

Medical Records and Industrial Hygiene Studies

for

B. F. Goodrich Company

Progress Report, March 20, 1974

24383601

Prepared by

TABERSHAW-COOPER ASSOCIATES, INC.

2180 Milvia Street

Berkeley, California 94704

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TABLE OF CONTENTS

- I. Introduction
 - A. Background
 - B. Format
 - C. Summary Timetable of Activities Completed
- II. Recommendations
 - A. Summary of Medical Recommendations
 - B. Summary of Industrial Hygiene Recommendations
 - C. Summary of Epidemiologic Recommendations
- III. Projected Activities for March and April
- IV. List of Appendices
 - A. Summary report of meeting held February 27, Akron, to discuss TCA, Inc. activities (Dr. Tabershaw).
 - B. Summary report of March 5 meeting held to discuss suggested medical program for B. F. Goodrich (Dr. Tabershaw).
 - C. Industrial hygiene report on Louisville Plant (Dr. Tebbens/Dr. Reischl).
 - D. Letters describing particle sizes for PVC, and analyses of dust from bin sampled at Louisville.
 - E. Letter detailing specifications for Scrubber, available from Fisher-Klosterman, Inc.
 - F. Trip Report, Louisville Plant, February 18-21 (Dr. Barber, Mr. Davis, Ms. Lindsey)
 - G. Trip Report, Avon Lake, February 21 (Dr. Cooper).
 - H. Summaries of Epidemiological Studies, Avon Lake and Louisville (Dr. Utidjian and Dr. Husting).

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I. Introduction

A. Background

This report details the status as of March, 1974 of consultative activities provided by Tabershaw/Cooper Associates, Inc. to B. F. Goodrich Company with respect to the mortality and morbidity ascribed to the handling of vinyl chloride, especially in the B. F. Goodrich Louisville plant.

As proposed in a letter from TCA dated February 15, this consultation has had three phases. First, emergency action was initiated to assess and to establish further details of the events and conditions at Louisville, Avon Lake, and Niagara Falls leading to the identification of several deaths due to angiosarcoma. This first phase is well advanced, and has included epidemiologic, medical, and industrial hygiene studies. The results to date form the body of this report.

Second, general consultation has been provided by Dr. I. R. Tabershaw and others, and the recommendations which have been discussed in meetings with B. F. Goodrich officers are reiterated in this report.

Finally, Tabershaw/Cooper Associates, Inc. is developing specific proposals which are based upon the findings reported here. These proposals will be addressed to (a) the development of an Occupational Health Surveillance System, (b) a Technical Information Monitoring System, (c) the review and adjustment of the occupational medical program, (d) the development of a series of epidemiologic studies, and (e) the review and adjustment of current industrial hygiene activities.

B. Format of the Report

Recommendations based on the findings of activities will be presented first. Following, individual sections will describe the activities and discuss the results from each of the areas of medical evaluation, epidemiology, and industrial hygiene.

C. Summary Timetable of Activities Completed

February 15	Letter proposal from TCA to B. F. Goodrich.
February 18	B. F. Goodrich-Louisville, Kentucky plant visited by TCA team to gather and evaluate data.
February 21	Visit to Avon Lake by Dr. Cooper, TCA, and assistant to gather and evaluate medical data.
February 22-23	Visit to Louisville, completed by Dr. Tebbens, to conduct industrial hygiene survey.

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February 27

Meeting of B. F. Goodrich officers in Akron, with Dr. Tabershaw, for discussion of TCA activities.

March 5

Meeting between Dr. Tabershaw, Goodrich officers, and C. D. C. representatives to discuss tentative medical program. Preliminary report of TCA epidemiologic activity presented to B. F. Goodrich.

II. Recommendations

A. Summary of Medical Recommendations

1. It was suggested (See Appendix A) that there are some concerns over present record keeping practices. Records should distinguish between deceased employees, active employees, and former employees still living.
2. It is recommended that cooperation should be given where possible, but the legal rights of various agencies and individuals to inspect records should be clearly defined. (See Appendix A).
3. The organization of the B. F. Goodrich medical department should be modified so that medical surveillance of workers is adequate, so that the occupational physician responsible for diagnosis and prevention and the clinician responsible for treating workers are identified and distinguished; so that nursing staff adequately perform health and laboratory surveillance; and so that laboratory testing is centralized. It may be necessary to establish or designate an outside laboratory to accomplish the last point.
4. A requirements analysis should be performed now. TCA will make a specific proposal.
5. Research attitudes as expressed by various agencies should be evaluated for their potential impact upon B. F. Goodrich and its employees. A mechanism should be established to review continuously and evaluate research proposals and findings.
6. A three phase program for identification and control of liver disease was discussed at a meeting in Cleveland on March 5. Dr. Tabershaw suggested liver scans as a fourth phase. (See Appendix B).

B. Summary of Industrial Hygiene Recommendations

1. Although levels of PVC dust are below nuisance limits in the Louisville plant, dust levels in some locations probably are high if it is determined that PVC dust is active, with or without entrained VCM. (See Appendix B).

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2. It was agreed in meetings including Dr. Tabershaw and Dr. Strassburg, that determination of dust levels, as well as determination of VCM levels, would be continued in all plants. (See Appendix B).

3. It was agreed that PVC products will be evaluated for their VCM levels.

4. It was agreed that environmental analysis leading to control of PVC compounding, mixing, and fabrication will be initiated and expanded.

5. The report by Dr. Tebbens and Dr. Reischl of TCA noted that great changes in exposures have been effected in the Louisville plant in the last two months. (See Appendices C, D, E).

6. The TCA industrial hygiene report (See Appendix C), recommends that PVC dust concentrations should be drastically reduced at packing stations, drying operations, and other locations. (See Appendix D).

7. The TCA report recommends that two procedures should be worked out and implemented as soon as possible to evaluate exposure of individuals to VC. The two methods should be personal monitoring and biomonitoring. Persons with greater exposure should be monitored more frequently. When developed, the monitoring procedures should be routine and continuous. (See Appendix C).

8. The TCA report recommends that mechanism of adherence of (or of incorporation) of VC on PVC should be investigated. Two factors should be considered initially. First, the Total VC that can be removed from the solid. Second, the rate at which desorption occurs under different ambient (including elevated) temperatures, including body temperature, should be measured. (See Appendix C).

C. Summary of Epidemiologic Recommendations

1. From findings of the visit to Louisville by the TCA team, it is suggested that B. F. Goodrich construct accurate job histories on current employees at all plants. This could be done by personnel staff through questionnaires and interviews, and would be useful in future evaluations of exposure histories.

2. It is suggested that B. F. Goodrich order permanent retention of all plant medical files. Some plants now destroy these after five years.

3. It is recommended that B. F. Goodrich immediately establish a system of review for all health insurance claim forms on a current basis. Such a review would have identified the claim form of Mr. Sims, the death revealed by the press, which clearly indicated that he had angiosarcoma. The forms could be reviewed by the plant nurse.

4. It is suggested that an epidemiologic study of deaths at all B. F. Goodrich plants be undertaken as soon as possible, focusing on

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plants making or involved with butadiene, and looking for patterns of morbidity or mortality which might be due to industrial exposure. TCA will submit proposals for epidemiologic studies.

5. TCA will continue to collect and analyze epidemiologic data from Louisville, Avon Lake, and Niagara. The current status of these studies, which are well advanced, is reported in Appendices F, G and H. The data required to complete the Phase I (emergency action) epidemiology include:

- a - Detailed job histories of five known cases of angiosarcoma from Louisville, constructed by the plant.
- b - Description of plant procedures provided NIOSH by Louisville.
- c - Medical insurance claim forms in Louisville personnel files.
- d - Confirmation of three deaths at Avon Lake (See Appendix G).
- e - Hospital records and autopsy data collected by C. D. C. for Louisville, Avon Lake and Niagara Falls.
- f - Any other records held by Dr. Creech or other B. F. Goodrich personnel relating to known living cases of angiosarcoma.
- g - Complete review of records for Niagara Falls employees.

III. Projected Activities for March and April

1. The Phase I activities will be concluded as rapidly as possible and a report submitted. Delays at this stage depend upon obtaining data in the control of other persons or agencies. If it seems expeditious, this phase will be completed by a visit by TCA professional staff to C. D. C. (Atlanta), Louisville, and to Cleveland. The general purpose of this trip would be to review the existing data with involved individuals and to verify that all possible sources of information have been exhaustively studied. This may be necessary to provide B. F. Goodrich with assurance regarding the Louisville situation.

2. In mid-March, TCA professional staff and staff from Informatics will meet with B. F. Goodrich personnel to discuss plans for a REQUIREMENTS ANALYSIS leading to a comprehensive surveillance system, with appropriate record.

3. The results of a preliminary search and review of the literature will be submitted. A detailed proposal for a comprehensive search, including refinement of the search strategy, collection, review and evaluation of relevant literature will be submitted.

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4. Dr. I. R. Tabershaw, supported by the TCA staff, will continue to be available to B. F. Goodrich for consultation.

Additional proposals will be submitted, as appropriate, from TCA, dealing with needed medical activities, epidemiology, and industrial hygiene.

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Appendix A.- Report on meeting at B.F. Goodrich, Akron. Wednesday,
February 27, 1974. Dr. I.R. Tabershaw, M.D.

A Strategy Meeting on VCM is held at 8:15 nearly every morning at BFG Chemical Company. Present on Wednesday, February 27th, were:

Anton Vittone - President, Goodrich Chemical Co.
M. N. Johnson, M.D. - Director of Environmental Health, BFG
Roger Strassburg, Ph.D. - Director of Environmental Affairs, BFG
Thomas Dukes - Department of External Communications, BFG
John Nelson - Vice President for Manufacturing, Goodrich Chemical Co.
William Becker - Corporate Counsel, BFG
Harold Fast, Corporate Counsel, BFG
Irving R. Tabershaw, M.D. - TCA

There was a telephone hook-up with the Louisville plant personnel who participated in the conference. The major subject was the TCA interim report on our ongoing activities.

Epidemiology

As background, I presented the objectives of the clinical follow-back study on death certificates.

1. To determine if any additional angiosarcomas were noted on death certificates or in the clinical or hospital files of persons who died and were known to have worked for BFG.
2. To determine if, for anything other than angiosarcoma of the liver, there was any pattern of mortality that might be related to occupational exposure while employed at BFG.
3. To allay the anxiety of current workers by demonstrating BFG's determination to search for all factors which might shed light on matters affecting their health. Review of such data might discover personal and other health factors which could influence the occurrence of occupational disease. It might also assist in determining which examinations and laboratory tests might reveal incipient or occult disease.
4. To provide a background and information against which workmen's compensation claims could be evaluated.
5. To determine the validity and accuracy of findings and conclusions which will be reached by the official State and Federal agencies.
6. To provide a basis for the type and volume of data input to a comprehensive health surveillance system to be organized by BFG.

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7. To provide positive or negative data on health effects of specific compounds known to be used in BFG and to determine the dose-effect relationship.

Epidemiologic Findings

Our preliminary report shows that:

- 146 deaths in Louisville (Dr. Barber and Mr. Davis visited - see Appendix F);
- 35 deaths, Avon Lake (Dr. Cooper visited);
- 19 deaths, Calvert City;
- 10 deaths, Niagara Falls.

After presentation of the current information on each plant, it was agreed that:

1. Death certificates at other locations be thoroughly searched in a similar manner (Pedrickton, New Jersey; Henry, Illinois).
2. That BFG study its entire chemical plant personnel, even if not exposed to PVC. The joint health program of the rubber industry and the Rubber Workers Union, carried out through Harvard University, will provide some input.
3. We continue cooperative relations with the Center for Disease Control (HEW) and attempt to get copies of all the information they obtain, but to review it independently.
4. BFG appoint a records administrator (BFG designated William Wilcox several weeks ago) to be the focal point of all health data gathering and review.

Industrial Hygiene

Preliminary data itemizing TCA's study of PVC dust levels in various locations in the Louisville Plant was presented (See Appendix C). Dr. Strassburg indicated that some elements of this information will be submitted to the Department of Labor this week. A complete report from TCA will follow shortly.

Findings: Even very dusty areas in the Louisville plant are well below nuisance limits. However, if PVC dust is considered active (with, and without, entrainment of VCM), then dust levels in some locations are high as compared to standards for silica dust. However, no standard has as yet been set for PVC, but it is expected that after March 10th, when DOL hearings close, a standard for PVC dust will be promulgated.

The emergency carcinogen standards for 14 substances were discussed. If VCM is considered a carcinogen (and it must), then, possibly, PVC containing <0.001% (1000 p.p.m.) will not be considered cancer suspect.

It was decided:

1. To continue to determine dust levels in all plants (in addition

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to the present program of determining and controlling VCM levels);

2. That PVC products will be evaluated for their VCM content.

3. That environmental analyses leading to control of PVC compounding, mixing, and fabrication will be initiated and expanded.

Louisville Plant

There are 146 known dead. 137 death certificates are in hand, and the others are being sought. See table in Appendix H which summarizes the present status.

The names of the individuals in Group III and Group IV were reviewed with Mr. Wilcox who will make every effort to gather more information. When CDC data is delivered to TCA (it will cover some of the names of people in Groups III and IV), the above evaluation will be corrected. It appears unlikely that new cases of angiosarcoma in deceased BFG employees will turn up.

Avon Lake

Thirty-two of the 35 death certificates and other available information in the personnel, medical and insurance files were reviewed by Dr. Cooper. A copy of his report is appended. It appears that there are no hidden angiosarcomas in the group. The three unknowns will be assiduously followed by Mr. Wilcox.

Niagara Falls

There are 10 known deaths in the Niagara Falls population. There appear to be no significant problems, but follow-back information is not available but will be gathered by CDC and by Mr. Wilcox.

Health information in the files still available to BFG on persons known to have worked in this plant is currently being reviewed.

Calvert City

There are 19 known deaths in Calvert City, of which 14 were plant workers potentially exposed to VC. Seven appear to be in need of immediate follow-up. The death certificates were reviewed by Mr. Hibbard of TCA and copies will be obtained and followed up by Mr. Wilcox and Dr. Guyton. The cases of current interest are: 3 - cancer of the lung; 1 - cancer, unspecified; 1 - cancer of the kidney; 1 - cancer of the brain; 1 - cancer of the liver, unspecified.

General

1. Medical information on known and potential cases of angiosarcomas and the selection of medical tests and the management of workers with positive findings were thoroughly discussed with Dr. Johnson.

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2. A courtesy call was paid to Dr. Rex Wilson.

3. The management of health records was discussed with Mr. Wilcox and Dr. Strassburg. My concern for some aspects of records management were voiced at the BFG meeting, as well as to these men privately. Three types of records must be distinguished:

- a. deceased employees
- b. active employees
- c. employees known to be living, but no longer employed by BFG

We should cooperate, wherever possible, but the legal rights of various agencies and people to inspect these records should be clearly defined.

4. The probable need to reorganize the medical department was outlined. The present BFG medical department:

- a. has inadequate medical surveillance of the health of the worker;
- b. does not distinguish the clinician responsible for treating the worker with the occupational physician responsible for diagnosis and prevention;
- c. does not use the nursing staff adequately in terms of health and laboratory surveillance, and
- d. does not centralize testing; a special laboratory established by BFG should be considered, quality control, cost, and service are important aspects of an effective program.

5. The need for a comprehensive occupational Health Surveillance System was discussed with Dr. Johnson, Dr. Strassburg, and Mr. Wilcox. The planning for such a system should be done now, rather than later. The first step is a Requirements Analysis; Occupational Physician, Industrial Hygiene, and Systems Analysis skills are needed. TCA will send to Cleveland a professional health data analyst to define the scope of such a project and to answer questions. Following this, TCA would make a proposal.

6. Research attitudes, as expressed by NIOSH, CDC, NCI, and perhaps other agencies need careful review and determination whether such research programs, implemented through BFG, serve its employees. Work morale, production schedules, legal liabilities, and costs may be severely affected. Constant evaluation and policy determinations are needed as research proposals are made to BFG.

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Appendix B.- Report on medical meeting at B.F. Goodrich, Cleveland,
Ohio, March 5, 1974.

Present: M. N. Johnson, M.D., William Wilcox, Roger Strassburg, Ph.D.--
Goodrich

Clark Heath, M.D. and Henry Falk, M.D. -- CDC

I. R. Tabershaw, M.D. -- TCA

MEDICAL PROGRAM

Dr. Johnson presented his tentative medical program until NIOSH recommendations are available. This program for control of liver disease from exposure to VCM stems from the recent NIOSH meeting of liver experts in Washington (3/2/74).

Phase I SMA 12 + gamma glutamyl-trans-peptidase (GGT). If normal,
repeat in 6 months.

Phase II If one abnormality,* repeat in 3 weeks.

Phase III If two or more abnormalities,** then

- a. repeat SMA and GGT;
- b. fractionate bilirubin;
- c. fractionate LDH;
- d. CBC and platelet count;
- e. chest X-ray;
- f. liver scan; and
- g. physical examination.

* remove from exposure on basis of clinical judgement of plant physician.

** remove from exposure until all tests are completed and patient is evaluated.

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NOTES:

1. Heath and Falk suggested removal of an additional 40 cc of blood at time of first SMA 12.
 - a. 20 cc to be frozen and stored for future studies at CDC.
 - b. 20 cc for study by NCI. To this fraction, add 5 cc Cleland reagent for proline hydroxylase (earliest known test for fibrosis). Dr. Popper suggests that fibrosis is earliest evidence of reaction to angiosarcoma.
2. GGT - Liver Panel agreed that this is the earliest test for hepatocellular damage.
3. Dr. Tabershaw suggested using liver scans as a Phase IV step. It is a clinical tool which has to be carried out away from the plant in a hospital or radiologist's office. It is not always available locally.

It was agreed to follow through on mortality study by CDC at Louisville, Avon Lake, and Niagara Falls. CDC will provide TCA with duplicates of all their materials.

No policy was adopted regarding morbidity studies. CDC will recommend medical program to NIOSH within one week. NIOSH will forward this program, after review, to DOL.

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Appendix C.- Report of industrial hygiene survey of B.F. Goodrich Louisville, Kentucky plant. Dr. Tebbens and Dr. Reischl

I. Past Events.

The first visit to this plant on February 22 and 23, 1974, was to both walk through it and make some dust concentration observations. These activities are detailed in Part II of this report. Part I is a "view from outside" which might help clarify what past exposures have contributed to the current epidemic of angiosarcoma.

It was quite evident that exposure was not limited to vinyl chloride (VC) and polyvinyl chloride (PVC). While these are the predominant raw material and product respectively, dozens of other chemicals contribute to producing PVC or other polymers, copolymers or adjunct polymers.

The PVC process flow seems to have few variations from the following:

1. Start with empty and clean polymerization vessel (poly). These are 1100 to 1600 gallon capacity.
2. Close bottom valves.
3. Add water to poly.
4. Add catalysts.
5. Close and bolt man head.
6. Reduce pressure to remove air.
7. Add VC and check pressure build up. Final pressure 100 ± 15 p.s.i.
8. With cooling and continuous agitation the reaction proceeds for several hours.
9. Blow down to receiver tank with excess VC piped to recovery area. So far system is closed, though leaks are possible at valves, man head, etc. No large leak could be tolerated during reaction.
10. Wash and store wet product. Subsequently dry by spray-dry or venture dry; this becomes product for packaging or further processing.
11. Wash down poly with water through opened man head after exhaust hose put in poly. In some cases wash water dumped to open channel on blow-down floor. Other cases wash water kept in closed systems to a water recovery process.
- 11a Alternately, insert HRC (with its own man head cover) and clean tank with 5000 lb water pressure nozzles. Water disposal as above.
12. Reinsert exhaust hose and allow 20 minutes ventilation.
13. Every few batches, helper enters poly to hand scrape sides, remove knots of polymer and generally renew the reaction vessel. This may take as much as an hour.
14. Process repeats - It is obviously a batch process of an estimated 12 hours duration per cycle. Two operators and a helper handle about 2 dozen polys which are on 24 hour/day production.

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The reaction vessels are in multistory buildings. High volume fans had been installed to provide some general ventilation through the buildings but opened windows were more effective. Since the windows are kept closed in cold weather, there might have been a general buildup of VC from leaks, escapes from open polys, escapes from wash water, etc. Such concentrations could have developed to 200-300 p.p.m. without detection, since VC provides no warning odor below that concentration. This general concentration might have been most pronounced on the blow down tank floor because of the practice of dumping wash water into open channels. Exposure of helpers cleaning polys was probably very high at times and must have been high on the average. Some recent data obtained in polys after product discharge suggest concentrations up to a few hundred and occasionally a few thousand p.p.m. of VC during different phases of cleaning and evacuation of the polys. The amount of air moved through the exhaust hose lines was not measured, but was not impressive in many cases. If several were in use, each was less effective since they are on a common header and some at the end of long ducts might have been very ineffective. In the larger polys (ca. 215 ft³) some 150 c.f.m. of ventilation would be needed to provide what was described as a required 1 1/2 air changes per minute. This seems doubtful. Furthermore, the scraping and knot removal was described as releasing considerable trapped VC practically in the face of the helper working in the poly.

We believe this to have been a high exposure, possibly near the then TLV of 500 p.p.m. with excursions to several times that concentration. There were additional potentials of exposure around storage facilities for VC, one such being the refrigerated rank rooms. There should have been no regular exposure of persons here unless that of maintenance personnel, though concentrations due to valve leaks, etc. might have been high.

Exposure of persons to PVC dust must have occurred in the past at levels which were at least as great as indicated in Part II. Probably less ventilation was provided by open doors and windows than is now the case; dust levels at the spray drying operation may have been twice as high as measured, and somewhat higher at the packing operations. One possible significant factor was the statement that, until recently, a packer tended to remain in that activity, not progressing in the job categories open to other workers in the plant.

The extent of VC exposure associated with the PVC dust is not clear. That there is some is indicated by the fact that VC in moderate to fairly high levels, 100-200 p.p.m. is found around stored PVC in warehouses.

II. Site Visit to B.F. Goodrich Chemical Company, Louisville, Kentucky. February 22 and 23, 1974.

1. Upon arrival at the plant on February 22, 1974, discussions with Joseph Robbins, chemical engineer and acting industrial hygienist, provided a basic background and overview of the plant's operations, production schedule and basic chemical processes. With Edward Katzenmeyer, corporation industrial hygienist in attendance during the afternoon, history of previous PVC exposures of workers were reviewed. Ongoing

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monitoring programs and future improvements were also discussed. General concerns for reducing vinyl chloride emissions into buildings and into the atmosphere were discussed. Schemes for improvement of general ventilation within buildings were presented.

2. After several discussions a tour was conducted to observe actual operations. The following areas of operation were visited:

- a. Reactor areas (Bldg 131)
- b. Recovery operations area (Bldg 125)
- c. Polymerization process areas (Bldg 121, 11, 30, 15)
- d. VCL distillation area (Bldg 115)
- e. VCL synthesis area (Bldg 127)
- f. High temperature processing area (Bldg 29)
- g. PVC drying areas (Bldg 129, 112)
- h. Hycar grinding area (Bldg 132)
- i. PVC packing areas (Bldg 112, 129)
- j. Hycar area (Bldg 126)

During the tour, several areas with the substantial dust concentrations were noted. These areas were located in buildings #112, #129 and #132. The operations involved PVC packing, PVC paste drying and Hycar grinding (See map for location of buildings).

3. To evaluate the dust concentrations in buildings #112, #129, and #132, a total of 20 air samples were obtained on February 23, 1974. Six air samples were obtained using Millipore filters (about 2-hour sampling time for each measurement). Fourteen air samples were obtained using the electronic dust monitoring instrument (4-minute sampling time for each measurement). Both total dust and respirable dust was evaluated. Station samples as well as personal samples were obtained.

4. The following are summaries of dust measurement values obtained in buildings #112, #129, and #132. No nuisance TLV was exceeded in any area measured.

Building 112: Packing areas.

PERSONAL SAMPLES:

1. 3.49 mg/m³ (Resp.)
2. 1.13 mg/m³ (Total)

STATION SAMPLES:

1. 1.27 mg/m³ (Resp.)
2. 3.49 mg/m³ (Total)

Building 129: Spray-drying areas

PERSONAL SAMPLES:

1. 8.35 mg/m³ (Total)

STATION SAMPLES:

1. 0.18 mg/m³ (Resp.)
2. 1.25 mg/m³ (Resp.)
3. 7.95 mg/m³ (Total)
4. 1.60 mg/m³ (Total)
5. 2.34 mg/m³ (Total)
6. 1.25 mg/m³ (Total)

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Building 132: Hycar grinding - some spray drying

PERSONAL SAMPLES:

1. 0.71 mg/m³ (Total)

STATION SAMPLES:

1. 0.38 mg/m³ (Resp.)
 2. 0.17 mg/m³ (Total)
 3. 0.72 mg/m³ (Total)
 4. 0.77 mg/m³ (Total)
 5. 1.83 mg/m³ (Total)
 6. 1.11 mg/m³ (Total)
 7. 1.38 mg/m³ (Total)
 8. 0.34 mg/m³ (Total)

III. Status at Present.

Great changes in exposure have been effected in the past two months. These are as follows:

1. An air line respirator is worn by any person entering a poly.
2. Window panes have been removed from production buildings to insure some natural ventilation.
3. Charcoal cartridge respirators are used by persons in the reactor areas whenever they suspect an exposure may exist. Cartridges changed daily.
4. Round-the-clock monitoring for VC is done in the reactor areas, with leak detection as a significant objective, but examination of exposure an additional purpose.
5. Packers and operators around the spray-drying systems wear filter respirators almost continuously where dust dispersion is evident.
6. Lunch rooms have been established away from work areas.
7. The never wash systems for polys reduce open flow of wash water by closed water recovery system.
8. Scott air packs required for entrance to closed tank rooms, whether refrigerated or not.
9. A careful work activity evaluation of each category of worker is being made to correlate with the environmental measurements of VC.
10. A continuous monitoring (and alarm) system is ordered for use in several areas where VC might escape or accumulate.

Our evidence on dust dispersion indicates that on a nuisance basis, alone there is no severe problem. Nuisance dust standards are: 5 mg/m³ of respirable dust and 15 mg/m³ of total dust.

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IV. Proposals.

1. It seems certain that some other standard will evolve for PVC dust. By microscopic observation of collected samples and by data supplied from Louisville, the particle size is relatively large and the material has a low density. Thus, relatively large particles by diameter might be expected to be retained in the respiratory system. Even that which is not may be inhaled and subsequently swallowed. In any case, the PVC dust concentrations should be reduced drastically at packing stations, drying operations, and other locations.

2. Two procedures should be worked out as soon as possible to evaluate exposure of individuals to VC. These are personal monitoring and biomonitoring. The methods for accomplishing these objections are not immediately evident but should be investigated vigorously. Once available, the procedures should be applied in such a way as to sample with the greatest frequency those persons with greater exposure, ultimately routinizing the procedures to provide continuing information.

3. Additionally, the mechanism of adherence (or incorporation) of VC on the PVC should be investigated. To start, two factors might be measured: 1) the total VC that can be removed from the solid; and 2) the rate at which desorption occurs under different ambient, and possibly elevated temperatures (including body temperature).

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Appendix D.- Copy of letter describing particle sizes for PVC, and analyses of dust from bin sampled at Louisville plant.

BFGoodrich

B.F. Goodrich Chemical Company

A DIVISION OF THE B.F. GOODRICH COMPANY

BELLS LANE · LOUISVILLE KY. 40201

February 27, 1974

Dr. Bernard D. Tebbens
Industrial Hygiene Consultant
2180 Milvia Street
Berkeley, California 94704

Dear Dr. Tebbens:

As requested, I am submitting the particle size distribution and bulk densities of the more common type of PVC.

<u>Type</u>	<u>Particle Size</u>	<u>Bulk Density</u>
440X30 (VC1 Vinyl Acetate)	Shown on attached sheet	35 #/ft ³
427 (VC1 Vinyl Acetate)	10% < than 60-80 M 90% < than 135-155 M	35 #/ft ³
443 (VC1 VC1 ₂ Vinyl Acetate)	35% through 149 M 16% through 74 M 12% through 44 M	35 #/ft ³
202 (VC1, VC1 ₂)	90% < 108-135 M 10% < 40-60 M	28-32 #/ft ³
222 (VC1, VC1 ₂)	57-81% through 149 M 5-20% through 74 M	50 #/ft ³
121 Paste	10-15 M range	15 #/ft ³
126 Paste	1-8 M range	13 #/ft ³
103EP F-76 (Common PVC Type)	See attached sheet	29-30 #/ft ³

If I can assist you further, please contact me.

Sincerely,

Joseph W. Robben

Joseph W. Robben

JWR:cls

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TO:	FIELD POINT OR AKRON DEPARTMENT & BLDG. NO.	DATE YOUR LETTER
K. J. Kaminski	Cleveland Office - Engineering Dept.	
FROM:	FIELD POINT OR AKRON DEPARTMENT & BLDG. NO.	DATE THIS LETTER
C. A. Daniels	Avon Lake Technical Center	12-17-73
SUBJECT		

Particle Size Analyses of Louisville Dust Bin. Samples: 103EP, 440X30 and 106 F-2 Lot 7830.

Three samples of resin were submitted for particle size analysis: 103EP (Dust Bin), 440X30 (Dust Bin) and a 106 F-2 Lot 7830 sample. There were to be analyzed by Micromeritics techniques, but since 440X30 is not a homogeneous sample, but a blend, it required the use of the Coulter Counter electrozone sensing method.

The results, shown on the attached graphs, indicated the 103EP #3 sample to contain about 19 wt. % particles larger than 100 μ , and none smaller than 2 μ . The distribution was quite broad, and bimodal, with a single population about 80 μ in mean diameter, and a secondary broad distribution with about a 6 μ mean diameter.

The 440X30 dust bin sample also appears bimodal in distribution, but very broad with so much overlap that they are difficult to separate. Approximately, it appears to contain two distributions peaking at 2.0 μ and 9.5 μ . There are no particles larger than 40 μ , and since our lower limit was 1.26 μ , we could not discern particles less than this.

The 106 F-2 resin sample was sharply distributed, above ⁴²⁴1 mean diameter, lower limit 15 μ and contains 14% larger than 100 μ .

C. A. Daniels
C. A. Daniels

rym

- cc: E. Collins
A. Schultz
R. Zimmer
C. T. F.

Attmts. /2/

24383000

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Fisher-Klosterman, Inc.

P.O. BOX 11043 STATION H.
LOUISVILLE, KENTUCKY 40211
PHONE: AREA CODE 502 - 776-1503

December 24, 1973

Mr. W. D. Jones
Senior Buyer
Capital Equipment
B. F. Goodrich Chemical Company
6100 Oak Tree Boulevard
Cleveland, Ohio 44131

Ref: Your R.F.Q. of September 13, 1973
PVC Expansion - Louisville
Our Proposal of October 5, 1973

Dear Mr. Jones:

We have had, over the last several weeks, a good many telephone conversations with your Mr. William Bispeck. In response to his inquiries, we have furnished additional technical data on our WL-850 Scrubber (Item I-B-1 in our October 5 proposal). The purpose of this letter, then, is to incorporate in a single document, the performance data, pricing, terms and warranty on the premise that Goodrich may wish to purchase the scrubber only, rather than the complete system as proposed.

We will furnish one (1) 10 gauge T304 Stainless Steel WL-850 Wet Dust Collector, as shown in our Bulletin 220W. The shell will be externally reinforced with four (4) stiffening rings. No structural supports are included. The price is \$10,415.00.

Conditions at the scrubber inlet are: 103 EP-F-76

1. Gas: Moisture laden air at 180° F
2. Gas Volume: 42,404 ACFM
3. Gas Density: 0.0597 lbs./cu.ft.
4. Gas Viscosity: 1.347×10^{-5} lbs. (mass)/ft.-sec.
5. Particulate: PVC Fines, effluent from cyclone
6. Specific Gravity: 1.35 (PVC fines)
7. Loading: 3,300 lbs./hour (10.96 grains/S.C.F.)(a)
8. Particle Size Analysis(a)

Stokes Equivalent
Dia., Microns

% Finer
By Weight

180	6.51
Distribution of Portion Finer than 180 Microns	
180	100.
170	92.83
154	76.39
142	61.71
130	46.93
118	32.23
100	16.80

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December 24, 1973

80	6.56
60	1.95
50	0.77
40	0.39
32	0.17
24	0.06
16	0.01

- (a) The above distribution is expressed in Stokes Equivalent Diameters as determined by the Bahco Micro-Particle Classifier as specified in A.S.M.E. Power Test Code No. 28. It and the loading are derived by applying the efficiency curve of an F.K.I. XQ-58 Cyclone to the particle size distribution furnished in your specifications.

Scrubber performance, at the above conditions are:

1. Water Rate: 85 gal./min. (b)
2. Pressure Loss: 2.7 inches w.c.
3. Fractional Efficiency Curve (c)

<u>Stokes Equiv. Dia., Microns</u>	<u>% Efficiency By Weight</u>
1	0.6
2	6.2
3	20.1
4	40.4
5	61.7
7	90.4
10	99.7
13	100.0

4. Total Efficiency: 99.99%+
5. Outlet Emissions: 0.0001 lbs./hr.
6. At 90% of specified flow rate, the following performance will apply:
 - a. Pressure Loss: 2.2 inches w.c.
 - b. Particle Dia. at 95% efficiency: 8.4 microns
 - c. Total Efficiency: 99.99%+
 - d. Outlet Emissions: 0.003 lbs./hr.
7. At a pressure loss of 1.0" w.c., an 11.4 micron particle will be collected with 95% efficiency
8. At a pressure loss of 4.0" w.c., a 6.6 micron particle will be collected with 95% efficiency
9. No access door is included. If interior access is required, we will make the collector roof and outlet pipe removable as an extra
10. At specified operating conditions, we would expect a 15° to 30° F drop in air temperature through the scrubber and a 5° to 15° F rise in water temperature.

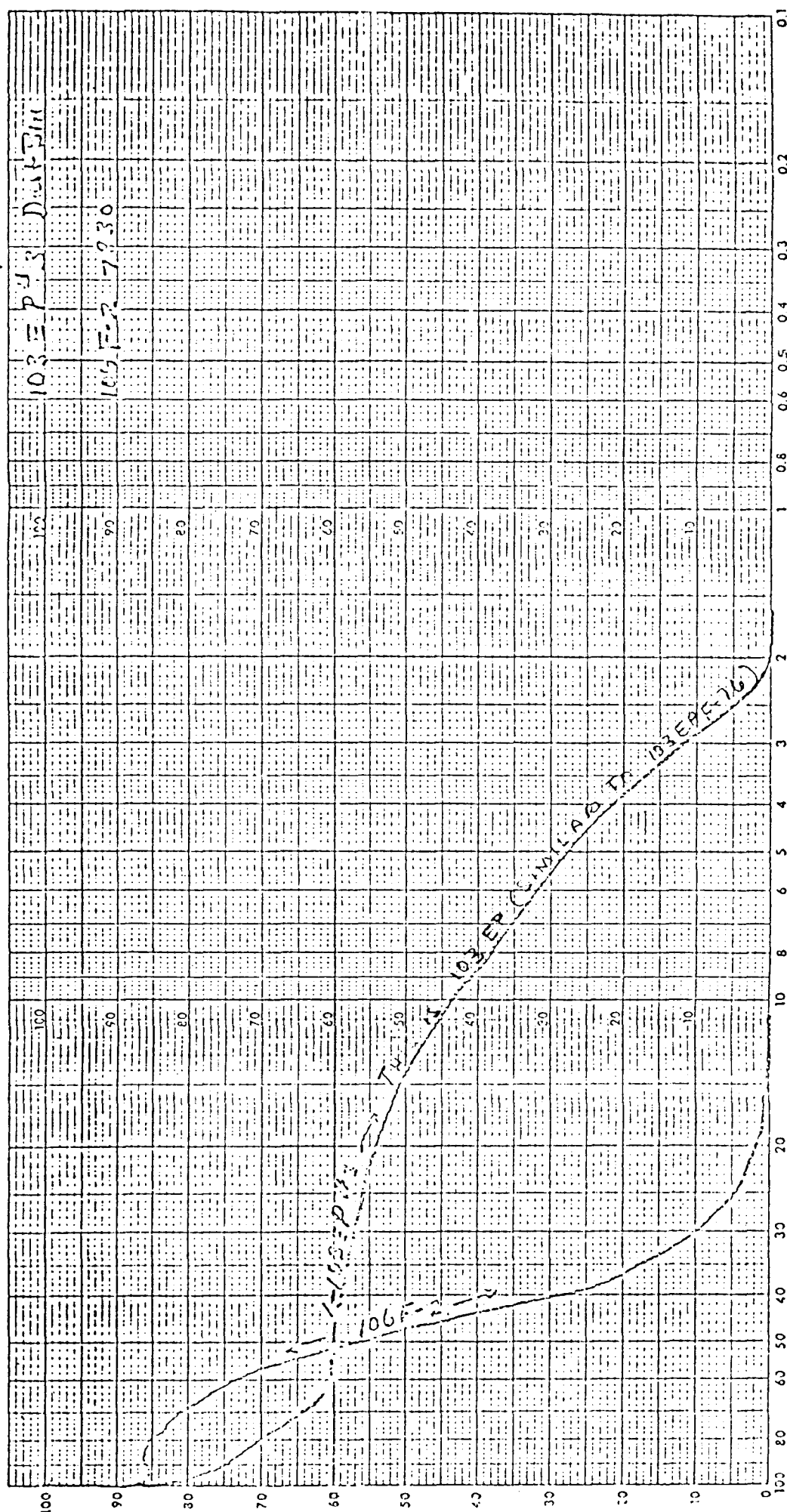
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SAMPLE IDENTIFICATION Dust Bin Sample - Test 1 DATE 12-11-73

Density g/cc LIQUID g/cc Viscosity cps BY H.F.

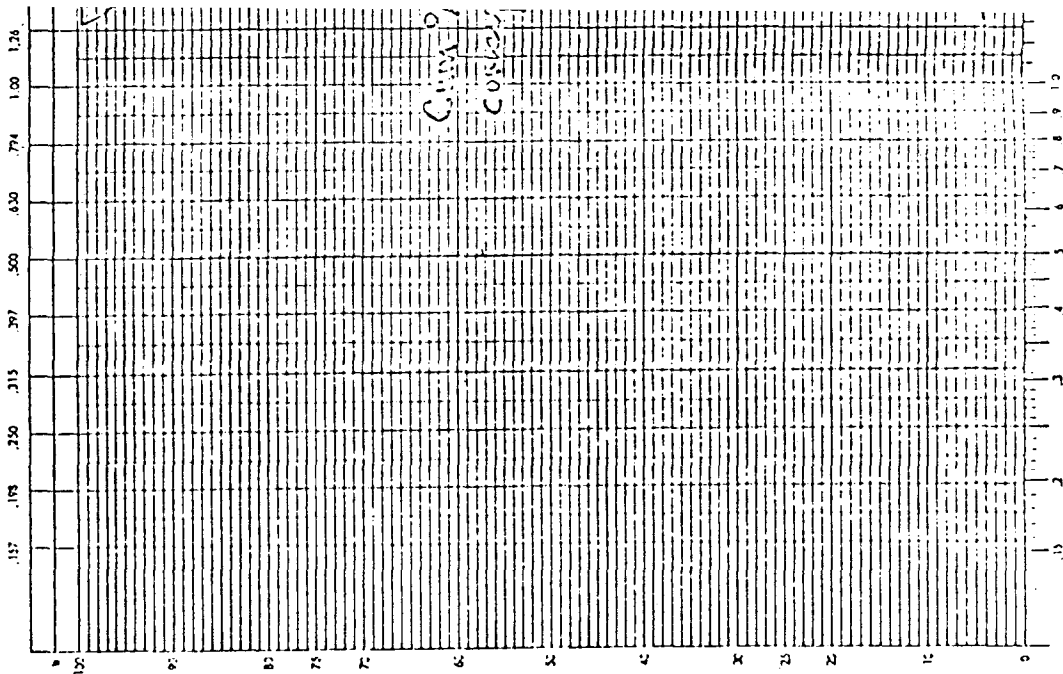
Preparation TEMPERATURE 30 °C

DBS RATE 14

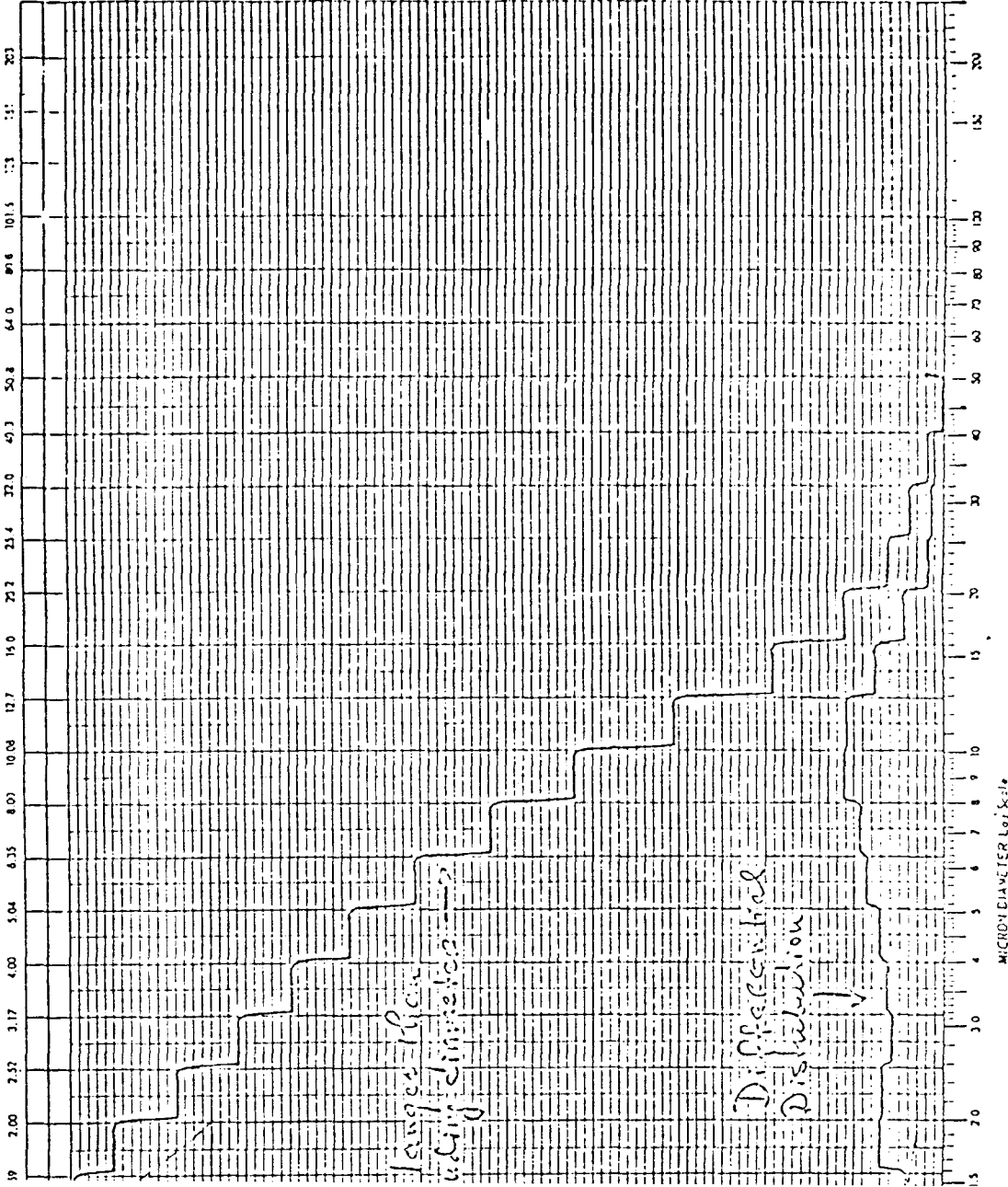


EQUIVALENT SPHERICAL DIAMETER, MICRONS.

Model	BFG
Operator	HF
Electrolyte	TA
Sample	H ₂ O X 30 Pws T B124



$k = d \sqrt{\frac{2}{\lambda}}$ FOR MODEL T		$\frac{A_2}{A_1} = \left(\frac{d_2}{d_1}\right)^3$ FOR MODEL TA		$\frac{A_2}{A_1} = \left(\frac{d_2}{d_1}\right)^3$ FOR MODEL TA		$\frac{A_2}{A_1} = \left(\frac{d_2}{d_1}\right)^3$ FOR MODEL TA		SUPPLEMENTARY DATA	
APER. SIZE	SERIAL	PLAT DIA.	W	± LA	A	D.A.	W	± LA	A
DISPERSE									
Ray House	100								



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Appendix F.- Trip Report, Louisville Plant, February 18-21, 1974.
Dr. Barber, Mr. Davis, Ms. Lindsey

We arrived in Louisville on the evening of Monday, February 18 and met with Mr. Bill Wilcox, Manager of Employee Relations from the Cleveland office.

At Mr. Wilcox's request, we arrived at the plant at 7:45 a.m. and set-up shop in a small conference room adjacent to Mr. Pember's office. All available personnel records (87 in total) of individuals who had died were brought into the room.

We found that five different lists of deaths existed. Dr. Coleman Carter and Dr. Henry Falk of CDC were at the plant and had one list. The plant had prepared two lists and Mr. Wilcox had brought another list from Cleveland. Our first task was to consolidate all lists so that we were certain of the total deaths.

We then structured a large spread sheet to record all available data in one place. In a meeting with Drs. Carter and Falk it was decided that we would concentrate on plant records while they began to discover what was available at hospitals. We fed names and hospital identifications to Dr. Carter and he searched hospital records.

We established contact with the State Registrar of Kentucky in Frankfort and arranged for rapid recovery of death certificates as we identified a need. By Wednesday noon, we had constructed a list of 114 death certificates which were not contained in personnel files. Mr. Wilcox took this list to Frankfort and recovered an initial 23 certificates. He made arrangements for the remainder to be collected on Thursday. This was done and a total of 113 of the 114 certificates were retrieved. An additional 24 certificates were discovered in plant personnel files and another seven certificates were retrieved later from Indiana by Mr. Wilcox. These numbers would indicate a total of 144 certificates out of the total deaths of 146. This is not true since there are still a few unidentified duplicates. We estimate approximately 9 certificates missing. Two of these died in Florida, one in Georgia and one in Ohio.

We were unable to examine plant medical files for deceased employees. Existing files were requested from the plant, and they were received at TCA on March 11th.

SUMMARY OF RECORD SYSTEM

1. Four basic records exist for each employee during his active employment:

- Plant Personnel File
- Plant Medical File
- Headquarters Insurance Claim File
- Local Hospital or Physician's File

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After death, a Death Certificate will exist and may or may not be available through company records. An autopsy file may exist in his hospital records.

2. There is no basic records destruction program in existence at Goodrich. Plant Medical says they destroy records two years after the employee departs. Personnel says they use five years. Personnel also claims that it maintains a card file listing job positions in perpetuity. All of these statements proved "inoperative" after records were inspected.

3. The Plant Personnel File appears to be the most comprehensive. It contains a record of the jobs held by the employee along with dates. It receives a copy of any medical insurance claim submitted by the man's doctor. This claim form includes the reason for treatment. The file contains transmittal letters showing where other types of records have been sent. It contains disciplinary actions taken against the man. Sometimes it contains copies of letters indicating some medical problem. It also contains supervisor rating forms which comment on the man's work habits, abilities, weaknesses, attitudes, etc.

Suggestions for consideration of Goodrich:

1. Begin to construct accurate job histories on current employees at all plants. This can be done by personnel people through questionnaires and interviews.

2. Immediately order permanent retention of all plant medical files. Some plants now destroy these after five years.

3. Immediately establish a system of review for all health insurance claim forms on a current basis. Mr. Sims (the death revealed by the press) had an insurance claim form in his personnel file which predated his death in 1964. The claim clearly indicated that he had an angiosarcoma.

4. Begin an epidemiology study of all deaths at all Goodrich plants with priority placed on those Goodrich Chemical plants making or involved with butadiene.

NOTE:

Currently the plant is offering SMA-12's to all plant employees. In November, SMA-12's were run on 271 exposed workers. Those indicating any abnormality have had a liver profile run. Those indicating abnormalities have a liver scan performed. Those indicating an abnormal scan are referred for biopsy.

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Appendix G.- Trip Report, Avon Lake, February 21, 1974. Dr. W.C. Cooper

In company with Miss Jane Lindsey, visited Avon Lake, General Chemical Plant of B.F. Goodrich Chemical Company from 8:30 a.m. to 3:00 p.m.

Initial contact was Mr. R.L. (Ron) Cross, Industrial Relations Manager, also met Mr. Robert (Bob) Rylands, Plant Manager, Mr. William (Bill) Gunning, Safety Manager, and Mrs. Alma McClelland, Plant Nurse. The plant physician, who spends one hour a day at the plant, Dr. J.W. Newman, was absent on vacation, but I talked with him by telephone. He had done personal follow-ups on four questionable cases.

Miss Lindsey and I reviewed personnel records of all men in the chemical plant who had died and compared then with the death certificates we had received in MCA study. Separate report on this will be made at a later date.

Some of the discrepancies between cases shown us at the plant and those received in MCA study were due to the fact that Technical Center people were not included in the latter. Also, there were some differences in the interpretation of work assignments. For example, one chemical worker who had begun as a plant guard and was terminated as a plant guard, was omitted. There were two recent deaths for whom death certificates were not obtained, but the nurse said coronary and emphysema were causes.

Physical Examinations

1. Plant does not do periodic examinations.
2. There has been a program to detect acroosteolysis (annual films, of hands, formerly 2 times a year) and we were shown typical hand x-rays.

Definite diagnosis is made on the basis of the latter. Those with symptoms only are called questionable. There have been about six cases according to the plant nurse. Those on removal from VC have had regression of bone changes to nearer normal but often with stubbing of terminal phalanx. There are also 18 questionable acroosteolysis cases whose names would be readily available.

3. Beginning about 1967, the plant did bilirubin and SGPT pre-employment -- about 40 per annum since then. The plant has been performing SMA-12's recently, 567 in all. Of these about 150 were sufficiently abnormal in the liver group (bilirubin, Alk. P., LDH, and SGOT) for repeats. The most marked deviation was a worker (whose name is available) with LDH of 320 and SGOT of 55. Most of the repeats were because of miniscule aberrations in one reading.

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Appendix H-Summaries of Epidemiological Studies, Avon Lake and Louisville.
Dr. Utidjian and Dr. Husting

THIRTY-FIVE (35) alleged deaths were studied. Death certificate information was available on all but 3.

The underlying causes of death as certified in the 32 were distributed as follows:

CARDIOVASCULAR DISEASES (mostly ischemic heart disease)	20 (57%)
ALL MALIGNANCIES	7 (20%)

Breakdown:	4 primary lung cancer
	1 cancer of colon
	1 melanoma
	1 unknown primary with secondaries in liver and other abdominal sites
	1 (additional lung cancer case in a cardiovascular death)

MOTOR-VEHICLE ACCIDENTS	2 (6%)
INDUSTRIAL ACCIDENT (electrocution)	1 (3%)
SEPTICEMIA	1 (3%)
CEREBROVASCULAR ACCIDENT	1 (3%)

AUTOPSIES: The autopsy rate was high at 14 (40%). Fifteen deaths were definitely not autopsied, according to the death certificates. In 6 cases it is not known whether autopsies were performed or not.

ANGIOSARCOMA IN THE LIVER: There is no positive evidence of the occurrence of this lesion among the 35 deaths reviewed, whether as the certified cause of death, as a certified significant condition also present at death, or from autopsy reports. Autopsy reports making no mention of angiosarcoma in the liver, or of any other liver lesion which could possibly be confused with it, are regarded as the most solid evidence that the individual did not have detectable angiosarcoma in the liver at the time of his death.

In all the deaths in which autopsies were not performed the hypothetical possibility remains that angiosarcoma in the liver might have been present but clinically undetected. However, all the causes of death reviewed seemed perfectly credible and sufficient causes, compatible with the age at death. In two cases there was evidence of other liver lesions present at death; 1 case of "early fatty changes" (histologically) and one case of chronic cholecystitis and choledocholithiasis. Neither of these liver lesions is known to be associated with angiosarcoma, or likely to be confused with it.

24382003

Preliminary report on status of 146 known dead employees of B. F. Goodrich, Louisville, Kentucky - Chemical Plant: March 3, 1974. Based on insurance records, personnel files, death certificates, some autopsy data, but not on hospital records.

<u>DIAGNOSIS</u>	<u>NUMBER OF CASES</u>	<u>PER CENT</u>	<u>AUTOPSY PERFORMED</u>			<u>DEATH CERTIFICATE SEEN (TCA)</u>		
			<u>yes</u>	<u>no</u>	<u>??</u>	<u>yes</u>	<u>no</u>	<u>??</u>
CONFIRMED ANGIOSARCOMA	5	3.4%	2	3		4	1	0
OTHER MALIGNANCIES (based on above information)								
Malignancies of liver, not angiosarcoma	2			1	1	2	-	0
Malignancies of lung	8		1	4	3	8	-	0
Reticuloses, including leukemia	6		2	2	2	6	-	0
Malignancies of the brain	4			2	2	4	-	0
Other malignancies, including G. I.	<u>8</u>	<u> </u>	<u>1</u>	<u>6</u>	<u>1</u>	<u>8</u>	<u>-</u>	<u>0</u>
TOTAL	28	19.2%	4	15	9	28	-	0
OTHER MALIGNANCIES (more information needed)	6	4.1%	2	2	2	4		2
INSUFFICIENT INFORMATION (Further follow-up recommended)	8	5.5%		3	5	5		3
IMPONDERABLE (Further information unlikely)								
Sudden death	9		1	7	1	9	-	0
Other causes	<u>21</u>	<u> </u>	<u>-</u>	<u>14</u>	<u>7</u>	<u>21</u>	<u>-</u>	<u>0</u>
TOTAL	30	20.5%	1	21	8	30	-	0
NON-MALIGNANT CAUSES								
Cardiovascular	48		8	31	9	45	1	2
Respiratory, lung	10		2	6	2	10	-	0
Renal (primary cause)	1		1	0	0	1	-	0
Diabetic, endocrine	4		1	2	1	4	-	0
Non-vascular neurologic	2		-	1	1	2	-	0
Other	<u>4</u>	<u> </u>	<u>2</u>	<u>-</u>	<u>2</u>	<u>4</u>	<u>-</u>	<u>0</u>
TOTAL	69	47.3%	14	40	15	66	1	2
GRAND TOTAL	146	100%	23	81	42	137	2	7

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