STUDY PLAN

CONTROL TECHNOLOGY ASSESSMENT OF CHEMICAL PROCESS - BATCH UNIT OPERATIONS

NIOSH CONTRACT NO. 210-80-0071

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Submitted To:

Harold Van Wagenen
NIOSH Project Officer
4676 Columbia Parkway
Cincinnati, Ohio 45226

Prepared By:

ENVIRO CONTROL, INC.
The Dynamac Building
11140 Rockville Pike
Rockville, Maryland 20852

TABLE OF CONTENTS

Study Plan

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. PB90-142696
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16. Abstract (Limit: 200 words) The scope of this report was to discuss the study plan devised for the evaluation of technology used to reduce or prevent occupational exposure to hazardous chemicals during batch chemical operations in the synthetic organic chemical manufacturing industries. The primary concern of this effort was batch operations as their cyclical nature placed more stress on the control mechanisms in place and particularly on sealing device components than did continuous operations. A study of continuous process operations was not precluded, however, since these results may be readily applied to batch operations. Some of the control technology to be investigated included the use of valve seals, pump seals, agitator and compressor seals, other rotating and reciprocating seals, pipe flanges, equipment body flange seals, process stream sampling, and communication with the workplace during hazardous operations. Controls considered in this study included not only engineering controls but also monitoring devices, changes in work practices, and the use of personal protective equipment.

17. Document Analysis a. Descriptors

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c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages 76
	22. Security Class (This Page)	22. Price

TABLES

FIGURES

APPENDICES

STUDY PLAN SUMMARY

Enviro Control, Inc. (ENVIRO) is under contract to the National Institute for Occupational Safety and Health (NIOSH) to perform a Control Technology Assessment of Chemical Process Batch Unit Operations (Contract No. 210-80-0071). Control technology includes all means of eliminating or minimizing worker exposure to hazardous chemicals - engineering controls, monitoring devices, work practices, and personal protective equipment. Investigation of engineering controls will include study and field testing of processing equipment emission points and their various sealing devices (both static and dynamic). To enlist cooperation and support for the program, this document was prepared to inform various segments of the chemical industry and representatives of government and labor as to the scope of work and approach to be used. Enviro and NIOSH are soliciting comments and criticisms of the study plan to ensure that all pertinent questions are addressed. Also they request industrial firms and their trade associations to suggest chemical processing facilities with superior control technology, including facilities which incorporate effective fugitive emission sealing devices (frequently referred to as seals and fittings) on their chemical processing equipment.

The study can be summarized as follows:

Scope of Work

Document and evaluate the control technology used to reduce or prevent occupational exposure to hazardous chemicals during batch chemical operations in the Synthetic Organic Chemical Manufacturing Industries (SOCMI). The main thrust of the assessment is concerned with batch operations because their cyclic nature places more stress on the controls and especially sealing device components than continuous operations. However, study of continuous process operations are not precluded since the results may be readily applied to batch operations.

Approach

The chemical processing industries either produce or employ a substantial number of commercially important hazardous chemicals. The most effective control technology is likely to be located and/or practiced in chemical processing facilities handling such hazardous chemicals. Therefore a preliminary group of hazardous chemicals (Appendix B in the study plan) was selected. Processes employing these chemicals will be considered for study since they represent a wide variety of unit operations for which the potential for worker exposure must be minimized. In some cases because of proprietary information concerns, controls may be discussed without reference to the chemical process stage involved.

The study focuses on major batch unit operations (having a wide range of applications across industry lines) and their auxiliary emission sealing devices. The equipment used to implement these unit operations has many types of emission points in common:

- Valve seals
- Pump seals
- Agitator and compressor seals
- Other rotating and reciprocating shaft seals
- Pipe flanges
- Equipment body flange seals (including manhead)
- Process stream sampling
- Process streams in open or partial communication with the workplace during:
  - Charging materials
  - Discharging materials
  - Maintenance
  - Open or vented vessels, conveyors, etc.

Emissions from identical sealing devices can vary because of differences in severity of process conditions and inherently different physical properties of chemicals.

Estimation of control technology effectiveness will be based on a combination of work area air sampling (with emphasis on operator work stations) and evaluation of process equipment sealing devices. Sealing device evaluation will include monitoring, bagging, emission sampling, and emission rate determination.

Goals

Assessment objectives include:

1. Identifying and selecting batch unit operations and associated sealing devices for evaluation based on the following considerations:
   - Severity of hazard and potential for worker exposure,
   - Existence of effective control technology,
   - Control technology transfer potential,
   - Fundamental understanding of the relationship of control technology performance, process operating conditions, and physical properties of the chemicals or chemical mixtures being handled,
   - Projected future trends.
2. Conducting preliminary surveys and detailed studies at selected chemical processing facilities to obtain the following information:
   - Validation of the control technology performance relationships,

- Determination of control technology options effectiveness,

- Documentation of relationship between sealing mechanism performance, process operating conditions, physical properties of chemicals being handled, and sealing device design parameters,

- Available costs involved in control equipment purchase, installation, operation, and maintenance (information sources being plant engineering and maintenance personnel and/or vendors).

3. Preparation of a final report on control technology that will provide readily accessible information on the following:

   - A catalog of effective control technology options (Table 1 details current information status on control options and proposed study and report goals),

   - Fugitive emission sealing device evaluation results (in summary form),

     - A description of key sealing concerns,

     - A summary of key design parameters in terms of process operating variables, mechanical design features, and the physical/chemical properties of the materials handled by the equipment being sealed,

     - A discussion of limitations for sealing device applications (i.e., advantages and disadvantages),

     - Examples of successful application and use of procedures documented in the report.

   - Available engineering cost estimates on installation, operation, and maintenance of control technology options,

   - Areas where control technology is deficient, and research and development recommendations for future studies to alleviate these deficiencies.

Table 1. Control Technology Options

CATEGORIES OF CONTROL TECHNOLOGY	STATUS OF INFORMATION	PROGRAM AND REPORT GOALS
I-Equipment Design Changes • Fugitive emission sealing devices • Equipment layout	• Much qualitative, and some semi-quantitative data, published • Engineering methodology for understanding and selecting seals, largely unpublished • Some information on predictive design for release and dispersion of chemicals from emission sources has been published	• Present engineering summary on sealing devices that: - provides understanding of emission mechanisms - Enables engineer to more effectively select and specify seals for chemical processing applications (include examples) • Present information enabling designers to correlate specific sealing device emission rates to concentrations of hazardous chemicals in work place air (give illustrative examples)
II-Means to Isolate Worker • Control room • Automation - 3 general levels:	• Well-known techniques	• Summarize principles
- Single-loop analog controllers	• Considerable information is available	• Summarize analog control systems used in industry
- Microprocessor-based process control	• A number of firms have commercially available microprocessor-based control equipment. The costs of software and operator/programer skill levels required to implement these control systems are expected to decrease	• Document examples of systems encountered
- Computer process control	• Extensive information available on large computer-controlled installations	• Summarize the complex computer systems used in industry
III-Elimination by Substitution of Less Hazardous Chemicals or Processes	• Some information on examples published	• Document examples
IV-Devices to Control Hazardous Emissions Once They Enter Work Environment • Local exhaust ventilation • General ventilation	• Design procedures well developed and published • Some qualitative information on air recirculation applications published • NIOSH does not recommend air recirculation systems when volatile hazardous chemicals are present	• Provide references to guidelines and check points ensuring ventilation systems are suitable for the application • Present examples of novel ventilation systems encountered during facility visits

Table 1. (Continued)

CATEGORIES OF CONTROL TECHNOLOGY	STATUS OF INFORMATION	PROGRAM AND REPORT GOALS
V-Work Practices Work practices are the trained actions of the employee which result in the reduction of exposure through effective use of engineering controls, sanitation, and hygiene practices or other disciplines by which the employee performs the job	• Work practices well designed by some chemical firms • Information on work practices and resulting benefits not adequately reported in the technical literature	• Summarize work practices: - Group work practices by function and discuss special considerations in each grouping. Present illustrative examples
VI-Monitoring Systems On-line monitoring systems alert workers and identify emission sources when hazardous chemical concentrations exceed limits	• Prior NIOSH study completed and extensive quantitative information is available	• Summarize prior NIOSH study and present suggested procedures for selecting and implementing monitoring systems • Document monitoring systems observed in facility visits
VII-Administrative Controls Administrative controls are any procedures which significantly limit daily exposure by control or manipulation of the work schedule	• Used in selected applications	• Document examples of administrative controls
VIII-Personal Protective Equipment	• Considerable information published. Used in selected applications where alternative control options are not suitable or feasible, particularly applicable for maintenance operations	• Summarize types of suitable equipment observed in facility visits (prepare table summary)

NOTES:

1. Categories I, II, III, and IV are considered to be engineering controls.
2. Categories V, VII, and VIII will be evaluated on the basis of professional judgment and documented when determined to be appropriate for the hazardous work situation.
3. Order of listing does not indicate relative importance. Such a priority listing can be developed for any specific situation and may vary from situation to situation.

I. INTRODUCTION

A. Background

One of the programs of the National Institute for Occupational Safety and Health (NIOSH) is the documentation and development of control technology that is effective in reducing occupational hazards. Since 1976, NIOSH has sponsored control technology assessments of the plastic and resins industry, primary and secondary smelting operations, foundries, pesticides manufacturing, dry cleaning operations, tire manufacturing, spray painting, raw cotton processing, and pulp and paper processing operations. The objective of these assessments is to assist industry in improving worker protection, particularly when problems arise or when new health standards are promulgated. Effective control technology described in these reports should be transferable to other industrial situations, thus providing more efficient and rapid implementation of needed improvements.

With authority and direction from the Occupational Safety and Health Act of 1970, the Division of Physical Science and Engineering is performing this study to identify the most effective technology for controlling worker exposure to hazardous chemicals encountered in chemical process batch unit operations. The study will focus on (but is not limited to) the following industrial categories of the Synthetic Organic Chemicals Manufacturing Industries (SOCMI) wherein unit operations are widely employed.

Plastics and resins	SIC 2821
Pesticides	SIC 2879
Explosives	SIC 2892
Surfactants	SIC 2841
Pharmaceuticals	SIC 2834
Organic dyes and pigments	SIC 2865
Plasticizer and specialty chemicals	SIC 2869

Since NIOSH has conducted assessments for the plastics and resins and pesticides industries, emphasis will be on the other above listed industries. However, some of the facilities previously studied in these two prior assessments will be recontacted for added details on effective sealing devices.

Appropriate control technology from these two industries will be reevaluated on the basis of a batch unit operations standpoint and included in the final report. Of particular interest are the engineering controls, monitoring devices, and work practices employed in modern batch polymerization facilities handling highly hazardous vinyl chloride monomer and/or acrylonitrile.

B. Objectives and Scope of Study

The purpose of this study is to document and evaluate effective control technology that is currently used to reduce or prevent occupational exposure to hazardous chemicals and chemical mixtures from batch unit operations. The main thrust of the assessment is concerned with batch operations rather than

continuous because the cyclic nature of processes places more stress on the controls and sealing device components. However, detailed studies of continuous process operations are not precluded since the results may be readily applied to batch operations. The control technology to be studied will cover:

- Engineering controls - elimination by substitution, equipment sealing device selection and design change, means to control hazardous emissions once released, isolation of the worker;

- Monitoring devices - instrument systems that monitor the workplace and/or alert the workers to failure of engineering controls or process equipment, or to unusual increases in levels of hazardous substances;

- Work practices - operating procedures that minimize individual exposure to hazardous chemicals;

- Personal protective equipment - respirators, face masks, and protective clothing worn by workers to prevent inhalation and/or physical contact with hazardous chemicals.

The study will emphasize engineering controls: the majority of the study effort will be devoted to the identification and assessment of engineering controls, with the remainder divided between the identification of personal protective equipment, work practices, and monitoring systems. Evaluation of engineering controls will include study and field testing of process equipment emission point sealing devices (both static and dynamic) determined to be effective in preventing emissions.

Where effective control technology is found, costs to implement and operate the controls will be estimated from information provided by both plant personnel and/or vendors, and updated to current cost levels where possible. Cost effective controls will be identified for the various unit operations.

This control technology information will be partially obtained by literature search, but primarily by on-site surveys conducted by contractor personnel with direction from the NIOSH project officer. Current plans call for 35 preliminary surveys. Based on information from these, a lesser number of facilities (not to exceed 25) will be revisited to perform detailed studies of items of interest.

During this study, control technology will be documented in sufficient detail to enable industry to adapt and replicate the effective controls in other plant and industry situations. In addition, the following will be provided in the final report document:

- Recommendations for effective dissemination of information concerning control technology,

- Identification of control technology deficiencies,

- Recommendations for research and development of control technology where control technology is inadequate or does not exist.

It is important that results and conclusions be presented in a manner that is both understandable and credible to labor organizations, industry engineers and managers, industrial hygienists, and other interested individuals.

C. Approach

Major steps in performing the study include:

1. Conducting preliminary surveys to obtain sufficient information for later selection of appropriate facilities for detailed studies.

2. Selecting facilities for detailed studies. The detailed studies will include monitoring, emission point sealing device evaluation (bagging, emission sampling, and emission rate determination), air sampling, and other measurement methods to determine control technology effectiveness. Also included will be further documentation of structural and operational details of unit operation equipment and their sealing devices observed in the preliminary site surveys. A comprehensive detailed study protocol will be written for each facility based on the information obtained in item 1. This will be supplied the facility prior to study team arrival.

3. Preparing a final report that provides information necessary for selecting and implementing control technology options, and planning research and development.

II. INVESTIGATION OF CONTROL TECHNOLOGY

A. Discussion of Categories

The control technology that will be assessed can be conveniently grouped into the categories listed below. Categories I, II, III, and IV are considered as engineering controls. Control categories V, VII, and VIII will be evaluated on the basis of professional judgement and documented if found to be appropriate for the hazardous work situation. The order of listing does not indicate the order of relative importance. Such a priority listing can be developed for any specific situation and may vary from situation to situation.

Category I - Specific equipment design changes.
- Fugitive emission sealing devices.
- Equipment layout.

Category II - Means to isolate worker.
- Control room.
- Automation.

Category III - Elimination by substitution of less hazardous chemicals or processes.

Category IV - Devices to control hazardous emissions once they enter work environment.
- Local exhaust ventilation.
- General ventilation.

Category V - Work practices. Work practice controls are the trained actions of the employees which result in the reduction of exposure through effective use of engineering controls, sanitation, and hygiene practices, or other procedures by which the employee performs the job.

Category VI - Monitoring systems. On-line monitoring systems that will alert workers and identify emission sources when concentrations of hazardous chemicals exceed specified limits.

Category VII - Administrative controls. Administrative controls are any procedures which significantly limit daily exposure by control or manipulation of the work schedule.

Category VIII - Personal protective equipment. Respirators, gloves, glasses, disposable clothing, ear plugs, etc.

B. Evaluation of Effectiveness

The assessment of control technology effectiveness will be based on two general approaches:

1. Analyzing sampling and direct reading instrument data describing pre- and post-control conditions, and

2. Engineering evaluation based on information other than sampling and monitoring data.

The components of the assessment may include sealing device evaluation in addition to determination of levels of exposure to hazardous chemicals. The assessment will also include evaluation of system operability, reliability, and complexity (in particular, operator interaction required).

Both engineering and non-engineering control methods will be evaluated by gathering and assessing available information concerning the following qualities:

1. Effectiveness will be evaluated by measurement of the ambient air concentrations of specific hazardous chemicals and the ability of these controls to consistently keep these concentrations below the maximum levels specified by OSHA PEL's (permissable exposure levels) for these chemicals. The control technology may eliminate or reduce worker exposure under all circumstances or only under certain circumstances. Isolation of pumps from process equipment can minimize hazardous chemical concentration in process areas, but increase maintenance personnel exposure. Where possible, the levels of exposure with controls will be compared to the worker exposure without controls, as indicated by sampling results obtained prior to installation. Effectiveness also depends on consistent application of control technology. For example, drawing samples from process streams (for quality control) may result in severe worker exposure in spite of effective controls during normal operation.

2. General applicability determines the degree to which the control technology is transferable to other facilities and operations. Applicability of control technology may depend on unique features of the installations examined. In general, non-engineering controls such as improved and/or increased maintenance, personal protective equipment, and changes in work practices are more easily transferred than engineering controls such as equipment isolation. However, the continuing success of non-engineering and engineering controls depends on management and worker commitment and follow-up efforts to ensure that the changes which have been instituted are preserved. For engineering controls, this requires a carefully planned systematic maintenance program.

3. Complexity affects control technology effectiveness. Monitoring techniques, i.e., gas chromatography, require operators with special skills which may not be currently available. Single and double mechanical sealed pumps and agitators may require more highly skilled maintenance than equivalent packed units. Some new techniques, such as the use of microprocessors for process control can reduce both labor requirements and worker exposure but require skilled servicing by outside contractors.

4. Adequate capability of control technology to potential excursions of process parameters from normal operating conditions allows a control to function effectively over a range of conditions. This is especially

true in batch chemical processing where startup and shutdown lead to frequent changes in the physical environment of the control. A wide range of process parameters must be anticipated where one or more pieces of process equipment are used to produce several different chemicals. In addition, control technology should continue to function under upset conditions.

5. Reliability evaluations of the control technology will be based on information obtained from the plants, vendors, and/or Enviro investigations. Central to this evaluation is the likelihood of production disruptions, reduced levels of production, and changes in product quality affecting production. The use of canned pumps (completely self-contained) can prevent fugitive emissions but may be more prone to mechanical failure than conventional pumps and require filters to prevent solids from entering. Such filters will require added maintenance for cleaning. In this example, the benefits of equipment isolation may be balanced by disruptions to production through mechanical failure. In other cases, production may not be disrupted, but control technology failure may cause reduced worker protection (i.e., failure of ventilation equipment).

6. Trade-offs or other problems may result from the use of a control. For example, equipment isolation by means of valve manifolds can result in additional maintenance requirements if it leads to accumulation of undesirable products in dead-end passages. Some engineering controls may shift the burden of maintenance to other portions of the process.

C. Preliminary Surveys

The preliminary surveys provide the opportunity to visually inspect the installation and control technology in use; collect information on its implementation, effectiveness, and cost; and to discuss it with plant personnel. A general preliminary survey protocol (which details procedures to be followed and information desired) is included as Appendix C. It will be forwarded to plant management prior to the preliminary survey. Non-proprietary information to be requested during the preliminary site surveys includes:

1. Age and size of facility, history of production, chemicals employed, and chemical processes used;

2. Plot plan and process detail of the unit operations of interest and other operations adjacent to it;

3. Company monitoring data covering conditions in the workplace both before and after installation of controls;

4. Information on the selection of the controls in use including definition of requirements, options considered, and basis of choice;

5. Worker activity information - total work force, number of workers potentially exposed, job and activity descriptions for these workers, health and safety program;

6. Information on any other controls in use or planned relevant to this process;

7. Operating data or information on the controls in use, past reliability, and improvements still needed;

8. Monitoring results defining effectiveness of control technology in use and characterization of work areas; and

9. Approximate cost information including equipment costs, installation cost, operation and maintenance costs, supplies needed, and energy requirements.

D. Detailed Studies

Detailed studies will be conducted to obtain additional information and evaluate control technology effectiveness through monitoring, sampling and analysis, and other measurements. When arrangements are being made to conduct a detailed study, a study protocol specific to the facility will be sent to management. These individual detailed study protocols will:

- Include process/occupational health reviews for each hazardous chemical encountered consisting of PEL, process flow scheme, unit operations used, physical properties of chemicals, emission points in the unit operations equipment, and in nearby areas, and health hazards (route of entry, symptoms, and target organs) as described and illustrated in Appendix B,

- List specific unit operations (and their accompanying sealing devices) to be surveyed,

- Identify the locations where chemical concentrations will be measured by monitoring instruments or sampling,

- Specify the kind of information still needed from operating departments (e.g., engineering, maintenance). Such important information includes:

  - Operating condition parameters and stream identification and composition encountered by the various sealing devices of interest in a given unit operation,

  - Mechanical design of the sealing devices, including materials of construction, drawings and photographs, performance and hardware specifications,

  - Maintenance requirements - both vendor recommendations and plant maintenance experience.

Sealing device evaluation and air sampling and monitoring for hazardous chemicals will be employed only to answer pertinent questions concerning the various control technology categories. General questions which need answering are:

- What are the extent of emission rate changes during batch process cycles? This involves conditions and time duration during unit operation charging, startup, reaction, shutdown, and cleanup.

- Are there interferences due to emissions from equipment located adjacent to the area of interest?

- What will the sampling results mean? Are they statistically valid? Do they represent anything other than the concentration levels at the time of sampling?

Predictive design techniques* based on engineering principles and properties of the chemicals may be used to estimate emission rates from process equipment.

Since sampling requirements will vary from facility to facility depending on the individual situation and the hazardous chemicals employed, only a general strategy can be presented in this study plan. A detailed study sampling strategy will include the selection of sampling points, the types of samples to be collected, the sampling equipment used, and the analytical procedures to be used for the samples collected. Based on preliminary survey information and processing equipment plot diagrams, the emission sources (the seals and fittings of the processing equipment) will be identified and located. Both emission source and air sampling will be conducted. First, the sealing devices will be monitored for emissions. Then selected sealing devices will be bagged in order to determine the emission rates and chemical composition of the emissions. Equipment and techniques are discussed in Hughes, T. W., et al.** Air sampling will be performed using NIOSH approved equipment and methods, and will be primarily area-type with concentration on operator work stations. The sampling equipment employed will depend on the chemicals or chemical mixtures being collected, concentration levels anticipated, configuration of unit operation process equipment being investigated, and control methods involved.

NIOSH validated analytical methods will be used wherever possible. Where NIOSH procedures are not available, procedures published in the literature will be used. If specific methods are not available for a given chemical, procedures for similar or related compounds may need to be suitably modified. In each instance, standards at appropriate concentrations will be used to verify the method. Sample analysis will be performed only in laboratories which have participated in the NIOSH Proficiency Analytical Testing (PAT) Program.

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* Jerry M. Schroy, Prediction of Workplace Contaminant Levels, Proceedings from NIOSH-sponsored Symposium on Control Technology in the Plastics and Resins Industry. February 27-28, 1979, Atlanta, GA.

** Hughes, T.W., D. R. Tierney, Z.S. Khan, "Measuring Fugitive Emissions from Petrochemical Plants," August 1979, pp. 35-9.

E. Access to Plants

A tentative list of facilities in the Synthetic Organic Chemical Manufacturing Industries (SOCMI) has been prepared employing EPA data on batch chemical process profiles. From this list approximately 35 will be selected for preliminary surveys. It will be updated as new information is collected from these surveys, literature references, and industry contacts. The NIOSH project officer and contractor program manager will jointly contact the companies to arrange access. This process is being facilitated by enlisting the support of various trade organizations and industry sources.

F. Unit Operations Profile

The cyclic nature of batch chemical processing and batch unit operations can cause emission of hazardous chemicals during startup and shutdown stages, not necessarily occuring in a continuous chemical processing system. This study focuses on major batch unit operations and their auxiliary emission sealing devices having a wide range of applications across industry lines. In some cases because of proprietary information concerns, controls may be discussed without reference to the chemical process stage involved.

Figure 1, a generalized functional diagram for chemical processing, illustrates the concept of batch unit operations in relationship to unit processes (chemical reactions). Table A-1 in Appendix A is a comprehensive list of batch unit operations.

The equipment used to implement unit operations has many types of emissions points in common as listed below:

- Valve seals
- Pump seals
- Agitator and compressor seals
- Other rotating and reciprocating shaft seals
- Pipe flanges
- Equipment body flange seals (including manhead)
- Process stream sampling
- Process streams in open communication with the workplace during:
  - Charging materials
  - Discharging materials
  - Maintenance
  - Open or vented vessels, conveyors, etc.

These process equipment sealing devices operate in a similar manner regardless of the chemicals handled or the mode of production (i.e., batch or continuous). The emission rates from identical sealing devices can vary because of the following factors:

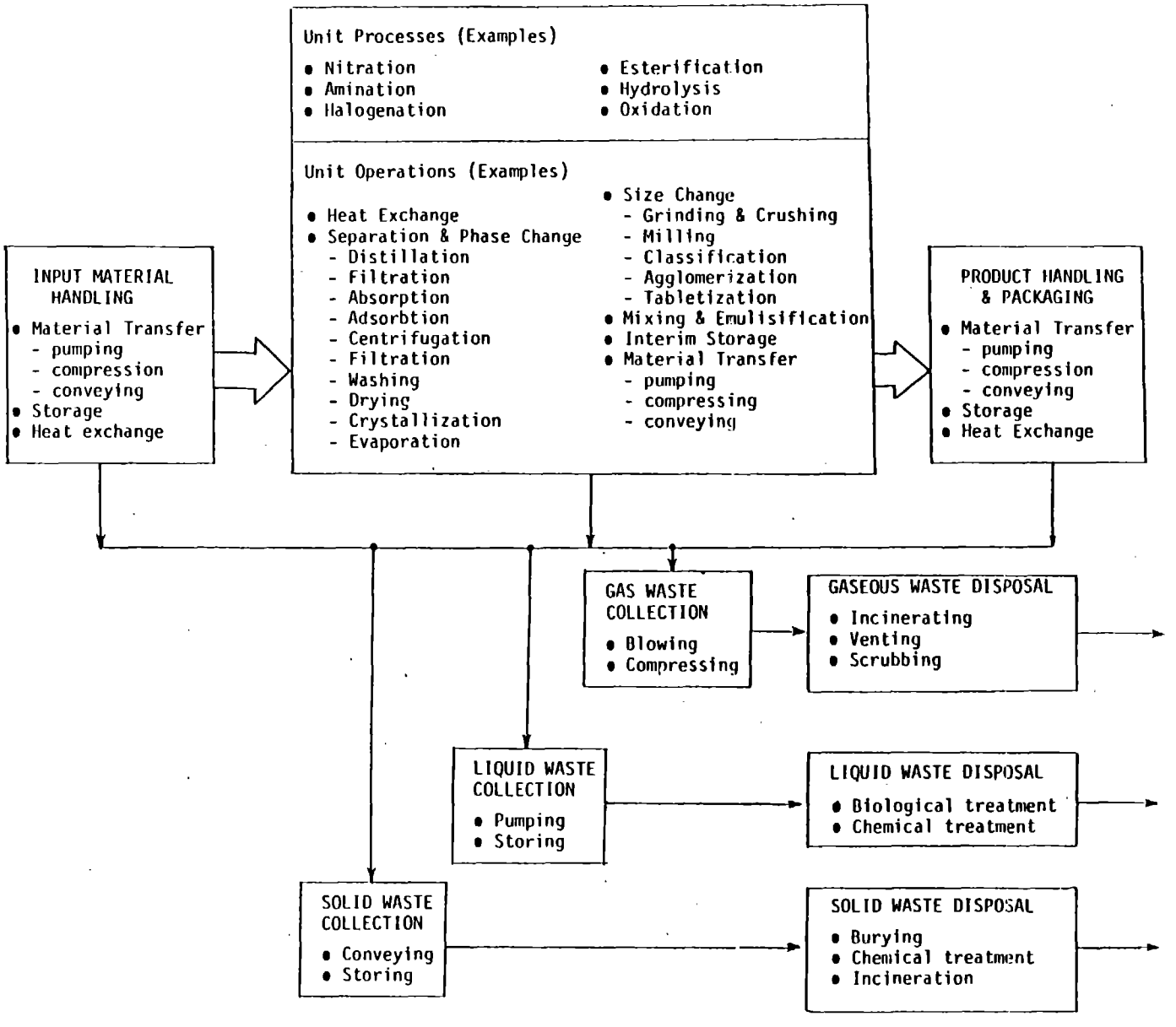


FIGURE 1. GENERALIZED FUNCTIONAL DIAGRAM - UNIT OPERATIONS

- Severity of process conditions - temperature, pressure, heating rates, etc.

- Physical properties of chemical handled - solid, liquid, gas, vapor pressure, and viscosity of liquids, particle size of solids.

Table A-2, Appendix A, lists the modes of release for commercially available equipment employed in batch unit operations for handling solids, liquids, and gases. It demonstrates that the modes of release are few for each type of equipment.

G. Preliminary Selection of Commercially Important Hazardous Chemicals

A preliminary selection of commercially important hazardous chemicals has been made and is shown in Appendix B (Table B-1). A principal consideration in drawing up this list has been to identify processes utilizing, producing, or handling hazardous chemicals, and employing a wide variety of unit operations.

Another principal consideration is that hazardous chemicals must be handled with special care. Hence, effective control technology is likely to be located and practiced in such chemical processing facilities. The method and reasons for selection of the listed hazardous chemicals are also presented in Appendix B under Table B-2.

For a portion of the tentatively selected hazardous chemicals, individual process/occupational health reviews have been prepared. These contain PELs, process flow scheme, unit operations used, physical properties of chemicals, emission points in the unit operation equipment, and health hazards (route of entry, symptoms, and target organs). Figure 2 is the review for acrylamide. The other 15 reviews are included in Appendix B as Figures 3 through 16.

Figure 2. Process/Occupational Health Review

ACRYLAMIDE

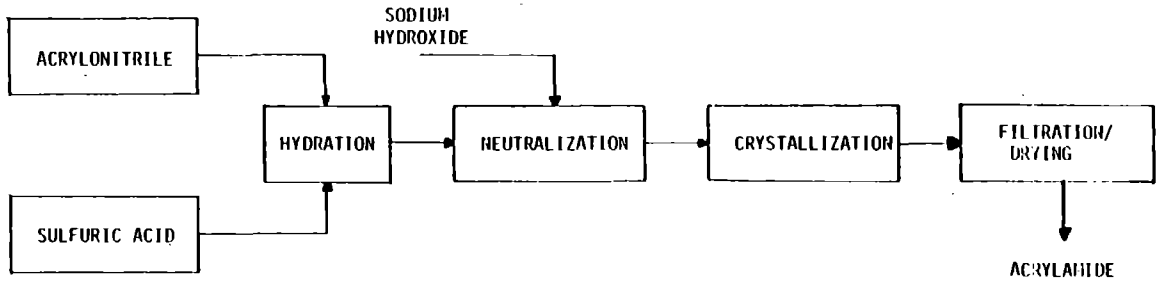
UNIT OPERATIONS USED

- Materials transfer
- Reaction
- Agitation
- Heat transfer
- Crystallization
- Filtration
- Drying
- Packaging

POTENTIAL EMISSION POINTS

- Raw material unloading/ charging
- Pump seals
- Valves/flanges
- Vessel entryways
- Agitator shaft seals
- Equipment cleanup
- Filter cleaning
- Product packaging

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and	Health Hazard	
CAS RN	Name	PEL	Physical Properties	Route of Entry	Effect
107-13-1	Acrylonitrile	2ppm	B.P. 171°F Solubility 7.1% V.P. 83mm	Inhalation Absorption Ingestion Contact	Irritant Carcinogen
79-06-1	Acrylamide	0.3mg/m³	M.P. 183°F Solubility 216% V.P. 0.007mm	Inhalation Absorption Ingestion Contact	Irritant Narcotic
7664-93-9	Sulfuric Acid	1 mg/m³	M.P. 37°F B.P. 518°F Solubility Miscible V.P. <0.001mm	Inhalation Ingestion Contact	Irritant
1310-73-2	Sodium Hydroxide	2mg/m³	M.P. 590°F B.P. 2534°F Solubility 50% V.P. approx. 0mm	Inhalation Ingestion Contact	Irritant

III. COST EVALUATION OF CONTROL TECHNOLOGY

A. Information to be Collected

The following information is needed to estimate control technology costs; this will be obtained from plant engineers and equipment suppliers:

- Equipment performance specifications,
- Hardware specifications,
- Descriptive pictures or drawings,
- Operating characteristics,
- Maintenance requirements,
- Approximate cost of construction, installation, startup, and current operation,
- Possible impact on process yield and/or labor productivity.

Equipment vendors will be contacted to obtain current equipment costs and additional data on expected performance characteristics, costs of equipment using alternate materials of construction, and variations in costs with the size of equipment.

B. Use of Information to Define Costs

The information collected will be used as follows:

- The cost data on purchases, construction, installation, startup, and current operating costs will be spot-audited to the level of confidence warranted;
- The equipment performance and hardware specifications will be reviewed for both unit operations and process requirements to determine if alternate materials and system components could be substituted to meet the performance requirements at less cost;
- If two or more controls are candidates for a given application, a comparative value analysis will be presented.

IV. DISCLOSURE OF RESULTS AND CONFIDENTIALITY

Names and locations of all plant sites in reports will be treated in accordance with the provisions of 42 CFR 85a (Appendix D). In the final overall study report, specific places of employment will not be identified. However, the plants and locations will be identified in both finished preliminary survey and detailed study reports. These latter finished reports are subject to mandatory disclosure under the Freedom of Information Act (5 U.S. 552).* Prior to leaving any facility, the contractor's team and NIOSH project officer (if present) will review all notes, sketches, and other information with company representatives to ensure that no proprietary information will be included in the contractor's draft report. Report handling steps include:

1. Contractor prepares and submits draft report to NIOSH project officer.

2. NIOSH project officer reviews for appropriateness and forwards to plant personnel.

3. Plant personnel review, correct errors, delete inadvertently contained proprietary information, and return the report to the NIOSH project officer.

4. NIOSH project officer reviews for appropriateness and forwards to the contractor.

5. Contractor prepares the finished report and sends it to the NIOSH project officer. Upon final approval, the NIOSH project officer distributes the finished report in accordance with 42 CFR 85a to:

    a. The plant management,
    b. The local labor representative,
    c. The NIOSH regional consultant,
    d. The OSHA Directorate of Technical Support (Washington, D.C.).

To allay the legitimate fears of the chemical industry regarding risks of leakage of proprietary information and trade secrets inadvertently included in draft copies of plant visit reports, both authorized NIOSH and contractor personnel will:

1. Handle such draft copies in accordance with the provisions of the NIOSH Sensitive Data Security Program;

2. Store such draft copies in NIOSH sensitive data security storage facilities;

3. Not supply such draft copies that are exempt from disclosure under the Freedom of Information Act.

*Finished preliminary survey and detailed study reports will not be reproduced or attached to any final overall study report.

V. SCHEDULE

The program has been divided into three phases. The following table presents the milestones and products to be delivered.

Table 2. Project Milestones and Products to be Delivered

Activity	Completion Dates	Products
Phase I		
Tripartite meeting of industry, labor and government to review the study plan		• Preliminary list of sites for preliminary surveys • Updated study plan • Minutes of meeting
Phase II		
Complete 25 preliminary plant surveys	November 1981	• Survey reports
Complete 5 in-depth plant surveys	November 1981	• Control technology descriptions and evaluations • Identification of sites for in-depth surveys
Phase III		
Complete 10 plant preliminary surveys	March 1982	• Survey reports
Complete 20 plant in-depth surveys	June 1982	• Identification of sites for in-depth surveys • Detailed evaluation of control technology • Cost evaluation
Submit Draft Final and Journal Summary Report	July 1982	• Draft technical report • Draft Journal report
Complete final report	November 1982	• Final report

APPENDIX A

UNIT OPERATIONS

Table A-1. Listing of Unit Operations

CLASSIFICATION OF UNIT OPERATION	EQUIPMENT
A. Transfer of Materials	
Transfer of gases	• piston compressors • turbine compressors • blowers
Transfer of liquids	• centrifugal pumps • turbine pumps • rotary pumps • piston pumps • air lift • blow cases • gravity flow (pipes & valves) • containers (e.g., drums, tank trucks)
Transfer of solids	• belt conveyer • screw " • pneumatic " • vibrating " • blow cases • containers (bags, portable bins)
B. Chemical Reaction	• closed vessels with agitators and heat exchangers • fixed bed catalyst • autoclaves

TABLE A-1 (continued)

CLASSIFICATION OF UNIT OPERATION	EQUIPMENT
C. Mixing	
Agitating (liquids)	• paddle & propeller mixers • pumps • agitators
Emulsifying	• paddle & propeller mixers • colloid mills • homogenizers • pumps
Dispersing	• paddle & propeller mixers • colloid mills • homogenizers • pumps
Mixing (solids)	• banbury mixers • screw mixers • tumbling barrels • roll mills • shear bar mixers
Kneading	• double-arm kneading mixers
Diffusing	• tanks • vats • diffusion cells
Dissolution	• tanks • vats • paddle and propeller mixers

TABLE A-1 (continued)

CLASSIFICATION OF UNIT OPERATION	EQUIPMENT
D. Size Alteration	
Pulverizing	• hammer mills • colloid mills • ball mills • tub mills • roller mills
Spraying	• spray nozzles • spray chamber • turbine-type dispensers
Coagulation	• tanks • reaction vessels
Flocculation	• tanks
E. Separation	
Separation-Physical (vaporization)	
Distillation	• columns: packed bubble & plate • pot & pipe stills • condensers • separators • heat exchangers
Evaporators	• tanks and kettles • evaporators - atmospheric & vacuum (single and multiple effect) • evaporators - film

TABLE A-1 (continued)

CLASSIFICATION OF UNIT OPERATION	EQUIPMENT
E. Separation (continued)	
Separation-Physical (vaporization) (continued)	
Drying	• atmospheric & vacuum dryers • pan and tray dryers • conveyer dryers • rotary drum • freeze dryers
Subliming	• retorts • condensing chambers
Separation-Physical (solution)	
Washing	• tanks • agitators • filters • thickeners
Extraction	• tanks • vats • agitators
Gas Absorbing	• packed towers • spray chambers • bubble & plate towers • blowers
Adsorption	• molecular sieves

TABLE A-1 (continued)

CLASSIFICATION OF UNIT OPERATION	EQUIPMENT
E. Separation (continued)	
Physical (solid phase)	
Crystallization	• vacuum crystallizers • vats • rotary & rocking crystallizers • evaporators
Melting	• kettles • crucibles • reaction equipment
Freezing	• molds • refrigeration equipment

TABLE A-1 (continued)

CLASSIFICATION OF UNIT OPERATION	EQUIPMENT
E. Separation (continued)	
Mechanical	
Screening	• shaking & vibrating screens
Pressing	• hydraulic presses
	• filter presses
Mechanical (Filtration)	
Pressure filtering	• filter presses
	• leaf filters
Vacuum filtering	• drum type filters
	• disk filters
	• leaf filters
	• thickeners
Centrifugal filtering	• semi-continuous filters
	• batch filters
Mechanical (Settling)	
Classifying	• bowl & drum classifiers
	• hydraulic cones
Air separation	• cyclones & multicyclones
Liquid settling	• tanks, vats
	• thickeners
Centrifugal settling	• batch centrifugals
	• cyclones
	• semi-continuous centrifuges

TABLE A-1 (continued)

CLASSIFICATION OF UNIT OPERATION	EQUIPMENT
F. Heat Transfer	• shell & tube exchanger • double-pipe exchanger • air coolers • furnaces • steam injection coils
G. Packaging	
Solids	
Bagging, Drumming, Canning, Tote bins, Hopper cars	• manual station • automatic machines
Liquids	
Bottling, Drumming	• manual station • automatic machines
Tank cars	• manual station
Gases	• steel bottles • tanks

TABLE A-1 (continued)

CLASSIFICATION OF UNIT OPERATION	EQUIPMENT
H. Storage	
Gases	• cylinders • tanks
Liquids	• tanks • drums • cans
Solids	• bins • bags • hoppers & silos
I. Process Control	
Sampling	• manual sampling • automatic sampling
Analyzing/sensing	• manual analysis • automatic analyzers • flow sensing • temperature sensing • pumps • heater exchangers • valves
Controllers	• manual control • automatic control

Table A-2. Emission Sources from Unit Operation Equipment

EQUIPMENT	APPLICATION	EMISSION SOURCES
Hammermills	• Pulverizing solids	• Dust leaks through seals and bearings • Vapors generated due to heat effects • Vented gases • Contact during maintenance • Disposal of solids
Columns (packed & bubble & plate)	• Distillation • Absorption	• Seals-flange • Seals-pumps • Piping joints • Venting • Residues remaining after shutdown • Contact during maintenance
Evaporators	• Evaporation	• Seals-flange • Seals-pumps • Piping joints • Venting • Residues remaining after shutdown • Contact during maintenance

TABLE A-2 (continued)

EQUIPMENT	APPLICATION	EMISSION SOURCES
Dryer-Vacuum Rotary	• Producing dry solid product from wet feed	• Bearings and seals • Dust during discharging and charging • Residues remaining after shutdown • Contact during maintenance
Bag Filling and Weighing Machine	• Filling bags with dry solids	• Vented air • Dust transfer by surface to surface contacts • Residues in equipment following shutdown • Bag leaks
Sampling Equipment	• Sampling of process fluids for chemical analysis	• Vented air • Vented sample stream • Residues in sample lines • Valve seals • Connector fitting seals • Spills
Pumps, Compressors, Blowers	• Transferring gases	• Leaking seals • Opening equipment not isolated or purged

TABLE A-2 (continued)

EQUIPMENT	APPLICATION	EMISSION SOURCES
Pumps	• Transferring liquids	• Leaking seals • Opening equipment not isolated or purged
Airlift	• Transferring solids or slurries	• Vented spent air • Seals leaking
Blow Cases	• Transferring liquids or slurries	• Vented spent air • Seals leaking
Closed Vessels With Agitators	• Chemical reactions • Mixing • Dispersing • Coagulating	• Leaking seals • Open equipment not totally purged or isolated • Vented gas phase when loading charge
Open Vessels With Agitators	• Liquid phase reaction of non-volatile materials • Coagulation • Flocculation • Mixing liquids/solids	• Aerosols or dusts leaving surface • Spills or splashes • Leaking seals
Colloid Mills	• Formation of emulsions • Homogenization	• Aerosols leaving liquid phase • Vapors generated due to heat effects • Leaking seals

TABLE A-2 (continued)

EQUIPMENT	APPLICATION	EMISSION SOURCES
Kneading Mixers Kneading Devices	• Compounding of solids by mechanical means	• Vapors, dust and aerosols generated during loading and operation • Residues remaining after discharge • Contact during maintenance • Leaking seals • Disposal of solids
Pumps	• Transfer of fluids between unit operations • Movement of fluid within a unit operation	• Leaking seals • Opening equipment not isolated • Opening equipment not properly purged
Drainage System	• Collect waste streams at various process points	• Vaporization to ambient air from surfaces • Aerosols leaving liquid surface • Dried solids accumulating and dispersing
Valves	• Either regulate or stop flow of materials	• Flow seal leakage • Leaking seals at stem and bonnet.

APPENDIX B

HAZARDOUS CHEMICALS

TABLE B-1

Preliminary Selection of Commercially Important Hazardous Chemicals

PRIMARY CHEMICAL PRODUCT	HAZARDOUS CHEMICALS ENCOUNTERED	UNIT PROCESS USED	REFERENCE*
1. acetanilide	acetic acid aniline	acidification	
2. acetyl chloride	acetic acid chlorine	chlorination	
3. acrylamide	acrylamide acrylonitrile sulfuric acid sodium hydroxide	hydrolysis/neutralization	Figure 2
4. p-aminophenol	nitrobenzene	reduction/neutralization	
5. amyl mercaptan	hydrogen sulfide	sulfonation	
6. amylphenol	phenol	phenol alkylation	
7. anisidine	anisidine	nitroanisole reduction	
8. benzamide	benzyl chloride	acylation	
9. benzenesulfonic acid	benzene sulfuric acid	benzene sulfonation	Figure 3
10. benzophenone	benzene	alkylation	
11. benzyl alcohol	benzyl chloride	hydrolysis	
12. benzylamine	benzyl chloride	benzyl chloride ammonolysis	
13. benzyl chloride	benzyl chloride	toluene chlorination	
14. benzyl dichloride	benzyl chloride benzene	toluene chlorination	
15. bromobenzene	bromine	benzene bromination	
16. butyronitrile	hydrogen cyanide	hydrocyanation	
17. carbon tetrabromide	carbon tetrachloride hydrogen bromide	hydrobromination	
18. chloroacetic acid	acetic acid	acetic acid chlorination	
19. m-chloroaniline	aniline	aniline chlorination	
20. chlorobenzene	benzene chlorine chlorobenzene hydrogen chloride	neutralization benzene chlorination	Figure 4
21. chlorobenzaldehyde	chlorine	chlorination	
22. chlorophenols (o,m,p isomers)	chlorine phenol	phenol chlorination neutralization	

* Reference refers to Figures 2 through 16

TABLE B-1
(Continued)

PRIMARY CHEMICAL PRODUCT	HAZARDOUS CHEMICALS ENCOUNTERED	UNIT PROCESS USED	REFERENCE*
23. chlorobenzoic acid	chlorine	chlorination hydrolysis	
24. chlorotoluene (o,p)	chlorine hydrochloric acid toluene o-chlorotoluene	toluene chlorination	Figure 5
25. cyclohexylamine	aniline cyclohexylamine	aniline hydrogenation	Figure 6
26. dichlorobenzene (o,p)	chlorine	chlorination	
27. diisodecyl phthalate	phthalic anhydride	esterification	Figure 7
28. diisooctyl phthalate	phthalic anhydride	esterification	Figure 8
29. cyanoacetic acid	hydrogen cyanide	hydrocyanation neutralization	
30. dichloroaniline	nitric acid	nitration reduction neutralization	
31. dinitrophenol	phenol	nitration	
32. dioxane	sulfuric acid	sulfonation	
33. diphenylamine	aniline	condensation	
34. diphenylthiourea	aniline	condensation	
35. dodecylphenol	phenol sulfuric acid	alkylation	Figure 9
36. ethyl ortho-formate	hydrogen cyanide	alchoholysis	
37. furfural	furfural	acid hydrolysis condensation dehydration	
38. hexachlordethane	chlorine hexachloroethane perchloroethylene sodium hydroxide	chlorination	Figure 10
39. hydroquinone	hydroquinone quinone aniline chromic acid sulfuric acid ethyl ether	reduction	Figure 11
40. maleic anhydride	maleic anhydride	oxidation	
41. malic acid	maleic anhydride	hydration	

* Reference refers to Figures 2 through 16

TABLE B-1
(Continued)

PRIMARY CHEMICAL PRODUCT	HAZARDOUS CHEMICALS ENCOUNTERED	UNIT PROCESS USED	REFERENCE*
42. methyl formate	formic acid	esterification	
43. 2-napthalene sulfuric acid	napthalene sulfuric acid	sulfonation hydrolysis	
44. beta napthol	napthalene	peroxidation	
45. nitrobenzoic acid	nitric acid nitro toluene	nitration oxidation	
46. nitrotoluene	nitric acid	nitration	
47. nonylphenol	phenol sulfuric acid	alkylation	Figure 12
48. octylphenol	phenol	alkylation	
49. pentaerythritol	acetaldehyde formaldehyde pentaerythritol	condensation neutralization	Figure 13
50. phenolsulfonic acid	phenol	sulfonation	
51. phenylendiamine	nitrobenzene	reduction	
52. phthalimide	phthalic anhydride	ammonolysis	
53. propylamine	hydrogen cyanide	hydrocyanation hydrolysis	
54. quinone	quinone aniline	oxidation	
55. sodium acetate	acetic acid sodium hydroxide	neutralization	Figure 14
56. sodium phenate	phenol sodium hydroxide	neutralization	Figure 15
57. sorbic acid	ketene crotonaldehyde	addition	
58. succinic acid	maleic anhydride	hydrogenation	
59. succinonitrile	acrylonitrile hydrogen cyanide	hydrocyanation	
60. sulfanilic acid	aniline sulfuric acid	sulfonation acidification	
61. tetrachloro-phthalic anhydride	chlorine phthalic anhydride	chlorination	
62. tetraethyl lead	lead	grignard electro-ylsis alkylation	
63. toluidine	nitrotoluene	reduction	

* Reference refers to Figures 2 through 16

TABLE B-1
(Continued)

PRIMARY CHEMICAL PRODUCT	HAZARDOUS CHEMICALS ENCOUNTERED	UNIT PROCESS USED	REFERENCE*
64. trichlorobenzene	chlorine benzene	chlorination neutralization	
65. vinyl chloride polymer	vinyl chloride monomer	polymerization	
66. xylidine	nitric acid xylidine	nitration reduction acidification	
67. ABS resin	acrylonitrile butadiene styrene	polymerization	Figure 16

* Reference refers to Figures 2 through 16

Table B-2. Method for Selection of Listed Hazardous Chemicals.

A priority system was developed based on:

- hazardous nature of the chemicals,
- number of workers potentially at risk,
- emission rates associated with unit operations,
- control technology employed.

More specifically, the choices were determined via the following steps.

- Chemicals were identified that have OSHA permissible exposure levels (PEL) less than 25 ppm and/or 2 mg/m^3.

- EPA data on batch chemical process profiles were used to determine which of the above were used and/or produced via batch processing.

- The producers of each of the chemicals associated with batch processing were identified from the TSCA Inventory of Producers of Chemicals in Commerce for 1977.

- Batch chemical processes were evaluated for exposure risk, emission potential, and chemical(s) produced, unit operations, and controls in place. In the following paragraphs, the quality of the data available for examing each of these factors is discussed.

  a. Exposure risk - The determination of exposure risk involves two types of data. The first is the hazard rating of a given chemical. The permissible exposure level (PEL) published by OSHA (29 CFR 1910) was used. The second type of data, the number of employees potentially at risk, was estimated using the Department of Labor employment figures for four-digit SIC codes. This number indicates overall employment for a specific industry. It does not differentiate between employees working in contact with batch operations and those in other areas of the facilities. Discussions with trade organizations, plants, and unions will provide information needed to estimate the number of workers exposed during batch unit operations in a specific industry.

  b. Potential for emission - Prior to the preliminary surveys and detailed studies, potential rates of emission (release of a chemical) from specific unit operations have been estimated on the basis of literature references and the professional judgement of the research team.

  c. Production of chemicals of interest - The annual amount of each chemical produced or utilized (including the number of facilities and the size and number of batches) is an important factor for which fairly reliable data are available.

d. Unit operations involved - The batch unit operations were identified by a literature search.

e. Controls in place - Current knowledge about controls has been factored into the preliminary ranking. Engineering controls were given higher priority in the selection process than monitoring, work practices, and personal protective equipment.

Tables B-3. Process/Occupational Health Reviews for Fifteen Selected Hazardous Chemicals (Fig. 3 through Fig. 16)

References employed for process/occupational health reviews were:

1. NIOSH/OSHA Pocket Guide to Chemical Hazards, DHEW (NIOSH) Publication No. 78-210, Sept 1978.
2. The Condensed Chemical Dictionary by G. G. Hawley (9th edition, 1977) Van Nostrand Reinhold Co.
3. Dangerous Properties of Industrial Materials by N. Irving Sax (5th edition, 1978) Van Nostrand Reinhold Co.
4. Toxic Substances Control Act (TSCA) Chemical Substance Inventory, Substance Name Index, Vols II, III, May 1979, US EPA Office of Toxic Substances, Washington, DC 20460

Figure 3. Process/Occupational Health Review

BENZENESULFONIC ACID

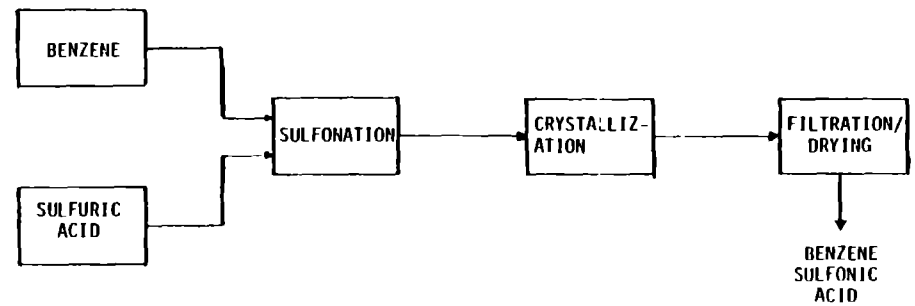
UNIT OPERATIONS USED

- Materials transfer
- Reaction
- Heat transfer
- Agitation
- Drying
- Crystallization
- Filtration
- Packaging

POTENTIAL EMISSION POINTS

- Tank car unloading
- Pump seals
- Valves/Flanges
- Vessel entryways
- Agitator shaft seals
- Filter cleaning
- Vessel cleaning

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
71-43-2	Benzene	10ppm	M.P. 42°F B.P. 176°F Solubility 0.18% V.P. 75mm	Inhalation Absorption Ingestion Contact	Irritant Narcotic Carcinogen
7664-93-9	Sulfuric Acid	1 mg/m³	M.P. 37°F B.P. 518°F Miscible V.P. <0.001	Inhalation Ingestion Contact	Irritant
98-11-3	Benezene-sulfonic acid	none	M.P. 77°F Miscible	Ingestion Inhalation	Irritant

Figure 4. Process/Occupational Health Review

CHLOROBENZENE

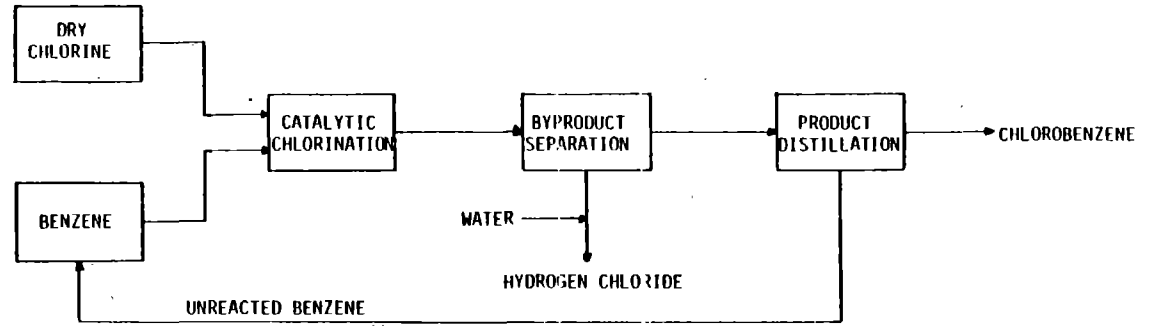
UNIT OPERATIONS USED

- Materials Transfer
- Reaction
- Heat Transfer
- Distillation
- Gas Absorption
- Packaging

POTENTIAL EMISSION POINTS

- Tank Car Loading/ Unloading
- Pump Seals
- Vessel Entryways
- Valves/Flanges
- Equipment Cleanup
- Venting

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and	Health Hazard	
CAS RN	Name	PEL	Physical Properties	Route of Entry	Effect
71-43-2	Benzene	10ppm	M.P. 42°F B.P. 176°F Solubility 0.18% V.P. 75mm	Inhalation Absorption Ingestion Contact	Irritant Narcotic Carcinogen
7782-50-5	Chlorine	1.0ppm	B.P. -29°F Solubility 0.7% V.P. >1atm	Inhalation Contact	Irritant
108-90-7	Chlorobenzene	75ppm	M.P. -47°F B.P. 270°F Solubility 0.1% V.P. 8.8mm	Inhalation Ingestion Contact	Irritant Narcotic
7647-01-0	Hydrogen Chloride	5ppm	B.P. -121°F Solubility 62% V.P. >1atm	Inhalation Ingestion Contact	Irritant

Figure 5. Process/Occupational Health Review

ORTHO-CHLOROTOLUENE

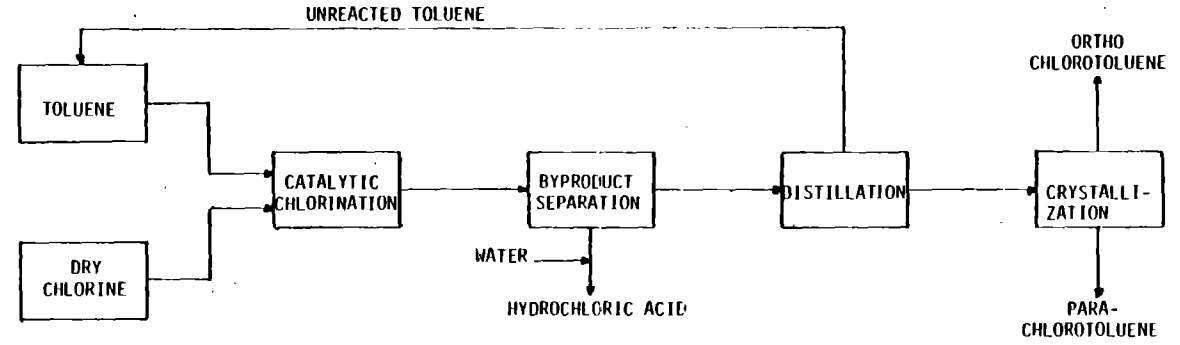
UNIT OPERATIONS USED

- Materials Transfer
- Reaction
- Heat Transfer
- Gas Absorption
- Distillation
- Crystallization

POTENTIAL EMISSION POINTS

- Raw Material Charging
- Pump Seals
- Venting
- Valves/Flanges
- Vessel Entryways
- Equipment Cleanup

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and	Health Hazard	
CAS RN	Name	PEL	Physical Properties	Route of Entry	Effect
7782-50-5	Chlorine	1.0ppm	B.P. -29°F Solubility 0.7% V.P. >1atm	Inhalation Contact	Irritant
7647-01-0	Hydrochloric Acid	5ppm	B.P. -121°F Solubility 62% V.P. >1atm	Inhalation Ingestion Contact	Irritant
108-88-3	Toluene	200ppm	M.P. -139°F B.P. 231°F Solubility 0.05% V.P. 22mm	Inhalation Ingestion Contact Absorption	Irritant Narcotic
95-49-8	Ortho-chlorotoluene	50ppm	M.P. -35.1°C B.P. 159.15°C Solubility limited	Inhalation Ingestion	Irritant Narcotic

Figure 6. Process/Occupational Health Review

CYCLOHEXYLAMINE

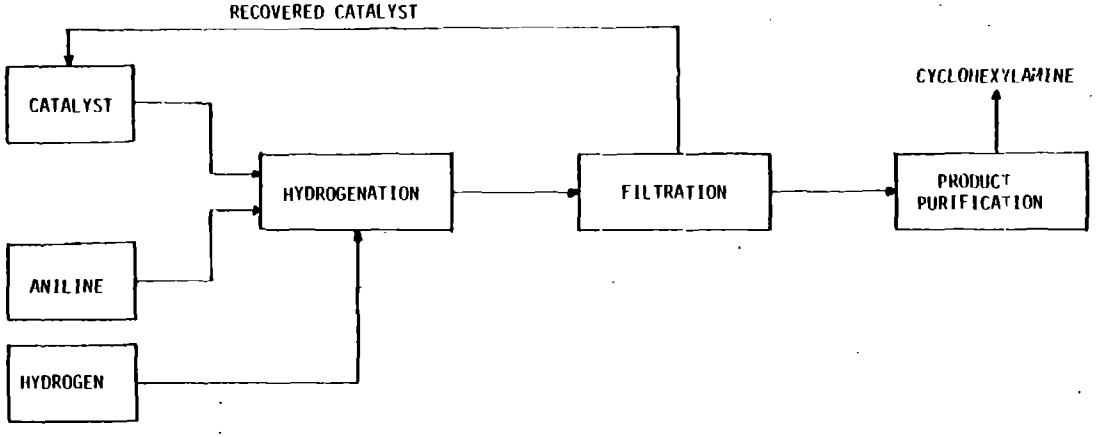
UNIT OPERATIONS USED

- Materials Transfer
- Heat Transfer
- Agitation
- Reaction
- Gas Absorption
- Filtration
- Distillation
- Packaging

POTENTIAL EMISSION POINTS

- Raw Materials Charge
- Pump Seals
- Valves/Flanges
- Venting
- Agitator Shaft Seals
- Equipment Cleanup
- Filter Cleaning
- Product Packaging

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
62-53-3	Aniline	5ppm	M.P. 21°F B.P. 364°F Solubility 3.5% V.P. 0.6mm	Inhalation Ingestion Absorption Contact	Irritant Narcotic
108-91-8	Cyclohexylamine	10ppm*	M.P. 0°F B.P. 275°F	Inhalation Ingestion Contact	Irritant

* ACGIH TLV's, 1978.

Figure 7. Process/Occupational Health Review

DIISODECYL PHTHALATE

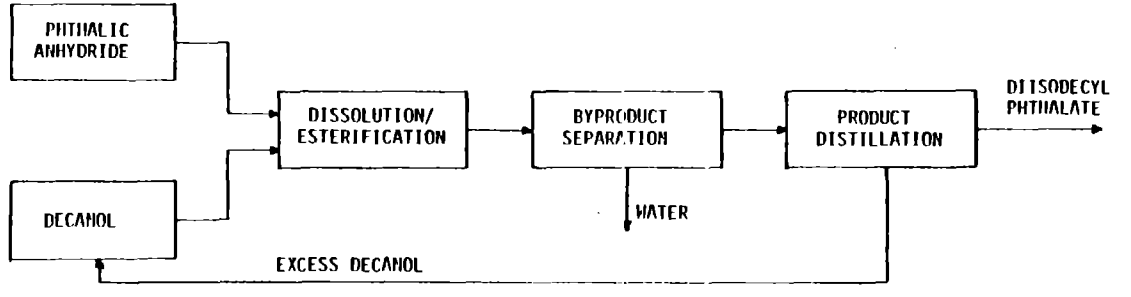
UNIT OPERATIONS USED

- Materials transfer
- Dissolution
- Agitation
- Heat transfer
- Reaction
- Distillation
- Gravity separation

POTENTIAL EMISSION POINTS

- Raw materials charge
- Pump seals
- Valves/flanges
- Agitator shaft seals
- Vessel entryways
- Equipment cleanup

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
85-44-9	Phthalic anhydride	2ppm	M.P. 268°F B.P. 543°F Solubility 0.62% V.P. <0.05mm	Inhalation Ingestion Contact	Irritant
26761-40-0	Diisodecyl phthalate	none		Ingestion	Irritant

Figure 8. Process/Occupational Health Review

DIISOOCTYL PHTHALATE

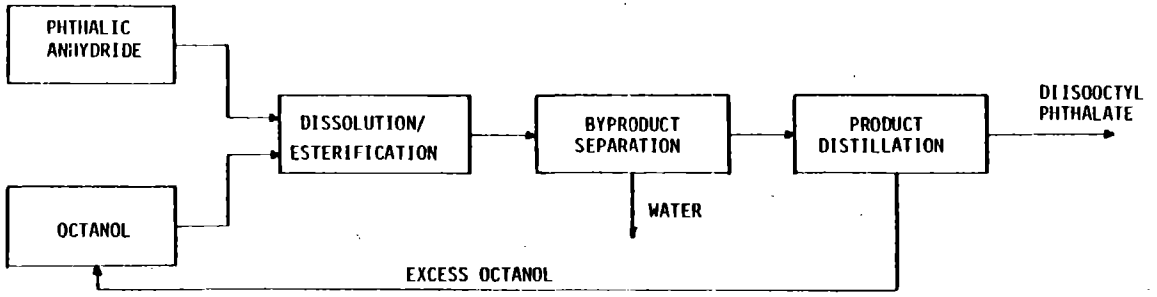
UNIT OPERATIONS USED

- Materials transfer
- Dissolution
- Agitation
- Heat transfer
- Reaction
- Distillation
- Gravity separation

POTENTIAL EMISSION POINTS

- Raw materials charge
- Pump seals
- Valves/flanges
- Agitator shaft seals
- Vessel entryways
- Equipment cleanup

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
85-44-9	Phthalic anhydride	2ppm	M.P. 268°F B.P. 543°F Solubility 0.62% V.P. <0.05mm	Inhalation Ingestion Contact	Irritant

Figure 9. Process/Occupational Health Review

DODECYLPHENOL

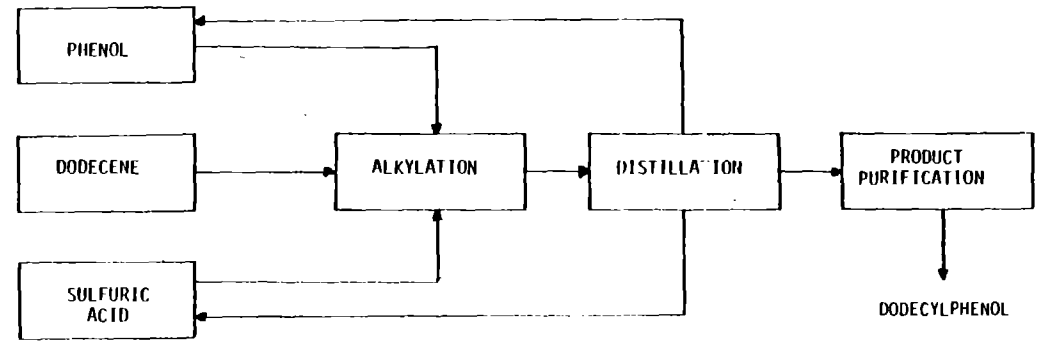
UNIT OPERATIONS USED

- Materials Transfer
- Heat Transfer
- Agitation
- Reaction
- Distillation
- Scrubbing
- Drying

POTENTIAL EMISSION POINTS

- Raw Materials Charge
- Pump Seals
- Valves/Flanges
- Venting
- Equipment Cleanup
- Agitator Shaft Seals

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
108-95-2	Phenol	5ppm	M.P. 106°F B.P. 359°F Solubility 8.4% V.P. 0.36mm	Inhalation Absorption Ingestion Contact	Irritant
7664-93-9	Sulfuric acid	1 mg/m³	M.P. 37°F B.P. 518°F Solubility Miscible V.P. <0.001mm	Inhalation Ingestion Contact	Irritant

Figure 10. Process/Occupational Health Review

HEXACHLOROETHANE

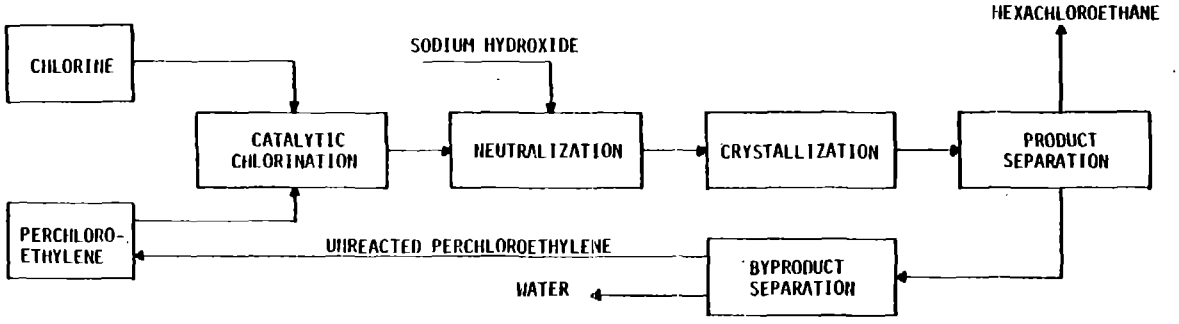
UNIT OPERATIONS USED

- Materials transfer
- Reaction
- Heat transfer
- Crystallization
- Centrifugation
- Gravity separation
- Packaging

POTENTIAL EMISSION POINTS

- Raw materials charging
- Pump seals
- Vessel entryways
- Valves/flanges
- Equipment cleanup
- Product packaging

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and	Health Hazard	
CAS RN	Name	PEL	Physical Properties	Route of Entry	Effect
7782-50-5	Chlorine	1.0ppm	B.P. -29°F Solubility 0.7% V.P. >1atm	Inhalation Contact	Irritant
67-72-1	Hexachloroethane	1ppm	M.P. 372°F Solubility 0.005% V.P. 0.22mm	Inhalation Absorption Contact Ingestion	Irritant
127-18-4	Perchloro-ethylene	100ppm	M.P. -8°F B.P. 250°F Insoluble V.P. 14mm	Inhalation Ingestion Contact	Irritant Narcotic
1310-73-2	Sodium Hydroxide	2 mg/m³	M.P. 590°F B.P. 2534°F V.P. ~0mm Solubility 50%	Inhalation Ingestion Contact	Irritant

Figure 11. Process/Occupational Health Review

HYDROQUINONE

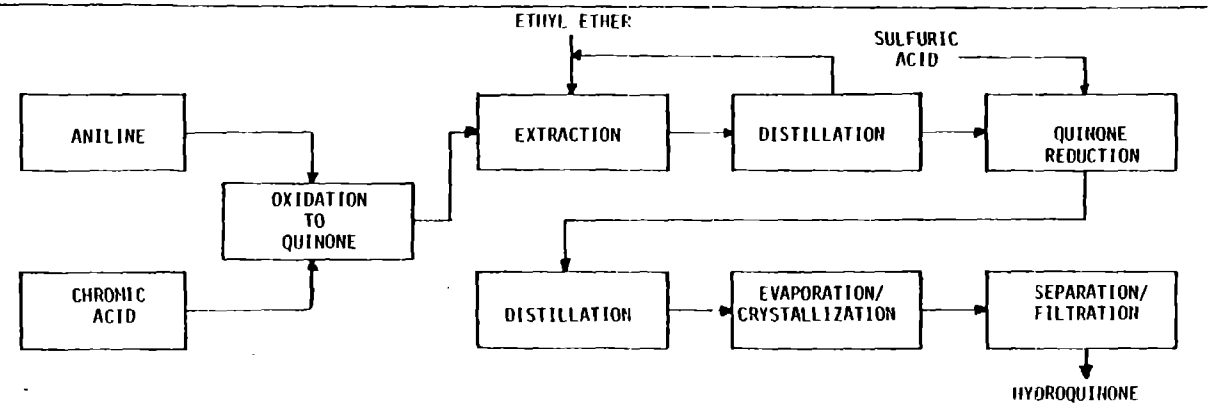
UNIT OPERATIONS USED

- Materials transfer
- Agitation
- Heat transfer
- Reaction
- Extraction
- Distillation
- Evaporation
- Crystallization
- Filtration
- Packaging

POTENTIAL EMISSION POINTS

- Raw materials charge
- Agitator shaft seals
- Pump seals
- Valves/flanges
- Vessel entryways
- Equipment cleanup
- Filter cleaning
- Venting
- Product packaging

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and	Health Hazard	
CAS RN	Name	PEL	Physical Properties	Route of Entry	Effect
62-53-3	Aniline	5ppm	M.P. 21°F B.P. 364°F Solubility 3.5% V.P. 0.6mm	Inhalation Absorption Ingestion Contact	Irritant Narcotic
123-31-9	Hydroquinone	2 mg/m³	M.P. 338°F Solubility 7% V.P. <0.001mm	Inhalation Ingestion Contact	Irritant Narcotic
106-51-4	Quinone	0.1ppm	M.P. 235°F Solubility 1.5% V.P. 0.1mm	Inhalation Ingestion Contact	Irritant
11115-74-5	Chromic acid	0.1 mg/m³	M.P. 385°F Soluble in water	Inhalation Ingestion Contact	Irritant
7664-93-9	Sulfuric acid	1 mg/m³	M.P. 37°F B.P. 518°F V.P. <0.001mm Solubility Miscible	Inhalation Ingestion Contact	Irritant
60-29-7	Ethyl Ether	400ppm	B.P. 95°F Solubility 7.5% V.P. 442mm	Inhalation Ingestion Contact	Irritant Narcotic

Figure 12. Process/Occupational Health Review

NONYLPHENOL

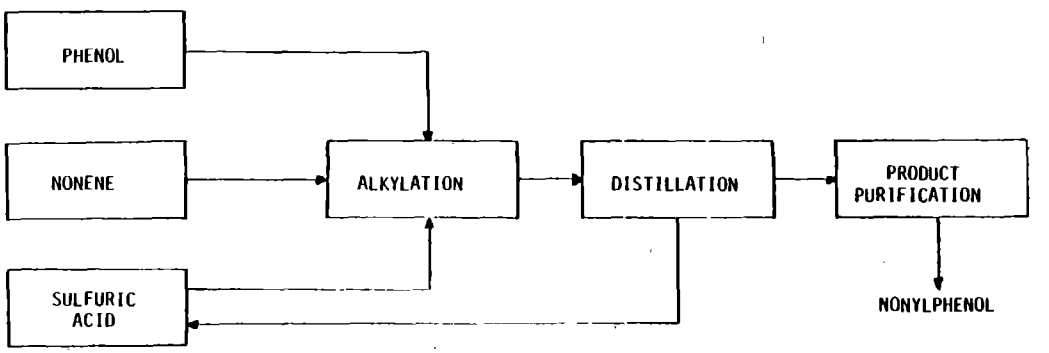
UNIT OPERATIONS USED

- Materials Transfer
- Heat Transfer
- Agitation
- Reaction
- Distillation
- Scrubbing
- Drying

POTENTIAL EMISSION POINTS

- Raw Materials Charge
- Pump Seals
- Valves/Flanges
- Venting
- Equipment Cleanup
- Agitator Shaft Seals

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
108-95-2	Phenol	5ppm	M.P. 106°F B.P. 359°F Solubility 8.4% V.P. 0.36mm	Inhalation Absorption Ingestion Contact	Irritant
7664-93-9	Sulfuric acid	1 mg/m³	M.P. 37°F B.P. 518°F Solubility Miscible V.P. <0.001mm	Inhalation Ingestion Contact	Irritant

Figure 13. Process/Occupational Health Review

PENTAERYTHRITOL

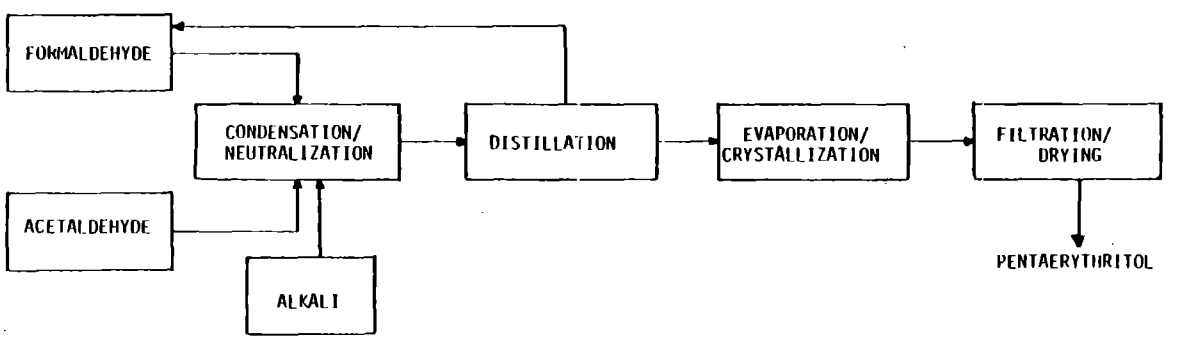
UNIT OPERATIONS USED

- Materials Transfer
- Agitation
- Heat Transfer
- Reaction
- Distillation
- Evaporation
- Crystallization
- Filteration
- Drying
- Packaging

POTENTIAL EMISSION POINTS

- Raw Materials Charge
- Venting
- Pump Seals
- Agitator Shaft Seals
- Valves/Flanges
- Vessel Entryways
- Equipment Cleanup
- Filter Cleaning
- Product Packaging

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
75-07-0	Acetaldehyde	200ppm	M.P. -193°f B.P. 69°F Miscible V.P. 750mm	Inhalation Ingestion	Irritant
50-00-0	Formaldehyde (50% aqueous solution)	3ppm	B.P. 214°F Miscible V.P. 1mm	Inhalation Ingestion Contact	Irritant Narcotic
115-77-75	Pentaerythritol	5 mg/m³	M.P. 269°C B.P. Sublimates Soluble in water	Inhalation	Irritant

Figure 14. Process/Occupational Health Review

SODIUM ACETATE

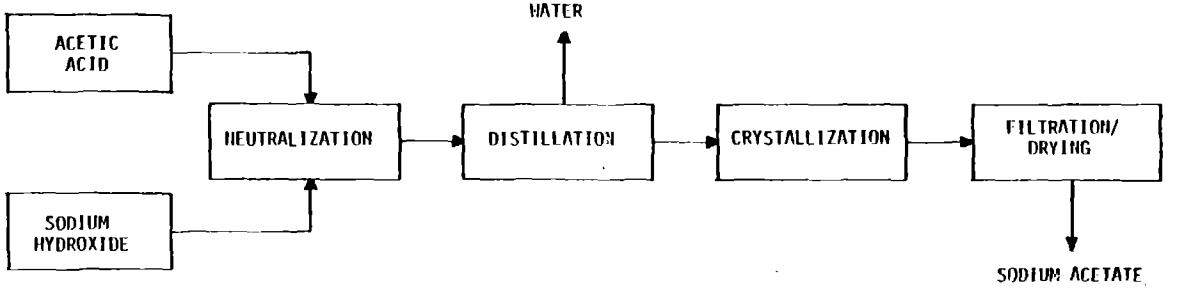
UNIT OPERATIONS USED

- Materials transfer
- Agitation
- Heat transfer
- Reaction
- Distillation
- Crystallization
- Filtration
- Drying
- Packaging

POTENTIAL EMISSION POINTS

- Raw materials charging
- Pump seals
- Valves/flanges
- Vessel entryways
- Agitator shaft seals
- Equipment cleanup
- Filter cleaning
- Product packaging

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
64-19-7	Acetic acid	10ppm	M.P. 62°F B.P. 244°F Miscible V.P. 11mm	Inhalation Ingestion Contact	Irritant
1310-73-2	Sodium hydroxide	2 mg/m³	M.P. 590°F Solubility 50% V.P. 0	Inhalation Ingestion Contact	Irritant

Figure 15. Process/Occupational Health Review

SODIUM PHENATE

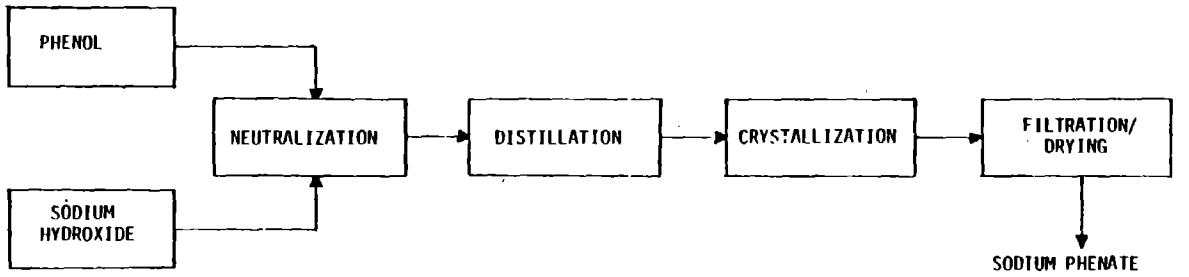
UNIT OPERATIONS USED

- Materials transfer
- Agitation
- Heat transfer
- Distillation
- Crystallization
- Filtration
- Drying
- Packaging

POTENTIAL EMISSION POINTS

- Raw materials charging
- Pump seals
- Valves/flanges
- Vessel entryways
- Agitator shaft seals
- Equipment cleanup
- Filter cleaning
- Product packaging

PROCESS FLOW SCHEME



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
108-95-2	Phenol	5ppm	M.P. 106°F B.P. 359°F Solubility 8.4% V.P. 0.36mm	Inhalation Absorption Ingestion	Irritant
1310-73-2	Sodium hydroxide	2 mg/m^3	M.P. 590°F Solubility 50% V.P. 0	Inhalation Ingestion	Irritant
139-02-6	Sodium phenate	none		Inhalation Ingestion Contact	Irritant

Figure 16. Process/Occupational Health Review

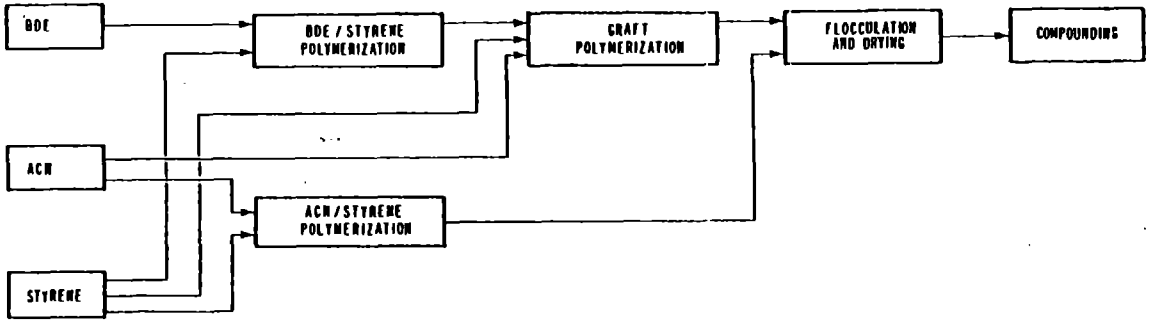
ABS RESIN

UNIT OPERATIONS USED

- Materials transfer
- Heat transfer
- Reaction
- Agitation
- Flocculation
- Drying
- Mixing

POTENTIAL EMISSION POINTS

- Raw materials charging/ unloading
- Pump seals
- Vessel entryways
- Agitator shaft seals
- Equipment cleanup
- Valves/flanges



Chemicals Involved			Chemical and Physical Properties	Health Hazard	
CAS RN	Name	PEL		Route of Entry	Effect
107-13-1	Acrylonitrile	2ppm	B.P. 171°F Solubility 7.1% V.P. 83mm	Inhalation Absorption Ingestion Contact	Carcinogen
106-99-0	Butadiene	1000ppm	B.P. 24°F Solubility 0.05% V.P. 910mm	Inhalation Contact	Irritant
100-42-5	Styrene	100ppm	B.P. 293°F Solubility 0.03% V.P. 4.5mm	Inhalation Ingestion Contact	Irritant Narcotic

APPENDIX C

PRELIMINARY SURVEY PROTOCOL

CONTROL TECHNOLOGY ASSESSMENT OF CHEMICAL PROCESS BATCH UNIT OPERATIONS

NIOSH CONTRACT No. 210-80-0071

Submitted to:

Harold Van Wagenen
NIOSH Project Officer
4676 Columbia Parkway
Cincinnati, OH 45226

Prepared by:

ENVIRO CONTROL, INC.
The Dynamac Building
11140 Rockville Pike
Rockville, MD 20852

TABLE OF CONTENTS

I. INTRODUCTION

Enviro Control, Inc. (ENVIRO) is under contract to the National Institute for Occupational Safety and Health (NIOSH), an agency of the Department of Health and Human Services, to conduct this Control Technology Assessment of Chemical Process Batch Unit Operations (contract No. 210-80-0071). The assessment objective is to study chemical process batch unit operation equipment and attached sealing devices, and operating procedures as a means of determining effectiveness of controls in reducing worker exposure to hazardous chemicals.

Satisfactory completion of the study objectives normally requires two successive visits to a facility. The first is a one to two day preliminary survey in which ENVIRO personnel (possibly accompanied by the NIOSH project officer) will observe conditions at the facility and collect available engineering and industrial hygiene data and information. Based on the team observations plus data and information supplied by the plant, some facilities will later be selected for detailed studies (3 to 5 day duration) of the effectivenss of control technology options. The facilities chosen for the detailed studies (including sealing device evaluation, air sampling, and measurement efforts) will be those judged to have the more effective control technology.

This protocol is intended to acquaint plant and company personnel with the objectives of the study, data and information needs, procedures to be followed by the facility review team, need for support from plant personnel, and the procedures for reporting preliminary survey information.

II. NATURE OF STUDY

Control technology includes all means of eliminating or minimizing worker exposure to hazardous chemicals - engineering controls, monitoring devices, work practices, and personal protective equipment. The investigation of engineering controls will include survey and field testing of processing equipment emission points and their various sealing devices (frequently termed seals and fittings). Important technical issues will be the technical feasibility, effectiveness, and range of applicability of various controls. A key economic issue will be cost effectiveness of different controls and/or different combinations of control options.

Work elements of the study include:

- Selection of thirty-five facilities for preliminary surveys to observe control technology in use and to obtain available data on effectiveness and approximate costs.

- Later selection of appropriate facilities (but not more than 25) for detailed studies. The detailed studies will involve monitoring, evaluation of process equipment sealing devices, air sampling, and other measurement efforts to determine control technology effectiveness. Further investigation and documentation of control technology observed in the preliminary survey will be conducted.

III. PROCEDURE FOR PRELIMINARY SURVEY

A two or three person team will conduct the survey. A typical team will comprise a chemical engineer and an industrial hygienist. The NIOSH project officer will accompany the Enviro team on some visits. Plant personnel will be notified in advance as to the members of the survey team.

The procedure for conducting these preliminary surveys will involve basically three steps:

1. The first step is a meeting between the survey team and plant management personnel and labor representatives to review the objective of the study, goals of this survey, and data and operating information gathered by plant personnel prior to the visit. Plant representatives will have an opportunity to ask questions about the program, how the data is to be used, etc. The team will ask questions to cover information gaps if the available data and information seems incomplete.

2. The second step is a team tour of the facility, assisted by plant personnel, to provide first-hand observation of the control technology employed.

3. For the third step, the team will again meet with the plant personnel for final information exchange. Prior to leaving the facility, the contractor's team and the NIOSH project officer (if present) will conduct a debriefing. The purpose is to ensure proprietary information will not be included in the contractor's draft report.

Within four weeks after the visit, Enviro will prepare a draft preliminary survey report. Subsequent report handling steps are:

1. Contractor submits this draft report to NIOSH project officer,

2. NIOSH project officer reviews for appropriateness and forwards to plant management personnel,

3. Plant personnel review, correct errors, delete inadvertently contained proprietary information and return the report to the NIOSH project officer,

4. NIOSH project officer reviews for appropriateness and forwards to the contractor,

5. Contractor prepares the finished report and sends it to the NIOSH project officer. Upon final approval, the NIOSH project officer distributes the finished report in accordance with 42 CFR 85a to:

    a. The plant management,
    b. The local labor representative,
    c. The NIOSH regional consultant,
    d. The OSHA Directorate of Technical Support (Washington, D. C.).

To allay the legitimate fears of the chemical industry regarding risks of leakage of proprietary information and trade secrets inadvertently included in draft copies of plant visit reports, both authorized NIOSH and contractor personnel will:

1. Handle such draft copies in accordance with the provisions of the NIOSH Sensitive Data Security Program;

2. Store such draft copies in NIOSH sensitive data security storage facilities;

3. Not supply such draft copies that are exempt from disclosure under the Freedom of Information Act.

Inclusion of plant names and locations in the finished preliminary survey reports is required by provisions of 42 CFR 85a (Appendix D). Also these finished reports are subject to mandatory disclosure under the Freedom of Information Act (5 US 552). Because 42 CFR 85a states that places of employment will not be identified in a final overall study report, both finished preliminary survey and detailed study reports will not be reproduced or attached to any final overall study report.

When a facility is selected for a detailed study, the plant and company management will be apprised. The unit operations and control technology to be evaluated in detail and the approach to be employed will be presented in a separate detailed study protocol written for this specific facility. The decision to perform a detailed study will normally be made several months after the preliminary survey. Detailed study reports will be handled in the same manner as the preliminary survey reports.

IV. DATA AND INFORMATION NEEDS

The basic objective of the preliminary site surveys is to visually inspect the plant and make a general evaluation. Non-proprietary information specific to a selected chemical process, its batch unit operations, and control technology will be requested. Information and data desired also cover:

a) Age and size of facility, history of production, and chemicals employed;

b) Plot plan and process details of the unit operations of interest and other operations adjacent to it;

c) Company monitoring data covering conditions in the workplace both before and after installation of controls (if available);

d) Information on the selection of the controls in use including definition of requirements, options considered, and basis of choice;

e) Worker activity information - total work force, number of workers potentially exposed at normal work stations, and job and activity descriptions for these workers', health and safety program;

f) Information on any other controls in use or planned relevant to this process;

g) Operating data or information on the controls in use, past reliability, and improvements still needed;

h) Air monitoring results defining effectiveness of control technology in use and characterization of work areas, and

i) Available cost information including equipment cost, installation cost, operation and maintenance costs, supplies needed, and energy requirements.

V. OUTLINE OF PRELIMINARY SURVEY REPORT

1.0 Summary

The summary will be a short (1/2-1 page) description of conditions and situations observed at the facility, and major conclusions or observations concerning the batch unit operations and engineering controls in use.

2.0 Introduction

2.1 Background Information on Facility

This section will include non-proprietary information on the facility: the chemicals employed, the products produced, the chemical processes used, batch unit operations observed, age and size of facility, history of production, total work force, number of workers potentially exposed, job and activity descriptions for these workers, and facility health and safety programs. In some cases because of proprietary information concerns, controls may be discussed without reference to the chemical process stage involved.

2.2 Unit Operations Description

Unit operations of interest will be described in this section. If possible, a generalized process flow diagram will be obtained from plant personnel and presented here, otherwise generic flow charts from the literature will be used. Specifics concerning the process equipment sealing devices and operating condition parameters will be presented. Potential sources of emissions will be identified on the flow diagram and discussed in the text. Equipment for limiting worker exposure to hazardous chemicals will be described. Accuracy and pertinency of technical reference information will be discussed with plant staff personnel.

3.0 Assessment of Control Technology

3.1 Basic Information

The specifics concerning facility control technology will be presented in this section. Particular emphasis will be placed on why the controls in use were selected, the information available at the time of selection, and the problems of installation. Diagrams or pictures of the engineering controls as installed will be presented. The manufacturers and vendors of major pieces of chemical processing equipment and attached sealing devices will be identified.

Available data or test information on emissions from batch unit operations prior to implementation of controls and also after will be presented in this section.

3.2 Operating Characteristics of Control and Effectiveness

Pertinent information concerning how well the system has functioned, its reliability and related topics will be presented. The advantages and disadvantages from the operator's standpoint will be discussed. Information to be included (where available) will be:

- Effectiveness of control,
- Reliability of system,
- Specific operating problems and results of attempts to correct them,
- Operator skill levels required to operate and maintain any system hardware,
- Maintenance requirements,
- Approximate installation and operating costs.

3.3 Applicability of Control Technology to Other Facilities

This will be a technical judgement-oriented discussion of the suitability of the control technology for application in (1) the same or other industries employing similar unit operations but with different chemicals and (2) other batch unit operations in similar chemical processing. Where data or information is incomplete, the effect of this deficiency on control technology will be noted.

APPENDIX D

Code of Federal Regulations,
Title 42, Part 85a

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE REGULATIONS FOR INVESTIGATIONS OF PLACES OF EMPLOYMENT

(Code of Federal Regulations, Title 42, Part 85a, 41 FR 45003, October 14, 1976; amended at 45 FR 2651, January 14, 1980)

Title 42-Public Health

CHAPTER I-PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

SUBCHAPTER G-OCCUPATIONAL SAFETY AND HEALTH RESEARCH AND RELATED ACTIVITIES

Part 85a-OCCUPATIONAL SAFETY AND HEALTH INVESTIGATIONS OF PLACES OF EMPLOYMENT

Sec

AUTHORITY: Sec 8(g), 84 Stat. 1600; 29 U.S.C. 657(g) and Sec. 508.83 Stat. 803.30 U.S.C. 957.
[Authority citation amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

85a.1 Applicability

(a) Except as otherwise provided in paragraph (b) of this section, the provisions of this part apply to investigations of places of employment which are conducted by NIOSH under sections 20 and 8 of the Occupational Safety and Health Act of 1970 and sections 501 and 103 of the Federal Mine Safety and Health Act of 1977.
[Section 85a.1(a) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(b) The provisions of this part do not apply to those activities covered by Part 85 of this chapter.

85a.2 Definitions

Any term defined in the Occupational Safety and Health Act of 1970 or the Federal Mine Safety and Health Act of 1977 and not defined below shall have the meaning given it in the Acts. As used in this part:

(a) "OSH Act" means the Occupational Safety and Health Act of 1970 (29 U.S.C. 651 et seq.) and "FMSH Act" means the Federal Mine Safety and Health Act of 1977 (30 U.S.C. 801 et seq.).
[Sections 85a.2 and 85a.2(a) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(b) "Assistant Regional Director" means any one of the ten Occupational Safety and Health Administration Assistant Regional Directors for Occupational Safety and Health.

(c) "Informed consent" means the knowing consent of an individual or his legally authorized representative, so situated as to be able to exercise free power of choice without undue inducement or any element of force, fraud, deceit, duress, or other form of constraint or coercion. The basic elements of information necessary to such consent include:

(1) A fair explanation of the

procedures to be followed, and their purposes, including identification of any procedures which are experimental;

(2) A description of any attendant discomforts and risks reasonably to be expected;

(3) A description of any benefits reasonably to be expected;

(4) A disclosure of any appropriate alternative procedures that might be advantageous for the subject;

(5) An offer to answer any inquiries concerning the procedures; and

(6) An instruction that the person is free to withdraw his consent and to discontinue participation in the investigation at any time without prejudice to the subject.

(d) "Investigation" means research projects, experiments, demonstrations, studies, and similar activities of NIOSH which are conducted under section 20 of the OSH Act and section 501 of the FMSH Act.
[Section 85a.2(d) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(e) "Legally authorized representative" means an individual or judicial or other body authorized under applicable law to consent on behalf of a prospective subject to such subject's participation in the particular activity or procedure.

(f) "NIOSH" means the National Institute for Occupational Safety and Health of the Center for Disease Control, Public Health Service, Department of Health, Education, and Welfare.

(g) "NIOSH authorized representative" means a person authorized by NIOSH to conduct investigations of places of employment, including any person that is fulfilling a contract agreement with NIOSH or is serving as an expert or consultant to NIOSH pursuant to the Act.

(h) "NIOSH Regional Office" means any one of the ten Department of Health, Education, and Welfare Regional Offices, the addresses of which are specified in 5.31 of Title 45, Code of Federal Regulations.

(i) "Places of employment" means any coal or other mine, factory, plant, establishment, construction site, or other area, workplace or environment where work is performed by any employee of an employer.
[Section 85a.2(i) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(j) "MSHA District Office" means any one of the Mine Safety and Health Administration's District Offices.
[Section 85a.2(j) added at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(k) "BOM" means the Bureau of Mines, Department of the Interior.
[Section 85a.2(k) added at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(l) "Employee" has the same meaning as stated in the OSH Act and for the purposes of this part includes "miner" as defined in the FMSH Act.
[Section 85a.2(l) added at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(m) "Employer" has the same meaning as stated in the OSH Act and for the purposes of this part includes "operator" as defined in the FMSH Act.
[Section 85a.2(m) added at 45 FR 2651, January 14, 1980, effective February 13, 1980]

85a.3 Authority for investigations of places of employment.

(a) NIOSH authorized representatives who have been issued official NIOSH credentials are authorized by the Director, NIOSH, under sections 20 and 8 of the OSH Act, sections 501 and 103 of the FMSH Act, and

this part: To enter without delay any place of employment for the purpose of conducting investigations of all pertinent processes, conditions, structures, machines, apparatus, devices, equipment, and materials within the place of employment; and to conduct medical examinations, anthropometric measurements and functional tests of employees within the place of employment as may be directly related to the specific investigation being conducted. Such investigations will be conducted in a reasonable manner, during regular working hours or at other reasonable times and within reasonable limits. In connection with any investigations, such NIOSH authorized representatives may question privately any employer, owner, operator, agent, or employee from the place of employment; and review, abstract, or duplicate employment records, medical records, records required by the Act and regulations, and other related records. In those instances where systems of records subject to review, abstration or duplication are of a confidential nature, such as medical records, and are abstracted or duplicated, NIOSH will maintain such systems in accordance with the Privacy Act of 1974 (5 U.S.C. 552a) and the implementing regulation of the Department of Health, Education, and Welfare (45 CFR Part 5b).

[Section 85a.3(a) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(b) Areas under investigation which contain information classified by an agency of the United States Government in the interest of national security will be investigated only by NIOSH authorized representatives who have obtained the appropriate security clearance and authorization.

85a.4 Procedures for initiating investigations of places of employment.

(a) Except as otherwise provided in paragraph (b) of this section, NIOSH authorized representatives will contact an official representative of the place of employment prior to any site visits and will provide the details of why an investigation of the place of employment is being conducted. Prior to the initiation of a site visit of a place of employment, representatives of the following organizations will be advised of the site visit and the reason for its conduct:

(1) The appropriate State agency designated under section 18(b) of the OSH Act or if no State agency has been designated under the OSH Act and in the case of the FMSH Act, the State agency which, in the judgment of NIOSH, would benefit the most from the investigation's findings.

[Section 85a.4(a)(1) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(2) If there is a local union at the place of employment, the local president, business manager or other appropriate individual; [Section 85a.4(a)(2) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(3) The appropriate Assistant Regional Director, when investigations are conducted under the OSH Act:

[Section 85a.4(a)(3) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(4) The appropriate MSHA District Office: the Director, BOM, and the Assistant Director for Mining, BOM, when investigations are conducted under the FMSH Act.

[Section 85a.4(a)(4) added at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(b) Advance notice of site visits

will not be given to the place of employment or local union at the place of employment when, in the judgment of the NIOSH authorized representatives, giving such notice would adversely affect the validity and effectiveness of an investigation. Those individuals and organizations specified in 85a.4(a)(1), (a)(3), and (a)(4) will be notified prior to the initiation of such a site visit. After the site visit has been initiated, and, as soon as possible thereafter, the NIOSH authorized representatives will contact those individuals specified in 85a.4(a)(2) concerning the nature and details of the site visit.
[Section 85a.4(b) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(c) In those instances where site visits are not necessary to the conduct of an investigation, the NIOSH authorized representatives will contact an official representative of the place of employment either verbally or through a written communication and provide the details of why an investigation of the place of employment is being conducted. If appropriate, the NIOSH authorized representatives will contact those individuals stipulated in paragraphs (a)(1), (a)(2), (a)(3), and (a)(4) of this section about the nature of details of the investigation.
[Section 85a.4(c) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

85a.5. Conduct of investigations of places of employment.

(a)(1) Prior to beginning a site visit, NIOSH authorized representatives will present their credentials to the employer, owner, operator or agent in charge at the place of employment, explain the nature, purpose and scope of the investigation and the records specified in 85a.3 which they wish to review, abstract or duplicate.

(2) In those instances where site visits are not necessary to the conduct of an investigation and the initial contact is made verbally, NIOSH authorized representatives will, at the request of the employer, owner, operator or agent in charge at the place of employment, provide a written explanation of the nature, purpose and scope of the investigation and the records specified in 85a.3 which they wish to review, abstract or duplicate.

(b)(1) At the commencement of an investigation, the employer, owner, operator or agent in charge at the place of employment shall precisely identify that information which is trade secret and might be seen or obtained by the NIOSH authorized representatives during the investigation. If the NIOSH authorized representatives have no clear reason to question such identification, such information will not be disclosed by NIOSH in accordance with the provisions of section (15) of the OSH Act. Generally, NIOSH will not question trade secret designations; however, if NIOSH at any time does question such identification, not less than 15 days' notice to the employer, owner, operator or agent will be given of the intention to remove the trade secret designation from such information. The employer, owner, operator or agent may within that period submit a request to the Director, NIOSH, to reconsider this intention and may provide additional information in support of the trade secret designation. The Director, NIOSH, will notify the employer, owner, operator or agent in writing of the decision which will become effective no sooner than 15 days after the date of such notice.
[Section 85a.5(b)(1) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(2) In those instances where the NIOSH authorized representative is a person fulfilling a contract agreement with NIOSH or is serving as an expert or consultant to NIOSH pursuant to the Act, the employer, owner, operator or agent in charge at the place of employment may, after advising the NIOSH contractor or consultant in writing, elect to withhold information deemed to be a trade secret from such a NIOSH authorized representative or prohibit entry into the area of the place of employment where such entry will reveal trade secrets. In those instances, where the subject information is needed or access to the area of the place of employment is necessary, in the judgment of NIOSH, to fulfill the goals of the investigation, NIOSH regular employees will then obtain the information or enter the subject area of the place of employment.

(c)(1) NIOSH authorized representatives will be in charge of site visits conducted pursuant to this part.

(2) Where there is a request by the representative of the State agency and/or employees, who were notified pursuant to 85a.4(a) (1) or 85a.4(a)(2) to accompany the NIOSH authorized representatives during the site visit of the place of employment, the NIOSH authorized representatives will allow this request if they determine that this will aid the investigation; or where in the judgment of the NIOSH authorized representatives, good cause has been shown why accompaniment by a third party who is not an employee of the employer is reasonably necessary to the conduct of an effective and thorough site visit, they may permit such third party to accompany them during the site visit; Provided, however, That access by such person(s) to areas described in 85a.5(c)(4) shall be in accordance with the requirements of such provision and access to areas containing trade secrets shall be with the consent of the employer, owner, operator or agent in charge at the place of employment.

(3) NIOSH authorized representatatives are authorized to deny the right of accompaniment under this paragraph to any person whose conduct in their judgment interferes with a fair and orderly site visit. In all instances, a representative of the employer shall be permitted to accompany the NIOSH authorized representatives during the site visit of the place of employment.

(4) With regard to information classified by an agency of the United States Government in the interest of national security, only persons authorized to have access to such information may accompany NIOSH authorized representatives in areas containing such information.

(d)(1) NIOSH authorized representatives are authorized: To collect environmental samples and samples of substances; to measure environmental conditions and employee exposures; to take or obtain photographs, motion pictures or video tapes related to the purpose of the investigation; to employ other reasonable investigative techniques, including medical examinations, anthropometric measurements and standardized and experimental functional tests of employees with the informed consent of such employees; to review, abstract and duplicate such personnel records as are pertinent to mortality, morbidity, injury, safety and other similar studies; and to question and interview privately any employer, owner, operator, agent or employee from the place of employment. The employer, owner, operator, or agent shall have the opportunity to review photographs, motion pictures and video tapes taken or obtained for the purpose of identifying those

which contain or might reveal a trade secret.

(2) Prior to the conduct of medical examinations, anthropometric measurements or functional tests of any employees, the NIOSH authorized representatives will obtain approval of the procedures to be utilized from the NIOSH Human Subjects Review Board and no employee examination, measurement or test will be undertaken without the informed consent of such employee.

(e) NIOSH authorized representatives will comply with all safety and health rules and practices at the place of employment and all NIOSH, Occupational Safety and Health Administration, and Mine Safety and Health Administration regulations and policies during a site visit and will provide and use appropriate protective clothing and equipment. In situtations requiring specialized or unique types of protective equipment, such equipment shall be furnished by the employer, owner, operator or agent in charge at the place of employment.
[Section 85a.5(e) amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

(f) The conduct of site visits will be such as to preclude unreasonable disruption of the operations of the place of employment.

85a.6. Provisions of suitable space for employee interviews and examinations.

An employer, owner, operator or agent in charge at the place of employment shall, on request of the NIOSH authorized representatives, provide suitable space at the place of employment, if such space is reasonably available, to NIOSH to conduct private interviews with, and medical examinations, anthropometric measurements and functional tests of employees. NIOSH authorized representatives will consult with the employer, owner, operator or agent as to the time and place of the private interviews, medical examination, anthropometric measurements and functional tests and will schedule same so as to avoid undue disruption of work at the place of employment. NIOSH will conduct the medical interviews, measurements, examinations, and tests specified under this part at its own expense.

85a.7. Imminent dangers.

Whenever, during the course of, or as a result of, an investigation under this part, the NIOSH authorized representatives believe there is a reasonable basis for an allegation of an imminent danger, NIOSH will immediately advise the employer, owner, operator or agent in charge at the place of employment and those employees who appear to be in immediate danger of such allegation and will inform the agencies identified in 85a. 4(a)(1), (a)(3), and (a)(4).
[Section 85a.7 amended at 45 FR 2651, January 14, 1980, effective February 13, 1980]

85a.8 Reporting of results of investigations of places of employment.

(a)(1) Specific reports of investigations of each place of employment under this part, with identification of the place of employment, will be made available by NIOSH to the employer, owner, operator or agent in charge at the place of employment, with copies to the appropiate officials and Agencies notified pursuant to 85a.4(a). Prior to release of such reports, a preliminary report will be sent by NIOSH to the employer, owner, operator or agent for review for trade secret information and technical in-

accuracies that may inadvertently be presented in the report. If requested in writing, the data used to compile the reports will be made available by NIOSH to the employer, owner, operator or agent in charge at the place of employment, except that data will not be released in a form that is individually identifiable.

(2) All specific reports of investigations of each place of employment under this part will be available to the public from the NIOSH Regional Consultant for Occupational Safety and Health in the appropriate NIOSH Regional Office.

(3) In certain instances, specific reports of investigations of each place of employment will not be prepared. In such instances, a closing conference at the place of employment will be conducted by the NIOSH authorized representatives and those individuals participating in the site visit to discuss the findings of the site visit and appropriate recommendations.

(b)(1) Any specific findings of individual employee medical examinations, anthropometric measurements and functional tests will be released by NIOSH authorized representatives to the company physician, private physician, or other person only pursuant to the written authorization of the employee; otherwise, the specific findings and other personal records concerning individuals will be maintained in accordance with 45 CFR, Part 5b and section 3 of the Privacy Act of 1974 (5 U.S.C. 552a). Notice of all NIOSH systems of records as defined in 45 CFR 5b.1(n) as a result of the investigations of places of employment pursuant to this part will be published in the FEDERAL REGISTER under Notices of Systems of Records for the Department of Health, Education, and Welfare.

(2) In cases where an employee shows positive significant medical findings, the employee and the physician(s) designated by the employee under 85a.8(b)(1) will be immediately notified by NIOSH.

(3) A summary of the findings of the examinations for each employee will be sent by NIOSH to the individual.

(c) The findings of a total investigation generally will be disseminated as part of NIOSH criteria documents, NIOSH technical reports, NIOSH information packets, scientific journals, presentations at technical meetings, or in other similar manners. These findings of a total investigation will be presented in a manner which does not identify any specific place of employment; however, it should be noted that the specific reports of investigations of each place of employment under this part are subject to mandatory disclosure, upon request, under the provisions of the Freedom of Information Act (5 U.S.C. 552).

[Title 42, Part 85a added 41 FR 45003, October 14, 1976]

B138
10