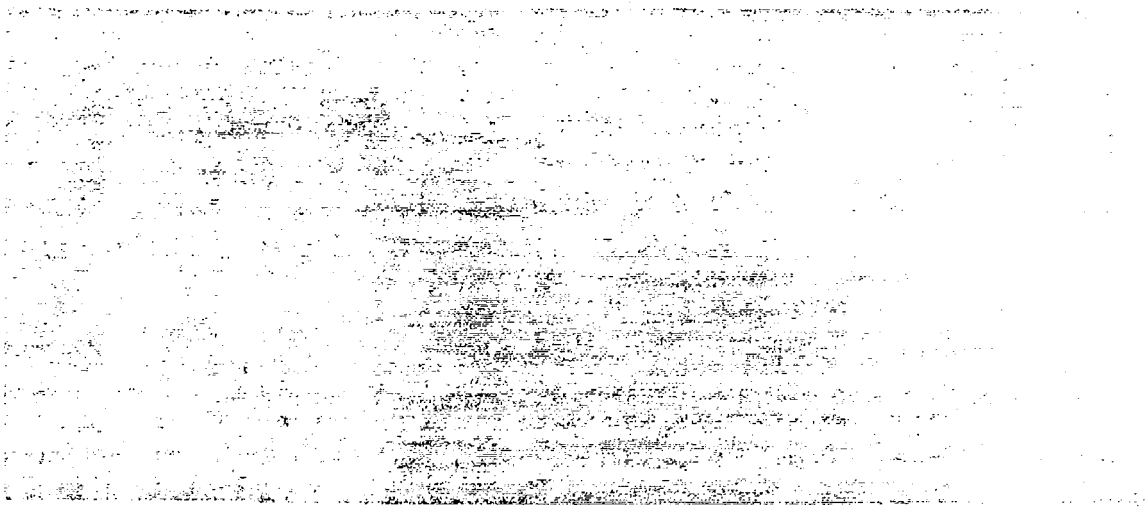
Equipment and test facilities are available to certify decibel ratings of industrial equipment according to national and industrial standards.

NOISE CONTROL

swanson environmental consultants will interpret noise data and recommend effective noise control measures through design, material installation, equipment modification and other engineering recommendations.

COMMUNITY NOISE EVALUATION

An increasing number of communities are enacting local noise ordinances. ***swanson environmental consultants*** will measure existing community noise levels, classify according to zones, and help make regulations meaningful in light of present and future industrial zoning and acceptable noise criteria.



Occupational Safety and Health

swanson environmental consultants offers:

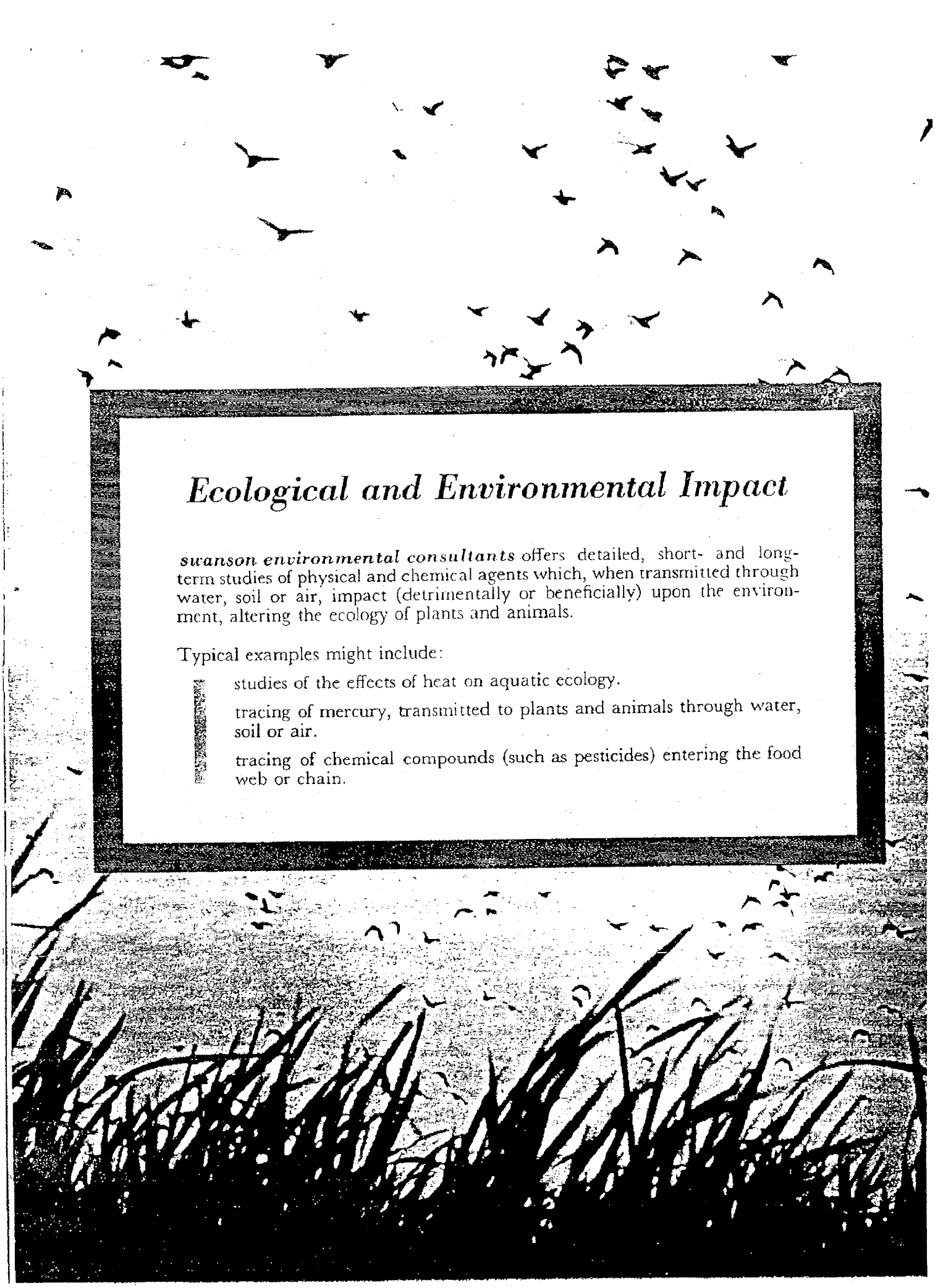
INDUSTRIAL HYGIENE SURVEYS

Recent enactment of the federal occupational safety and health law brings a new dimension to the identification and control of occupational hazards. To meet this dimension, ***swanson environmental consultants*** will provide industrial hygiene services, encompassing the measurement and evaluation of chemical, physical and radiological hazards which may be harmful to employees.

Hygienists will sample harmful agents and test physical factors, such as heat, light and noise. Typical surveys include:

- air sampling for dusts, vapors and gases.
- determination of the effectiveness of environmental controls (such as ventilation).
- determination of industrial requirements, process modifications and/or material substitution. In some cases, the proper choice and use of protective devices for personnel may be required.
- analysis and assessment of the effects of hazards.

When necessary, equipment will be designed to solve a particular problem or situation.



Ecological and Environmental Impact

swanson environmental consultants offers detailed, short- and long-term studies of physical and chemical agents which, when transmitted through water, soil or air, impact (detrimentally or beneficially) upon the environment, altering the ecology of plants and animals.

Typical examples might include:

- studies of the effects of heat on aquatic ecology.
- tracing of mercury, transmitted to plants and animals through water, soil or air.
- tracing of chemical compounds (such as pesticides) entering the food web or chain.

HWMURPHY18517



HWMURPHY18518

Laboratory Services

swanson environmental consultants provides laboratory analyses of substances associated with environmental, occupational or toxicological problems:

TRACE SUBSTANCE DETERMINATION

Precise analysis of mercury, cadmium, lead, silica, arsenic, beryllium, fluorides, industrial solvents, pesticides and other toxic materials, performed on:

biological samples—including blood, urine and tissue.

atmospheric samples—including particulates and gases.

water and waste water—including bacteriological examinations.

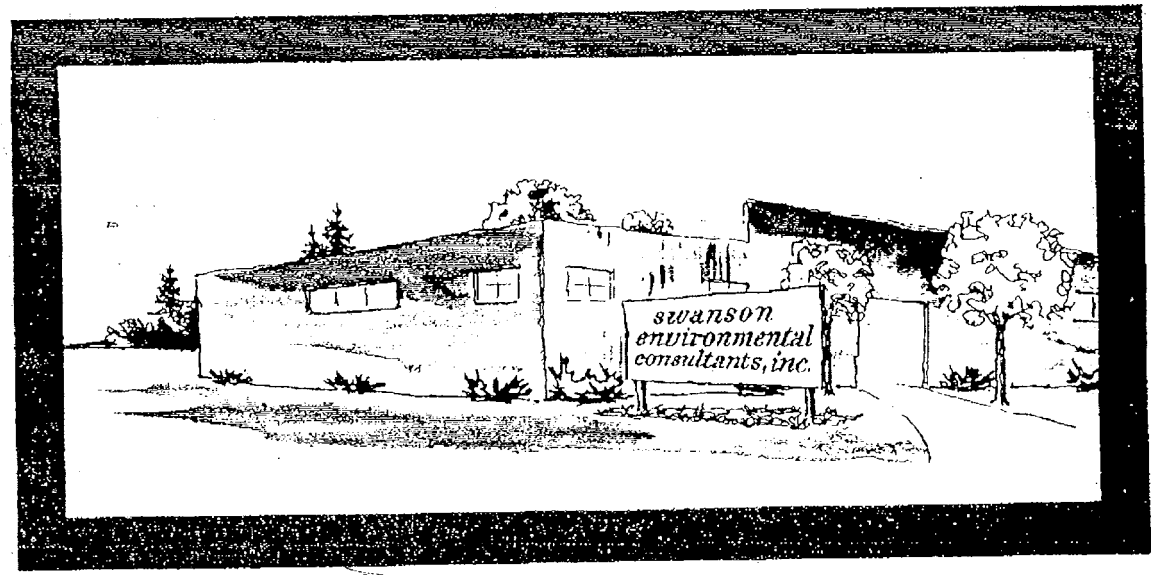
miscellaneous environmental samples—including soil and vegetation.

RADIATION ANALYSES

Low-level radiation measurements on environmental samples.

COMMERCIAL PRODUCT TESTING

Toxic hazard evaluations of commercial products.



HWMURPHY18519

Whatever your environmental problem, your first, most significant move toward a solution will be to secure a precise, objective assessment of the situation — conscientiously compiled by *swanson environmental consultants*.

Specifically, you might require detailed study of

the efficiency of your present — or projected — air pollution control equipment.

your status concerning present governmental regulations or controls.

emissions you may be discharging into water bodies, and their ecological effects on aquatic species.

levels of toxic dusts, vapors or gases within your plant.

the fate and effects of gaseous and liquid effluents released into the environment.

concentrations of metallic elements, such as mercury, lead, chromium, arsenic, cadmium, and other environmentally important trace materials.

your total emissions picture — an inventory of all effluents — solid, liquid and gaseous — released from your plant.

swanson environmental consultants, inc.

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ASBESTOS STUDY
FOR
THE BENDIX CORPORATION

I. INTRODUCTION

Swanson Environmental Consultants, Inc. were retained by The Bendix Corporation Friction Materials Division and Brake and Steering Division to make a study of asbestos exposures in their plants located in Troy, New York, Cleveland, Tennessee, and South Bend, Indiana.

The purpose of this study was to determine compliance or non-compliance in the Bendix plants cited above with asbestos exposure standards of the United States Department of Labor Occupational Safety and Health Administration.

The study was designed to include the following items:

a) Health problems associated with asbestos exposures

b) Current research and information on asbestos exposures

c) Existing concentrations of asbestos at workstations within the plants

d) Asbestos handling procedures

e) Type of asbestos used and changes that occur during manufacturing processes including information already accumulated by The Bendix Corporation

f) Extent of problem, if any, within The Bendix Corporation from asbestos (detailed definition of current federal, state, and local laws)

g) Recommendations based on field and research data.

Further, the study was designed to follow the raw asbestos material entering the plants through various manufacturing processes to define

any existing health hazard and observe any alteration to the raw material. The study was broken into three phases: field surveys, laboratory analyses, literature research and recommendations. Field surveys were conducted by Dr. Jon R. Swanson of Swanson Environmental Consultants, Inc. during the following periods at indicated Bendix plants:

DATE OF SURVEY	PLANT
March 20-24, 1972	Cleveland, Tennessee
April 3-7, 1972	Troy, New York
May 12, 1972	South Bend, Indiana

Prior to a detailed discussion of the study, a general discussion of asbestos and asbestos associated health problems appears appropriate.

II. GENERAL DISCUSSION OF THE ASBESTOS PROBLEM FACING INDUSTRY

A. Asbestos- Asbestos is the generic name applied to three groups of minerals having a fibrous cleavage and numerous mineral sub-divisions. Two distinct groups of these minerals are recognized due to their availability in nature, industrial use and resistance to fire and acid:

1. Serpentine: an example is chrysotile (white asbestos). Chrysotile is a hydrated magnesium silicate with fine fibers having a tubular structure. The hollow tube appearance of Chrysotile under transmission electron microscopy makes this material readily identifiable and discernible.

2. Amphibole (hornblende): examples are crocidolite (blue asbestos) and amosite (yellow-brown asbestos). Crocidolite is a sodium ferric silicate while amosite is a ferrous magnesium silicate. The fibers of crocidolite and amosite are solid and distinct from the tubular structure of chrysotile.

The principal chemical differences in these materials are shown in the

following table detailing bulk chemistry data. Fiber types are readily distinguishable from each other due to differences of the five major oxides.

TABLE NO. 1

ASBESTOS MINERALS
BULK CHEMISTRY RANGE

OXIDE	CHRYSOTILE	AMOSITE	CROCIDOLITE
SiO_2	38.0-44.0	49.0-53.0	49.0-53.0
MgO	40.0-42.0	1.0-7.0	0.0-0.3
FeOxides	0.1-4.0	34.0-44.0	30.0-40.0
CaO	0.0-1.0	0.0	0.3-2.7
Na_2O	0.0-trace	0.0	4.0-8.5

Also, the major sub-divisions of asbestos may be further subdivided by their physical properties. For example, chrysotile is sold according to various gradings which include such data as fiber length, hardness of of the fiber, and per cent extraneous material. A majority of the asbestos entering the United States is chrysotile. Approximately 85 per cent of the world's annual production comes from Canada, the Union of Soviet Socialist Republics, Rhodesia (all chrysotile producing) and South Africa (producing chrysotile, amosite, and crocidolite). Some crocidolite is produced in Western Australia.

World production exceeds 3,000,000 tons annually with the United States using approximately 1,000,000 tons per year. Some 200,000 tons of asbestos is used in the United States for products such as textiles, friction material, paper, paints, roof coatings, and other products.

The Bendix Corporation-Friction Materials Division purchases close to 10,000 tons annually. This purchase includes seven types of asbestos

(all chrysotile) according to 1971 data. The properties of these various asbestos types are utilized to alter the characteristics of the end product friction material. All the asbestos encountered during this study was chrysotile.

B. Health considerations associated with asbestos exposure

1. Historical- It is doubtful whether any mineral dust can be considered as entirely harmless under conditions of extreme exposure. However, for practical purposes mineral dusts can be divided into two classes-active and inert. The majority of dusts encountered in industry are relatively inert such as iron dust, silicate dusts, emery dusts and organic dusts. Such dusts may cause radiological pulmonary (chest x-ray) shadowing from the deposition of radio-opaque material in the lungs, but normally they have no accompanying fibrosis or loss of pulmonary function. Active dusts ("fibers") such as silica, asbestos, and bauxite fume will produce disabling pulmonary disease when dusts ("fibers") of proper particle size, physical and chemical propoerties are inhaled in sufficient concentrations.

Asbestos fibers* were recognized for their disease potential near the turn of the century. Exposure to high concentrations of asbestos fibers over several years resulted in a fibrotic proliferation of lung tissure with accompanying clinical conditions. This disease is called asbestosis. Clinically, asbestosis results in a shortness of breath, dry cough, rales in the later stages, raised diastolic blood pressure, and clubbing of the fingers. A chest x- ray will

* For purposes of this study a fiber is defined as a particle >5μm with a length to width ratio of at least 3:1.

reveal the diffuse fibrosis as a ground-glass appearance in the lung fields. "Asbestos bodies" were associated with lung tissue of persons diagnosed with asbestosis. These bodies are brownish spindle shaped structures which are bulbous on one or both ends found in lung tissue specimens and sputum of persons exposed to asbestos. Recently these "bodies" have been discovered in a large precentage of urban dwellers and are more appropriately called ferrunginous bodies. Normally, a "fiber" is found as the core of a ferrunginous body.

From the early 1900's many descriptions of asbestosis found their way into the scientific literature. However, it remained until 1938 for Dreessen* and his colleagues to recommend a standard for controlling exposure. They recommended a tentative limit of 5.0 million particles per cubic foot (mppcf) as determined by the impinger technique of dust sampling. This study had limitations such as the lack of long periods of employee association with asbestos. For example, of 541 employees studied, only 66 were employed over ten years.

Animal studies and other environmental observations did not show any information contrary to the tentative limit proposed by Dreessen and his colleagues. The level of 5.0 mppcf was thus adopted by The American Conference of Governmental Hygienists (ACGIH) as a Threshold Limit Value (TLV) in 1946. Threshold Limit Values as defined by the ACGIH refer to air-borne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. Threshold Limit Values (TLV) are based on the best available information from industrial experience,

*Dreessen, W. C., Dallavalle, J. M., Edwards, J. I., Miller, J. W., and Sayers, R. R. A Study of Asbestosis in the Asbestos Textile Industry. Public Health Bulletin No. 241, 1938.

from experimental human and animal studies, and , when possible, from a combination of the three. The basis on which the values are established may differ from substance to substance; protection against health impairment may be a guiding factor for some, whereas reasonable freedom from irritation, narcosis, nuisance, or other forms of stress may form the basis for others.

The TLV for asbestos of 5 mppcf was recommended through 1970. The limit was then changed to 12 and later 5 fibers greater than five microns in length per cubic centimeter of sampled air (5 fibers/cc >5μm*) after the ACGIH published notices of intended changes. The 5 fiber /cc limit is based on a prescribed sampling method using a fine filter and microscopic counting of fibers under phase contrast illumination. Conversion of data obtained using the impinger method (mppcf) into fiber counts/cc greater than 5μm is not recommended. However, a correlation between 12 fibers/cc and 2 mppcf has been used by some investigators.

The major reason for revision of the 5 mppcf limit was the mounting evidence relating cancer with asbestosis and asbestos exposure. Doll** pointed out that an excess of incidence of bronchogenic cancer greater than that expected from the general male population was present among persons who worked in a large asbestos complex. In the United States Selikoff *** and his colleagues studied 632 insulation workers who entered the trade before 1943. These workers were traced through 1962 showing 45 deaths from cancer of the lung or pleura**** whereas only 6.6 such deaths were

* 1μm = 1 micron = $\frac{1}{1,000,000}$ of a meter = 1/25,000 of an inch.

** Doll, R.S. Mortality from Lung Cancer in Asbestos Workers. Brit. J. Ind. Med., Vol. 12, p. 81, 1955.

*** Selikoff, I.J., Churg, J., and Hammond, E.C., Asbestos Exposure and Neoplasia. J. Am. Med. Assoc., Vol. 188, p. 22, 1964.

**** pleura - outer lining of the lung.

expected. Selikoff and his colleagues concluded:

> "The results with regard to carcinoma of the lung are clear. Industrial exposure to asbestos by insulation workers, as studied here, results in the incidence of cancer of the lung, approximately six to seven times the expected incidence."....

Selikoff and his colleagues also noted that three of the pleural tumors were mesotheliomas and commented on this as an exceedingly high incidence for this type of rare tumor.

In a subsequent study Selikoff and his colleagues* described a relation between exposure to asbestos and mesothelioma after the study of 307 consecutive deaths among asbestos insulation workers. They concluded:

> "It appears that mesothelioma must be added to the neoplastic risks of asbestos inhalation, and joins lung cancer (53 of 307 deaths) and probably cancer of the stomach and colon (34 of 307 deaths) as a significant complication of such industrial exposure in the United States."

Neoplasms, such as mesothelioma, were reported in the United States as occurring without x-ray evidence of asbestosis and at low exposure levels. The British questioned this evidence in a 1967 memorandum from the Ministry of Labor-Senior Medical Inspector. However, in 1968 the British Occupational Hygiene Society published their "Hygenic Standards for Chrysotile Asbestos Dust** which stated:

> "It is probable that the risk of being affected to the extent of having such early clinical signs will be less than 1 percent for an accumulated exposure of 100 fiber years per cm^3 (cc) or 2 fibers/cm^3 for 50 years, 4 fibers/cm^3 for 25 years or 10 fibers/cm^3 for 10 years."

* Selikoff, I.J., Churg, J., and Hammond, E.C., Relation Between Exposure to Asbestos and Mesothelioma. New Eng. J. Of Med., Vol. 212, p. 560, 1965.

** Hygiene Standard for Chrysotile Asbestos Dust. Amer. Occup. Hyg., Vol. 11, pp 47-49, 1968.

Thus, in effect the British Occupational Hygiene Society recommend a "TLV" of 2 fibers/cc>5μm as determined with the standard membrane filter technique.

Many investigators completed or commenced studies on asbestos and occupational health during the late 1960's to date. The question of asbestos exposure and cancer brought out many scientific and emotional responses from all quarters; industry, government, and academe. Many factors influencing the biological effects of asbestos are being discussed and studied. Factors such as:

a) Fiber length

b) Association between asbestos fibers contaminated with cancer producing hydrocarbons

c) Trace metals found in asbestos after grinding and milling

and others are currently under scientific scrutiny.

2. Current -However, for industry the above deliberations are somewhat academic due to the regulatory power provided with the enactment of the Williams-Steiger Occupational Safety and Health Act of 1970 which provided for the publication of an emergency temporary standard concerning asbestos exposure. Such a standard was published under the provisions of the law in the Federal Register on December 7, 1971 as follows:

> 1910.93a Asbestos dust- (a) 8-hour time-weighted average The 8-hour time-weighted average airborne concentration of asbestos dust to which employees are exposed shall not exceed 5 fibers longer than 5 microns per milliliter, as determined by the membrane filter method at 400-450 X (magnification) (4 millimeter objective) phase contrast illumination. Concentrations above 5 fibers per milliliter but not to exceed 10 fibers per milliliter may be permitted up to a total of 15 minutes in an hour, but for not more than 5 hours in an 8-hour day.

This emergency standard for asbestos dust exposure was further clarified in the Federal Register of January 12, 1972.

After consideration of the emergency standard and all comments pertaining to such a standard, the United States Department of Labor, Occupational Safety and Health Administration (OSHA) published under the OSHA act a Standard for Exposure to Asbestos Dust in the Federal Register of June 7, 1972. The standard limits industrial exposure to air-borne concentrations of asbestos as follows:

> 1910.93a Asbestos
> (a) Definitions. For the purpose of this section, (1) "Asbestos" includes chrysotile, amosite, crocidolite, tremolite, anthophyllite, and actinolite.
> (2) "Asbestos fibers" means asbestos fibers longer than 5 micrometers.
> (b) Permissible exposure to airborne concentrations of asbestos fibers-(1) Standard effective July 7, 1972. The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed five fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.
> (2) Standard effective July 1, 1976. The 8-hour time-weighted average airborne concentrations of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers, per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.
> (3) Ceiling concentration. No employee shall be exposed at any time to airborne concentrations of asbestos fibers in excess of 10 fibers, longer than 5 micrometers per cubic centimeter of air, as determined by the method prescribed in paragraph (e) of this section.

The time-weighted average concentration described in this standard refers to a method for adjusting to the fact that employees are exposed to variable concentrations throughout their work day. The eight-hour time-weighted average (TWA) may be determined as follows:

$$\frac{(\text{Hours} \times \text{concentration task A}) + (\text{Hours} \times \text{concentration task B}) + \text{etc.}}{8}$$

In effect, to obtain the eight hour TWA, sampling must be conducted during the entire eight-hour work period.

The new standard does call for a ceiling limit of 10 fibers/cc >5μm which is not be be exceeded at any time.

III. ASBESTOS STUDY

A. Introduction

The following plants were visited by Dr. Jon R. Swanson of Swanson Environmental Consultants, Inc.:

(a) Troy, New York

(b) Cleveland, Tennessee

(c) South Bend, Indiana

The purpose of these visits was to obtain air samples to determine asbestos concentrations throughout the plants and to make observations of dust generation sources , plant operating procedures, and existing air control systems for correlation with air sample results. Samples were taken in an identical manner by Dr. Jon R. Swanson in all plants. Mr. D. Stone, Mr. A. St.John, and Mr. R. Blair assisted in the field work at Troy, New York. Mr. J. Riopelle and Mr. H. Smith assisted in the field work at Cleveland, Tennessee. Mr. S. Baumgartner, Mr. O. Sliter, and Mr. B. Hoye assisted in the South Bend, Indiana plant. This section contains data on sampling procedures, laboratory procedures, airborne asbestos concentrations, and sources of dust generation.

B. Sampling Procedures

Asbestos samples were collected in each plant using the standard membrane filter technique used by OSHA and other industrial hygiene groups. This technique involves drawing air through a 0.8 micrometer pore size membrane filter held in an open face cassette at a rate of 1.0 liters per minute (lpm) up to 2.5 lpm. All samples were collected in this study at a rate of 2.0 lpm using a "constant" flow Bendix 115 A pump.

All pumps were calibrated with the 37mm membrane filter in-line prior to field use. Calibration was accomplished using a wet-test meter in the laboratory and 1.0 liter burette in the field. This type of personal air sampling pump maintained flow rates very reliably. Samples were collected in the worker's breathing zone by placing the pump on the worker and attaching the filter cassette over the shoulder near chin level. The cassette cap was removed leaving 855 mm^2 of surface area exposed for sampling. Samples were taken for a short duration of several minutes up to several hours. At the conclusion of sampling the cap was immediately replaced , and the filter cassette was sealed and marked. Also a large percentage of samples were collected in general areas of plants so as to characterize area asbestos fiber concentrations. Data sheets were completed in the field and laboratory. Observations were made during all sampling periods.

Laboratory counting was completed by Dr. Jon R. Swanson and Miss C. Tozer of Swanson Environmental Consultants, Inc. Scanning electron microscopy was performed by Mr. David Horowitz. Optical microscopy was completed according to the standard technique prescribed by the Federal Register at 400 X magnification under phase contrast illumination. A Nikon model STR-KE microscope equipped with a DLL 40X phase objective was used for fiber counting. Sizes >5μm were determined using a calibrated Porton reticle. Detailed methods as outlined by the National Institute for Occupational Safety and Health (NIOSH) and the Asbestos Textile Institute were followed for the counting procedure. Field counting was accomplished on a limited number of samples at Troy, New York and Cleveland, Tennessee.

Scanning electron microscopy was conducted on an Etec Scanning Electron Microscope. High resolution of the filter surfaces was available

using this technique as can be seen in the appended electron photomicrographs.

C. Results

1. Troy, New York

The results of air sampling conducted during the period of April 3-7, 1972 are summarized in Figure Number 1. The appendix contains field data obtained during the study. Electron photomicrographs are also appended.

Referring to Figure Number 1, it may be seen that sixty-eight samples were collected throughout Plant Two and Plant Four. Asbestos fiber concentrations ranged from a low of 0.2 fibers/cc to a high of 238.9 fibers/cc. The 0.2 level was found in the Industrial Relations office while the 238.9 level was present in the reclaim room during operation of the reclaim machinery. Very high air-borne concentrations of asbestos fibers were found in the following areas:

a) Dry Mix Presses (Plant 2)

b) Disk Pad Press (Plant 4)

c) Inspection Line (Plant 4)

d) Reclaim Room (Plant 2)

These very high concentrations are from either personal samples or samples taken in close proximity to the particular operating machine. Samples taken in general areas throughout Plants 2 and 4 ranged from 0.2 fibers/cc to 12.5 fibers/cc.

Referring to Figure Number 1, the majority of general area fiber concentrations can be seen to center around 2 fibers/cc with a range from 0.2 fibers/cc to 4.2 fibers/cc.

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2. Cleveland, Tennessee

The results from air sampling conducted during the period of March 20-24, 1972 are summarized in Figure Number 2. The appendix contains field data obtained during the study. Electron photomicrographs of representative samples from the Cleveland plant are also appended.

Referring to Figure Number 2, it may be seen that twenty-three samples were counted for fibers. Several samples were not counted due to heavy dust loadings on the filters. Asbestos fiber concentrations ranged from 0.6 fibers/cc to 18.1 fibers/cc. High concentrations were found in the dry mix press briquetting operation and the disk pad press operation. However, these operations also showed concentrations below 5 fibers/cc. General area samples throughout the plant ranged from 0.6 fibers/cc to 9.0 fibers/cc. The majority of samples show general airborne asbestos concentrations to be below 5 fibers/cc.

3. South Bend, Indiana

The results from air samples collected on May 12, 1972 are summarized in Figure Number 3. The appendix contains field data obtained during the study. Also appended are electron photomicrographs of representative samples from the South Bend plant.

Referring to Figure Number 3, it may be seen that sixteen samples were collected during the eight hour working period of the first shift on May 12, 1972. Asbestos fiber concentrations ranged from 0.0 fibers/cc to 2.8 fibers/cc. With the exception of the 2.8 fibers/cc count, all samples were below 1.0 fibers/cc. Area samples centered around 0.5 fibers/cc.

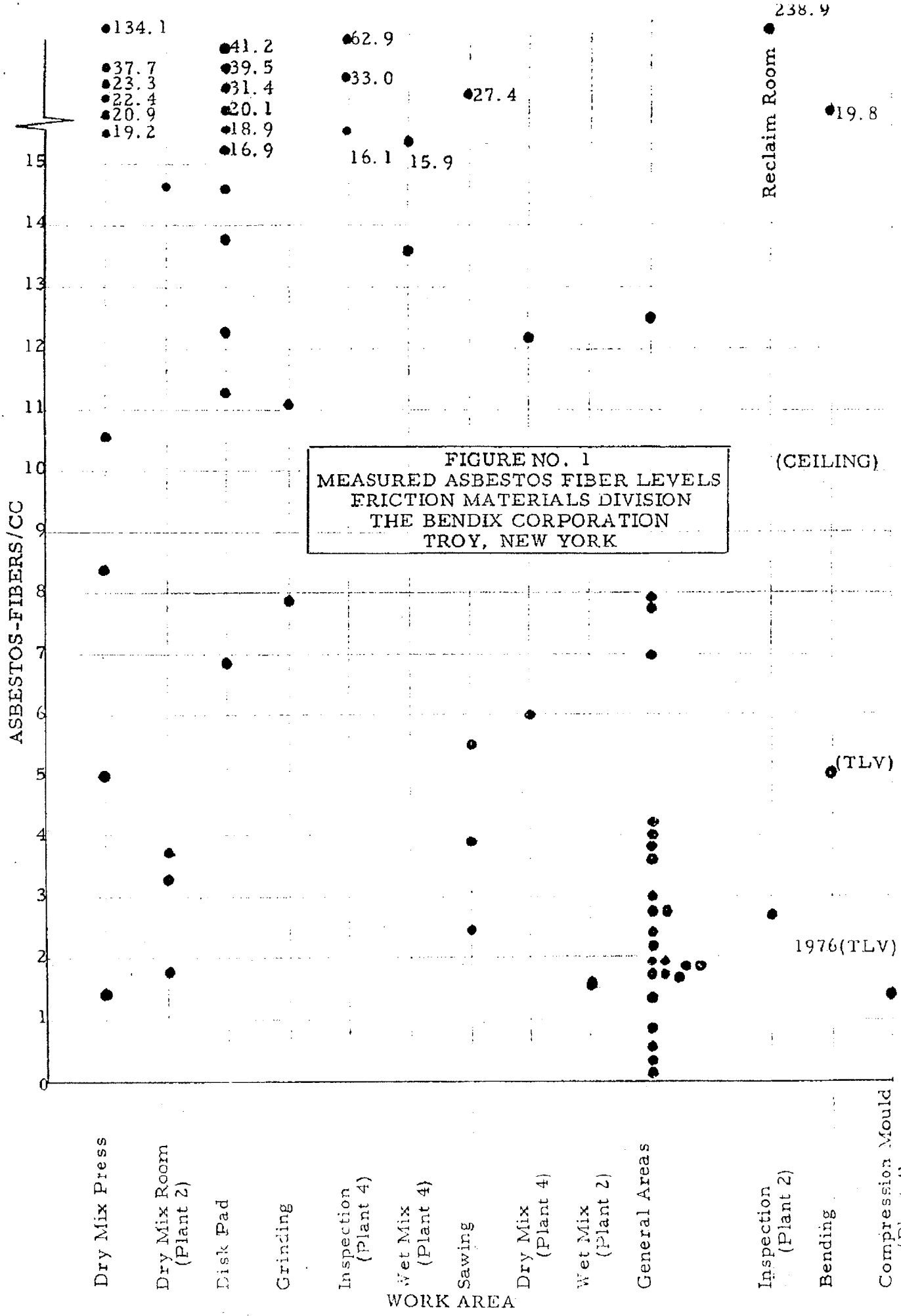
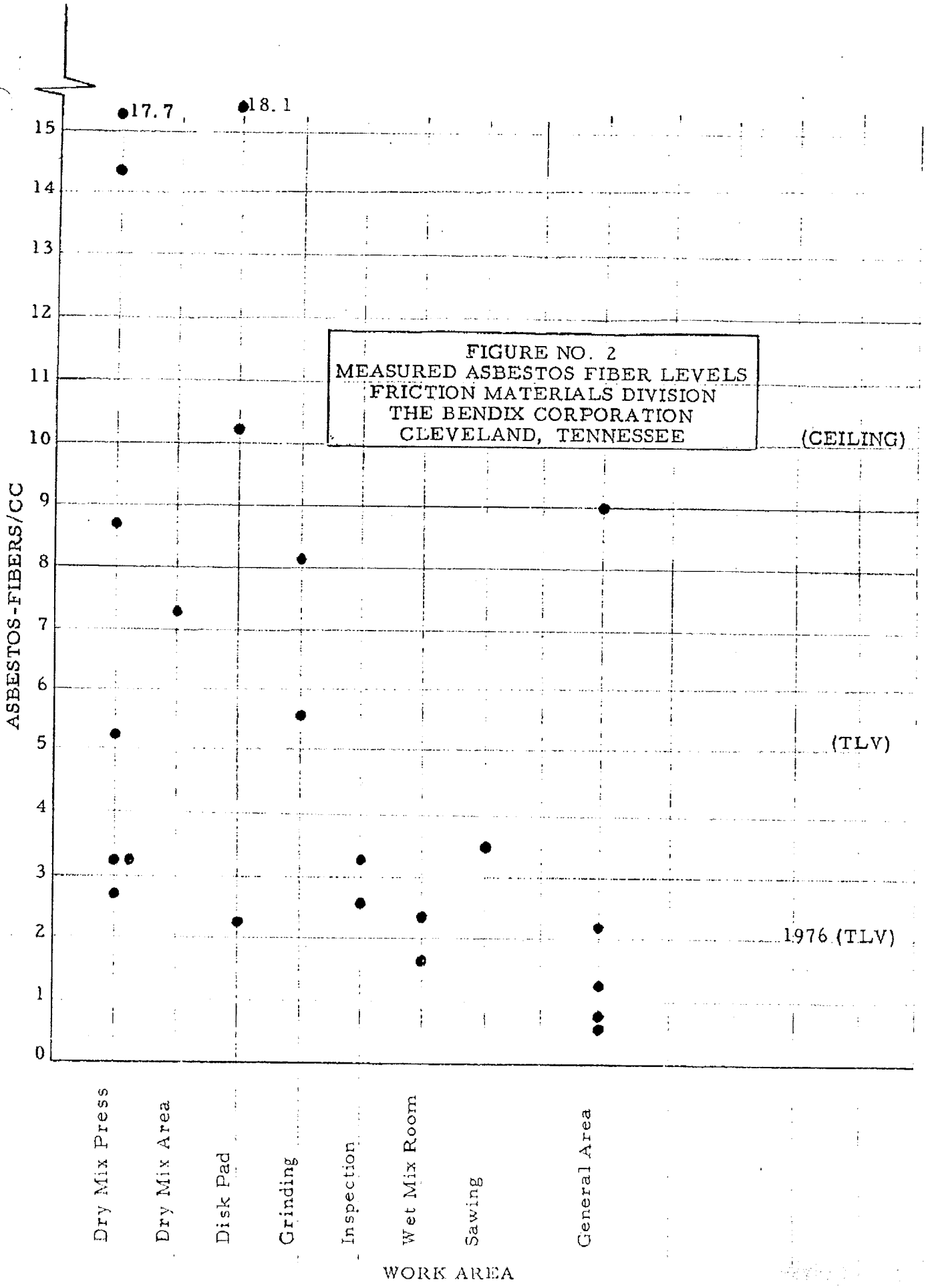
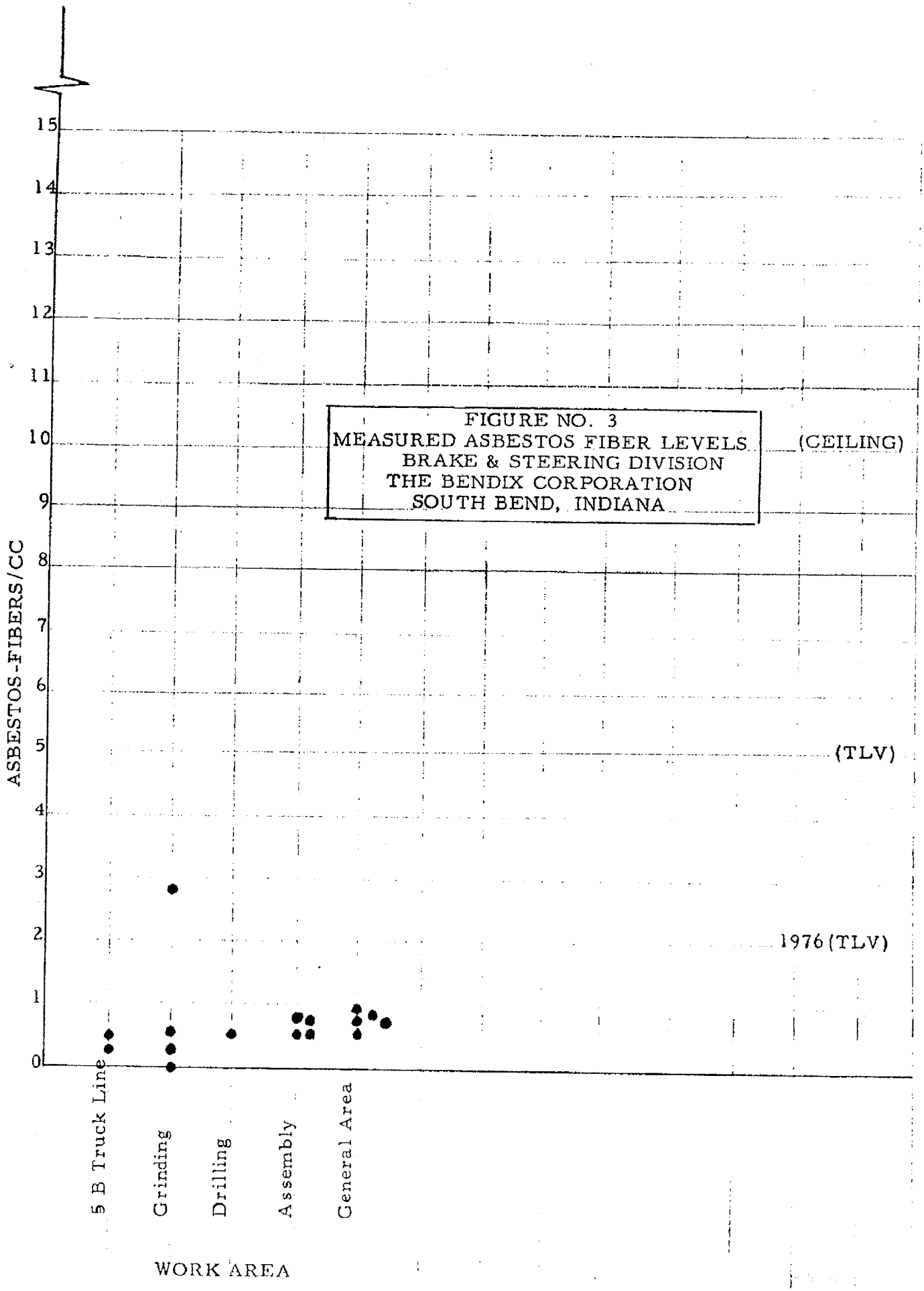


FIGURE NO. 1
MEASURED ASBESTOS FIBER LEVELS
FRICTION MATERIALS DIVISION
THE BENDIX CORPORATION
TROY, NEW YORK



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D. Discussion of Results

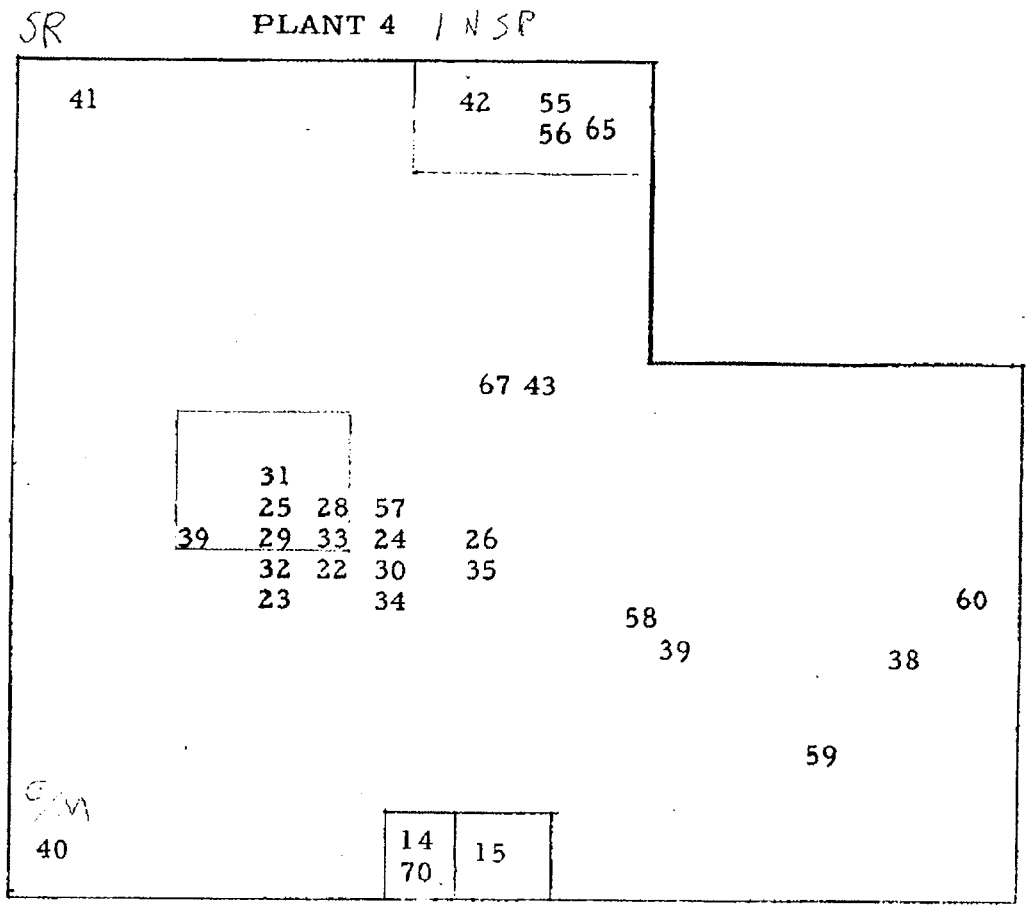
1. Troy, New York

Figure Number 1 provides a fairly complete graph of the problem areas while at the same time showing the general plant fiber concentrations to be within the 5 fibers/cc limit with a few exceptions. It should be pointed out that only a few operations are responsible for high fiber concentrations. Further, the operating personnel wear respiratory protective equipment and are not inhaling the high fiber concentrations. These few operations are also contaminating other areas of the plants due to existing air currents and bad housekeeping practices.

The dry mix press operation in Plant 2 is the major source of air-borne asbestos fibers. This area is also heated due to the influence of the curing presses. During the study the heated air currents laden with asbestos fibers could be observed from a vantage point down the aisle. The influence of this source is evident in Samples #10, 1, 3, 61, 8, 11, and 12 which were collected down the aisle away from the press area in respective order. Figure Number 4 presents data on sample positions at the Troy plants.

SAMPLE #	CONCENTRATION (Fibers/cc>5μm)
10	10.6
1	8.4
3	7.8
61	12.5
8	5.5
11	1.9
12	1.9

Plate #3 provides a visual description of the bulk dry mix material prior to pressing. Plate #11 and Plate #12 show the material under high and



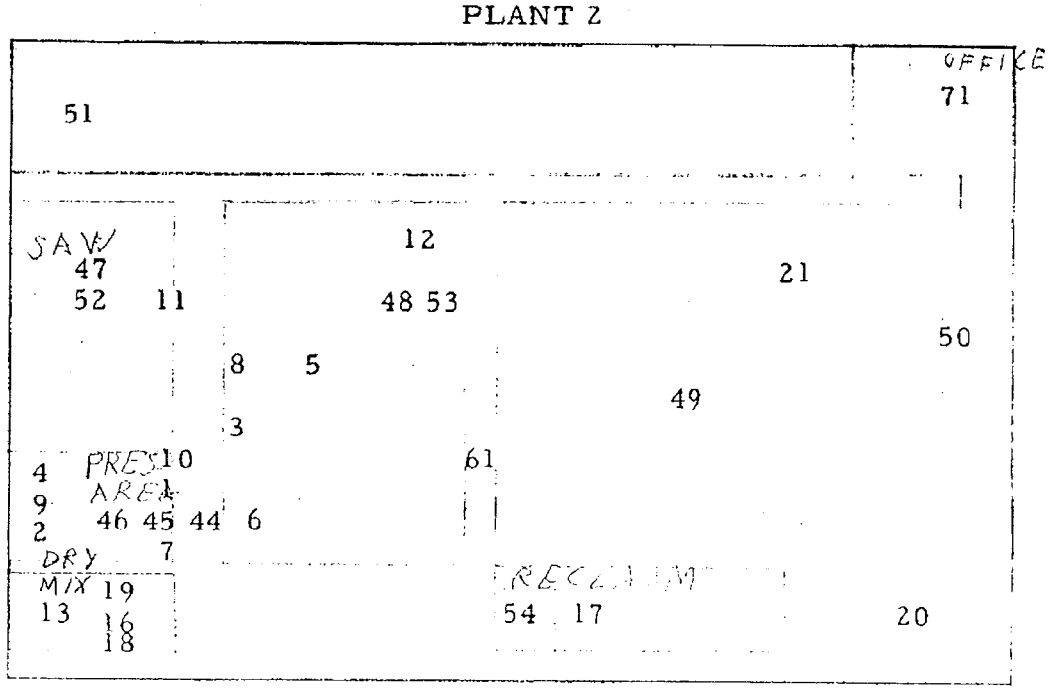


FIGURE NO. 4
SAMPLE POSITIONS
TROY, NEW YORK

medium magnification filtered out of the press operator's breathing zone. High fiber concentrations in this area can be attributed to the following:

a) handling and transfer of the bulk material to the moulds using the tote box, bucket, and under-over weighing system.

b) displacement of air as the press engages

c) air movement on the presses

d) excess material handling practices of employees

e) spillage and cleanup

f) reentrainment of dried material on the floor which is stirred up by work operations and carried aloft due to air currents in the area. (This situation could be worse in the summer if cooling fans are permitted in this area)

The results of sampling in this area show a need for complete review to eliminate fiber generation sources which are contaminating the dry mix press area and other areas of Plant 2.

A similar situation exists in Plant 4 at the disk pad presses. Samples surrounding this operation show it to be an effective source of contamination for other nearby areas in Plant 4. Permanently mounted circulating fans overhead are circulating asbestos fibers carried aloft. The disk pad operation is contributing to high asbestos fiber concentrations through the following:

a) handling and transfer of bulk materials

b) weighing process and press operating sequence

c) excess bulk material handling practices of employees

d) spillage and cleanup

e) handling of disk pads after pressing

f) reentrainment of spilled and dried material into the air due to truck traffic and the movement of personnel

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g) overhead circulating fans

h) handling and spillage of bulk material from the new vacuum material handling systems.

The majority of air-borne asbestos fibers in the disk pad area can be attributed to handling, spillage, and a drying time with subsequent reentrainment of fibers into the air. The high asbestos fiber concentrations point out the need for a complete review of the bulk material flow through the disk pad operation eliminating all asbestos fiber generating sources.

The dry mix rooms and wet mix rooms show a few elevated asbestos fiber concentrations. The source of these fibers is similar in all the mix areas and can be discussed together. Spillage bag handling and poor housekeeping account for a majority of the contamination. Any spillage of the raw asbestos leaves large clumps of this raw material desposited on the mixer, blender, floor, motor, and other surfaces. These clumps may be visualized in Plate 1. As this material is stirred up or blown about due to the operation of blending and mixing equipment, the clumps break down into smaller groups of fibers. These may be visualized in Plate 2. Literally, a small spill of raw asbestos may lead to millions of fibers becoming air-borne. This process was evident on the "Littleford" mixers where a small amount of spilled asbestos on the upper charge floor would work its way down to the motors and subsequently be blown like snow throughout the mix room from the operation of the motor. Bag handling practices in all mix areas allowed the spillage and generation of asbestos fibers. Pulsating damper bags on the Littleford mixers in Plant 4 contributed to the generations of asbestos fibers. Typical mixes include the following items:

a) Asbestos

b) Resin (wet or dry)

c) Friction Dust

d) Ground Rubber

e) Metal Chips or Dust

f) Coke Flour

g) Grit

h) Alumina

i) etc.

Asbestos is the principal ingredient, and thus, it appears that a better system for transporting asbestos to the mixer or blender charge openings could be devised. All spillage could perhaps be eliminated during charging. After mixing and blending the mix appears to generate very little dust until it is handled again at the presses. Resin may tend to hold the asbestos. This could be detrimental as far more resin dust is released during production operations, and depending on particle size, the resin could offer better penetration of asbestos fibers into the lung by acting as a carrier. Some evidence of this may be observed in Plate 4 and Plate 9.

Inspection offers the worst exposure condition as high asbestos fiber concentrations were found on the inspection lines where no respiratory protective devices are worn. Further, the inspectors are virtually trapped in their own "dust cloud" as the job calls for little movement or change of work position. Plates 13 thru 15 provide visual evidence as to the asbestos fiber hazard presented to inspectors. The dust generated at this work station is dependent on the cleanliness of finished product arriving from the grinding department. This, in turn, may be dependent on the type of product being handled as some types of linings appeared more dusty than others. The product at this stage has been subjected to high temperatures in curing and

grinding. This appears to cause the formation of conglomerates of asbestos fibers and can be seen in Plates 13, 14, and 15. A very high magnification of such a conglomerate may be seen in Plate 6. It appears that a very high number of asbestos fibers could be inhaled if these conglomerates were of small enough particle size. There appears to be a great need for cleaning loose dust from the products prior to inspection. This information appears conclusive that an asbestos fiber hazard is associated with the end product.

The ultra-high concentration found in the reclaim room requires the wearing of respiratory equipment at all times of operation. This operation must be reviewed closely eliminating all dust leakage points. Grinding and sawing operations showed some high concentrations. These appear to be related to contamination from other areas, carry-over of the bulk material product, and inefficient local exhaust systems. The exhausts were not checked during this study. The high figure (19.8) obtained at the bending area is not a valid sample as this filter was dropped and contaminated.

2. Cleveland, Tennessee

In a sense the results obtained at Cleveland closely resemble the Troy results but in a scaled down manner with one notable exception. The Cleveland plant is far superior in housekeeping practices.

The dry mix press operator's breathing zone concentrations ranged from 2.8 fibers/cc to 17.7 fibers/cc. On the basis of this sampling a time-weighted average would center between 5 and 10 fibers/cc. The variance is due to individual operating practices, neatness, and the type of mix in production. An excellent sampling (#116) was taken four feet away from the operation covering the general area of the dry mix press over a long time period (78 minutes). The level in this area was 2.2 fibers/cc. During

the sampling of this operation, it was discovered that large clumps of dry mix were contaminating the filter surface when sampling one operator who had a tendency to physically "scatter" clumps of the dry mix material into his breathing zone. Further, a large amount of dry mix material was collected by electrostatic deposition on the inner cassette plastic surface. This phenomenon was also observed to deposit a ring of dry mix material on the filter surface after sampling. Samples were thus carefully counted in the field to minimize these effects. These field counts showed a maximum fiber concentration for this operation at 5.4 fibers/cc. Thus, it is believed that the higher concentrations observed at this operation may not be completely representative of actual air-borne asbestos fiber concentrations. Also, during counting it was observed that some of the resin material could be mistaken as fibers. Plate 10 shows some resin (darker material) in fibrous shapes. Thus, counting errors at this operation could be introduced due to the nature of the resin-asbestos mix. Again, it should be pointed out out that respiratory protective equipment is worn by the operators in this area.

Air-borne contamination at these dry mix presses appeared to come from the following sources:

a) Material handling, weighing, and excess discard

b) Spillage and subsequent drying and reentrainment

c) Air displacement during the press cycle as the press plate enters the mould

d) Finished product stacking and handling at this work position

e) Cleanup

The major source of air-borne asbestos fibers is spillage and material handling.

The other area where high concentrations were observed was from the disk pad press. These presses are identical to those discussed for the Troy, New York plant. The method of handling the dry mix material, loading the press hoppers, and spillage as the moulds are filled contributes the major portion to air-borne asbestos concentrations in this area. Spillage with subsequent drying and reentrainment is very significant at this operation. It appears that the bulk material loading system and mould charging can be greatly improved to eliminate the spillage and air contamination.

The general area samples show this plant to have asbestos fiber concentrations around 2.0 fibers/cc. The sample showing 9.0 fibers/cc was taken during dry-mix blending on the night shift and represents contamination from the dry mix blenders. The dry mix operation can be eliminated from contaminating the general plant by enclosure, careful handling to avoid spillage when charging, and improved bag handling. Housekeeping in this area is not maintained at the same level as in the general plant.

The grinding operations show levels above 5.0 fibers/cc which may require some investigation of grinder local exhaust systems. The inspection line should be considered as a major problem area. (see discussion under Troy, New York)

3. South Bend, Indiana

Samples for this plant proved to contain fibers but at low air-borne concentrations. The highest count was 2.8 fibers/cc in the grinding area. Plate 5 shows a piece of resin collected on the filter surface while Plate 6 shows a conglomerate under high magnification containing many asbestos fibers. The presence of this conglomerate may be of importance and warrant more efficient control of grinding dusts.

The large number of fibers shown in the conglomerate (Plate 6) would constitute a health hazard if such conglomerates are inhaled and reach the lung alveolar surfaces. Conglomerate particle sizes appear small enough to (see Plates 13, 14, and 15) consider their inhalation and subsequent health risk a possibility at South Bend, Indiana.

In the limited study of the grinding areas in this plant one count was greater than the 1976 air-borne asbestos standard. It is possible that a more complete sampling may show other areas exceeding the 2.0 fiber/cc limit. Thus, the importance of improved housekeeping and grinder ventilation maintenance cannot be underestimated.

4. Summary

The seriousness of the high asbestos fiber concentrations at Troy, New York must be reviewed immediately in light of current federal regulations and the tough-concentrated approach being conducted by OSHA personnel throughout the country to enforce the new asbestos standard. A well-planned cleanup and control program with input from all helpful sources within The Bendix Corporation is required. Immediate commencement of such a coordinated effort may succeed in keeping the high fiber concentration operations at Troy, New York in production.

Cleveland, Tennessee shows the beginning signs of having a serious air-borne asbestos concentration problem. Application of solutions discovered and installed at Troy will be required to control asbestos concentration at Cleveland now, and, as the Cleveland plant expands. South Bend plant asbestos concentrations will require action to maintain an air-borne level below 2.0 fibers/cc.

In general, the study showed an asbestos problem throughout the manufacture and assembly of friction material products within The Bendix Corporation. Concentrated effort will be required in all these operations to

meet the new federal standards. A large economic investment appears necessary at Troy, New York to meet just the current federal standard.

A moderate investment in asbestos control devices appears necessary at Cleveland, Tennessee. The following recommendations are made to provide a starting point for Bendix remedial action. It is recommended that corporate interest and responsibility for such a program rest at the highest levels of The Bendix Corporation.

IV. Recommendations

A. Introduction

These recommendations are made in light of the following facts:

1. A ceiling limit of 10 fibers /cc>5μm now exists.
2. The allowable limit by law will be reduced from 5.0 fibers/cc>5μm to 2.0 fibers/cc>5μm in 1976.
3. Asbestos exposure and its relation to cancer will continue to be emphasized by the press, unions, and the government.
4. In our opinion, on-going epidemiological studies such as is being conducted in Manville, New Jersey will show disastrous results from asbestos exposure which will be publicized to the fullest and eventually lead to a required zero level of exposure. (This has already been requested)

B. Troy,New York

1. General
   a. Institute an improved and continual housekeeping program in the fiber generation areas using only vacuuming for asbestos material cleanup.
   b. Research new methods for asbestos containing bulk material handling.
   c. Eliminate raw asbestos handling where possible by direct charge to mixers and blenders from a separate but central storage area.

d. Eliminate contamination of high fiber concentration areas into other areas of the plant through:

(1) Isolation

(2) Elimination of fiber generation sources

(3) Removal of man-coolers and circulating fans

(4) Control of problem air currents

(5) Control of traffic

(6) Cleaning of unfinished product prior to transfer into other areas where possible

(7) Continual housekeeping

2. Specific

a. Dry Mix Press Area

(1) Control cure press hot air currents

(2) Ventilate presses

(3) Improve bulk material handling to control spillage and air-borne fiber generation

b. Disk Pad Area

(1) Eliminate overhead fans

(2) Improve bulk material handling systems so as to eliminate spillage and air-borne fiber generation

(3) Eliminate air-borne fiber generation from the new vacuum handling machines

(4) Eliminate contamination of surrounding plant areas

c. Mix Rooms

(1) Eliminate spillage through improved asbestos handling systems

(2) Eliminate bag handling to the greatest extent possible

(3) Enclose motor fans on mixers

(4) Eliminate pulsating expansion bag on mixers

(5) Control dust generation sources with local exhaust ventilation

d. Reclaim Room

(1) Isolate Area

(2) Enclose system and control air-borne fiber generation with local exhaust and general ventilation

e. Inspection

(1) Clean linings prior to inspection

(2) Provide local exhaust ventilation at inspection table surface

f. Grinding and Sawing

(1) Check all local exhaust systems

(2) Increase capture velocities if necessary

C. Cleveland, Tennessee

1. General

a. Use only vacuum cleaning for asbestos and asbestos containing mixes

b. Eliminate raw asbestos handling where possible

c. Cleanup spillage of asbestos and asbestos containing materials on a continued basis

2. Specific

a. Dry Mix Area

(1) Isolate this area from the rest of the plant

(2) Ventilate adequately to control leaks etc. during mixing

(3) Eliminate asbestos handling on main floor by direct charge into the mixers

(4) Eliminate bag handling and subsequent contamination

(5) Baghouse exhaust should be placed outside of the building

(6) Improve housekeeping by vacuuming rafters, equipment, etc., in dry mix area

b. Dry Mix Presses

(1) Improve dry mix bulk handling system

(2) Ventilate presses

(3) Institute vacuum cleanup more than once a shift

c. Disk Pad Presses

(1) Improve dry mix bulk handling systems to eliminate spillage and air-borne fiber generation

(2) Vacuum spillage more than once per shift

d. Inspection

(1) Clean linings prior to inspection

(2) Provide local exhaust ventilation at inspection table surface

e. Grinding and Sawing

(1) Check efficiency of local exhaust ventilation

(2) Increase capture velocities if necessary

f. Reclaim Area*

* was not observed (see Troy, New York)

D. South Bend, Indiana

1. Grinding Operation- Check local exhaust ventilation on grinders. Increase capture velocities if necessary.

2. Monitoring- Monitor air-borne asbestos concentrations quarterly

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E. The Bendix Corporation

1. Place highest priority to control program
2. Appoint high level officer to overall direction and follow up of committed action
3. Prepare appointee above to coordinate and approve all Bendix statements (public relations) concerning asbestos problems within The Bendix Corporation
4. Increase research for the use of an alternate material (to asbestos) in friction products.

Report Prepared By:

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