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NIOSH HEALTH HAZARD EVALUATION REPORT

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RCA Rubber Company
Akron, Ohio

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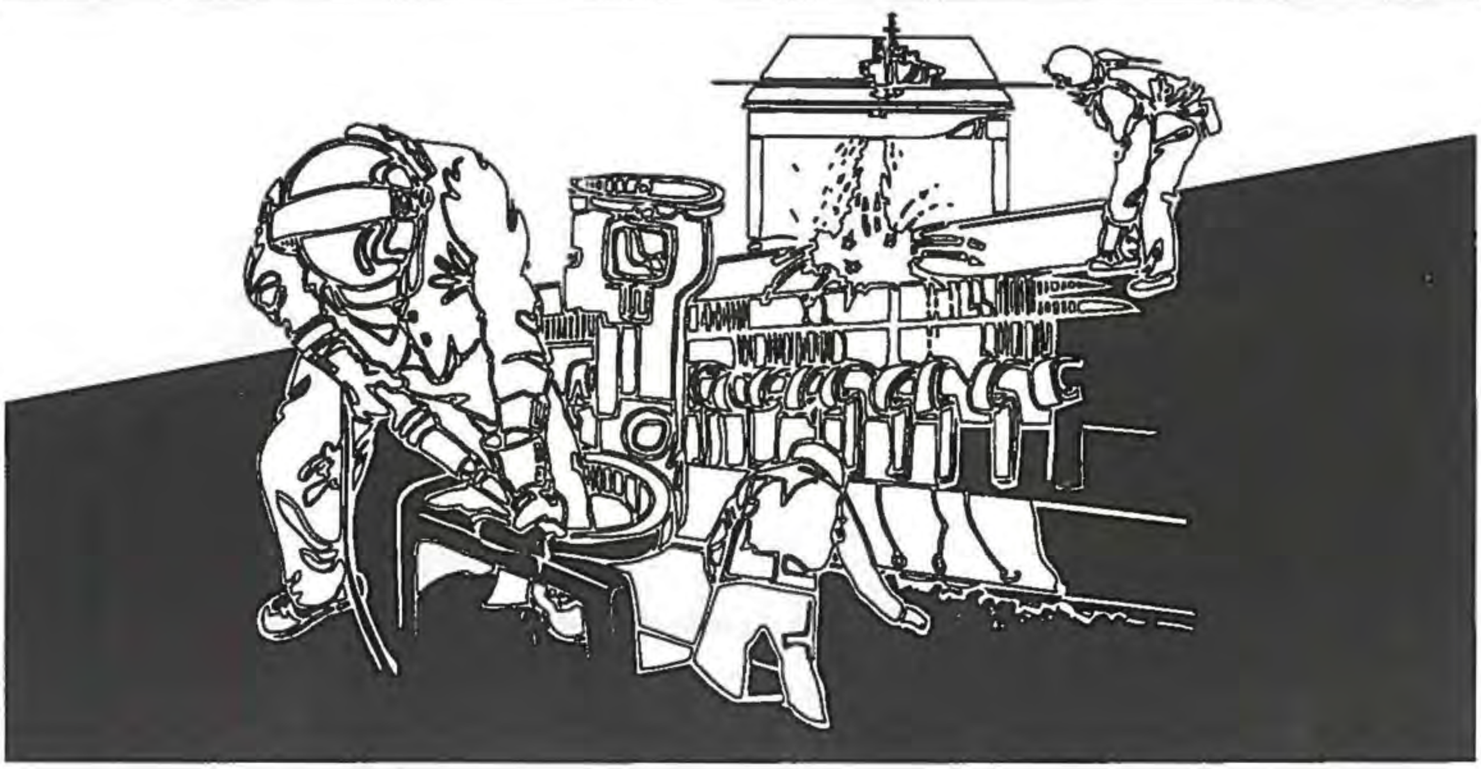

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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PREFACE

The Hazard Evaluations and Technical Assistance Branch of the National Institute for Occupational Safety and Health conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from an employer or authorized representative of the employees, to determine whether any substance normally found in the place of employment has potential toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance to Federal, State, local agencies, labor, industry, and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

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SUMMARY

On February 13, 1995, the National Institute for Occupational Safety and Health (NIOSH) received a management request for a health hazard evaluation (HHE) from the RCA Rubber Company of Akron, Ohio. The HHE request was for an industrial hygiene evaluation of potential occupational exposures to press operators and millmen to N-nitroso compounds and dusts generated during the manufacturing of rubber flooring.

On March 30, 1995, two NIOSH industrial hygienists conducted an initial site visit to the RCA Rubber Company. During that site visit, an opening conference was held by the NIOSH representatives to explain the HHE program and discuss the request made by RCA Rubber Company. Attending that opening conference were representatives from the RCA Rubber Company and representatives from the United Rubber, Cork, Linoleum and Plastic Workers of America, Local Union 8.

On April 18-20, 1995, NIOSH representatives returned to the RCA Rubber Company to conduct environmental sampling. Personal breathing zone air samples were collected on production workers for nitrosamine compounds, respirable dust, crystalline silica, carbon monoxide, and sulfur dioxide. In addition, area workplace samples were collected for nitrosamines, respirable dusts including crystalline silica, elemental metals, formaldehyde, carbon monoxide, and sulfur dioxide.

A total of 78 personal breathing zone (PBZ) and work area samples were collected and analyzed for nitrosamines. Only the nitrosamine N-nitrosopiperidine (NPIP) was detected on the samples collected. Low concentrations of NPIP were detected on 16 of the 78 (21%) samples. The range of NPIP detected on the samples was ND (not detected) to 0.53 micrograms per cubic meter of air ($\mu g/m^3$).

A total of 62 personal breathing zone and work area samples were collected and analyzed for respirable dust and crystalline silica. Overall, the range of respirable dust levels measured from all personal breathing zone samples collected throughout the plant was 0.03 - 3.17 milligrams per cubic meter of air (mg/m^3), with a mean exposure level of 0.56 mg/m^3 with a standard deviation 0.65. No crystalline silica was detected on any of the samples.

Twelve work area samples were collected and analyzed for 28 different elemental metals. Results of that analysis indicated only trace quantities of metals present on the samples.

Six formaldehyde samples were collected near the six large roll presses. No formaldehyde was detected on any of the samples collected. The highest carbon monoxide level measured near the #3 Banbury mixer was 8 (parts per million) ppm. The highest sulfur dioxide level measured was 0.3 ppm near the A-F presses.

The results of the environmental sampling conducted at the time of this survey did not indicate that a health hazard existed for either mixing or pressing employees. No specific exposures to the substances sampled were in excess of evaluation criteria. Based on the environmental data collected during this investigation, the mandatory use of respiratory protection by mixing and press personnel should be reviewed by company officials.

There were three specific areas in the mixing department in which dust respirators should continue to be used, despite exposure levels, until appropriate engineering controls are installed. Those areas are the #3 Banbury and #9 Banbury mixers, and compounders weighing scales. Even though dust levels were below existing occupational health standards, these areas deserve special attention for engineering controls.

Keywords: SIC 3069, rubber, flooring, nitrosamines, dust, crystalline silica, elemental metals, formaldehyde, carbon monoxide, sulfur dioxide, Banbury Mixer.

INTRODUCTION

On February 13, 1995, the National Institute for Occupational Safety and Health (NIOSH) received a management request for a health hazard evaluation (HHE) from the RCA Rubber Company of Akron, Ohio. The HHE request was for an industrial hygiene evaluation of potential occupational exposures to press operators and millmen to nitrosamines and dusts generated during the manufacturing of rubber flooring.

On March 30, 1995, two NIOSH industrial hygienists conducted an initial site visit to the RCA Rubber Company. During that site visit an opening conference was held by the NIOSH representatives to explain the HHE program and discuss the particular request made by RCA Rubber Company. Attending that opening conference were representatives from the RCA Rubber Company and representatives from the United Rubber, Cork, Linoleum and Plastic Workers of America, Local Union 8. After the opening conference, a tour of the plant was conducted and work locations pertaining to the HHE request were observed. After the plant tour, a closing conference was held to discuss the walk-through findings and future action planned by NIOSH. It was determined that NIOSH could assist both the RCA Rubber Company and union workers in evaluating potential exposures in their workplace. It was mutually decided that the follow-up evaluation would focus on the production and manufacturing areas of the plant, and sampling would be conducted for dusts and nitrosamine compounds.

On April 18-20, 1995, NIOSH representatives returned to the RCA Rubber Company to conduct environmental sampling. Personal breathing zone (PBZ) air samples were collected on production workers for nitrosamine compounds, respirable dust, crystalline silica, carbon monoxide, and sulfur dioxide. In addition, area workplace air samples were collected for nitrosamines, respirable dusts including crystalline silica, elemental metals, formaldehyde, carbon monoxide, and sulfur dioxide. This report presents the results of that environmental sampling and provides recommendations for corrective actions.

BACKGROUND

The principal products manufactured by the RCA Rubber Company are floor tiles, rubber runners, and rolls of rubber flooring. Approximately 200 workers are employed at RCA; approximately 60 workers having jobs with a potential for exposures to dusts and nitrosamine compounds. Production occurs during three shifts per day, seven days a week. The company has been in business at the same location in Akron, Ohio, for over 60 years.

Rubber flooring is manufactured at RCA Rubber by blending materials (clay, color additives, activators, and rubber) in Banbury mixers, transferring the material through a series of mills (dump mills, break-down mills, and jelly roll mills), pressing the material into sheets in a calendar, and finally curing the flooring in presses. After the flooring is cured in the presses, it is transported to the finishing department, then sent for packaging and shipping. Only the production department was included in this HHE.

In March 1990, NIOSH had conducted a previous HHE investigation (HETA 89-0302) at the RCA Rubber Company. During that investigation, short-term area nitrosamine samples were collected around the six roll presses. No nitrosamine compounds were identified in those samples.

Because of the potential for exposures to nitrosamine compounds and dusts generated during production of the rubber flooring, the RCA Rubber Company has instituted a respiratory protection program for employees. Workers working around the Banbury mixers, related mills, and presses are required to wear half facepiece organic vapor and dust respirators. All workers working around equipment identified as having the potential for generating an exposure to either nitrosamine compounds or dusts are required to wear the respiratory protection. This is a company policy, even though past environmental sampling has not identified the existence of an exposure problem.

SAMPLING METHODS

On April 18-20, 1995, environmental air samples were collected during the day shift in the production department to evaluate potential personal exposures to nitrosamines, dusts (including crystalline silica and elemental metals), carbon monoxide, and sulfur dioxide. Also, work area samples were collected for formaldehyde near the large presses, identified by RCA as presses A-F.

Unless otherwise indicated, all samples represented a time-integrated sample collected in the breathing zone of a worker for a full shift, generally seven hours (depending on individual work schedules).

Nitrosamines

Personal breathing zone air samples for nitrosamines were collected on production workers during the three day investigation. Nitrosamine samples were collected using solid sorbent ThermoSorb /N™ air samplers (Thermo Electron Corporation, Waltham, MA 02154) connected by tubing to battery powered air sampling pumps calibrated at a flowrate of 2.0 liters per minute (lpm).

Each sample was analyzed for N-nitrosodimethylamine (NDMA), N-nitrosodiethylamine (NDEA), N-nitrosodipropylamine (NDPA), N-nitrosodibutylamine (NDBA), N-nitrosopyrrolidine, (NPYR), N-nitrosopiperidine (NPIP), and N-nitrosomorpholine (NMOR)[1].

Respirable Dust and Silica

Personal breathing zone samples for the estimation of respirable dusts and respirable quartz dust exposure, were collected on pre-weighed, 37 millimeter (mm) diameter, 5-micron (µm) pore size, polyvinyl chloride (PVC) membrane filter, mounted in series with 10 mm Dorr-Oliver nylon cyclone. Air was drawn through the filter at a flow rate of 1.7 lpm using a battery powered sampling pump.

All air samples were analyzed for respirable dusts and total respirable crystalline silica (alpha quartz, tridymite, and cristobalite). Respirable dust content was analyzed gravimetrically according to NIOSH Method 0600[1] with the following modifications: (1) The filters were stored in an environmentally controlled room (21 ± 3°C and 40 ± 3% relative humidity (RH)) and were subjected to the room conditions for a sufficient time to achieve stabilization. Therefore, the method's 8- to 16-hour time for stabilization between tare weights was reduced to 5 to 10 minutes. (2) The filter and back-up pads were not vacuum desiccated. The total weight of each sample was determined by weighing the sample on an electrobalance and subtracting the previously determined tare weight of the filter.[1]

Respirable crystalline silica dust content was analyzed by NIOSH Method 7500,[1] using X-ray diffraction with the following modifications: (1) filters were dissolved in tetrahydrofuran rather than being ashed in a furnace; and (2) standards and samples were run concurrently and an external calibration curve was prepared from the integrated intensities rather than using the suggested normalization procedure. The analysis of some of the samples for quartz and cristobalite required additional modifications due to interference problems in the primary quartz region. These samples were analyzed on a Siemems D-5000 that used a profile-fitting program to remove the interference.

Elemental Metals

Work area samples for the estimation of exposure to elemental metals were collected on 37-mm (diameter), 0.8-µm (pore size) cellulose ester membrane filters, mounted in open-face cassettes. Air was drawn through the filters at a flow rate of 1.7 lpm using a battery powered sampling pump. All air samples collected for elemental metals analysis were digested according to NIOSH Method 7300[1] using a scanning inductively coupled plasma emission spectrometer.

Formaldehyde

Full shift work area samples for formaldehyde were collected on solid sorbent tubes (ORBO-23) using a constant flow sampling rate of 100 cubic centimeters per minute (cc/min). The collected samples were analyzed for formaldehyde utilizing a gas chromatograph equipped with a nitrogen-phosphorus detector according to NIOSH Analytical Methods 2541.[1]

Carbon Monoxide

Air samples for the estimation of carbon monoxide (CO) exposures were collected using Dräger diffusion detector tubes (Catalog No. 67 33191, National Dräger, Pittsburgh, Pennsylvania). These tubes were used to determine work area exposures to CO. These tubes operate on the diffusion properties of gases (Fick's Law of Diffusion); therefore, a sampling pump is not required for the measurement. The tube contains a yellow indicating layer that reacts with CO to change to a grayish black. Concentration of CO, in parts per million (ppm), is calculated by dividing the length of the discoloration, scaled in ppm-hours, by the time in hours that the tube was exposed. The detection range of this sampling method is 6 to 75 ppm for an 8-hour sampling duration. The accuracy for this method, as reported by the manufacturer, is ± 25%.

Sulfur Dioxide

Air samples for the estimation of work area exposures to sulfur dioxide (SO_2) were collected using Dräger detector tubes (Catalog No. 81 01091 National Dräger, Pittsburgh, Pennsylvania). This detector tube, similar to the CO tube, also operates by passive diffusion. The indicating layer changes from a bluish violet to pale yellow when exposed to SO_2. Concentration of SO_2 is calculated by dividing the length of the discoloration, scaled in ppm-hours, by the time in hours that the tube was exposed. The detection range of this sampling method is 0.7 to 19 ppm for an 8-hour sampling duration. The accuracy for this method, as reported by the manufacturer, is ± 25%.

EVALUATION CRITERIA

To assess the hazards posed by workplace exposures, NIOSH investigators use a variety of environmental evaluation criteria. These criteria suggest exposure levels which most workers may be exposed for a working lifetime without experiencing adverse health effects. However, because of wide variation in individual susceptibility, some workers may experience occupational illness even if exposures are maintained below these limits. The evaluation criteria do not take into account individual hypersensitivity, pre-existing medical conditions, or possible interactions with other workplace agents, medications being taken by the worker, or environmental conditions. The primary sources of evaluation criteria for the workplace are: NIOSH Criteria Documents and Recommended Exposure Limits (RELs),[(2)] the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs),[(3)] and the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs).[(4)] The objective of these criteria for chemical agents is to establish levels of inhalation exposure to which the vast majority of workers may be exposed without experiencing adverse health effects.

Occupational health criteria are established based on the available scientific information provided by industrial experience, animal or human experimental data, or epidemiologic studies. Differences between the NIOSH RELs, OSHA PELs, and ACGIH TLVs may exist because of different philosophies and interpretations of technical information. It should be noted that RELs and TLVs are guidelines, whereas PELs are standards which are legally enforceable. OSHA PELs are required to take into account the technical and economical feasibility of controlling exposures in various industries where the agents are present. The NIOSH RELs are primarily based upon the prevention of occupational disease without assessing the economic feasibility of the affected industries and as such tend to be conservative. A Court of Appeals decision vacated the OSHA 1989 Air Contaminants Standard in *AFL-CIO v OSHA*, 965F.2d 962 (11th cir., 1992); and OSHA is now enforcing the previous 1971 standards (listed in 29 CFR 1910.1000, Table Z-1-A). However, some states which have OSHA-approved State Plans continue to enforce the more protective 1989 limits. NIOSH encourages employers to use the 1989 limits or the RELs, whichever are lower.

Evaluation criteria for chemical substances are usually based on the average personal breathing zone (PBZ) exposure to the airborne substance over an entire 8- to 10-hour workday, expressed as a time-weighted average (TWA). Personal exposures are usually expressed in parts per million (ppm), milligrams per cubic meter (mg/m^3), or micrograms per cubic meter (μg/m^3). To supplement the 8-hr TWA where there are recognized adverse effects from short-term exposures, some substances have a short-term exposure limit (STEL) for 15-minute peak periods; or a ceiling limit, which is not to be exceeded at any time. Additionally, some chemicals have a "skin" notation to indicate that the substance may be absorbed through direct contact of the material with the skin and mucous membranes.

It is important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these occupational health exposure criteria. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, previous exposures, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, or with medications or personal habits of the worker (such as smoking, etc.) to produce health effects even if the occupational exposures are controlled to the limit set by the evaluation criterion. These combined effects are often not considered by the chemical specific evaluation criteria. Furthermore, many substances are appreciably absorbed by direct contact with the skin and thus potentially increase the overall exposure and biologic response beyond that expected from inhalation alone. Finally, evaluation criteria may change over time as new information on the toxic effects of an agent become available. Because of these reasons, it is prudent for an employer to maintain worker exposures well below established occupational health criteria.

Nitrosamines

Nitrosamines are compounds characterized by the -N--N=O functional group. They result from the combination of primary, secondary, or tertiary amines with nitrite. These reactions can occur in the laboratory; in various food, household, or industrial products; in industrial processes; and in vivo. Because of the variety of amines and reaction conditions possible, there are hundreds of nitrosamines; and because of the large number of exposure sources, including formation in vivo, there is a complicated matrix of total nitrosamine exposure. Occupational exogenous exposures have been observed in rubber industries, leather tanning industries, metal working industries, chemical industries, mining, pesticide production, detergent production, and fish factories.

Most nitrosamines are suspected to be human carcinogens, but direct causal associations have not yet been proven. Cancer is believed to be a multistage process, beginning with (1) *exposure* to a carcinogen or procarcinogen and followed by (2) *initiation* of a cell to a genetically altered cell by damage to the DNA; (3) *promotion* of the altered cell to a preneoplastic lesion; (4) *conversion* of the preneoplastic lesion to a malignant tumor through a genetic change; and finally (5) *progression* of the tumor to clinical cancer. Exposure to a carcinogen must result in a genetic change in order to initiate a cell; likewise, there must also be a genetic change for a preneoplastic lesion to convert into a malignant tumor.[5] These genetic changes can occur from spontaneous mutations, and they can also occur with DNA adduct formation from exposure to carcinogens that are initiators or promoters, or both. These genetic changes also must occur in certain chromosomal locations in order to cause the next step in carcinogenicity. Mutations in some of these chromosomal locations have been identified, such as activation of proto-oncogenes or inactivation of tumor suppressor genes, but these and other processes are still being researched.[5]

There are many confounding factors that prevent every exposure to a carcinogen from resulting in clinical cancer. Genetic predisposition—inheritance of certain genetic mutations, variations in activity of metabolizing enzymes and DNA repair enzymes, variations in immunity and immune cell enzymes—plays an important role in the development or lack of development of cancers. Variations in lifestyle and overall health can also play a part as these may affect immune function and intracellular repair processes.

The suspected mechanism of carcinogenesis of nitrosamines is that nitrosamines, from exogenous or endogenous sources, are metabolized into reactive intermediates which can then covalently bind to macromolecules, including DNA. If the adducts to the DNA result in a genetic mutation during the replication process, and if that mutation is in certain areas of the genome, the cell could undergo the second and third stages of carcinogenesis—initiation and promotion. If there was a second genetic change in the right place, conversion to a malignant tumor could result.

Although a causal association between nitrosamine exposure and human cancer has not yet been firmly established, there is circumstantial evidence that nitrosamines could cause cancer in humans. In 1956, Magee and Barnes demonstrated the carcinogenic potential of N-nitrosodimethylamine (NDMA) in rats.(6) Since then, nitrosamines have been studied extensively in laboratory animals. Approximately 90% of the 300 tested nitrosamines have shown carcinogenic effects in bioassays and laboratory animals. The animals that have been studied include mammals, birds, fish, and amphibia. Of the approximately 40 animal species tested, none has been resistant. The tumor sites depend on the specific nitrosamine, the species tested, and the route of administration. Nitrosamine affects have been demonstrated in the bladder, bronchi, central nervous system, earduct, esophagus, eyelid, duodenum, forestomach, glandular stomach, hematopoietic system, intestine, jaw, kidney, larynx, nasal cavity, oral cavity, ovary, liver, mammary glands, pancreas, pelvis, peripheral nervous system, pharynx, respiratory tract, skin, testes, trachea, uterus, and vagina.(7) Dose-response studies with rats have shown "no effect levels" corresponding to dietary concentrations of 1 part per million (ppm) NDMA, 1 ppm NDEA, and 1 ppm NPYR.(7) These N-nitrosamines and others appear to be very potent carcinogens.

All of the biochemical, pathological, and experimental data provides little evidence that humans might be resistant to the carcinogenic potential of nitrosamines.(8) Human tissues from the trachea, bronchus (lung), esophagus, colon, pancreatic duct, bladder, and buccal mucosa have been shown to metabolize nitrosamines into DNA-binding compounds.(8) Human liver tissue appears to metabolize nitrosamines with a similar activity to rodent liver tissue, and rodents have similar acute symptoms of liver necrosis and cirrhosis that have been observed in humans.(8) A few human DNA adduct studies have revealed higher levels of nitrosamine-related DNA adducts in cancer cases than in controls.(9,10) Studies in experimental animals have shown similar DNA adduct formation to those detected in the human studies.(11-13)

Only one nitrosamine, NDMA, is regulated in the United States. Both OSHA and NIOSH considers NDMA as an occupational carcinogen, recommending that its exposure be reduced to the lowest feasible concentration. There are no established *numerical* exposure limits in this country.

Germany has strict regulations for occupational exposures to nitrosamines. In general industry, the total exposure to all nitrosamines present may not exceed 1 µg/m^3. In special cases, such as rubber vulcanization, exposures to all nitrosamines present may not exceed 2.5 µg/m^3. In addition to these regulations, eight nitrosamines are regulated individually—nitrosodimethylamine, nitrosomorpholine, nitrosopiperidine, henyl-ethylnitrosamine, phenyl-methylnitrosamine, di-N-butylnitrosamine, di-iso-propylnitrosamine, and diethylnitrosamine.

Particulates, not otherwise classified

In contrast to fibrogenic dusts which cause scar tissue to be formed in the lungs when inhaled in excessive amounts, so-called "nuisance dust" now termed "Particles Not Otherwise Classified, PNOC" have a long history of little adverse effects on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. Such dusts have been called (biologically) "inert" dusts, but the latter term is inappropriate because there is no dust which does not invoke some cellular response in the lung when inhaled in sufficient amount. However, the lung-tissue reaction caused by inhalation of nuisance dust has the following characteristics: the architecture of the air spaces remains intact; scar tissue is not formed to a significant extent; and, the tissue reaction is potentially reversible.

Excessive concentrations of dusts in the workroom air may seriously reduce visibility; may cause unpleasant deposits in the eyes, ears, and nasal passages; or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by the rigorous skin cleansing procedures necessary for their removal.(14) Often the chemical composition of the airborne particulate does not have an established occupational health exposure criterion. It has been the convention to apply a generic exposure criterion in such cases. Formerly referred to as nuisance dust, the preferred terminology for the non-specific particulate ACGIH TLV criterion is now *"particulates, not otherwise classified (n.o.c.),"* [or *"not otherwise regulated"* (n.o.r.) for the OSHA PEL].(15)

The OSHA PEL for total particulate, n.o.r., is 15.0 mg/m^3 and 5.0 mg/m^3 for the respirable fraction, determined as an 8-hour TWA exposure. The ACGIH recommended TLV for exposure to a particulate, n.o.c., is 10.0 mg/m^3 (total dust, 8-hour TWA).

Silica (Quartz, Cristobalite)

Crystalline silica (quartz) and cristobalite have been associated with silicosis, a fibrotic disease of the lung caused by the deposition of fine particles of crystalline silica in the lungs. Symptoms usually develop insidiously, with cough, shortness of breath, chest pain, weakness, wheezing, and non-specific chest illnesses. Silicosis usually occurs after years of exposure, but may appear in a shorter period of time if exposure concentrations are very high.(16) The NIOSH RELs for respirable quartz and cristobalite, published in 1974, are 50 $\mu g/m^3$, as TWAs, for up to 10 hours per day during a 40-hour work week.(17) These RELs are intended to prevent silicosis. However, evidence indicates that crystalline silica is a potential occupational carcinogen and NIOSH is currently reviewing the data on carcinogenicity.(18-20) The OSHA PELs and the ACGIH TLVs for respirable quartz and cristobalite are 100 and 50 $\mu g/m^3$, as 8-hour TWAs, respectively.

Formaldehyde

Formaldehyde is a colorless gas with a strong odor. Exposure can occur through inhalation and skin absorption. The acute effects associated with formaldehyde are irritation of the eyes and respiratory tract and sensitization of the skin. The first symptoms associated with formaldehyde exposure, at concentrations ranging from 0.1 to 5 parts per million (ppm), are burning of the eyes, tearing, and general irritation of the upper respiratory tract. There is variation among individuals, in terms of their tolerance and susceptibility to acute exposures of the compound.(21)

In two separate studies, formaldehyde has induced a rare form of nasal cancer in rodents. Formaldehyde exposure has been identified as a possible causative factor in cancer of the upper respiratory tract in a proportionate mortality study of workers in the garment industry.(22) NIOSH has identified formaldehyde as a suspected human carcinogen and recommends that exposures be reduced to the lowest feasible concentration. The OSHA PEL is 0.75 ppm as an 8-hour TWA and 2 ppm as a STEL.(23) The ACGIH has designated formaldehyde to be a suspected human carcinogen and therefore, recommends that worker exposure by all routes should be carefully controlled to levels "as low as reasonably achievable" below the TLV. The ACGIH has set a ceiling limit of 0.3 ppm.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless, tasteless gas produced by incomplete burning of carbon-containing materials; e.g., natural gas. The initial symptoms of CO poisoning may include headache, dizziness, drowsiness, and nausea. These initial symptoms may advance to vomiting, loss of consciousness, and collapse if prolonged or high exposures are encountered. Coma or death may occur if high exposures continue.[24-28]

The NIOSH REL for CO is 35 ppm for an 8-hour TWA exposure, with a ceiling limit of 200 ppm which should not be exceeded. The NIOSH REL of 35 ppm is designed to protect workers from health effects associated with COHb (carboxyhemoglobin) levels in excess of 5%. The ACGIH recommends an 8-hour TWA TLV of 25 ppm as an 8-hour TWA. The OSHA PEL for CO is 50 ppm for an 8-hour TWA exposure. In addition to these standards, the National Research Council has developed a CO exposure standard of 15 ppm, based on a 24 hours per day, 90-day TWA exposure.[29]

Sulfur Dioxide

Sulfur dioxide is intensely irritating to the eyes, mucous membranes, and respiratory tract. It can cause burning of the eyes and tearing coughing and chest tightness. Exposure may cause severe breathing difficulties. It forms sulfurous acid on contact with moist membranes.[30] NIOSH, OSHA, and ACGIH have set an exposure limit of 2 ppm for sulfur dioxide.

RESULTS

Nitrosamines

A total of 79 personal breathing zone and work area samples were collected and analyzed for the seven nitrosamine compounds previously mentioned. Appendix I shows the results of all the nitrosamine samples collected during this investigation. Of those 79 samples, 66 (85%) were personal breathing zone samples, 12 (15%) were collected at various work locations throughout the plant, and 1 (1%) was voided. Twenty-three of the personal breathing zone samples (including the one voided sample) and five work area samples were collected on employees involved in mixing operations. Forty-four personal breathing zone and seven work area samples were collected on employees involved in pressing.

Of the seven nitrosamine analytes, only N-nitrosopiperidine (NPIP) was detected. Low concentrations of NPIP were on 16 of the 78 (21%) samples collected. The range of NPIP detected on all the samples collected was ND (not detected) to 0.53μg/m^3. The minimum detectable concentration (MDC) for this analysis was 0.01μg/m^3. Sample results listed as ND were below the MDC.

The sampling results were further stratified by production area, either mixing or pressing. For identification, the dividing line between mixing and pressing used in this analysis was simply the point where dry ingredients were no longer used in the process.

Therefore, the mixing operations included jobs such as the Banbury mixers and relief persons, mill operators, supply men, compounders, colormen, and paper bailers, etc. The pressing operations included jobs such as press operators, breakdown operators, jelly rollers, calender operators, etc.

A summary of the sampling results in Table 1 shows that samples collected in the mixing areas showed the highest concentration of NPIP exposures. Of the 22 personal breathing zone samples collected in the mixing area, 8 had detectable NPIP. The NPIP detected, although low, ranged from 0.01 - 0.53 $\mu g/m^3$. The average NPIP exposure for those eight samples was 0.14 $\mu g/m^3$. The highest exposure to NPIP, 0.53 $\mu g/m^3$, was measured on the Banbury Relief occupation. This was the only occupation which showed detectable NPIP on all three samples collected during the three day investigation.

Table 1. NPIP Sampling Summary.

	Personal Sample Results		***Area Sample Results***	
	Mixing	***Pressing***	***Mixing***	***Pressing***
Samples with NPIP	8	6	1	1
Mean NPIP Exposure	0.14 $\mu g/m^3$	0.02 $\mu g/m^3$	0.07$\mu g/m^3$	0.01 $\mu g/m^3$
Standard Deviation	0.16	0.004	n/a	n/a
Range	0.01 - 0.53 $\mu g/m^3$	0.01 - 0.02 $\mu g/m^3$	n/a	n/a

Of the 44 personal breathing zone air samples collected throughout the press areas of the plant, 6 (14%) showed detectable NPIP. The amount of NPIP detected on those six samples collected in the press areas ranged from 0.01 - 0.02 $\mu g/m^3$. The highest exposure, 0.02 $\mu g/m^3$, was measured at the 84" mill, 1-2 presses and 17-20 presses.

Respirable Dust and Crystalline Silica

A total of 62 personal breathing zone and work area samples were collected and analyzed for respirable dust and crystalline silica exposure. Appendix II shows the results of all the respirable dust and crystalline silica samples collected during this investigation.

Of the 62 samples collected, 50 (81%) were personal breathing zone samples and 12 (19%) were work area samples. Overall, the range of respirable dust levels measured from all personal breathing zone samples collected throughout the plant was

0.03 - 3.17 milligrams per cubic meter of air (mg/m^3), with a mean exposure level of 0.56 mg/m^3, and a standard deivation of 0.65.

The respirable dust results are also summarized in Table 2 according to production area; mixing or pressing. Both personal breathing zone samples and work area collected on occupations involved in mixing operations showed a higher exposure to respirable dust as compared to pressing operations. None of the 50 personal breathing zone samples collected from either the mixing or pressing areas exceeded the OSHA respirable dust exposure criteria of 5 mg/m^3 for particles not otherwise classified.

Table 2. Summary of Respirable Dust Sampling Data

	Personal Sample Results		*Area Sample Results*	
	Mixing	*Pressing*	*Mixing*	*Pressing*
Number of Samples	30	20	7	5
Mean	0.76 mg/m^3	0.24 mg/m^3	1.55 mg/m^3	0.14 mg/m^3
Standard Deviation	0.76	0.15	2.88	0.32
Range	0.06 - 3.17 mg/m^3	0.03 - 0.70 mg/m^3	0.12 - 8.59 mg/m^3	0.06 - 0.32 mg/m^3

Of the 12 area samples, one sample, 94-4366, showed a respirable dust level of 8.59 mg/m^3. That sample was collected near the #3 Banbury mixer, directly by the load bin. That sample was placed near the bin by the NIOSH investigator in order to expose it to as much dust as possible in order to serve as a bulk dust air sample. The results from that sample do not reflect a potential exposure level.

All samples collected for respirable dust were also analyzed for crystalline silica. No crystalline silica was detected on any of the 62 samples collected during this investigation.

Elemental Metals

During this investigation, 12 work area samples were collected and analyzed for 28 different elemental metals. Results of that analysis indicated only trace quantities of metals present. The primary metals observed on the samples were iron (Fe), aluminum (Al), copper (Cu), calcium (Ca), magnesium (Mg), titanium (Ti), and Zinc (Zn). All sampling results for the metals identified were far below any existing exposure criteria;

and in many cases, the amounts observed on the samples were at or slightly above the minimum detectable concentration.

Formaldehyde

Workers were concerned that an emulsion, Dow Corning® 36, used as a releasing agent in the presses could release formaldehyde. A label on the emulsion container states that when the emulsion is heated above 300°F that formaldehyde vapors could be produced. The presses operate at 300°F.

Six formaldehyde samples were collected on ORBO-23 sampling tubes near the large roll presses, identified by RCA as A-F. No formaldehyde was detected on any of the samples collected. The minimum detectable concentration of formaldehyde was 0.001 ppm.

Carbon Monoxide

Eight area samples for carbon monoxide were collected throughout the mixing and press areas. Of those eight samples, three samples showed trace quantities of carbon monoxide. The highest carbon monoxide level measured near the #3 Banbury mixer was 8 ppm. None of the carbon monoxide samples exceeded any existing exposure criteria.

Sulfur Dioxide

Sixteen area samples for sulfur dioxide were collected throughout the plant. Of those samples, only four samples showed trace amounts of sulfur dioxide. The highest sulfur dioxide level, 0.3 ppm, was measured near the A-F presses. Many of the sulfur dioxide samples collected near the presses showed an interference in the length of color stain and were voided. The interference observed was most likely due to the steam (water vapor) coming from the presses. None of the sulfur dioxide samples exceeded exposure criteria.

CONCLUSIONS/RECOMMENDATIONS

During this survey, results of the environmental sampling did not indicate that a health hazard existed for either mixing or pressing employees. Personal breathing zone samples were collected on production employees involved in either mixing or pressing operations. None of the samples collected exceeded any of the existing exposure criteria.

N-nitrosopiperidine (NPIP) was the only nitrosamine detected on the samples collected at the RCA Rubber Company. NPIP, as with other nitrosamines, is classified as a suspected human carcinogen. However, there are currently no airborne standards for exposure to NPIP. As with any carcinogen, NIOSH recommends that occupational exposures be controlled to the lowest feasible limit. In reviewing the nitrosamine sampling data collected at RCA Rubber Company, it has been concluded that the levels of nitrosamine detected would constitute a lowest feasible limit exposure. Of those samples in which NPIP was detected, most all were at or just above the minimum detectable concentration. Therefore, the NPIP exposures encountered would not represent a health hazard to employees.

The RCA Rubber Company has instituted a respiratory protection program for employees working in the production areas of the plant. One reason for instituting this program was due to the uncertainty of employees workplace exposures. Employees working in the mixing areas of the plant are required to wear dust respirators and those working around the mixers, mills, and presses are required to wear half facepiece organic vapor and particulate respirators. Based on the environmental data collected during this investigation, the mandatory use of respiratory protection by mixing and press personnel should be reviewed by company officials.

There are four specific areas in the mixing department in which respirators should be used, despite exposure levels, until appropriate engineering controls are installed. Based on our observations of work practices, we feel that there is a potential for excessive dust exposures to occur at those work sites. Those areas are the #3 Banbury and #9 Banbury mixers, compounders weighing scales, and the paper bailer. Even though dust levels were below existing occupational health standards, these areas deserve special attention for engineering controls since large quantities of airborne dusts were observed emanating from these machines, and/or sampling indicated these were a siginificant sources of airborne dusts within the plant.

The #3 Banbury mixer is a major source of dust generation and suspension within the plant. Although the mixer is fitted with local exhaust ventilation, dust was observed escaping from the rear of the mixer. Each time the mixer's piston shaft is raised or lowered, dust blows from the opening at the rear of the mixer. It appears that the cover plate is missing from the mixer's piston housing. The #9 Banbury had a cover plate over the piston shaft housing and no dust was observed escaping. A cover plate should be installed over the piston housing.

The second area which requires engineering controls is the weighing table for the #9 Banbury mixer. A canopy hood with side draft is located directly above the mixer to capture dusts generated during the mixing process. However, the conveyor-type table where the dry ingredients are dumped and weighed has no dust control. During this investigation, it was observed that one of the operator's greatest potential for exposure occurred during the emptying of bags onto the table. Canopy hoods are not recommended as a method of contaminant control in a worker's breathing zone. This is because the contaminate is pulled up past the worker's breathing zone. The recommended method of control in this situation would be to pull the contaminant away from the worker's breathing zone. There are a number ways of accomplishing this, such as the installation of a slotted hood directly behind the conveyor which pulls the dust away from the operator's breathing zone. Another method would be to use a push - pull ventilation system, one that pushes clean air from behind the worker into a plenum that is pulling the dust away from the operator.

Another area which depends on a canopy hood to control dust exposures is the area where the compounder weighs dry ingredients. This is a similar situation in which the canopy hood is not an effective dust control technique. Again the dust is pulled up past the worker's breathing zone. As with the #9 Banbury mixer, the best method of controlling exposures would be to pull the dust away from the worker.

An engineering firm familiar with ACGIH Industrial Ventilation[31] recommendations should be retained to redesign the exhaust hoods in the mixing areas. Any design which draws the dust past the worker's breathing zone should be discouraged. In addition, a thorough evaluation of all the existing ventilation systems should be conducted to assure that the capture velocities are adequate and there are no leaks in the systems.

General housekeeping of the plant, particularly the mixing areas, needs to be addressed by RCA management and workers. Where local exhaust ventilation and collection systems are used, they should be maintained to prevent the accumulation or recirculation of particulate matter into the workplace. Emphasis should be placed upon cleanup of spills, preventive maintenance and repair of equipment, and proper storage of materials. Cleaning by blowing with compressed air or dry sweeping should be prohibited and dustless methods of cleaning such as vacuuming or washing down with water, should be evaluated.

Finally, the RCA Rubber Company should conduct periodic industrial hygiene sampling of plant operations. This will be particularly important in the event of a process or chemical ingredient change. It is not necessary to sample the entire plant each time, but rather target particular processes. All sampling records should be maintained in accordance with OSHA regulations, and results posted for employee inspection. A list of industrial hygiene consultants are available in a number of different professional journals.

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1. RCA Rubber Company
2. United Rubber Workers of America, Local 8
3. OSHA, Region V

This report will serve to close-out this health hazard evaluation at the RCA Rubber Company of Akron, Ohio. For the purpose of informing affected employees, copies of this report should be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Appendix I
Nitrosamine Sampling Results

HETA 95-0162
RCA Rubber Company
Akron, Ohio
April 18-20, 1995

Sample Date	Sample Number	Sample/Worker Location	Sample Type	Sample Volume (liters)	Concentration ($\mu g/m^3$)						
					NDMA	NDEA	NDPA	NDBA	NPYR	NMOR	NPIP
41895	824501	Banbury Relief	Personal	866	ND	ND	ND	ND	ND	ND	0.06
41895	824502	#9 Banbury Supply	Personal	840	ND	ND	ND	ND	ND	ND	0.18
41895	824503	#3 Banbury Operator	Personal	866	ND	ND	ND	ND	ND	ND	ND
41895	824504	Colorman	Personal	850	ND	ND	ND	ND	ND	ND	ND
41895	824505	#3 Mill Operator	Personal	834	ND	ND	ND	ND	ND	ND	ND
41895	824506	Press Operator (A-F)	Personal	812	ND	ND	ND	ND	ND	ND	ND
41895	824507	#1-2 Press Operator	Personal	796	ND	ND	ND	ND	ND	ND	ND
41895	824508	Wig-Wag Operator	Personal	838	ND	ND	ND	ND	ND	ND	ND
41895	824509	VOID	-	-	-	-	-	-	-	-	-
41895	824510	#3 Compounder	Personal	780	ND	ND	ND	ND	ND	ND	ND
41895	824511	Press Operator (A-F)	Personal	808	ND	ND	ND	ND	ND	ND	ND
41895	824512	Breakdown Mill Operator	Personal	826	ND	ND	ND	ND	ND	ND	ND
41895	824513	#17-20 Press Operator (Bottom)	Personal	794	ND	ND	ND	ND	ND	ND	ND
41895	824514	Windup Operator	Personal	812	ND	ND	ND	ND	ND	ND	ND
41895	824515	#9 Banbury Mixer	Area	750	ND	ND	ND	ND	ND	ND	0.07
41895	824516	84" Mill	Personal	820	ND	ND	ND	ND	ND	ND	ND
41895	824517	#22-23 Press Operator	Personal	798	ND	ND	ND	ND	ND	ND	ND
41895	824518	#9 Compounder	Personal	836	ND	ND	ND	ND	ND	ND	0.01
41895	824519	Paper Bailer	Personal	842	ND	ND	ND	ND	ND	ND	ND
41895	824520	Slab-off Mill Operator	Personal	824	ND	ND	ND	ND	ND	ND	ND
41895	824521	#3 Mill	Area	752	ND	ND	ND	ND	ND	ND	ND
41895	824522	#9 Mil	Area	740	ND	ND	ND	ND	ND	ND	ND
41895	824523	#3 Banbury Mixer	Area	762	ND	ND	ND	ND	ND	ND	ND
41895	824524	Calender Operator	Personal	818	ND	ND	ND	ND	ND	ND	ND
41895	824525	#17-20 Press Operator (Top)	Personal	788	ND	ND	ND	ND	ND	ND	ND
41895	824526	Calender Helper	Personal	822	ND	ND	ND	ND	ND	ND	ND

Sample Date	Sample Number	Sample/Worker Location	Sample Type	Sample Volume (liters)	Concentration ($\mu g/m^3$)						
					NDMA	NDEA	NDPA	NDBA	NPYR	NMOR	NPIP
41895	824527	Jelly Roller	Personal	816	ND	ND	ND	ND	ND	ND	ND
41895	824528	#9 Banbury Operator	Personal	442	ND	ND	ND	ND	ND	ND	0.05
41995	824529	Calender Operator	Personal	846	ND	ND	ND	ND	ND	ND	ND
41995	824530	#3 Compounder	Personal	868	ND	ND	ND	ND	ND	ND	ND
41995	824531	Tread Press (#18)	Area	798	ND	ND	ND	ND	ND	ND	ND
41995	824532	Above 84" Mill	Area	806	ND	ND	ND	ND	ND	ND	0.01
41995	824533	#3 Banbury Mixer	Area	808	ND	ND	ND	ND	ND	ND	ND
41995	824534	Presses (Between D&E)	Area	800	ND	ND	ND	ND	ND	ND	ND
41995	824535	#1-2 Press Operator	Personal	836	ND	ND	ND	ND	ND	ND	ND
41995	824536	#17-20 Press Operator (Bottom)	Personal	858	ND	ND	ND	ND	ND	ND	0.02
41995	824537	Windup Operator	Personal	854	ND	ND	ND	ND	ND	ND	ND
41995	824538	Calender Helper	Personal	862	ND	ND	ND	ND	ND	ND	ND
41995	824539	Sander	Personal	838	ND	ND	ND	ND	ND	ND	ND
41995	824540	Jelly Roller	Personal	808	ND	ND	ND	ND	ND	ND	ND
41995	824541	84" Mill Operator	Personal	678	ND	ND	ND	ND	ND	ND	ND
41995	824542	Slab-off Mill Operator	Personal	858	ND	ND	ND	ND	ND	ND	ND
41995	824543	Breakdown Mill Operator	Personal	868	ND	ND	ND	ND	ND	ND	ND
41995	824544	Paper Bailer	Personal	880	ND	ND	ND	ND	ND	ND	ND
41995	824545	Banbury Relief	Personal	678	ND	ND	ND	ND	ND	ND	0.53
41995	824546	Wig-Wag Operator	Personal	670	ND	ND	ND	ND	ND	ND	0.01
41995	824547	#9 Compounder	Personal	690	ND	ND	ND	ND	ND	ND	0.17
41995	824548	#3 Banbury Operator	Personal	888	ND	ND	ND	ND	ND	ND	ND
41995	824549	Colorman	Personal	882	ND	ND	ND	ND	ND	ND	ND
41995	824550	#9 Banbury Operator	Personal	698	ND	ND	ND	ND	ND	ND	0.01
41995	824551	#3 Banbury Mill Operator	Personal	882	ND	ND	ND	ND	ND	ND	ND
41995	824552	#22-23 Press Operator	Personal	842	ND	ND	ND	ND	ND	ND	ND
41995	824553	#17-20 Presses (Top)	Personal	846	ND	ND	ND	ND	ND	ND	ND
41995	824554	Press Operator (A-F)	Personal	862	ND	ND	ND	ND	ND	ND	ND
41995	824555	Press Operator(A-F)	Personal	858	ND	ND	ND	ND	ND	ND	ND
42095	824556	Tread Presses	Area	832	ND	ND	ND	ND	ND	ND	ND
42095	824557	Jelly Roller	Area	834	ND	ND	ND	ND	ND	ND	ND
42095	824558	Offices (Background)	Area	838	ND	ND	ND	ND	ND	ND	ND
42095	824559	#3 Banbury Mixer	Area	832	ND	ND	ND	ND	ND	ND	ND

Sample Date	Sample Number	Sample/Worker Location	Sample Type	Sample Volume (liters)	Concentration ($\mu g/m^3$)						
					NDMA	NDEA	NDPA	NDBA	NPYR	NMOR	NPIP
42095	824560	Jelly Roller	Personal	836	ND	ND	ND	ND	ND	ND	ND
42095	824561	#3 Banbury Mill Operator	Personal	880	ND	ND	ND	ND	ND	ND	ND
42095	824562	Colorman	Personal	920	ND	ND	ND	ND	ND	ND	ND
42095	824563	#22-23 Press Operator	Personal	854	ND	ND	ND	ND	ND	ND	0.01
42095	824564	Slab-Off Mill Operator	Personal	886	ND	ND	ND	ND	ND	ND	ND
42095	824565	Jelly Roller	Personal	870	ND	ND	ND	ND	ND	ND	ND
42095	824566	Wig-Wag Operator	Personal	874	ND	ND	ND	ND	ND	ND	ND
42095	824567	Sander	Personal	832	ND	ND	ND	ND	ND	ND	ND
42095	824568	84" Mill Operator	Personal	868	ND	ND	ND	ND	ND	ND	0.02
42095	824569	Breakdown Mill Operator	Personal	866	ND	ND	ND	ND	ND	ND	ND
42095	824570	Wind-up Operator	Personal	868	ND	ND	ND	ND	ND	ND	ND
42095	824571	Calender Helper	Personal	868	ND	ND	ND	ND	ND	ND	ND
42095	824572	Calender Operator	Personal	868	ND	ND	ND	ND	ND	ND	ND
42095	824573	Press Operator (A-F)	Personal	866	ND	ND	ND	ND	ND	ND	ND
42095	824574	#17-20 Press Operator (Top)	Personal	856	ND	ND	ND	ND	ND	ND	ND
42095	824575	#17-20 Press Operator (Bottom)	Personal	846	ND	ND	ND	ND	ND	ND	0.02
42095	824576	Forklift Operator	Personal	820	ND	ND	ND	ND	ND	ND	ND
42095	824577	1-2 Press Operator	Personal	856	ND	ND	ND	ND	ND	ND	0.02
42095	824578	Press Operator (A-F)	Personal	872	ND	ND	ND	ND	ND	ND	ND
42095	824579	Banbury Relief	Personal	880	ND	ND	ND	ND	ND	ND	0.10
Minimum Detectable Concentration					**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**

ND = Not Detected

N-nitrosodimethylamine (NDMA), N-nitrosodiethylamine (NDEA), N-nitrosodipropylamine (NDPA), N-nitrosodibutylamine (NDBA), N-nitrosopyrrolidine, (NPYR), N-nitrosomorpholine (NMOR), and N-nitrosopiperidine (NPIP)

Appendix II
Respirable Dust and Silica Dust Sampling Results

HETA 95-0162
RCA Rubber Company
Akron, Ohio
April 18-20, 1995

Sample Date	Sample Number	Sampler/Worker Location	Sample Type	Sample Volume (liters)	Respirable Dust Concentration (mg/m³)	Silica Dust Concentration (mg/m³)
41895	95-0159	Slab-off Mill Operator	Personal	706	0.14	ND
41895	95-0158	#9 Banbury Operator	Personal	728	3.15	ND
41895	95-0160	Breakdown Mill Operator	Personal	706	0.38	ND
41895	95-0162	#9 Banbury Mixer	Area	639	0.25	ND
41895	95-0161	#3 Banbury Operator	Personal	731	0.60	ND
41895	95-0154	Wig-Wag Operator	Personal	700	0.24	ND
41895	95-0153	#3 Compounder	Personal	666	0.62	ND
41895	95-0155	#1-2 Press Operator	Personal	678	0.21	ND
41895	95-0157	#22-23 Press Operator	Personal	687	0.29	ND
41895	95-0156	Banbury Relief	Personal	738	0.85	ND
41895	95-0170	#3 Mill	Area	639	0.53	ND
41895	95-0169	#9 Mill	Area	634	0.39	ND
41895	95-0172	Paper Bailer	Personal	712	3.17	ND
41895	95-0175	#3 Banbury Operator	Personal	719	0.70	ND
41895	95-0174	Colorman	Personal	716	0.70	ND
41895	95-0164	84" Mill Operator	Personal	700	0.29	ND
41895	95-0163	Forklift Operator	Personal	660	0.14	ND
41895	95-0165	#3 Banbury Supplyman	Personal	707	0.47	ND
41895	95-0168	Compounder	Personal	711	0.06	ND
41895	95-0166	#3 Banbury Mixer	Area	646	0.71	ND
41995	94-4400	#3 Compounder	Personal	741	0.50	ND
41995	94-4401	#22-23 Press Operator	Personal	721	0.19	ND
41995	94-4398	Tread Press (#18)	Area	683	0.06	ND
41995	94-4399	Slab-off Mill Operator	Personal	733	0.18	ND
41995	94-4407	Jelly Roller	Personal	690	0.14	ND
41995	94-4408	84" Mill	Area	685	0.12	ND
41995	94-4402	Breakdown Mill Operator	Personal	731	0.26	ND
41995	94-4406	84" Mill Operator	Personal	571	0.49	ND
41995	94-4388	#9 Banbury Operator	Personal	590	0.97	ND
41995	94-4389	Sander	Personal	719	0.08	ND
41995	94-4390	#9 Compounder	Personal	587	1.48	ND
41995	94-4385	#3 Banbury Mill Operator	Personal	748	0.43	ND
41995	94-4386	Paper Bailer	Personal	745	1.96	ND
41995	94-4387	Sander	Personal	706	0.06	ND
41995	94-4394	Presses (Between D & E)	Area	678	0.32	ND
41995	94-4396	Colorman	Personal	746	0.52	ND
41995	94-4397	#3 Banbury Operator	Personal	750	0.80	ND
41995	94-4391	Banbury Relief	Personal	576	0.45	ND
41995	94-4392	Wig-Wag Operator	Personal	568	0.26	ND
41995	94-4393	#3 Banbury Mixer	Area	690	0.26	ND
42095	95-0171	#3 Compounder	Personal	711	0.59	ND

Sample Date	Sample Number	Sampler/Worker Location	Sample Type	Sample Volume (liters)	Respirable Dust Concentration (mg/m^3)	Silica Dust Concentration (mg/m^3)
42095	94-4371	Roll Presses (Desk)	Area	709	0.17	ND
42095	94-4372	Office (Background)	Area	711	0.06	ND
42095	94-4374	#3 Banbury Operator	Personal	755	0.32	ND
42095	94-4373	Sander	Personal	707	0.13	ND
42095	95-0173	#3 Banbury Mill Operator	Personal	748	0.95	ND
42095	95-0305	Colorman	Personal	782	0.52	ND
42095	94-4366	#3 Banbury Mixer	Area	706	8.59	ND
42095	95-0176	Finish Sander	Personal	672	0.12	ND
42095	94-4370	Tread Presses (#18)	Area	707	0.07	ND
42095	94-4369	Break-down Mill Operator	Personal	736	0.03	ND
42095	94-4381	#9 Banbury Operator	Personal	757	1.00	ND
42095	94-4380	#9 Compounder	Personal	753	0.57	ND
42095	94-4382	22-23 Press Operator	Personal	728	0.12	ND
42095	94-4384	Slab-off Mill Operator	Personal	755	0.37	ND
42095	94-4383	Wig-Wag Operator	Personal	745	0.15	ND
42095	94-4379	Jelly Roller	Personal	740	0.03	ND
42095	94-4375	Sander	Personal	712	0.18	ND
42095	95-0167	Banbury Relief	Personal	760	0.61	ND
42095	94-4376	Paper Bailer	Personal	751	0.97	ND
42095	94-4378	#3 Compounder	Personal	743	0.09	ND
42095	94-4377	84" Mill Operator	Personal	740	0.26	ND
Minimum Detectable Concentrations					**0.01**	**0.01**
Minimum Quantifiable Concentrations					**0.02**	**0.03**

Delivering on the Nation's promise:
Safety and health at work for all people
Through research and prevention

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