NIOSH CONTROL TECHNOLOGY ASSESSMENT OF THE PLASTICS AND RESINS INDUSTRY:

METHODS AND APPROACH

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As background for the upcoming open floor discussion, I'd like to review how the study was conducted, describing the significant problems encountered and how they were overcome.

The primary objective of the study was to assess and document engineering control technology used to reduce worker exposure to toxic chemicals and harmful physical agents in the plastics and resins industry. The assessment was to be accomplished primarily through in-plant survey of 9 polymerization processes selected to best represent the industry relative to criteria such as common unit operations, maximum number of workers and best control technology. The scope of work encompassed all processes used to manufacture the polymerized materials listed in Standard Industrial Classifications 2821 and 2822, including thermoplastic and thermosetting resins, elastomers, and synthetic rubber. All operations from receipt of raw materials through compounding of polymerized materials were to be included in the assessment.

Prior to selecting the 9 survey sites, it was first necessary to broadly determine the types of processes to be included. We soon recognized that the plastics and resins industry is extremely diverse and complex and therefore not easily characterized by a single parameter such as process type. There are at least 20 distinct polymerization processes used to produce many hundreds of different polymerized products. Rather than develop meaningless statistical techniques to select optimum process categories for site surveys, we decided it was preferable to use a common sense approach based on our understanding of the objectives of the study. Our logic was as follows:

1. The seven additional polymerization processes used to manufacture thermoplastic resin, elastomers and synthetic rubber make up a much larger percentage of the industry output and number of workers than do the 13 condensation polymerization processes used to produce thermosetting resins. Thus these processes were emphasized in the study.

2. Polyvinyl chloride is commonly produced by four of the seven addition polymerization processes, Also, because of the very strict OSHA regulations for vinyl chloride, these plants were known to possess effective, sophisticated control technology. Therefore PVC plants were subject to a far disproportionate number of surveys.

3. During the study, NIOSH was very interested in processes using styrene, particularly styrene butadiene rubber plants. For this reason, we decided to include three processes using large amounts of styrene, including a polystyrene and ABS-SAN resin process and an SBR process.

4. Even though the three addition polymerization processes for polyethylene and polypropylene comprise a large percentage of the industry output and number of workers, none were included as survey sites. We concluded that these processes do not use large quantities of toxic materials, and are thus not good subjects for assessment of control technology.

5. Many polymerization plants also possess compounding operations. It was thus decided not to select compounding operations for specific surveys; rather, we would evaluate these operations while at a given plant to survey a selected polymerization process.

In retrospect, I feel that this common sense approach to process selection yielded a very representative and useful assessment of control technology in the industry. It is strongly felt that other process selection techniques based primarily on process or material production rates or number of workers would have diminished the effectiveness of the study. I do, however, regret the omission of a solution polymerization process using large amounts of a solvent such as benzene - frankly, we did survey such a process but determined that the controls were not sufficiently effective to be included in the study.

Once we had determined the types of processes to be surveyed, it was necessary to locate and gain voluntary access to well controlled plants using these processes. This turned out to be a very difficult and time consuming task because we could not identify an industy-wide organization or association to assist us and, since this was the first study of its type, plant personnel were somewhat reluctant to cooperate at first. There were many concerns about proprietary information, and skepticism relative to the end use of the study. However, after several months, we were able to obtain a sufficient number of plants that were willing to cooperate in the study and possessed effective controls. Two other factors were important in the selection of the survey sites. First, it was determined that it was best to include an equal number of batch and continuous processes. Second, we also felt that it would be most useful to concentrate on retrofit controls, such as those implemented in PVC plants after promulgation of the OSHA standard for vinyl chloride. Our reasoning was that the most consequential control technology problems and need for information occur in existing plants following the passage of new standards, such as the recent standard for acrylonitrile. We also believe that, in most cases, the ability already exists to design and construct new plants to comply with existing standards. Furthermore, evaluation of controls in new plants may not generally be applicable to existing plants.

A major impact on how the surveys were conducted was the level of funding for the project, equivalent to an effort of slightly more than one man-year. To put this in perspective, it should be noted that NIOSH is currently funding similar studies with budgets several times larger than this. The study objectives were quite broad in scope, incorporating controls for all potential toxicants and physical stresses in both polymerization and compounding processes. Clearly, priorities had to be established to focus the effort on the most important issues; otherwise we would have either run out of money long before the project was completed or else ended up with a final document that covered all possible areas, but was too diluted to be useful. After studying the industry, we decided to concentrate on evaluating control technology used to minimize worker exposure to toxic monomers such as vinyl chloride, styrene and acrylonitrile. Controls for minor process additives and other potential toxicants used in small quantities, and for noise and heat stress were not neglected, but were relegated to a position of secondary importance. Essentially, the same was true for compounding operations, although a sufficient number were observed to allow an evaluation of needed improvements. The relatively small budget also limited the number of in-plant air samples that could be collected and analyzed. This constraint had two major effects on the surveys: First, it was necessary to use existing plant sampling data wherever possible to evaluate the effectiveness of control systems. All of the PVC plants we surveyed possessed exhaustive monitoring data that we were able to use to full benefit. However, most other plants had not collected extensive sampling data, and control system effectiveness had to be evaluated based on a limited number of samples. Second, we did not have sufficient funds to allow a large amount of investigative type sampling needed to evaluate the effectiveness on individual controls on overall worker exposure. However, since most plants utilized a systems approach to control exposures, it was generally sufficient to evaluate the effectiveness of the control system as a whole.

Although there are many issues concerning the conduct of the study that I'd like to discuss, there is only time to briefly touch on one additional item, i.e., the problems associated with proprietary technology. In most plants, sophisticated controls were developed requiring extensive research and development, as exemplified by monomer stripping operations in PVC processes. In all cases details of these technologies were considered proprietary and at best we were only able to describe them relative to performance criteria. Due to the extreme importance of such technologies, it is strongly suggested that procedures be developed in the future to allow dissemination of this information, while protecting the interests of the companies who develop it.

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MR. HAAG: Our next speaker, Dr. Julius Bochinski, is the Manager of the Industry Study Group of Enviro Control. He was also deeply involved with the project. He is a chemical engineer from Iowa State University and the University of Detroit. During the past year he has worked in the area of control technology. Dr. Bochinski will be discussing the conclusions of the study and some of the significant findings in outlining some recommendations.

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RESULTS, CONCLUSIONS AND RECOMMENDATIONS

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Since all the attendees have been given a copy of the report (DHEW-NIOSH Publication No. 78-159), I will discuss only the highlights of this study. The areas I will address are:

- The need for a systems approach
- Recommendations for research
- Conclusions

Reduction of vinyl chloride levels in the PVC plant was achieved after a substantial effort to identify and reduce or eliminate emissions from all sources in the plant. In other words, you have to use a systems approach. Also, with a continuing effort by management in identifying and correcting problems with compliance with the vinyl chloride standards, compliance would not be possible. In my opinion, the most effective means of reducing emissions was stripping the monomer from the resins as soon as possible.

The problems presented for consideration for research by NIOSH were selected on the following basis: Resolution would result in a significant reduction of worker exposure; the problems are common to various segments of the industry; and the effort and cost involved would be commensurate with the expected results.

We have the following five general recommendations:

- The safety work practices are often the most cost effective investment. However, long-term success in the area depends on educational level of the worker and attitude of management, physical appearance of the environment, housekeeping practices and age level of the workers, and engineering controls operating effectively.

- Real time monitoring instruments are needed that are more reliable and simpler to operate and less expensive.

- Computer control of processes - further automation will reduce worker exposure, reduce human error. Automation with monitoring instruments of work procedures that have a high incident of worker exposure is needed.

- Better mechanical designs of certain equipment would reduce maintenance problems. Better seals and better materials of construction are most important. Improved seals on rotating equipment would substantially reduce worker exposure. Early failure could be the result of construction, poor preventive maintenance or improper installation.

- The additives were not evaluated. Many of the thousands of common though minor ingredients used may not have been subjected to toxic analysis and evaluation. Many of the additives are purchased as trade name products, so the users do not know what they really have.

In conclusion, reduction and exposure levels requires three things:

- Technical expertise
- Time
- Financial Resources

You must have sufficient technical capability, and you must have adequate time and financial resources to integrate your activities with the other activities in the company. Extrapolation of control technology must be done with care. Attention must be paid to physical and chemical properties of hazards you intend to control.

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MR. WALTER HAAG: At this time we will have a critique of the study report by John Barr of Air Products and Chemicals, Inc., followed by an open discussion of the study from the floor.

NIOSH

SYMPOSIUM PROCEEDINGS

Control Technology in the Plastics and Resins Industry

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

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