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THE UNITED STATES
DEPARTMENT OF LABOR
OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
DOCKET OSH-36

TESTIMONY OF
AIR PRODUCTS AND CHEMICALS, INC.

AIR PRODUCTS AND CHEMICALS, INC.
Five Executive Mall Building
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Wayne, Pennsylvania 19087

June 27, 1974

AP00040499

Testimony of Richard Fleming

Greetings --

I. INTRODUCTION

I am Richard Fleming, Group Vice President of Air Products and Chemicals, Inc. I am responsible for the Chemical Group of our company headquartered at Valley Forge, Pennsylvania. Testifying with me today are Mr. John T. Barr, Technical Manager - Manufacturing and Dr. Paul Kotin, M.D., our consultant on VCM medical matters. Also with me are Dr. A. Ross Adams, General Manager, Plastics Division; Mr. T. L. Carey, Vice President of Manufacturing; and Mr. Joseph T. Sebastianelli, Attorney.

Air Products operates two plants for the production of polyvinyl chloride using the suspension process and located at Pace, Florida and Calvert City, Kentucky. Combined capacity of the two plants is approximately 200 million lbs./year, or approximately 3.5% of the total PVC industry. Air Products also operates a PVC compounding facility at Calvert City, and small PVC plastics fabrication plants at Morristown, New Jersey, Costa Mesa, California, Durant, Mississippi, and Homestead, Pennsylvania. In addition, we now operate a plant at Calvert City for the production of a different class of polymers, sold as water emulsions, which also uses vinyl chloride as one of several monomers for a portion of its output and we have a second plant of this type under construction at South Brunswick, New Jersey. The total

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number of employees engaged in all these operations, including all service support and management is about 500.

Air Products is a non-integrated producer of PVC. We purchase all of our raw materials and are only very slightly integrated forward into fabrication using less than 2% of our PVC production. We are about 10th in capacity among PVC producers, but a relatively large proportion of our output is in special types of polymers. Our PVC plants have been operating since 1957 and 1959, each coming to Air Products as part of acquisitions of larger businesses, the Florida plant in 1969 and the Kentucky plant in 1971.

Air Products has participated in industry studies of health hazards of VCM and will continue to do so. Our own medical examination program, which will be discussed later by Dr. Kotin, has covered approximately 480 present employees. We have also studied the mortality experience of all employees who have worked in these plants. We have found no cases of angiosarcoma.

Air Products and Chemicals, Inc. is deeply concerned about the question of appropriate protection of the health of its employees and of all those involved in the VCM-PVC industry. We are participating fully in whatever activities we can recognize as worthwhile in developing facts that permit determination as to what that health protection means in practical terms. We believe in establishing and observing soundly conceived regulations designed to assure safe working conditions.

We are also very concerned that unwisely conceived and unnecessarily restrictive regulations not be promulgated. Such regulations work to the disadvantage of all concerned, worker, company, consumer, and the economy as a whole.

II. OBJECTIVES OF TESTIMONY

Thus our purposes here today are as follows:

(a) To present for the public record a resume of our study of the health of our own employee population - and to offer the conclusions our medical consultants have reached from these studies at the present time. This is meant as a contribution to the national study of employee health in the VCM-PVC industry that is so urgently needed to guide the formulation of safe practices.

(b) To offer some perspectives on what we consider some key issues relative to arriving at appropriate regulations.

(c) To provide testimony on what we believe is feasible and workable and why, in the way of regulated occupational exposure.

(d) To offer some detailed comments on the proposed regulation for the consideration of those who will write the final one. These will not be presented orally at this meeting in the interests of time, but will be a part of our written submission.

III. EARLY TOXICOLOGY

In much of the information presented prior to and during these hearings it has been or will be stated by many observers that general concern about human exposures to vinyl chloride have passed through three distinct phases as follows:

Phase 1 - fire and explosion concerns and narcotic effects;

Phase 2 - concerns regarding AOL; and

Phase 3 - concerns regarding carcinogenicity.

Phase 1 concerns were the only ones of significance from the inception of manufacture and polymerization of vinyl chloride in Germany in the early 1930's until the early 1960's, a period of 25 - 30 years. During this period, VCM was used as an anesthetic, such was the understanding of its toxicology during this time. A number of toxicological studies made in this period show only minor effects from exposures to what were usually high dosages for relatively short periods of time compared to the more recently published information concerning longer term exposures.¹ It is perhaps pertinent to note that many more persons have been injured or killed as a result of flammability and narcotic hazards than from any recognized toxicological effects of vinyl chloride.

AOL was first observed in PVC workers in 1960-1962 both here and abroad and in about 1966 a causal relation between VCM exposure and AOL was established. Since AOL occurrence

1. Documentation of the Threshold Limit Values for Substances in Workroom Air. American Conference of Governmental Industrial Hygienists (3rd Ed. 1971).

was almost exclusively among reactor cleaners who came into frequent physical contact with VCM, precautions were taken to limit or eliminate this and the incidence of AOL declined markedly. These and other plant and operational changes resulted in lower exposure of operating personnel generally to VCM concentrations.

IV. EXPOSURE EXPERIENCE

Industry conducted toxicology studies, exemplified by those extensively reported by Dow, showed that lower exposure levels were necessary to avoid the possibility of toxicological effects of chronic exposure. Specific standards of 500 ppm TWA and then a 500 ppm ceiling were set by ACGIH and later by OSHA and met by industry.

The actual levels of VCM in plant atmospheres to which workers were actually exposed is not a matter of record. The need for such information was not understood and the instrumentation to readily measure it was not available for most of the period of historical operation. Attempts now to reconstruct historical exposure levels are admittedly crude but they are nonetheless instructive. The lower explosive limit for VCM in air at ambient conditions is 3.6%, i.e. 36,000 ppm. In the phase 1 period this was the absolute upper limit of concern to plant operators. Even with a safety factor of 10, levels of 3,600 ppm would have been tolerated if no

other problems were found or expected. It is reasonable to expect that such levels were encountered at times in early operations by some individuals.

It is very difficult to reconstruct the pattern or frequency of early peak levels of exposure in any reliable way. It has seemed more realistic, and perhaps more pertinent, to attempt estimates of the average, long term continuing exposure to which an individual was subjected. Thus TWA data have been used to characterize the cumulative long term dosage thought to have been experienced by workers in PVC plants.

The Chemical Industry Association of the UK has recently stated their estimates of the average TWA exposure of workers in UK plants. These estimates show the following variation over time:

	<u>Average TWA</u>
1945 - 1955	1000 ppm
1955 - 1960	400-500 ppm
1960 - 1970	300-400 ppm
mid 1973	150 ppm
now	50 ppm

Since the technology and equipment used in UK operations, and the economic and safety considerations concerning VCM loss control were not appreciably different from those prevailing in the U.S. or other parts of the world, one could reasonably expect similar estimates to characterize operations in this country. In fact, it is our judgement that these figures are reasonable estimates of what prevailed, on average, in

this country. Our estimates for our own plants are about the same as this table. Note that these are average figures so that some plants must have been higher at least part of the time. Furthermore, it seems clear that within those plants some individuals probably had even higher exposures.

V. CURRENT SITUATION

The recent liver cancer findings are the legacy of this type of exposure. Each case found to date has involved an individual who has worked through periods of high level exposure by any current day measure, and all have worked for some time in jobs where the highest individual exposures have been encountered.

Thus far the extensive search of the human experience for angiosarcoma among workers in VCM-PVC has turned up 19 cases since 1961. Of these, 13 are in the U.S., found among the employees of 15 VCM plants and 36 PVC plants. Of the 13 cases, 7 have occurred at one PVC plant, 3 at another. A U.S. total of 4 PVC-VCM plants have had known cases. There are thus 47 plant populations who have no record of angiosarcoma although they have lived through periods of exposure well above levels no one would tolerate in the light of current information.

There is a considerable body of animal exposure data to show decreasing hazards with decreasing exposure levels of VCM. Moreover, the human experience in its plants reported by Dow at the February hearing has shown no incidence of angiosarcoma among its

workers from long term average exposures of between 100 ppm and 200 ppm/TWA. Air Products own health studies show one case of AOL and no other health problems related to exposure in our operations to date.

Although exposure levels in fabricating plants have generally been very low, exposures in a few jobs in these plants have historically probably been of the order of 15-25 TWA. Until the recent announcement of the GE wire coating case, and the case of the accountant at a vinyl sheet producing plant there were no reported angiosarcoma cases among fabrication plant employees. As we heard in yesterday's testimony, any relationship between these cases and exposure to VCM remains conjectural at this time. Careful study of the very large body of human experience already available in the history of PVC fabrication operations is clearly warranted and can shed important light on the hazards of relatively low level exposure.

Exposure levels in VCM plants are generally considerably lower than in PVC plants because of the continuous process technology of the monomer operations and the generally outdoor construction of these plants. Only one angiosarcoma case has been found among VCM workers and this man is reported to have worked on very high exposure tasks related to sampling and catalyst tube cleaning. He also worked in PVC for the final year of his working life.

All of these considerations lead to the idea of a relatively safe but readily measurable level of VCM in a work environment.

We therefore support the proposal for a 25 TWA exposure level effective October 5, 1974. As we will show later, we believe that this level is also feasibly attainable, though a difficult and expensive one to continuously meet 100% of the time, as we would hope to do under such a regulation. Lower levels, proposed for later achievement, are much more difficult and much more speculative as to achievement at this time in our view. This too will be elaborated on by Mr. Barr.

VI. EFFECT OF STANDARD ON OPERATIONS

Any level of exposure that is required by a new standard that is below current achievement confronts a producer with essentially three alternatives:

- 1) Since he does not meet the standard, he can shut down and abandon the business. The economic consequences of this on the producer and his employees are apparent. The effect on his customers depends upon what alternative sources of material they can find. SPI testimony covers this in some detail.

- 2) He may make changes, involving capital expenditure or otherwise, to bring his operations into compliance. Depending on the severity of the standard this will take more and more fundamental and expensive changes and thus longer and longer times, and may reduce output although not stop it entirely.

- 3) He may decide to replace his current plant with a new one designed to meet the new standard. This route, of course, requires the most in time and capital money.

Thus far, all producers have been proceeding according to alternative #2. Everyone has obviously done the quickest, easiest, most effective things first. This has permitted most of us to quickly approach conformance to the emergency standard now in effect. I say approach because I do not believe any PVC producer is able to stay below 50 ppm 100% of the time at every location in his plant. I know that we are not, in spite of our most strenuous efforts, and I believe we may be ahead of a number of other producers in measures we have taken.

Because of the volatility of VCM and the internal pressures in PVC equipment, every flange, valve, pump, compressor, heat exchanger, and other piece of process equipment is a potential source of leaks. Much of the equipment must be opened routinely for cleaning and inspection to insure safe operation, and large quantities of air pass through other items of equipment such as centrifuges and driers. There is no one thing to be done to limit VCM loss to the plant atmosphere, there are literally hundreds of leaks or potential leaks to deal with. This should make it clear how hazardous are estimates

of future achievable VCM levels in plant air and how likely it is that excursions in these levels will unpredictably occur from time to time. Replacement of older equipment with newer types, designed with minimum leakage in mind, depends upon availability and deliverability of such replacements. Delivery of even an exhaust fan takes months in the current high capital spending environment. Major equipment takes many more months.

Although we at Air Products are not at all satisfied with our ability to guarantee conformance with the current emergency standard, we support the 25 TWA proposal for October 5, 1974. We need the delivery of new equipment to meet this level but have some confidence that we can meet it. The concept of a ceiling level, and how it is to be measured and administered requires clarification in the proposed standard, and Mr. Barr will cover this in our more detailed comments to follow.

Alternative 3 requires some comment. For any producer of PVC other than one who also produces VCM this is not currently a realistic alternative. Air Products for some time has been attempting to develop an assured source of supply for enough VCM to build a new, modern PVC plant. We are naturally reluctant to do this without such a source. Two years of contact and/or negotiation with every conceivable supplier has yielded nothing of substance. We can foresee no change in this situation for some time, at least until substantial new VCM capacity is announced for merchant sales and is nearing production. No such plant, which takes three years to build, is now in prospect. Under these circumstances, should any significant part of the industry be forced to shut down by unrealistic regulation, greatly increased concentration of the industry will surely result.

VII. VENTILATION CONSIDERATION

Any estimate of achievable levels in the plant atmosphere is of course dependent on the degree of plant ventilation permissible as well as on the degree to which VCM is released. Virtually all of the testimony presented in this hearing will be based on the basic presumption that very extensive use of strong ventilation is acceptable. This is so because no practical technology exists for the removal of VCM from large volumes of plant air. It seems clear from current information

that this presents no real problems but it must be recognized that unrealistic actions in the way of external environmental regulation can negate practicality just as easily as unsound in-plant regulations.

VIII. FABRICATION SITUATION

Consideration of fabricating operations as potentially regulated ones must also be given. There are sufficient data now becoming available to warrant a judgment that if resins containing not more than 0.05% by weight of uncombined VCM are shipped from the polymer plants that there is no need to regulate warehouses, shipping facilities or fabrication operations. Data to support this will be offered by Mr. Barr. There are two possible places in fabrication operations that should have some elementary precautions in effect, however. Such precautions seem to be already adequately covered by existing OSHA requirements.

At the point where the PVC container is first opened, the contained air, although quite small in volume, and in absolute VCM content, may be high in VCM concentration. In an impervious container such as a tank car or a silo the concentration will usually be above the corresponding ppm of free VCM in the resin. In a porous container, like a paper bag, the concentration in the contained air will be very noticeably lower. In either case, this air should be exhausted outside of the work area by

appropriate ventillation means. In a similar way, gases evolving from the first heating and exposure of the molten resin should be similarly vented. With these simple precautions the atmosphere in the fabricating work space may be expected to be at levels not exceeding 2 ppm and probably very much lower. TWA's for such plants might be expected to average 1 or less for the employees involved.

We therefore recommend that fabrication facilities processing resins of less than 0.05% uncombined VCM be considered non-regulated areas within the meaning of the proposed standard.

I would now like to introduce John T. Barr, Technical Manager for Chemical Group manufacturing.

Testimony of John T. Barr, Regarding Technical
Feasibility of the Proposed Permanent Standard.

These comments are presented for your consideration and are based on the best information available to us at this time. I shall discuss (1) the sources of exposure to our workers, and the methods of exposure reduction which we have used, (2) the methods of monitoring, (3) the programs for exposure reduction which we have in progress, (4) the situation in fabrication plants which we have studied, and (5) a summary of our specific comments on the proposed standard. In addition, we will submit a detailed written commentary on the standard, with suggested changes.

1. Sources of Exposure and Exposure Reduction Methods

About 80% of the PVC which is manufactured in the U.S. today is made by the process which APCI employs, that is, the batch suspension process, and most plants, as do ours, contain a multiplicity of relatively small reactors. These reactors must be opened frequently for charging and cleaning. It is the vapors from these operations, and from the VCM degassing from slurry and dried powder that form the greatest sources of VCM exposure to workers.

The second greatest source is the fugitive emissions from leaks at gaskets, valve stems, pump seals, and other mechanical joints in the piping of the plants. These two sources will continue to be a problem no matter how well maintained or how carefully operated is the plant.

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Monitoring of the VCM concentrations taken in our plants during the last week in January disclosed that we had many areas around reactors, pumps, and weigh tanks that contained concentrations in the 200-400 ppm range, with a few isolated points even higher, although the general work space was usually in the 50-200 ppm range. This survey substantiated the results of earlier tests.

At this time, APCI accelerated its monomer exposure reduction program which had been started almost a year earlier. We mounted a major engineering and renovation program, including extensive revision to operating procedures, to reduce the chance of release of VCM inside the building; special retraining of operators; and augmentation of the total ventilation system for buildings and equipment. We instituted the use of airline respirators for reactor cleaning or entering vessels containing VCM, and while doing maintenance work that could release VCM. We were fortunate that we had placed an order in the summer of 1973 for much of the equipment needed for the polymer building ventilation improvements, and that this was being in fact delivered in early 1974. Other equipment was obtained from wherever available and some was diverted from its intended application in other areas for this service. Immediate attention was given to the trouble spots, by the assignment of all available technical and maintenance personnel. This allowed us to reduce the exposure to the point that by the time the temporary standard of 50 ppm

took effect on 5 April, 1974 we were already in substantial compliance. Continued work has enabled us to achieve an average 8 hour TWA in the 20-25 ppm range for our workers in the polymerization building, and even lower for those in other job locations. Once again it must be pointed out that these are average TWA figures and many of our results are above this average.

Moreover, we still are having difficulty in maintaining our work spaces below the present standard of 50 ppm ceiling all of the time since it is impossible to guarantee that a leak will not develop, and that an employee will not be exposed temporarily to a concentration above a specified level, no matter what that level may be.

We want to emphasize the difficulty of a ceiling concept. Technology does not now exist that will give instantaneous readings of VCM concentrations at the worker breathing zone. Therefore, there must be an allowable time period in the standard for the monitoring system to sense a rise in concentration and to warn the employee to put on breathing protection. In addition, the use of that breathing protection must be permitted on a continuing basis when the designated ceiling is exceeded. We cannot understand the practicality or validity of a ceiling standard without such provisions, since it is not reasonable or enforceable, and in the last analysis, we believe that the best basis for the protection of a worker is the control of his total exposure.

Another point which also needs emphasis is that while stopping VCM emissions at their source is clearly the first exposure control priority, the ability to continue to utilize ventilation is essential to overcome the effects of inevitable leaks and losses from any practical system.

2. Monitoring Methods

We have found that two basic monitoring programs are necessary for us to understand completely the problems which we must solve; (1) area monitoring, and (2) the determination of individual employee exposures by personal monitoring.

Area monitoring was first performed in our plants with a portable total hydrocarbon analyzer. This is still being used regularly as a leak detector and to cover those areas which are not covered by fixed point monitors.

We were able to have a 10-point fixed monitor in service in each plant by early April. This is a chromatographic device which separates and measures the actual VCM concentration. A second 10-point instrument is now in service, giving us 20 points for our area monitoring in each plant.

Personal monitoring has been in effect since late February using the carbon tube method, and we now have four months experience. We have found that 8 hr. measurements are more reliable and give more realistic data than do the shorter sampling periods which have been recommended.

All three of these instruments have been cross-checked and calibrated against our laboratory chromatographs, first by using identical samples on all instruments simultaneously, and second by taking field samples and rerunning them in the laboratory. We have found the correlation to be excellent and therefore recommend that both methods be employed.

3. Programs in Progress

We have completed nearly all of those things which can be done with materials and technology at hand. Further improvements require substantial outlays of engineering efforts, capital, and above all, time to obtain and install the necessary equipment.

We have had on order for almost 5 months now rotating vane compressors to replace the reciprocating machines currently in service in our monomer recovery section. These existing compressors are a source of monomer because of leaks at the shaft seals. The presently promised delivery indicates that we will have the new compressors in service by July of 1975.

We have been working for more than two years, and have spent more than a million dollars, on the development of a solvent cleaning system for the polymerization vessels. This would effectively eliminate the need to open or enter these vessels, and thus greatly reduce the exposure potential. We are not yet completely satisfied with the system, and a recent request for quotations on the required equipment to expand the system from its present level of operation resulted in

estimated delivery times of from two to two and a half years after the order is accepted.

Even standard equipment such as pumps and valves run several months to a year for delivery, and as all of the industry knows, it is impossible to get early delivery on monitoring equipment, apparently because of the large orders placed by governmental agencies. Other quoted delivered times for the type of equipment which we will need are:

pressure vessels:	2 years or more
instruments:	12 to 14 months
field erected tanks:	16 to 20 months
structural steel:	10 to 16 months
centrifuges:	20 months to 2 years.

This situation will deteriorate rather than improve as more companies move to reduce their exposures and we can expect that at least two years will be necessary for any major capital improvements.

Even assuming, however, that major improvements are committed to, we cannot expect to accomplish any further order of magnitude improvements such as we have achieved in the past six months. The very fact that our worker exposure is now averaging 20-25 TWA in itself indicates that many of the readings are above 25, with a few above 50, and we expect that we shall have a very difficult time in maintaining all 8 hour TWA exposure at a level below 25 ppm, if, in fact, we can do it

at all. We can support the SPI proposal of 25 TWA as a goal that we have a reasonable hope of achieving by October, 1974, beyond that we cannot state with certainty the results of technology which is yet to be applied.

4. Fabricators Plant

We believe that PVC fabrication operations do not require regulation under standards being considered for VCM and PVC plants, since exposures to VCM at the fabricators' plants which we have studied are now very low, because very little monomer is present in these plants.

The monomer content of our resins has followed a pattern very similar to that of VCM in the workplace. Levels of 0.1-0.2% by weight in the resin were quite normal as recently as 1973. The steps which were taken to reduce worker exposure in PVC manufacturing plants have produced as a side effect a reduction of the residual monomer. In addition, other work programs have been aimed specifically at this problem, so that at present we can manufacture most, but not all resin containing less than 0.1% free VCM. Air Products has a line of specialty resin, that represent a small portion of its output, with quite low residual levels. The great majority of the general purpose resins, however, representing 65-75% of all our production, now fall into the range of 0.025%-0.075% by weight. We believe that with present programs we can achieve by October, 1975, a goal of 0.05% for all resin at the time of shipment from the plant, and the actual content by the time it is processed will be lower than this.

Our position was substantiated by the results of measurements of the VCM levels in a number of our customers' plants as well as in our own compounding and fabrication operations. We have found these exposures to run no higher than 1-2 ppm, and they are generally well below 0.5 ppm. These results are being obtained while processing polymer of normal monomer content, and with the standard ventilation of the type which is required for ordinary industrial hygienic purposes.

A further important point is that there is no potential for a large release of VCM at a fabrication plant as there could be at a VCM or PVC operation.

Neither do we see any problem in the transportation of PVC. For example, should a 40,000 lb. truck load of PVC containing 0.05% VCM lose even half of its VCM over a several day trip, this would only amount to a loss of 10 lbs. of monomer, which would be so diluted along the route that it would be unmeasurable.

Thus, we can recommend without reservation the exemption from the standards of facilities involved in the handling of materials containing less than 0.05% by wt. uncombined VCM from this standard.

5. Comments on the Proposed Standard

We have prepared a detailed list of objections to the proposed standard as published, and have supplied alternate wording where its is needed. Some of these suggestions differ substantially from other proposals which are being made, and we urge your serious consideration of them. In the interest of brevity, we are submitting these in writing, as Appendix A, and ask that they be made a part of the record of this hearing. A brief summary will be given here.

1. We propose to substitute a limit of 25 TWA, 40 ceiling in place of the no detectable level.
2. Monitoring should include both the work zone and the employee.
3. Respirators may be of the half-face or full face, air supplied type, and shall be worn as soon as possible after it has been detected that the ceiling has been exceeded.
4. Impervious suits should not be required, but clean work clothing be furnished as appropriate.
5. We propose that the permanent standard not apply to PVC, waste streams or finished or semi-finished product, including compound, which contains less than 0.05% by weight uncombined vinyl chloride, or to the transportation or processing of PVC with this level of free VCM.

6. Conclusion

In conclusion, we respectfully submit that the proposed permanent standard fails to meet the basic requirements in the Occupational Safety and Health Act of 1970 either as to necessity, or as to technical and economic feasibility, and that it represents a substantial departure in principle from other standards. Many of its specific requirements are either impossible to meet or are unnecessarily restrictive, and some offer greater hazards than that which they propose to remedy. We therefore request your serious consideration of our comments and suggested changes.

TESTIMONY OF DR. PAUL KOTIN
REGARDING MEDICAL RESULTS

This is a report of the results of screening of present employees of Air Products and Chemicals, Inc., who are engaged in the handling of vinyl chloride monomer, and on the results of my examination of death certificates of those PVC employees who left the company or died while employed.

I was employed as a consultant by Mr. Richard Fleming, Group Vice President Chemicals Group of Air Products and Chemicals, Inc., in early February, 1974, for the specific purpose of establishing and conducting a medical evaluation and surveillance program for employees exposed to vinyl chloride. As a first step physicians were identified in the two areas where APCI has VC operators. Dr. William N. Blalock of Paducah, Kentucky, and Dr. Barkley Beidleman of Pensacola, Florida, agreed to serve and in consultation with them, a medical examination protocol was developed and carried out for employees in plants at Calvert City, Kentucky, under the supervision of Dr. Blalock, and at Pace, Florida, under the supervision of Dr. Beidleman.

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Both physicians are certified in the American Board of Internal Medicine. Dr. Blalock is a specialist in gastroenterology and hepatology, and Dr. Beidleman is a member of a large medical group with specialists in gastroenterology and hepatology. Following several meetings between myself and the two physicians, a screening and review procedure was adopted for the APCI employees at the two plants. Special emphasis was directed towards identifying and specifically testing for the two diseases for which there were demonstrated associations between VC exposure and disease -- acroosteolysis and angiosarcoma of the liver. These areas of emphasis were part of a complete review of each patient which included the following:

A complete and detailed medical history was taken on each employee. Afterward, a physical examination and a series of laboratory procedures were performed as follows:

Pensacola, Florida
(Dr. Beidleman)

Chest x-rays
Hand x-rays
Blood urea nitrogen (BUN)
Uric acid
Phosphorus

Paducah, Kentucky
(Dr. Blalock)

Chest x-rays
Hand x-rays
Blood urea nitrogen (BUN)
Uric acid
Phosphorus

Pensacola, Florida
(Dr. Beidleman)

Calcium
Alkaline phosphatase
Total protein
Albumin
Bilirubin
Cholesterol
Globulin
Glucose
Triglycerides
Serum glutamic oxalacetic
transaminase (SGOT)
Lactic dehydrogenase (LDH)
Alpha fetoprotein (AFP)
Carcinoembryonic antigen (CEA)
Complete blood count (CBC)

Paducah, Kentucky
(Dr. Blalock)

Calcium
Alkaline phosphatase
Total protein
Albumin
Bilirubin
Cholesterol
Chloride
Serum glutamic oxalacetic
transaminase (SGOT)
Lactic dehydrogenase (LDH)
Complete blood count (with
platelets) (CBC)
Serum glutamic pyruvic
transaminase (SGPT)

Differences in the laboratory tests performed in Florida and Kentucky reflected the availability of laboratory resources. Testing showing abnormal laboratory findings in any employee were repeated to assure their authenticity. In addition to repetition of the preceding tests when indicated, the following additional tests were