SELECTION OF PRIORITY HAZARDOUS CHEMICALS FOR PERMEATION TESTING AND HAZA. (U) COAST GUARD RESEARCH AND DEVELOPMENT CENTER GROTON CT M S HENDRICK ET AL.
HAZARDOUS
SELECTION OF PRIORITY CHEMICALS FOR PERMEATION TESTING AND HAZARDOUS CHEMICAL SPILL DETECTION AND ANALYSIS

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and

CLARE B. BILLING, JR.

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FINAL REPORT
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Prepared for:

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Washington, DC 20593
This report describes the use of a relational data base for the selection of priority hazardous chemicals to give a reasonable starting point and a logical sequence for conducting development programs involving chemical pollutants. The chemicals considered for the data base in this report are those that are most likely to be encountered in or near a marine environment. The first task required identification of those chemicals to which protective clothing is to be exposed. For the second task, a priority list was needed for the development of identification, classification, and quantification response techniques. The strategy was to gather information on spill incidence, chemical hazards, and need for clothing protection associated with each chemical. This information was compiled from a variety of sources and stored in the Chemical Hazard Information Files (CHIFs) data base using a computer and commercially available data base management software. Selection criteria were established for each task and documented along with sources of information, CHIFs data base structure, programs to enter and sort information, and the hazardous chemical priority lists.
# METRIC CONVERSION FACTORS

## Approximate Conversions to Metric Measures

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*1° in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25.
SD Catalog No. C13 10 286
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INTRODUCTION

The purpose of this study was the selection of the highest priority hazardous chemicals in the marine environment. The Priority Chemical Lists are to be used for further research in two Coast Guard Project areas: Hazardous Chemical Protective Clothing (4155) and Chemical Analysis for Pollution Response and Law Enforcement (4154). Objectives of this report are to publish the Priority Chemical Lists and to document the sources and selection criteria which were used in the selection of the chemicals. Equally important is to describe the methodology used for establishing a data base to sort chemical data - with the hope that it will provide a useful model for the application of chemical data base management for project decision-making and evaluation.

The selection of priority hazardous chemicals requires objective criteria with which to rank chemicals. The storage, organization, and manipulation of information are functions that are ideally suited for computers. With commercially available data base management programs, information on hazardous chemicals can be organized, stored, and sorted. The selection criteria, however, must be provided by the data base user. The usefulness of the results depends on both the quality of the information which is entered and the selection criteria that are used. By automating the process of sorting data, a data base management system gives the user the freedom to evaluate different selection criteria, to combine the selection criteria in various ways, and to handle large amounts of data with little additional effort. Modification of the list of chemicals is easily accomplished if new sources of information are identified. Because spills of different hazardous chemicals are not expected to occur with the same frequency, it is important to have the ability to evaluate and update the list periodically to reflect trends over time.

The data base was designed to accomplish project goals. To accomplish these goals most efficiently, we have relied on secondary sources of
information compiled by the Coast Guard and other government agencies. Information on hazardous chemicals was selected for its relevance to the research projects underway at the Coast Guard Research and Development (R&D) Center. The purpose was not to provide or maintain a source of information for general use by the public. The general approach we have used can be adapted to many applications and will be described in detail.

This report does not document the developmental history of the priority lists, but it does include the sources used, the current structure of the data base, and the selection criteria developed for each priority list.

DEVELOPMENT OF THE CHEMICAL HAZARD INFORMATION FILE (CHIFs) DATA BASE

The selection of hardware and software was determined by availability. Because the scope of the data base work did not justify a dedicated computer, computers at the R&D Center were examined for their capability to perform these tasks, with access to the computer a primary consideration. The best choice was an HP 9000 series multiuser computer located in the Marine Fire Research Branch (MFRB). A terminal for this computer was located in the Chemistry Branch and was available on a part-time basis for the CHIFs data base work. Data base management software was also available through MFRB. Table I lists the specifications for Informix (2), the data base management software used for these studies. The storage capacity of the software far exceeded the needs anticipated for CHIFs; no more than the 1100 CHRIS list chemicals, and a far smaller number of sources of information for each chemical would be included. In addition, the number of logical statements that could be handled in each sorting procedure was far greater than the capability of data base programs for smaller computers. Unlike personal computer data base software, this data base management system required programming to define the structure of the data base, format the data base entry screens, and generate reports from the data base. This inconvenience is more than offset by the storage capacity as well as by the flexibility offered by the relational data base. This data base software can also expand or
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INFORMIX Specifications

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modify the structure of an existing data base. The CHIFs data base was expanded as additional sources of information were identified and made available; it can be updated from year to year.

The CHIFs data base was modified in the course of its development to include additional sources of information by expanding the number of files within the data base. The data base as of March 1986 included six files containing information on:

1. Chemical hazard and spill history information
2. NOAA Chemical Advisory Report System
3. National Response Center spill reports (1985)
4. Permeation Test Method Information
5. Protective Clothing Material Product Information
6. Permeation Test Results

Each file contains separate fields for different types of information within it. The fields within the first file contain information on chemical hazards and spill history and are shown in Table II. This was the original file to be established. A more complete description of the fields is included in Appendix A.

Special programs to format the screen for data entry speed the data entry process. These clearly identify each item to be entered, and where the information is to be stored in the data base. Options are available for checking the data and entering default values. Appendix B includes a sample program to illustrate screen entry as well as copies of the programs used for this work.
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CHEMICAL HAZARD AND SPILL HISTORY INFORMATION FILES

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SELECTION OF PRIORITY HAZARDOUS CHEMICALS FOR PERMEATION TESTING

Background

The U.S. Coast Guard personnel use chemical protective clothing in responding to hazardous chemical spill incidents. The Coast Guard is in the process of developing new totally encapsulating suits, and it is important that the protective clothing material that is selected be compatible with the chemicals to which it will be exposed. For this reason, the Chemistry Branch at the Coast Guard R&D Center was assigned the project of testing and evaluating prospective suit materials. The scope of this project and the details of permeation testing have been described (10). One aspect of the project involves testing the protective clothing material's resistance to chemicals selected from CHRIS. The CHIFS data base was developed and used to expedite this selection process. The ultimate outcome of this research will be a suit user's manual to guide response personnel in selecting the appropriate suit for the specific chemical environment.

Selection Criteria

Selecting a smaller subset of priority chemicals for actual testing requires a process of decision-making regarding criteria that should be used to sort the chemicals into groups and then to assign priority. Figure 1 shows the groups into which chemicals were sorted. The x-axis indicates if the chemical has a spill history reported by any references in the data base. The y-axis shows whether the chemical was recommended for inclusion in the list of chemicals for which the Coast Guard requires a totally encapsulating suit (6). A third criterion for grouping the chemicals is based on what we call the hazard level of the chemical. This criterion combines several factors to group chemicals into one of three of the following levels:
FIGURE 1. - SELECTION CRITERIA USED FOR PRIORITY HAZARDOUS CHEMICALS PERMEATION TESTING
Level A: The chemical has been assigned either a carcinogen class "1" or highly toxic "2", or toxic through skin absorption "S" in the Hazard Assessment Index (4), or the NFPA has assigned it a "4", its highest health hazard rating (5).

Level B: A hazard Assessment Index of "3" or a NFPA rating of "3".

Level C: Other chemicals not in A or B.

A fourth criterion, the physical state of the material at room temperature, was later added so that liquids could be selected first for testing by the ASTM standard method, F-739-85, which applies only to permeation tests with liquids. The priority list which was generated for initial permeation testing includes only liquid chemicals, as discussed above.

Programs for Sorting Chemicals

Computer programs generated reports which divided the chemicals into groups. These were written according to the simple high level commands described in the Informix User's Manual (2). These programs are presented in Appendix C.

List of Hazardous Chemicals for Permeation Testing

The 116 chemicals selected for permeation testing are listed in Table III in alphabetical order by CHRIS code. The list includes Threshold Limit Values, the concentrations to which 8-hour exposures are considered safe. A listing of the chemicals sorted into groups is included in Appendix D. The rationale behind this selection process is based on combining two primary considerations: health hazards and spill history.

The groups which were selected for testing, in order of priority, are indicated by number on Figure 1:
**TABLE III**

Priority Chemicals for Permeation Testing
Listed in Alphabetical Order

<table>
<thead>
<tr>
<th>CHRIS</th>
<th>CHEMICAL NAME</th>
<th>TLV (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAC</td>
<td>acetic acid</td>
<td>25.00</td>
</tr>
<tr>
<td>AAD</td>
<td>acetaldehyde</td>
<td>180.00</td>
</tr>
<tr>
<td>ACA</td>
<td>acetic anhydride</td>
<td>20.00</td>
</tr>
<tr>
<td>ACC</td>
<td>acetyl chloride</td>
<td>20.00</td>
</tr>
<tr>
<td>ACN</td>
<td>acrylonitrile</td>
<td>4.50</td>
</tr>
<tr>
<td>ACR</td>
<td>acrylic acid</td>
<td>30.00</td>
</tr>
<tr>
<td>ACT</td>
<td>acetone</td>
<td>1780.00</td>
</tr>
<tr>
<td>ACO</td>
<td>acetone cyanohydin</td>
<td></td>
</tr>
<tr>
<td>ADN</td>
<td>adiponitrile</td>
<td></td>
</tr>
<tr>
<td>ALA</td>
<td>allyl alcohol</td>
<td>5.00</td>
</tr>
<tr>
<td>ALC</td>
<td>allyl chloride</td>
<td>3.00</td>
</tr>
<tr>
<td>ANL</td>
<td>aniline</td>
<td>10.00</td>
</tr>
<tr>
<td>ARL</td>
<td>acrolein</td>
<td>0.25</td>
</tr>
<tr>
<td>ATN</td>
<td>acetonitrile</td>
<td>70.00</td>
</tr>
<tr>
<td>BAM</td>
<td>n-butylamine</td>
<td>15.00</td>
</tr>
<tr>
<td>BAN</td>
<td>n-butyl alcohol</td>
<td>150.00</td>
</tr>
<tr>
<td>BCL</td>
<td>benzyl chloride</td>
<td>5.00</td>
</tr>
<tr>
<td>BCN</td>
<td>n-butyl acetate</td>
<td>710.00</td>
</tr>
<tr>
<td>BNZ</td>
<td>benzene</td>
<td>30.00</td>
</tr>
<tr>
<td>BRX</td>
<td>bromine</td>
<td>0.70</td>
</tr>
<tr>
<td>BTC</td>
<td>n-butyl acrylate</td>
<td>55.00</td>
</tr>
<tr>
<td>BTR</td>
<td>n-butylaldehyde</td>
<td></td>
</tr>
<tr>
<td>BUA</td>
<td>t-butyamine</td>
<td>15.00</td>
</tr>
<tr>
<td>CBB</td>
<td>carbon disulfide(bisulfide)</td>
<td>3.00</td>
</tr>
<tr>
<td>CBT</td>
<td>carbon tetrachloride</td>
<td>12.00</td>
</tr>
<tr>
<td>CCT</td>
<td>creosote</td>
<td>0.10</td>
</tr>
<tr>
<td>CDN</td>
<td>chlordane</td>
<td>0.50</td>
</tr>
<tr>
<td>CHX</td>
<td>cyclohexane</td>
<td>1050.00</td>
</tr>
<tr>
<td>CMH</td>
<td>cumene hydroperoxide</td>
<td></td>
</tr>
<tr>
<td>CPL</td>
<td>chloropicrin</td>
<td>0.70</td>
</tr>
<tr>
<td>CRB</td>
<td>chlorobenzene</td>
<td>350.00</td>
</tr>
<tr>
<td>CRF</td>
<td>chloroform</td>
<td>50.00</td>
</tr>
<tr>
<td>CRS</td>
<td>cresol</td>
<td>22.00</td>
</tr>
<tr>
<td>CSA</td>
<td>chlorosulfonic acid</td>
<td></td>
</tr>
<tr>
<td>CSS</td>
<td>sodium hydroxide solution(caustic soda)</td>
<td>2.00</td>
</tr>
<tr>
<td>CTA</td>
<td>crotonaldehyde</td>
<td>6.00</td>
</tr>
<tr>
<td>DCM</td>
<td>methylene chloride</td>
<td>261.00</td>
</tr>
<tr>
<td>DEA</td>
<td>diethanolamine</td>
<td>15.00</td>
</tr>
<tr>
<td>DEE</td>
<td>dichloroethylether</td>
<td>30.00</td>
</tr>
<tr>
<td>DIA</td>
<td>diisopropylamine</td>
<td>20.00</td>
</tr>
<tr>
<td>DNA</td>
<td>di-n-propylamine</td>
<td></td>
</tr>
<tr>
<td>CHRIS</td>
<td>CHEMICAL NAME</td>
<td>TLV (mg/m³)</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>------------</td>
</tr>
<tr>
<td>DOX</td>
<td>1,4-dioxane</td>
<td>3.60</td>
</tr>
<tr>
<td>DPC</td>
<td>1,3-dichloropropene</td>
<td>5.00</td>
</tr>
<tr>
<td>DPP</td>
<td>dichloropropane</td>
<td>300.00</td>
</tr>
<tr>
<td>DSF</td>
<td>dimethyl sulfate</td>
<td>0.50</td>
</tr>
<tr>
<td>EAC</td>
<td>ethyl acrylate</td>
<td>20.00</td>
</tr>
<tr>
<td>EAL</td>
<td>ethyl alcohol</td>
<td>1900.00</td>
</tr>
<tr>
<td>EAM</td>
<td>ethylamine</td>
<td>18.00</td>
</tr>
<tr>
<td>EDA</td>
<td>ethylenediamine</td>
<td>25.00</td>
</tr>
<tr>
<td>EDB</td>
<td>ethylene dibromide</td>
<td>1.00</td>
</tr>
<tr>
<td>EDC</td>
<td>ethylene dichloride</td>
<td>20.00</td>
</tr>
<tr>
<td>EET</td>
<td>ethyl ether</td>
<td>1200.00</td>
</tr>
<tr>
<td>EGL</td>
<td>ethylene glycol</td>
<td>125.00</td>
</tr>
<tr>
<td>EPC</td>
<td>epichlorohydrin</td>
<td>10.00</td>
</tr>
<tr>
<td>ETA</td>
<td>ethyl acetate</td>
<td>1400.00</td>
</tr>
<tr>
<td>ETB</td>
<td>ethyl benzene</td>
<td>435.00</td>
</tr>
<tr>
<td>ETO</td>
<td>ethion</td>
<td>0.40</td>
</tr>
<tr>
<td>FFA</td>
<td>furfural</td>
<td>8.00</td>
</tr>
<tr>
<td>FMS</td>
<td>formaldehyde</td>
<td>1.50</td>
</tr>
<tr>
<td>GAT</td>
<td>gasoline</td>
<td>900.00</td>
</tr>
<tr>
<td>GTA</td>
<td>glutaraldehyde</td>
<td>0.70</td>
</tr>
<tr>
<td>HCN</td>
<td>hydrogen cyanide</td>
<td>11.00</td>
</tr>
<tr>
<td>HDZ</td>
<td>hydrazine</td>
<td>0.10</td>
</tr>
<tr>
<td>HFA</td>
<td>hydrofluoric acid</td>
<td>2.50</td>
</tr>
<tr>
<td>HFX</td>
<td>hydrogen fluoride</td>
<td>2.50</td>
</tr>
<tr>
<td>HPO</td>
<td>hydrogen peroxide</td>
<td>1.50</td>
</tr>
<tr>
<td>HXA</td>
<td>n-hexane</td>
<td>180.00</td>
</tr>
<tr>
<td>IPA</td>
<td>isopropyl alcohol</td>
<td>980.00</td>
</tr>
<tr>
<td>IPP</td>
<td>isopropylamine</td>
<td>12.00</td>
</tr>
<tr>
<td>MAL</td>
<td>methyl alcohol</td>
<td>260.00</td>
</tr>
<tr>
<td>MAM</td>
<td>methyl acrylate</td>
<td>35.00</td>
</tr>
<tr>
<td>MEK</td>
<td>methyl ethyl ketone</td>
<td>590.00</td>
</tr>
<tr>
<td>MFA</td>
<td>motor fuel anti-knock compounds (lead alkyls)</td>
<td>0.07</td>
</tr>
<tr>
<td>MIK</td>
<td>methyl isobutyl ketone</td>
<td>200.00</td>
</tr>
<tr>
<td>MLT</td>
<td>malathion</td>
<td>10.00</td>
</tr>
<tr>
<td>MMM</td>
<td>methyl methacrylate</td>
<td>410.00</td>
</tr>
<tr>
<td>MPT</td>
<td>methyl parathion mp=65F</td>
<td>0.20</td>
</tr>
<tr>
<td>MTC</td>
<td>methyl chloride</td>
<td>105.00</td>
</tr>
<tr>
<td>NAC</td>
<td>nitric acid</td>
<td>5.00</td>
</tr>
<tr>
<td>NLD</td>
<td>naled</td>
<td>3.00</td>
</tr>
<tr>
<td>NPP</td>
<td>2-nitropropane</td>
<td>35.00</td>
</tr>
<tr>
<td>MSS</td>
<td>naptha</td>
<td>400.00</td>
</tr>
<tr>
<td>NTB</td>
<td>nitrobenzene</td>
<td>5.00</td>
</tr>
<tr>
<td>NTM</td>
<td>naphthalene</td>
<td>50.00</td>
</tr>
<tr>
<td>OLM</td>
<td>oleum</td>
<td>1.00</td>
</tr>
<tr>
<td>PAC</td>
<td>phosphoric acid</td>
<td>1.00</td>
</tr>
<tr>
<td>PAL</td>
<td>n-propyl alcohol</td>
<td>500.00</td>
</tr>
<tr>
<td>PCB</td>
<td>polychlorinated biphenyl compounds</td>
<td>0.001</td>
</tr>
<tr>
<td>CHRIS</td>
<td>CHEMICAL NAME</td>
<td>TLV (mg/m³)</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>PHN</td>
<td>phenol</td>
<td>19.00</td>
</tr>
<tr>
<td>PNA</td>
<td>propionic acid</td>
<td>30.00</td>
</tr>
<tr>
<td>POX</td>
<td>propylene oxide</td>
<td>50.00</td>
</tr>
<tr>
<td>PPO</td>
<td>phosphorus oxychloride</td>
<td>0.60</td>
</tr>
<tr>
<td>PPT</td>
<td>phosphorus trichloride</td>
<td>1.50</td>
</tr>
<tr>
<td>PRA</td>
<td>n-propyl amine</td>
<td></td>
</tr>
<tr>
<td>PTO</td>
<td>parathion</td>
<td>0.10</td>
</tr>
<tr>
<td>SFA</td>
<td>sulfuric acid</td>
<td>1.00</td>
</tr>
<tr>
<td>SFM</td>
<td>sulfur monochloride</td>
<td>6.00</td>
</tr>
<tr>
<td>SHD</td>
<td>caustic soda (sodium hydroxide)</td>
<td>2.00</td>
</tr>
<tr>
<td>SHR</td>
<td>sodium hydrosulfide solution</td>
<td></td>
</tr>
<tr>
<td>STC</td>
<td>silicon tetrachloride</td>
<td></td>
</tr>
<tr>
<td>STY</td>
<td>styrene</td>
<td>420.00</td>
</tr>
<tr>
<td>TCL</td>
<td>trichloroethylene</td>
<td>270.00</td>
</tr>
<tr>
<td>TDI</td>
<td>toluene diisocyanate</td>
<td>0.04</td>
</tr>
<tr>
<td>TEC</td>
<td>1,1,2,2-tetrachloroethane</td>
<td>7.00</td>
</tr>
<tr>
<td>TCE</td>
<td>trichloroethane</td>
<td>900.00</td>
</tr>
<tr>
<td>TEL</td>
<td>tetraethyl lead</td>
<td>0.07</td>
</tr>
<tr>
<td>TEP</td>
<td>tetraethyl pyrophosphate</td>
<td></td>
</tr>
<tr>
<td>TLI</td>
<td>o-toluidine</td>
<td>9.00</td>
</tr>
<tr>
<td>TML</td>
<td>tetramethyl lead</td>
<td>0.07</td>
</tr>
<tr>
<td>TOL</td>
<td>toluene</td>
<td>750.00</td>
</tr>
<tr>
<td>TPT</td>
<td>turpentine</td>
<td>560.00</td>
</tr>
<tr>
<td>TTE</td>
<td>tetrachloroethylene</td>
<td>670.00</td>
</tr>
<tr>
<td>VAM</td>
<td>vinyl acetate</td>
<td>15.00</td>
</tr>
<tr>
<td>VCI</td>
<td>vinylidene chloride</td>
<td>4.00</td>
</tr>
<tr>
<td>XLM</td>
<td>xylene</td>
<td>435.00</td>
</tr>
<tr>
<td>XYL</td>
<td>xylenol</td>
<td></td>
</tr>
</tbody>
</table>

There are a total of 116 chemicals.
1. All the chemicals at Hazard Level A. Only 12 of these chemicals had not been included on the encapsulated suit list (6). A decision was made to include them as a backup to provide an additional margin of safety by not relying solely on one source for hazard evaluation. This group included 51 chemicals.

2. Hazard Level B chemicals with both an encapsulated suit requirement and a spill history. There were 24 chemicals in this group.

3. Fourteen chemicals which had both a spill history and an encapsulated suit requirement, although they had not been included in Hazard Level A or B.

4. Chemicals were in Hazard Level B with a spill history that had not previously been selected in one of the above groups.

Group 1 contains all the liquid chemicals which cause the most serious problems (to the extent we can determine), whether they have ever been spilled or not. Groups 2 and 3 include all those chemicals which need totally encapsulated suits (6) if they have a spill history. Group 4 chemicals are toxic and have a spill history.

For chemicals not tested, other chemical class representatives in the database can give reliable estimates of permeation properties. Other tasks within the permeation project address more fundamental aspects of permeation, so that projections of the permeation characteristics for other chemicals can be based on the results of this subset of high priority chemicals.
HAZARDOUS CHEMICAL PRIORITY LIST FOR ANALYSIS FOR POLLUTION RESPONSE
AND LAW ENFORCEMENT

Background

The purpose of this project is to evolve a rapid response capability to classify, identify, and quantify spilled chemicals in the marine environment. Analytical techniques useful for either the field or the laboratory must be developed. Analytical method development is a complex process, and it is not possible, at the present time, to develop one simple technique by which every chemical can be analyzed (11). For this reason, one element of this project, from the beginning, has been to establish a priority ranking of hazardous chemicals present in or near the marine environment. The objective was to identify those chemicals posing the greatest threat to people and/or the environment. A Priority List (12) for Project 4154 was selected in 1979. The selection criteria included chemicals that could be shipped by water. However, the list of over 400 chemicals was not stored on computer and did not rank chemicals. The current project seeks to select a smaller number of priority chemicals and rank them based on information about chemical hazards and spill frequency.

Selection Criteria

After the priority list for Permeation Testing was completed, additional information was acquired. The Hazardous Materials Response Branch of the National Oceanic and Atmospheric Administration (NOAA) maintains files of computerized information on hazardous chemicals (CHEMREPS), which have been described by Ernst (13). These are transmitted to NOAA scientific support coordinators in the field, who assist the Coast Guard in spill situations. A separate file was created in the data base for CHEMREP information. This file contains fields for chemical names, information on whether the chemical had been encountered in a real spill, and whether the chemical is planned for inclusion, but not yet a part of the CHEMREP system. The NOAA CHEMREPS were used as an indication of whether a serious spill had occurred.
Other sources used for the 4154 priority list included the Hazardous Index (4) and whether or not the chemical was reported to the Pollution Incident Reporting System (PIRS) (7,8). For a Hazard Index of 1 (carcinogens), or 2 (very toxic), relatively few spill incidents were required to justify inclusion on the priority list. Either inclusion on the CHEMREP list as a spill or a PIRS report will identify the chemical for selection. At a hazard assessment index of 3 (toxic hazard) and above, the criteria are more restrictive. The criteria for each level of hazard index are shown in Table IV.

Priority List Chemicals

Eighty-one (81) chemicals were selected based on the criteria discussed above; one was added in the evaluation process (see below). These chemicals are included in Table V, and they account for 92% of the 1,303 PIRS spills of hazardous chemicals compiled for 1973-1983. The top 25 chemicals shown in Table V account for 82% of the reported spill incidents. Table VI shows the ranking of these substances based on their hazard index and physical state. Six solids, 11 gases, and 65 liquids are represented. The hazard indices indicate that many of these chemicals are extremely toxic.

Evaluation of the Priority List

Past spills of chemicals may indicate that a chemical is more likely to be spilled in the future, but this is by no means a certainty. We compared our 4154 Priority List to a list of chemicals which had been spilled in 1985, as compiled by the National Response Center (NRC). The NRC list contained many petroleum oils, which we excluded from consideration because the Coast Guard has an Oil Identification Laboratory with established analytical protocols (13). The NRC list also included all incidents, not just those to which the Coast Guard had responded. Although separating Coast Guard responses for the
### TABLE IV
CRITERIA FOR SELECTING PRIORITY LIST CHEMICALS

<table>
<thead>
<tr>
<th>HAZARD ASSESSMENT INDEX&lt;sup&gt;a&lt;/sup&gt;</th>
<th>CHEMREP&lt;sup&gt;b&lt;/sup&gt;</th>
<th>PIRS ('73-83) (# of spills)</th>
<th>PIRS ('73-79) (% of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (CARCINOGENS)</td>
<td>+</td>
<td>&gt;0</td>
<td>&gt;0</td>
</tr>
<tr>
<td>2 (HIGH TOXIC HAZARD)</td>
<td>+</td>
<td>&gt;0</td>
<td>&gt;0</td>
</tr>
<tr>
<td>3 (TOXIC HAZARD)</td>
<td>+</td>
<td>≥10</td>
<td>≥0.1</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>≥4</td>
<td></td>
</tr>
<tr>
<td>OTHER (INCLUDING UNCLASSIFIED)</td>
<td>+</td>
<td>≥5</td>
<td>≥0.1</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>≥10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> For Hazard Assessment Indices of 1 or 2, appearance on CHEMREP list or any reported spill automatically selects the chemical. For an Index of 3 or Other, only two conditions need to be met.

<sup>b</sup> Either listed at present or planned to be included in compilation of chemicals to which NOAA has responded.
### TABLE V

**4154 PRIORITY LIST HAZARDOUS CHEMICALS**

In order of Spill Frequency

<table>
<thead>
<tr>
<th>CHRIS</th>
<th>CHEMICAL NAME</th>
<th>PIRS SPILLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFA</td>
<td>sulfuric acid</td>
<td>128</td>
</tr>
<tr>
<td>SHD</td>
<td>caustic soda (sodium hydroxide)</td>
<td>95</td>
</tr>
<tr>
<td>PCB</td>
<td>polychlorinated biphenyl compounds</td>
<td>92</td>
</tr>
<tr>
<td>XLM</td>
<td>xylene</td>
<td>92</td>
</tr>
<tr>
<td>BNZ</td>
<td>benzene</td>
<td>91</td>
</tr>
<tr>
<td>AMA</td>
<td>ammonia</td>
<td>85</td>
</tr>
<tr>
<td>TOL</td>
<td>toluene</td>
<td>81</td>
</tr>
<tr>
<td>HCL</td>
<td>hydrochloric acid</td>
<td>63</td>
</tr>
<tr>
<td>STY</td>
<td>styrene</td>
<td>59</td>
</tr>
<tr>
<td>CLX</td>
<td>chlorine</td>
<td>35</td>
</tr>
<tr>
<td>CRL</td>
<td>cresol</td>
<td>33</td>
</tr>
<tr>
<td>PHN</td>
<td>phenol</td>
<td>26</td>
</tr>
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There are a total of 82 chemicals; there are 11 gases, 65 liquids and 6 solids.
entire year was not possible, the Coast Guard generally responds to fewer discharges of gases, and more to spills into water, than other agencies (14). The list of NRC incidents was entered into a separate file in the data base, and the spills ordered according to frequency. Disregarding oils, multiple, and unknown spills, the five most frequently spilled - or discharged - chemicals in 1985 were PCBs, sulfuric acid, ammonia, chlorine, and hydrochloric acid. These five chemicals accounted for 1362 of the 2882 hazardous chemical spills, or 47% of the known, non-petroleum related incidents. These same hazardous chemicals were also in the top 10 frequently spilled chemicals on the PIRS compilation, accounting for 34% of the PIRS hazardous chemical spills. The difference is due to the increase in the number of PCB incidents reported to the NRC. Of the top 25 NRC spills—excluding asphalt, creosote, jet fuel, kerosene, and petroleum oils—shown in Table VII, twenty-one are on the 4154 hazardous chemical spill priority list. The compounds which we had included on the priority list accounted for 68% of the total number of NRC incidents. The 81 chemicals selected for the 4154 priority list account for 77% of the hazardous chemical spills reported to the National Response Center in 1985.

The Environmental Protection Agency (EPA) has independently compiled an "Acute Hazardous Events Database", which was based on a much more serious extensive survey (15). The results are consistent with our observation that a few hazardous chemicals are involved in a disproportionately high percentage of spill incidents. The EPA data base includes all spills, in industrial settings as well as transportation incidents; transportation-related spills accounted for only 35% of the total spill incidents. The pattern is the same: 58% of all incidents involved only 20 substances. PCBs were involved in the greatest number of incidents. The EPA data base included data on incidents which had caused death or injury. Chlorine, ammonia, hydrochloric acid, and sulfuric acid were involved most frequently in these serious incidents. These chemicals were also at the top of the NRC list and in the top ten of our priority list.
TABLE VII
MOST FREQUENTLY SPILLED CHEMICALS REPORTED TO THE NATIONAL RESPONSE CENTER

NRC-CHRIS comparison for CHIFs chemicals

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</tr>
<tr>
<td>TCL trichloroethylene</td>
<td>0</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

* Combined on 4154 Priority List as sodium hydroxide.
Examination of the chemicals on the NRC list reveals that ammonium nitrate was involved in 14 incidents in 1985. NOAA had included it in the CHEMREPS. NOAA response personnel indicated that this chemical has been involved in spills into waterways, where it can pose serious problems. Examination of the original data base sources suggest that it was probably omitted because "ammonium compounds" were not individually identified, therefore they were not included on the list of CHRIS chemicals. Ammonium nitrate was added to the priority list, increasing the number of compounds to 82. Tables V and VI reflect the addition of this compound.

The correspondence of the 4154 priority list with the NRC and EPA lists confirm the value of our strategy of identifying the most serious problem chemicals and concentrating development efforts in the areas which will be most beneficial.

CONCLUSIONS AND FUTURE WORK

The CHIFs data base has been a helpful tool for information storage and retrieval in formulating lists of priority hazardous chemicals for further research. Work which will be based on these priority lists include:

1. Evaluating the 4154 priority list on a regular basis to identify chemicals which may be increasing in frequency of spillage.

2. Evaluating analytical methods for hazardous chemical response situations. This evaluation will screen methods for their capability of a rapid analytical response, or turn-around-time, either in the field or in the laboratory. This evaluation will begin with the most frequently spilled chemicals and extend to the entire 4154 priority list. The results will be available for use in the field through the NOAA Hazardous Material Spill Response System.

3. The chemicals selected for permeation testing for project 4155 have been contracted to a private contract laboratory for routine testing. The results of this study will be used to prepare a manual for the use of the new totally encapsulated suits developed by the Coast Guard.
4. Results of permeation testing will be stored in a separate file in the data base and transmitted via computer to a data base of permeation results which is being compiled by the National Institute for Occupational Safety and Health (NIOSH). The data will also be sent directly to Coast Guard Headquarters.
REFERENCES


15. Private communication LT HANEWICH, National Response Center.

APPENDIX A

STRUCTURE OF THE DATA BASE

The first 19 fields shown in Table II in the Chemical Hazard and Spill History Information File store three types of information:

1) Identification and Classification

2) Chemical Hazard Information

3) Spill History

The first field contains the name referred to in other sources of information. For identification purposes, this must be a unique name, so synonyms for the same name were consolidated under one name.

The CHRIS Code from the Coast Guard's Chemical Hazard Response Information System (Field 2) is a unique identifier for all chemicals and chemical mixtures listed in the CHRIS manual (1). The data base is structured so that two records of information cannot have the same CHRIS code. The CHRIS code was used to check that two names for the same chemical had not been entered. The physical state of the chemical at room temperature was entered in field three. Whether the compound is a solid, liquid, or gas at room temperature was taken from the CHRIS manual. Classification into chemical groups is in fields four through six. The R&D Class (field 5) is a previously developed internal classification system and is shown in Table A-1. The permeation class is a classification scheme proposed to the ASTM as a way of organizing chemicals into groups for reporting permeation results. This proposal is based on a three digit code assigned to the classification groups for organic chemicals in the Kodak catalogue. A listing can be found in Reference (3).

Hazard information is contained in fields 7 through 12.
Table A-1

R&D Center
Chemical Classification Scheme

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pesticides</td>
</tr>
<tr>
<td>2</td>
<td>Monomers</td>
</tr>
<tr>
<td>3</td>
<td>Inorganic acids</td>
</tr>
<tr>
<td>4</td>
<td>Inorganic caustics</td>
</tr>
<tr>
<td>5</td>
<td>Inorganic halogen compounds</td>
</tr>
<tr>
<td>6</td>
<td>Other inorganic cations and anions</td>
</tr>
<tr>
<td>7</td>
<td>Saturated hydrocarbons</td>
</tr>
<tr>
<td>8</td>
<td>Unsaturated hydrocarbon</td>
</tr>
<tr>
<td>9</td>
<td>Halogenated organics</td>
</tr>
<tr>
<td>10</td>
<td>Alcohols</td>
</tr>
<tr>
<td>11</td>
<td>Aldehydes and keytones</td>
</tr>
<tr>
<td>12</td>
<td>Glycols and epoxides</td>
</tr>
<tr>
<td>13</td>
<td>Carboxylic acid and derivatives</td>
</tr>
<tr>
<td>14</td>
<td>Nitriles and isocyanates</td>
</tr>
<tr>
<td>15</td>
<td>Amines and imines</td>
</tr>
<tr>
<td>16</td>
<td>Organic sulfur compounds</td>
</tr>
<tr>
<td>17</td>
<td>Aromatics</td>
</tr>
<tr>
<td>18</td>
<td>Organometallics and organosilicons</td>
</tr>
<tr>
<td>19</td>
<td>Phenol</td>
</tr>
<tr>
<td>20</td>
<td>Nitro cpds</td>
</tr>
<tr>
<td>21</td>
<td>Heterocyclic cpds</td>
</tr>
<tr>
<td>22</td>
<td>Phosphorous cpds</td>
</tr>
<tr>
<td>23</td>
<td>Ether</td>
</tr>
<tr>
<td>24</td>
<td>Peroxides</td>
</tr>
<tr>
<td>25</td>
<td>Oils</td>
</tr>
</tbody>
</table>
The totally-encapsulated suit requirement was entered into field 12 as a yes or no, based on information in Reference (6). This information also reflects the degree of hazard of a compound. Because this encapsulated suit information is important to Coast Guard operations in the field, all the chemicals for which such protection is needed were entered into the data base. No primary sources were used for hazard information; several sources which had examined the toxicological and health hazard information were relied upon for judgments which our study did not have the expertise or resources to duplicate.

Spill history was based on a number of different sources, and entered into fields 13 through 17. The CHRIS codes were identified for all the spills mentioned in the various spill sources. All the other information was then entered for each spilled chemical.

Field 18 indicates if the chemical had been selected in 1979 for the first 4154 Priority List (12). Field 19 recently added to store the results of the 4154 and 4155 Priority Lists generated as described in this report.

Figure A-1 shows a simple program to create or modify a data base file. It is necessary to name the data base, the file, and the fields within the file. The shaded words in Figure A-1 illustrate sample names which were used. For each field, the field type must be specified; if the field contains ASCII characters, the length must also be specified. An index indicates that the field will be used for identification. The complete set of programs which were used to build the data base in its current state are included.
FIGURE A-1. SAMPLE PROGRAM ILLUSTRATING COMMANDS USED TO BUILD THE DATABASE
PROGRAM A-1. CHEMICAL HAZARD AND SPILL HISTORY INFORMATION FILE

database hazchem

file chemclass

field chris_code  type character  length 3  index  
duplicates
field chemname  type character  length 50  index  
field rdc_class  type character  length 2  
field chris_class  type character  length 2  
field adl_class  type character  length 2  
field kodak_class  type character  length 3  
field list  type character  length 1  
field haz_index  type character  length 1  
field skin_tox  type character  length 1  
field nfpa_hlth  type character  length 1  
field nfpa_fire  type character  length 1  
field nfpa_reac  type character  length 1  
field suit  type character  length 1  
field solubility  type double  
field polarity  type character  length 1  
field spills83  type integer  
field ms084  type character  length 1  
field strike84  type character  length 1  
field ms0_det  type character  length 1  
field pirs_percent  type double  
field noaa84  type integer  
field argonne  type character  length 1  
field form  type character  length 1  
field priority54  type character  length 2  
field priority55  type character  length 2  
field tlv  type double  
field detector  type character  length 10  
end

PROGRAM A-2. NOAA CHEMREP INFORMATION FILE

database hazchem

file chr

field chrname  type character  length 50  index  
field chr_code  type character  length 3  index duplicates  
field drill  type character  length 1  index duplicates  
field plan  type character  length 1  index duplicates  
end
PROGRAM A-3. NRC INFORMATION FILE

database hazchem

file nrcinfo

field nrc_chris type character length 3 index dups
field num85 type integer
end

PROGRAM A-4. CHEMICAL PROTECTIVE CLOTHING INFORMATION FILE

database hazchem

file product

field product_id type character length 8 index
field tpmname type character length 25
field product_type type character length 2 index dups
field generic_nm type character length 30
field supplier_nm type character length 50
field product_mat type character length 3
field product_cond type character length 30
field product_supplier type character length 3
field product_catnum type character length 12
field product_lot type character length 20
field product_date type date
field product_thk type double
field product_desc type character length 60
field product_amt type character length 30
end
PROGRAM A-5. PERMEATION TEST METHOD INFORMATION FILE

database hazchem

file method

field lab_name
field method_id
field model_id
field col_name
field inj_temp
field oven_temp
field det_temp
field temp_gradient
field dial_flow
field gc_attn
field gc_range
field int_model
field int_attn
field int_thresh
field int_pkwidth
field int_mode
field col_media
field col_sys
field other_cond
field deviations
end

PROGRAM A-6. PERMEATION TEST RESULTS INFORMATION FILE

database hazchem

file results

field results_notebookid
field results_runnum
field results_rundate
field results_btl
field results_bt2
field results_bt3
field results btcv
field results_thkcv
field results_permrate
field results_thk
field results_obsv
field results_matid
field results_methodid
field results_numsamples

A-7
field concl  type double
field response1 type double
field conc2  type double
field response2 type double
field conc3  type double
field response3 type double
field inj_vol  type double
field det_limit type double
field perm_chem1 type character length 25 index dups
field perm_chem2 type character length 25 index dups
field perm_chem3 type character length 25 index dups
field chemsource1 type character length 25
field chemsource2 type character length 25
field chemsource3 type character length 25
field chemvol1 type character length 6
field chemvol2 type character length 6
field chemvol3 type character length 6
field CAS1  type character length 10
field CAS2  type character length 10
field CAS3  type character length 10
field t_cell  type character length 6
field templ  type float
field results_runlength type double
field results_modelid type character length 10 index dups

end
APPENDIX B

SCREEN ENTRY PROGRAMS

A sample program to enter two pieces of information, the chemical name and its CHRIS code, is shown in Figure B-1. Any number of different programs for screen display can be written or modified at any time. Screen displays for data entry are accessible from the main menu of the data base program.
Database Hazchem Screen
{Name [list 1]
CHRIS code [list 2]
}
End

Attributes
List 1 = chemname
List 2 = code
End

FIGURE B-1.  SAMPLE PROGRAM ILLUSTRATING COMMANDS TO CREATE SCREEN ENTRY DISPLAY
PROGRAM B-1. CHEMICAL CLASSIFICATION HAZARD AND
SPILL HISTORY INFORMATION ENTRY

database hazchem

screen

CHRIS code: [a]
chemical name: [b]
form (l,s,g): [w]

chemical class: R&DC [c] CHRIS [d] ADL [e] Kodak [f]

4154 list? [g] skin toxicity? [i]

hazard assessment index: [h]

NFPA ratings: health [j] fire [k] reactivity [l]

solubility parameter & polarity index: [v] [n]

encapsulated suit? [m]
PIRS spills '83: [o]

PIRS% '73-'79: [s] NOAA '84: [t] Argonne priority: [u]

end

attributes

a = chris_code, upshift;
b = chemname;
c = rdc_class, right;
d = chrTs_class, right;
e = adl_cTass, right;
f = kodak_class, right;
g = list 4154, include = (Y,y,""), upshift;
i = skin_tox, include = (s,S,""), upshift;
h = haz_Tindex, include = (1 to 6,"","n");
j = nfpa_hlth, include = (0 to 4,"");
k = nfpa_fire, include = (0 to 4,"");
PROGRAM B-1. (continued)

l = nfpa_reac, include = (0 to 4, " ");
v = solubility;
n = polarity, include = (s, S, m, M, p, P, " "), upshift;
m = suit, include = (y, Y, n, N, " "), upshift;
o = spills83, right;
p = mso84, include = (y, Y, " "), upshift;
q = strike84, include = (y, Y, " "), upshift;
r = mso_det, include = (y, Y, " "), upshift;
s = pers_percent;
t = noaa84, right;
u = argonne, include = (1 to 6, " ");
w = form, include = (1, s, g, " ");
end

PROGRAM B-2. NRC INFORMATION ENTRY

database hazchem

screen

NATIONAL RESPONSE CENTER DATA

1985 totals

CHRIS code [11]

Number of incidents [12]

end

attributes

11 = nrc_chris;
12 = num85;
end
PROGRAM B-3. PROGRAM TO ENTER PRIORITY LIST RESULTS

database hazchem

screen

CHRIS code: [a ]
chemical name: [b ]

4154 priority list? [g ]
4155 priority list? [h ]

Threshold Limit Value (mg/m3)? [l ]

Detector? [m ]

end
attributes
a = chris_code, upshift;
b = chemname;
g = priority54, include = (Y,y," "), upshift;
h = priority55, include = (1,2,3,4," ");
l = tlv;
m = detector;
end
APPENDIX C

PROGRAMS TO IDENTIFY CHEMICALS FOR PRIORITY LISTS

PROGRAM C-1. HAZARD CLASS A CHEMICALS

database hazchem end
read into x chemclass
where
  (haz_index=1 or haz_index=2 or skin_tox="s" or skin_tox="S" or
   nfpa_hlth=4)
  and form="1"
end
sort by spills83 descending
end
format
first page header
print "Priority 1 Type A Liquid chemicals"
print " arranged by spill frequency"
skip 2 lines
print "CHRIS chemical name #PIRS spills suit"
skip 1 line
on every record
print chris_code, 2 spaces, chemname, 2 spaces, spills83, 2 spaces, suit
on last record
print "There are a total of ", count using "###", " chemicals"
print "There are a total of ", total of spills83 using "###", " spills"
end

PROGRAM C-2. GROUP IB CHEMICALS

database hazchem end
read into x chemclass
where
  (suit="y" or suit="Y")
  and (spills83 <> 0 or mso84 <> " "
       or strike84 <> " " or mso_det <> " "
       or pirs_percent > 0 or noaa84 > 0 or argonne <> " ")
  and not (haz_index=1 or haz_index=2 or skin_tox="s" or skin_tox="S" or
           nfpa_hlth=4)
  and (haz_index=3 or nfpa_hlth=3)
  and form="1"
end
sort by spills83 descending
end
format
first page header
print "Encapsulated suit chemicals with a spill history"
print " Group IB arranged by chemical form and class"
skip 2 lines
print "CHRIS chemical name PIRS spills,index,nfpa"
skip 1 line
on every record
print chris code, 2spaces,chemname,spills83,lspace,haz_index,lspace,nfpa_hlth
on last record
print "There were a total of ",total of spills83 using "###","spills."
skip 2 lines
print "There are a total of ", count using "###", "chemicals"
end

PROGRAM C-3. GROUP IIIB CHEMICALS

database hazchem end
read into x chemclass
where (suit <> "Y" and suit <> "y")
and (spills83 > 0 or ms084 <> ""
or strike84 <> "" or mso det <> ""
or pirs_percent > 0 or noaa84>0 or argonne <> ""
and not (haz_index=1 or haz_index=2 or skin_tox="s" or skin_tox="S"or
nfpa_hlth=4)
and (haz_index=3 or nfpa_hlth=3)
and form="l"
end
sort by spills83 descending
end
format
first page header
print "Non-encapsulated suit chemicals with a spill history"
print "Group IIIB arranged by chemical form and class"
skip 2 lines
print "CHRIS chemical name PIRS spills,index,nfpa"
skip 1 line
on every record
print chris code, 2spaces,chemname,spills83,lspace,haz_index,lspace,nfpa_hlth
on last record
print "There were a total of ",total of spills83 using "###","spills."
skip 2 lines
print "There are a total of ", count using "###", "chemicals"
end

PROGRAM C-4. GROUP IC CHEMICALS

database hazchem end
read into x chemclass
where (spills83 > 0 or ms084 <> ""
PROGRAM C-4 (continued)

or strike84 <> " " or mso Det <> " "
or pirs_percent > 0 or moa84 > 0 or argonne <> " "
or argonne <> " "
and (suit="y" or suit="Y")
and not (haz_index=1 or haz_index=2 or skin_tox="s" or skin_tox="S"or
nfp_hlth=4 or haz_index=3 or nfp_hlth=3)
and sim="T"
end
sort by spills83 descending
end
format
first page header
print "PRIORITY IC liquid chemicals"
print "arranged by frequency of spill PIRS 73-83 compilation"
skip 2 lines
print "CHRIS chemical name 83PIRS comp, hazard code,NFPA,skin"
skip 1 line
on every record
print chris_code, 2spaces,chemname,2
spaces,spills83,1space,haz_index,1space,nfpa_hlth,1space,skin_tox
on last record
skip 1 line
print "There were a total of ",total of spills83 using "###","spills."
skip 1 line
print "There are a total of ",count using "###",
" chemicals"
end

PROGRAM C-5. 4154 PRIORITY LIST CHEMICALS BY PIRS OCCURRENCES

database hazchem end
read into y chemclass chr
joining chris_code= optional chrcode where
chris_code <> " "
and (Haz_index="1" or haz_index="2")
and ((chrcode <> " " or spills83 > 0 or pirs_percent > 0))
end
read into x chemclass chr
joining chris_code= optional chrcode where
chris_code <> " "
and (spills83 4)
or (spills83 > 1 and chrcode <> " ")
or (pirs_percent > 0.1 and chrcode <> " ")
and haz_index="3"
PROGRAMS TO IDENTIFY CHEMICALS FOR PRIORITY LISTS (continued)

PROGRAM C-5 (continued)

end
assign a=y union x
end
read into z chemclass chr
joining chris_code= optional chrcode
where
chris_code <> " "
and ((spills83 > 10 or pirs_percent > 1.0)
or (chrcode <> " " and spills83 > 5))
and not(haz_index="1" or haz_index="2" or haz_index="3")
end
assign b=z union a
end
sort by spills83 descending
end
format
first page header
print "Priority List 4154 - Hazardous Chemicals"
print "These chemicals are listed in order of PIRS occurrences"
skip 2 lines
print "CHRIS chemical name PIRS spills"
skip 1 line
on every record
print chris_code, 1 space,chemname,spills83
on last record
skip 2 lines
print "There are a total of ", count using "###",
"chemicals"
print "This accounts for ", total of (spills83) using "####",
"chemical spills"
end

PROGRAM C-6. 4154 PRIORITY LIST GROUPED BY CHEMICAL STATE AND HAZARD INDEX

database hazchem end
read into y chemclass chr
joining chris_code= optional chrcode
where
chris_code <> " "
and (haz_index="1" or haz_index="2")
and (chrcode <> " " or spills83 > 0 or pirs_percent > 0)
end
read into x chemclass chr
joining chris_code= optional chrcode
where
chris_code <> " "
and (spills83 > 4)
PROGRAM C-6 (continued)

or (spills83 > 1 and chrcode <> "")
or (pirs_percent > 0.1 and chrcode <> "")
and haz_index="3"
end
assign a=y union x
end
read into z chemclass chr
joining chris_code= optional chrcode
where
chris_code <> ""
and ((spills83 > 10 or pirs_percent > 1.0)
or (chrcode <> "" and spills83 > 5))
and not(haz_index="1" or haz_index="2" or haz_index="3")
end
assign b=z union a
end
sort by form haz_index
end
format
first page header
print "Priority List 4154 Hazardous Chemicals"
print "These chemicals are grouped into solids, liquids, and gases"
print "and listed by hazard index"
skip 2 lines
print "CHRIS chemical name chemical hazard"
skip 1 line
on every record
print chris_code, 2spaces, chemname, form, 5 spaces, haz_index
on last record
skip 2 lines
print "There are a total of ", count using "###", " chemicals"
end
APPENDIX D

4155 PRIORITY LIST CHEMICALS IN PRIORITY GROUPS

TABLE D-1

KEY TO DETECTOR CODES AND COLLECTION MEDIA FOR PERMEATING TESTING

<table>
<thead>
<tr>
<th>Method of Detection</th>
<th>Collection Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas Chromatographic Techniques</strong></td>
<td></td>
</tr>
<tr>
<td>F = Flame Ionization Detector</td>
<td>air</td>
</tr>
<tr>
<td>E = Electron Capture Detector</td>
<td>air</td>
</tr>
<tr>
<td>H = Hall Detector</td>
<td>air</td>
</tr>
<tr>
<td>FP = Flame Photometric Detector</td>
<td>air</td>
</tr>
<tr>
<td><strong>Colorimetric Techniques</strong></td>
<td></td>
</tr>
<tr>
<td>C = Colorimetric standard method or</td>
<td>water</td>
</tr>
<tr>
<td>commerical test kit based on method</td>
<td></td>
</tr>
<tr>
<td><strong>Ion Chromatography</strong></td>
<td></td>
</tr>
<tr>
<td>A = Anion Column</td>
<td>water</td>
</tr>
<tr>
<td>Cat = Cation Column</td>
<td>water</td>
</tr>
<tr>
<td><strong>Other Techniques</strong></td>
<td></td>
</tr>
<tr>
<td>SI = Specific ion electrodes</td>
<td>water</td>
</tr>
<tr>
<td>P = Polarography</td>
<td>water</td>
</tr>
<tr>
<td>IR = Infrared spectrographic analysis</td>
<td>air</td>
</tr>
</tbody>
</table>
### TABLE D-2

**Group I-IV Liquid Chemicals**  
Arranged by Number of PIRS Spills ('73-'83)

**PS** = PIRS spills  
**S** = Need for encapsulated suit (Y=Yes)

<table>
<thead>
<tr>
<th>CHRIS</th>
<th>CHEMICAL NAME</th>
<th>DETECTOR CODE</th>
<th>PS</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNZ</td>
<td>benzene</td>
<td>F</td>
<td>91</td>
<td>Y</td>
</tr>
<tr>
<td>TOL</td>
<td>toluene</td>
<td>F</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>STY</td>
<td>styrene</td>
<td>F</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>CRS</td>
<td>cresol</td>
<td>F/C</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>PHN</td>
<td>phenol</td>
<td>F/C</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>FNS</td>
<td>formaldehyde</td>
<td>C</td>
<td>17</td>
<td>Y</td>
</tr>
<tr>
<td>MTC</td>
<td>methyl chloride</td>
<td>H/E</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>ACN</td>
<td>acrylonitrile</td>
<td>F</td>
<td>12</td>
<td>Y</td>
</tr>
<tr>
<td>NAC</td>
<td>nitric acid</td>
<td>A/C</td>
<td>8</td>
<td>Y</td>
</tr>
<tr>
<td>VAM</td>
<td>vinyl acetate</td>
<td>F</td>
<td>8</td>
<td>Y</td>
</tr>
<tr>
<td>VCI</td>
<td>vinylidene chloride</td>
<td>H/E</td>
<td>8</td>
<td>Y</td>
</tr>
<tr>
<td>CBT</td>
<td>carbon tetrachloride</td>
<td>H/E</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>HFA</td>
<td>hydrofluoric acid</td>
<td>A/C</td>
<td>6</td>
<td>Y</td>
</tr>
<tr>
<td>TCL</td>
<td>trichloroethylene</td>
<td>H/E</td>
<td>5</td>
<td>Y</td>
</tr>
<tr>
<td>ADN</td>
<td>adiponitrile</td>
<td>F</td>
<td>4</td>
<td>Y</td>
</tr>
<tr>
<td>CRF</td>
<td>chloroform</td>
<td>H/E</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>EAM</td>
<td>ethylamine</td>
<td>F</td>
<td>3</td>
<td>Y</td>
</tr>
<tr>
<td>ANL</td>
<td>aniline</td>
<td>F</td>
<td>2</td>
<td>Y</td>
</tr>
<tr>
<td>BAN</td>
<td>n-butyl alcohol</td>
<td>F</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>BCL</td>
<td>benzyl chloride</td>
<td>F</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>BVA</td>
<td>t-butyl amine</td>
<td>F</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>CSA</td>
<td>chlorosulfonylic acid</td>
<td>A</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>EPC</td>
<td>epichlorohydrin</td>
<td>H/E</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>HCN</td>
<td>hydrogen cyanide</td>
<td>SI/C</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>MPT</td>
<td>methyl parathion mp=65F</td>
<td>FP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPB</td>
<td>nitrobenzene</td>
<td>E</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>PTO</td>
<td>parathion</td>
<td>FP</td>
<td>1</td>
<td>Y</td>
</tr>
<tr>
<td>POX</td>
<td>propylene oxide</td>
<td>F</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TEC</td>
<td>1,1,2,2-tetrachloroethane</td>
<td>H/E</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>DPC</td>
<td>1,3-dichloropropene</td>
<td>H/E</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>DOX</td>
<td>1,4-dioxane</td>
<td>F</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>NPP</td>
<td>2-nitropropane</td>
<td>F/FP</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>ALC</td>
<td>allyl chloride</td>
<td>H/E</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>BRX</td>
<td>bromine</td>
<td>C/P</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>CBB</td>
<td>carbon disulfide(bisulfide)</td>
<td>E</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>CPL</td>
<td>chloropicrin</td>
<td>H/E</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>CTA</td>
<td>crotonaldehyde</td>
<td>F</td>
<td>0</td>
<td>Y</td>
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</table>

D-2
<table>
<thead>
<tr>
<th>CHRIS</th>
<th>CHEMICAL NAME</th>
<th>DETECTOR CODE</th>
<th>PS</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEE</td>
<td>dichloroethylether</td>
<td>H/E</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>DIA</td>
<td>diisopropylamine</td>
<td>F</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>DSF</td>
<td>dimethyl sulfate</td>
<td>FP</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>EDB</td>
<td>ethylene dibromide</td>
<td>H/E</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>EDC</td>
<td>ethylene dichloride</td>
<td>H/E</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>GTA</td>
<td>glutaraldehyde</td>
<td>F</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>HFX</td>
<td>hydrogen fluoride</td>
<td>C/A</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>IPP</td>
<td>isopropylamine</td>
<td>F</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>MFA</td>
<td>motor fuel anti-knock compounds (lead alkyls)</td>
<td>E</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>TLI</td>
<td>o-toluidine</td>
<td>F</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>STC</td>
<td>silicon tetrachloride</td>
<td>E</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>TDI</td>
<td>toluene diisocyanate</td>
<td>F</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>ACY</td>
<td>acetone cyanohydrin</td>
<td>F</td>
<td>0</td>
<td>Y</td>
</tr>
<tr>
<td>BAM</td>
<td>n-butylamine</td>
<td>F</td>
<td>0</td>
<td>Y</td>
</tr>
</tbody>
</table>

There are a total of 51 chemicals.

There are a total of 398 spills.
TABLE D-3

Group IB Encapsulated Suit Liquid Chemicals with a Spill History
Arranged by Number of PIRS Spills ('73-'83)

PS = PIRS spills
H = Hazard Index
N = NFPA classification

<table>
<thead>
<tr>
<th>CHRIS</th>
<th>CHEMICAL NAME</th>
<th>DETECTOR CODE</th>
<th>PS</th>
<th>H</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFA</td>
<td>sulfuric acid</td>
<td>A/C</td>
<td>128</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>AAC</td>
<td>acetic acid</td>
<td>F</td>
<td>13</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>ACT</td>
<td>acetone</td>
<td>F</td>
<td>11</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>EAC</td>
<td>ethyl acrylate</td>
<td>F</td>
<td>11</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>ACR</td>
<td>acrylic acid</td>
<td>F</td>
<td>10</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>MIK</td>
<td>methyl isobutyl ketone</td>
<td>F</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>AAD</td>
<td>acetaldehyde</td>
<td>F</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>TCE</td>
<td>trichloroethane</td>
<td>H/E</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>ACA</td>
<td>acetic anhydride</td>
<td>IR</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>ATN</td>
<td>acetonitrile</td>
<td>F</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>ALA</td>
<td>allyl alcohol</td>
<td>F</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>DPP</td>
<td>dichloropropane</td>
<td>F/E</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>ACC</td>
<td>acetyl chloride</td>
<td>IR</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ARL</td>
<td>acrolein</td>
<td>F</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>MAM</td>
<td>methyl acrylate</td>
<td>F</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>TEL</td>
<td>tetraethyl lead</td>
<td>E</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>XYL</td>
<td>xylenol</td>
<td>F</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>DNA</td>
<td>di-n-propylamine</td>
<td>F</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>HDZ</td>
<td>hydrazine</td>
<td>P/C</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>PRA</td>
<td>n-propyl amine</td>
<td>F</td>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>OLM</td>
<td>oleum</td>
<td>A/C</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>PPT</td>
<td>phosphorus trichloride</td>
<td>E</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CSS</td>
<td>sodium hydroxide solution</td>
<td>Cat</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>TML</td>
<td>tetramethyl lead</td>
<td>E</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

There were a total of 199 spills.

There are a total of 24 chemicals in this group.
TABLE D-4

Group IC Encapsulated Suit Liquid Chemicals with a Spill History
Arranged by Number of PIRS Spills (’73-'83)

PS = PIRS spills
H = Hazard index
N = NFPA index

<table>
<thead>
<tr>
<th>CHRIS</th>
<th>CHEMICAL NAME</th>
<th>DETECTOR CODE</th>
<th>PS</th>
<th>H</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCB</td>
<td>polychlorinated biphenyl compounds</td>
<td>E</td>
<td>92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CDN</td>
<td>chlordane</td>
<td>E</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPO</td>
<td>hydrogen peroxide 60%</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>MLT</td>
<td>malathion</td>
<td>FP</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTR</td>
<td>n-butyraldehyde</td>
<td>F</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>SHR</td>
<td>sodium hydrosulfide solution</td>
<td>C/A/Cat</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>ETO</td>
<td>ethion</td>
<td>FP</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETC</td>
<td>ethylene cyanohydrin</td>
<td>F</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>NLD</td>
<td>naled</td>
<td>E</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPO</td>
<td>phosphorus oxychloride</td>
<td>C/A</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFM</td>
<td>sulfur monochloride</td>
<td>C/A</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TEP</td>
<td>tetraethyl pyrophosphate</td>
<td>FP</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCT</td>
<td>creosote</td>
<td>F</td>
<td>0</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>CMH</td>
<td>cumene hydroperoxide</td>
<td>F</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

There were a total of 109 spills.

There are a total of 14 chemicals in this group.
TABLE D-5

Group IIIB Non-encapsulated Suit Liquid Chemicals with a Spill History
Arranged by PIRS Spills ('73-'83)

PS = PIRS spills
H = Hazard assessment index
N = NFPA classification

<table>
<thead>
<tr>
<th>CHRIS</th>
<th>CHEMICAL NAME</th>
<th>DETECTOR CODE</th>
<th>PS</th>
<th>H</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>XLM</td>
<td>xylene (meta-xylene as model)</td>
<td>F</td>
<td>92</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>EGL</td>
<td>ethylene glycol</td>
<td>F</td>
<td>23</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>PAC</td>
<td>phosphoric acid</td>
<td>C/A</td>
<td>22</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CHX</td>
<td>cyclohexane</td>
<td>F</td>
<td>17</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>MAL</td>
<td>methyl alcohol</td>
<td>F</td>
<td>11</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>NTM</td>
<td>naphthalene</td>
<td>F</td>
<td>10</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>EAL</td>
<td>ethyl alcohol</td>
<td>F</td>
<td>9</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>MEK</td>
<td>methyl ethyl ketone</td>
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<td>6</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>EDA</td>
<td>ethylenediamine</td>
<td>H/E</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>TPT</td>
<td>turpentine</td>
<td>F</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>DCM</td>
<td>methylene chloride</td>
<td>H/E</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>HXN</td>
<td>n-hexane</td>
<td>F</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>ETB</td>
<td>ethyl benzene</td>
<td>F</td>
<td>3</td>
<td>3</td>
<td>2</td>
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<tr>
<td>MMM</td>
<td>methyl methacrylate</td>
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<td>3</td>
<td>2</td>
</tr>
<tr>
<td>DEA</td>
<td>diethanolamine</td>
<td>F</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CRB</td>
<td>chlorobenzene</td>
<td>H/E</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>ETA</td>
<td>ethyl acetate</td>
<td>F</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
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<td>ethyl ether</td>
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<td>3</td>
<td>2</td>
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<td>2</td>
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<tr>
<td>BCN</td>
<td>n-butyl acetate</td>
<td>F</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>BTC</td>
<td>n-butyl acrylate</td>
<td>F</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>PAL</td>
<td>n-propyl alcohol</td>
<td>F</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>PNA</td>
<td>propionic acid</td>
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<td>3</td>
<td>2</td>
</tr>
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<td>GAT</td>
<td>gasoline</td>
<td>F</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>IPA</td>
<td>isopropyl alcohol</td>
<td>F</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
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<td>naphtha</td>
<td>F</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>TTE</td>
<td>tetrachloroethylene</td>
<td>H/E</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

There were a total of 224 spills.

There are a total of 27 chemicals in this group.