

DRAFT

HAZARDOUS AIR POLLUTANTS

Air Exposure and Preliminary Risk Appraisal  
for 35 U.S. Counties

APPENDICES

Prepared for:

U.S. Environmental Protection Agency  
Office of Policy Analysis  
401 M Street, S.W.  
Washington, D.C. 20460

Prepared by:

Versar Inc.  
6850 Versar Center  
Springfield, Virginia 22151

and

American Management Systems  
1777 N. Kent Street  
Arlington, Virginia 22209

Contract #68-01-6715

September, 1984

## LIST OF APPENDICES

- Appendix A - A Description of the Hazardous Emissions Model and Integrated System (HEMIS)
- Appendix B - Carcinogenic Risk Factors
- Appendix C - Description of the National Emission Data System (NEDS)
- Appendix D - Pollution Selection and Point Source Background Data
- Appendix E - Area Source Emission Factor Documentation
- Appendix F - Non Traditional Sources
  - F-1 Waste Oil
  - F-2 Publicly Owned Treatment Works
  - F-3 Treatment Storage and Disposal Facilities and Superfund Sites
- Appendix G - Phase II Point Source Emissions Data
- Appendix H - Procedures for the Selection of Stack Parameters
- Appendix I - Annual Incidence of Cancer for Coke Oven Plants
- Appendix J - Raw Outputs from HEMIS

## **APPENDIX A**

### **A Description of the Hazardous Emission Model and Integrated System**

**DRAFT**

## A Brief Description of The Hazardous Emission Model and Integrated System (HEMIS).

### The Computer System Developed for the Study

The system designed and implemented for the air toxics study is called "HEMIS" -- the Hazardous Emissions Model and Integrated System. The purpose of this section is to provide a brief overview of the main functions, design and operations of HEMIS.

#### 1. Main Functions

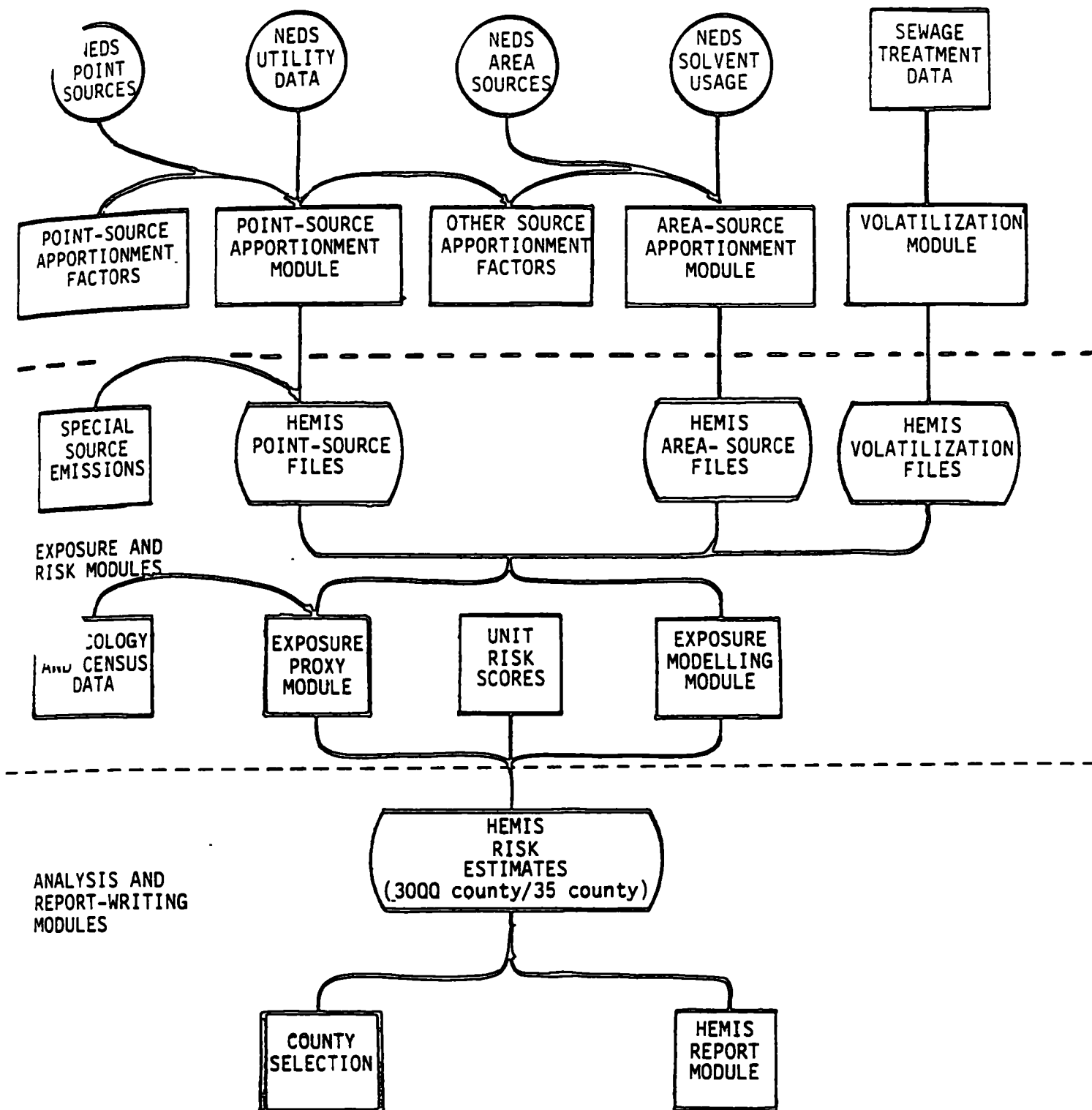
In summary, HEMIS fulfilled the following functions:

- Used algorithms to estimate air toxic emissions for nearly 300,000 point sources and a variety of area sources in the 3,000+ U.S. counties.
- Ranked the 3,000 counties on the basis of various emissions-based and surrogate risk indices, to assist in selecting the 35 counties for analysis.
- Produced tap files for input to the exposure models used in the study.
- Integrated the results of the exposure modelling with emissions and potency data.

#### 2. Design

HEMIS was designed and implemented on the IBM-3081 at EPA's National Computer Center (NCC). Exhibit 2-1 illustrates the structure of HEMIS. As shown, the system has several categories of modules: (1) emissions estimation modules; (2) exposure and risk calculation modules; and (3) analysis and report-writing modules, to print out data and produce tabular and graphical outputs. The three modules share a common data base using Statistical Analysis System (SAS), a software package maintained and supported at NCC.

EMISSION ESTIMATION MODULES:



Overview of HEMIS

### 3. Operations

HEMIS performed the following operations:

- The system used the emission and apportionment factors developed for the study to estimate pollutant loadings for both point and area sources. The algorithms are described in Section 2.0 of the accompanying report. As its source data, HEMIS incorporated data files on point and area-source including VOC emission rates, operating rates, fuel and solvent consumptions, vehicle miles travelled (VMT), and gasoline marketed. The source of most of this data was the National Emissions Data System (NEDS) maintained by EPA's National Air Data Branch (NADB). Applying the apportionment factors to this baseline data, HEMIS created a data base which in its entirety, contains more than 366,000 records.
- It applied methods developed for this study to estimate volatilization of organics from sewage treatment plants, a source not covered in NEDS. The volatilization model covered more than 100 plants and incorporated data from more than 10,000 indirect dischargers. The volatilization file itself contains 14,000 emissions estimates.
- HEMIS incorporated population and land-mass data from Oak Ridge National Laboratory's Geoecology System and from U.S. Census Bureau. Using population and density data and unit risk scores described later in this study, it helped rank all 3000+ U.S. counties with respect to population-weighted, density-weighted, and potency-weighted risk, as well as aggregate air toxics emissions. These rankings were useful in selecting 35 counties for further study.
- For the 35 counties, the system stored emissions data and stack parameters for 2000 major facilities. For the major facilities, HEMIS maintained the plant-by-plant and area source exposure factors produced by the Gaussian dispersion/exposure model (GAMS).
- For both the 3000+ counties and the 35 counties, the system was used to calculate incidences of cancer by multiplying the emission of a pollutant times the risk score for that pollutant and the exposure-proxy (3000+ counties) or exposure factor (35 counties) for a area source, to estimate incidences of cancer.
- Finally, HEMIS produced individuals printouts and charts for the study.

**APPENDIX B**  
**Carcinogenic Risk Factors**

**DRAFT**

## APPENDIX 8

### Carcinogenic Unit Risk Factors for Selected Pollutants

| Pollutant            | Unit Risk Factor     | Source             |
|----------------------|----------------------|--------------------|
| Acrylonitrile        | $6.8 \times 10^{-5}$ | Clement Associates |
| Arsenic              | $4.3 \times 10^{-3}$ | CAG                |
| Benzene              | $6.9 \times 10^{-6}$ | CAG                |
| Benzo(a)Pyrene       | $3.3 \times 10^{-3}$ | CAG                |
| Beryllium            | $4.0 \times 10^{-4}$ | CAG                |
| 1,3-Butadiene        | $4.6 \times 10^{-7}$ | Clement Associates |
| Cadmium              | $2.3 \times 10^{-3}$ | CAG                |
| Carbon Tetrachloride | $1.5 \times 10^{-5}$ | CAG                |
| Chloroform           | $1.0 \times 10^{-5}$ | CAG                |
| Chromium (total)     | $1.2 \times 10^{-2}$ | CAG                |
| Coke oven emissions  | $6.2 \times 10^{-4}$ | CAG                |
| Ethylene Dibromide   | $5.1 \times 10^{-4}$ | CAG                |
| Ethylene Dichloride  | $7.0 \times 10^{-7}$ | CAG                |
| Formaldehyde         | $6.1 \times 10^{-7}$ | CAG                |
| Gas Vapors           | $7.5 \times 10^{-7}$ | CAG                |
| Nickel (total)       | $3.3 \times 10^{-4}$ | CAG                |
| Pentachlorophenol    | $3.9 \times 10^{-7}$ | Clement Associates |
| Perchloroethylene    | $2.9 \times 10^{-6}$ | CAG                |
| Styrene              | $2.9 \times 10^{-7}$ | Clement Associates |
| Trichloroethylene    | $4.1 \times 10^{-6}$ | CAG                |
| Vinyl chloride       | $2.6 \times 10^{-6}$ | CAG                |



## APPENDIX C

Description of the National Emissions Data System (NEDS)

DRAFT

**EPA-450/4-80-013**

# **NEDS**

## **National Emissions Data System Information**

**Monitoring and Data Analysis Division  
National Air Data Branch**

**U S ENVIRONMENTAL PROTECTION AGENCY  
Office of Air, Noise, and Radiation  
Office of Air Quality Planning and Standards  
Research Triangle Park, North Carolina 27711**

**July 1980**

## OVERVIEW OF THE NATIONAL EMISSIONS DATA SYSTEM

### GENERAL DESCRIPTION

The National Emissions Data System (NEDS) is a computerized data-handling system that accepts, stores, and reports on the latest available information relating to sources of air pollutant emissions of particulates,  $SO_x$ ,  $NO_x$ , CO, and hydrocarbons. In NEDS, sources are treated either as point sources or area sources. As defined in EPA reporting regulations, point sources are stationary sources that emit more than 100 tons per year of any of the five pollutants covered in NEDS. A point source is considered to be an individual facility or company location. Some point source facilities emitting less than 100 tons per year are also included in NEDS at the option of the state agencies which submit the point source data. Area sources are all other stationary sources that individually emit less than 100 tons/year and all mobile sources. In NEDS, emissions from area sources are considered collectively on a county basis.

All source-related data are entered into NEDS via specifically formatted point and area source coding forms (Figure 1 and Figure 2) and are stored in separate point and area source files. Data stored for point and area sources are described below.

### POINT SOURCE DATA

The point source data are collected by State and local air pollution control agencies utilizing State questionnaires and plant visits. These data are coded onto the point source form (or produced in the same format by computer programs) and submitted for inclusion in NEDS through the EPA Regional Offices. The States are required to update the data as new sources are constructed, and when existing sources are modified or cease operation. The regulation prescribing reporting of point source data is 40CFR 51.321.

The current NEDS point source file reflects the latest data reported by State agencies. Since annual reporting is not required for all sources, all point sources in NEDS do not have a common year of record. It is assumed that no significant changes have occurred for those sources whose reported year of record is older than the current year.

Data reported for point sources in NEDS may be categorized according to the following groups:

General source information - name, address, type(s) of source(s), Standard Industrial Classification, year of record, and comments.

Emissions data - operating or production rates and capacities, estimated emissions, estimation method, and type and efficiency of control device for each pollutant.

Modeling parameters - UTM coordinates of source, stack height and diameter, exhaust gas temperature, and gas flow rate.

Compliance information - allowable emissions, compliance status, and compliance schedules.

NEDS point source data are organized into three hierarchical levels.

1. Plant level data apply to an entire facility defined as a point source.
2. Point level data apply to individual emission points within a plant. A plant may contain any number of emission points. A point is that portion of a facility that may be considered individually for emission purposes. A point may contain one or more processes or pieces of equipment that are related in contributing to the emissions from the point. In most cases, a point emits pollutants through a single confined location such as a stack, but it may emit pollutants at more than one location or at no clearly defined location within a plant.
3. Process level data apply to individual processes within a point and are utilized to calculate emissions. Each process is defined by a Source Classification Code (SCC). In general, for each SCC there are emission factors, which relate the quantity of pollutants generated by a process to annual process operating rate. These emission

| State | County | AQCR | Plant ID Number |
|-------|--------|------|-----------------|
| 1     | 2      | 3    | 4               |
| 5     | 6      | 7    | 8               |
| 9     | 10     | 11   | 12              |
| 13    |        |      |                 |

**NATIONAL EMISSIONS DATA SYSTEM (NEDS)  
ENVIRONMENTAL PROTECTION AGENCY  
OFFICE OF AIR PROGRAMS**

**POINT SOURCE  
Input Form**

**FORM APPROVED  
OMB NO 156 R0085  
Date \_\_\_\_\_**

Name of Person  
Completing Form \_\_\_\_\_

|                |                |   |                  |                                |                                |  |                         |                           |            |                            |            |                     |                                  |                     |                   |    |    |                         |    |    |    |   |        |                   |        |          |    |        |    |    |    |                     |    |     |        |                |    |        |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----------------|----------------|---|------------------|--------------------------------|--------------------------------|--|-------------------------|---------------------------|------------|----------------------------|------------|---------------------|----------------------------------|---------------------|-------------------|----|----|-------------------------|----|----|----|---|--------|-------------------|--------|----------|----|--------|----|----|----|---------------------|----|-----|--------|----------------|----|--------|----|----|----|--------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| City           |                | Utm Zone                                      | Utm Easting      | Establishment Name and Address |                                |  |                         |                           |            |                            |            |                     |                                  |                     |                   |    |    |                         |    |    |    |   |        | Contact: Personal |        |          |    |        |    |    |    |                     |    | OWN | Action | cd             |    |        |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 14             | 15             | 16  | 17               | 18                             | 19                             | 20   | 21                      | 22                        | 23         | 24                         | 25         | 26                  | 27                               | 28                  | 29                | 30 | 31 | 32                      | 33 | 34 | 35 | 36  | 37     | 38                | 39     | 40       | 41 | 42     | 43 | 44 | 45 | 46                  | 47 | 48  | 49     | 50             | 51 | 52     | 53 | 54 | 55 | 56     | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| Point ID       | Year of Record | SIC   | (PS) Locs        | UTM COORDINATES                |                                |  |                         | STACK DATA                |            |                            |            |                     |                                  |                     |                   |    |    | Units with common stack |    |    |    |   |        |                   |        |          |    | Action | cd |    |    |                     |    |     |        |                |    |        |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 14             | 15             | 16  | 17               | 18                             | 19                             | 20   | 21                      | 22                        | 23         | 24                         | 25         | 26                  | 27                               | 28                  | 29                | 30 | 31 | 32                      | 33 | 34 | 35 | 36  | 37     | 38                | 39     | 40       | 41 | 42     | 43 | 44 | 45 | 46                  | 47 | 48  | 49     | 50             | 51 | 52     | 53 | 54 | 55 | 56     | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| Year of Record |                | Boiler Design Capacity 10 <sup>6</sup> BTU/hr | Primary Part     | Secondary Part                 | Primary SO <sub>2</sub>        | Secondary SO <sub>2</sub>                      | Primary NO <sub>x</sub> | Secondary NO <sub>x</sub> | Primary HC | Secondary HC               | Primary CO | Secondary CO        | ESTIMATED CONTROL EFFICIENCY (%) |                     |                   |    |    |                         |    |    |    |   | Action | cd                |        |          |    |        |    |    |    |                     |    |     |        |                |    |        |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 16             | 17             | 18  | 19               | 20                             | 21                             | 22   | 23                      | 24                        | 25         | 26                         | 27         | 28                  | 29                               | 30                  | 31                | 32 | 33 | 34                      | 35 | 36 | 37 | 38  | 39     | 40                | 41     | 42       | 43 | 44     | 45 | 46 | 47 | 48                  | 49 | 50  | 51     | 52             | 53 | 54     | 55 | 56 | 57 | 58     | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |    |    |
| Year of Record |                | % ANNUAL THRUPT                               | NORMAL OPERATING |                                | EMISSION ESTIMATES (tons/year) |  |                         |                           |            |                            |            |                     |                                  |                     | ESTIMATION METHOD |    |    |                         |    |    |    |   |        |                   | Action | cd       |    |        |    |    |    |                     |    |     |        |                |    |        |    |    |    |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 16             | 17             | 18  | 19               | 20                             | 21                             | 22   | 23                      | 24                        | 25         | 26                         | 27         | 28                  | 29                               | 30                  | 31                | 32 | 33 | 34                      | 35 | 36 | 37 | 38  | 39     | 40                | 41     | 42       | 43 | 44     | 45 | 46 | 47 | 48                  | 49 | 50  | 51     | 52             | 53 | 54     | 55 | 56 | 57 | 58     | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |    |    |
| Year of Record |                | ALLOWABLE EMISSIONS (tons/year)               |                  |                                |                                |  |                         |                           |            |                            |            | COMPLIANCE SCHEDULE |                                  |                     |                   |    |    |                         |    |    |    | COMPLIANCE STATUS UPDATE                      |        |                   |        |          |    |        |    |    |    | CONTROL REGULATIONS |    |     |        |                |    |        |    |    |    | Action | cd |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 16             | 17             | 18  | 19               | 20                             | 21                             | 22   | 23                      | 24                        | 25         | 26                         | 27         | 28                  | 29                               | 30                  | 31                | 32 | 33 | 34                      | 35 | 36 | 37 | 38  | 39     | 40                | 41     | 42       | 43 | 44     | 45 | 46 | 47 | 48                  | 49 | 50  | 51     | 52             | 53 | 54     | 55 | 56 | 57 | 58     | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |    |    |
| Year of Record |                | SCC   |                  |                                |                                | Annual Fuel Process Solid Waste Operating Rate |                         |                           |            | Hourly Maximum Design Rate |            |                     |                                  | Fuel Sulfur Content |                   |    |    | Fuel Ash Content        |    |    |    | Fuel Moisture Content 10 <sup>6</sup> BTU SCC |        |                   |        | Comments |    |        |    |    |    |                     |    |     |        | Source Control |    | Action | cd |    |    |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 16             | 17             | 18  | 19               | 20                             | 21                             | 22   | 23                      | 24                        | 25         | 26                         | 27         | 28                  | 29                               | 30                  | 31                | 32 | 33 | 34                      | 35 | 36 | 37 | 38  | 39     | 40                | 41     | 42       | 43 | 44     | 45 | 46 | 47 | 48                  | 49 | 50  | 51     | 52             | 53 | 54     | 55 | 56 | 57 | 58     | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |    |    |
| Year of Record |                | SCC   |                  |                                |                                | COMMENTS                                       |                         |                           |            |                            |            |                     |                                  |                     |                   |    |    |                         |    |    |    |   |        |                   |        |          |    |        |    |    |    |                     |    |     |        | Source Control |    | Action | cd |    |    |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 14             | 15             | 16  | 17               | 18                             | 19                             | 20   | 21                      | 22                        | 23         | 24                         | 25         | 26                  | 27                               | 28                  | 29                | 30 | 31 | 32                      | 33 | 34 | 35 | 36  | 37     | 38                | 39     | 40       | 41 | 42     | 43 | 44 | 45 | 46                  | 47 | 48  | 49     | 50             | 51 | 52     | 53 | 54 | 55 | 56     | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |

Figure 1. Point source form

factors are used to compute emissions. Multiple processes and multiple SCC's may be grouped under one emission point, as in the case of boilers using two fuels or two separate processes sharing the same stack.

The point source file provides for the use of alternative methods for determining the emissions being reported. Emissions are usually calculated for each SCC using the emission factors in the SCC emission factor file; however, by use of an appropriate code on the input form and completion of fields for recording hand-calculated emission estimates, the emission-factor-computed emissions may be replaced by any more accurate estimates of emissions available. If no emission factors are available for an SCC, an alternative method is used to estimate emissions for these records.

The point source data are routinely submitted by States to the Regional Offices and by the Regional Offices to the National Air Data Branch. These data are updated on a regular update schedule and are then available for generation of publications or computerized reports.

#### AREA SOURCE DATA

Area source data are developed mainly by NADB, but may be supplemented by data voluntarily submitted by State agencies. NEDS area source data are grouped as follows:

General source information - name and location of area (county) source, year of record.

Activity levels - countywide activity level of each area source category, (e.g., tons of coal burned in all domestic space heating equipment in a county).

Emissions data - emissions estimates for the entire county for each pollutant as well as for each source category for each pollutant.

Activity levels are derived primarily from related information published by other Federal agencies, supplemented by special data developed by EPA for the purpose of developing NEDS area source inventories. Published data such as fuel use by State, motor vehicle miles of travel by State and county, and forest fire acres burned by State are used with related data such as employment, population, and miscellaneous geographic or economic data available on a county-by-county basis to derive annual estimates of the activity levels for each of the NEDS area source categories. The activity

levels derived are adjusted to account for point source activity (such as fuel use by point sources) so that the area source data reflect only the activity levels (and resulting calculated emissions) that are not accounted for by point sources.

The area source emission estimates are calculated for each source category utilizing emission factors which are contained in the NEDS area source emission factor file. For many categories, the same emission factors are used for all counties; however, for some source categories, State or county specific emission factors account for local variables that affect emissions. These more specific emission factors are used in NEDS calculations for all highway motor vehicle categories, fugitive dust categories, and for selected other categories in a few counties where data are available to develop more applicable emission factors than the national emission factors. Provision is also made, as an option, to override computer-calculated emissions for any source category for any county, by hand calculated emissions that may be more accurate than any simple emission-factor calculation.

The area source data are updated on an annual basis by the National Air Data Branch. All area source data in the file at any given time therefore reflect a common year of record.

**APPENDIX D**

**Pollutant Selection and  
Point Source Background Data**

**DRAFT**



This Appendix contains the pollutant recommendations and point source emissions background data for Phase I of the Air Toxics Study. The recommended pollutants were selected from the Table of Pollutants proposed by the IEMD-OAQPS staff (see Attachment 1). The point source emissions background data includes the facility names, locations, and capacity levels for the major point sources emitting the recommended pollutants; however, this was only included when readily available.

This Appendix contains information only on point sources and pollutant recommendations. The references used in pollutant selection are presented in Attachment 2, and a summary of the recommended pollutants is presented in Attachment 3.

This Appendix is organized by the pollutants listed in Attachment 1. Information on each of these toxic pollutants is presented below:

1,3-Butadiene: Recommendation - Include

1,3-Butadiene is used mostly to produce synthetic rubber. This chemical is included in the Organic Species Handbook and the AMS data tape. However, supplemental work will be done for the manufacturing facilities based on Versar (1984). The 1,3-butadiene manufacturing facilities and their annual capacities are listed in Attachment 4.

Total Chromium: Recommendation - Include

Total chromium emissions from point sources can be characterized as being emitted from direct sources or from inadvertent sources. Direct sources include chromite ore refining, ferrochromium production, refractory manufacture, chromium chemicals manufacture, chromium plating, steel production, electric furnaces, basic oxygen furnaces, open hearth furnaces, and leather tanning.

Indirect sources of chromium are generated from coal and oil combustion, cement production, municipal refuse and sewage sludge incineration, cooling towers, and asbestos mining and milling.

Dioctylphthalate (DEHP): Recommendation - Include

DEHP is mostly used as a plasticizer in Polyvinyl Chloride (PVC) resins. Manufacturing emissions are comparatively insignificant compared to DEHP emissions from PVC production and processing (approximately 20 kkg compared to 1120 kkg) (Versar 1982). Therefore, emphasis will be placed on DEHP emissions from PVC operations. Attachment 5 presents the U.S. PVC producers and their 1980 capacities.

4,4-Methylenedianiline (MDA): Recommendation - Exclude

Nearly all MDA manufactured in this country is used captively to produce methylene phenyl diisocyanate (MDI) polymer which is then used to produce polyurethane foams (MATHTECH Inc. 1982). It is recommended that MDA be excluded from this study because MDA air emissions are negligible. It has been reported there are no air emissions from manufacturing (ESE 1981). In addition, since most of the MDA produced is captively converted to MDI polymer on-site, any other possible air emissions of MDA should be insignificant.

Pentachlorophenol (PCP): Recommendation - Include

PCP is used as a fungicide in wood preservatives and cooling towers. Atmospheric releases of PCP have been estimated to be 50 kkg from production, 344 kkg from preserved wood, and 228 kkg from cooling towers (USEPA 1980a). Emissions factors could only be readily developed for production. Consequently, PCP was excluded from Phase I, but it was included in Phase II, when area source emissions (i.e., from cooling towers and preserved wood) could be added to the analyses.

1,2-Toluene diisocyanate (TDI): Recommendation - Exclude

TDI is used to make polyurethane foams. Mostly because of its low vapor pressure, manufacturing air emissions are assumed to be negligible. Furthermore, air emissions of TDI at polyurethane manufacturing plants were found to be insignificant ( $1.8 \times 10^{-8}$  lb TDI/lb of product) (Smith and LaShelle 1974). Therefore, it is suggested that TDI not be considered in this study.

Ethylene Dibromide (EDB): Recommendation - Include

EDB is used in leaded gasoline and in numerous pesticide formulations (USEPA 1981b). No emission factors could be found for EDB manufacturing and for pesticide applications. However, emission factors are available for the use of EDB in leaded gasoline. Therefore, EDB emission estimates will only include releases from the combustion of leaded gasoline in automobiles.

Ethylbenzene: Recommendation - Include

Ethylbenzene is used to manufacture styrene and other miscellaneous organic chemicals. During the quick literature search that was performed, no emission factors were located. However, this pollutant is covered in the Organic Species Handbook, and it is listed in the current AMS data tape. If any additional information can be readily found, supplemental data will be added.

Styrene: Recommendation - Include

Styrene is used exclusively for the manufacture of plastics (Kirk-Othmer 1983). No emission factors were found; however, this pollutant is included in the current AMS data tape. If additional information can be quickly located, it will be added to these data.

Dioxin: Recommendation - Exclude

Dioxin is most commonly produced and emitted during combustion processes. The formation of dioxin depends on numerous factors, e.g., wastefeed or fuel components, combustion temperature, and residence time. No emissions factors were found during the literature search. Consequently, unless some readily available data can be found, the emissions of dioxin cannot be determined.

#### Coke Oven Emissions: Recommendation - Include

The evaluation of coke oven emissions is very complex. However, metallurgical coke manufacturing is included in the Organic Species Handbook and thus it can be included in this study. Because of the difficulty in characterizing coke oven emissions and since the locations and coke throughputs of the 53 coke oven plants are not known, no supplemental work will be performed.

#### Nickel: Recommendation - Include

Nickel is mostly used in metal alloys, electroplating operations, and batteries. However, nearly 89 percent of all atmospheric emissions of nickel are from the combustion of fossil fuels; alloys manufacturing only accounts for 5 percent of the total nickel air emissions (USEPA 1981d). Therefore, to characterize atmospheric nickel emissions, emphasis will be placed on utilities and area sources that involve the combustion of fossil fuels.

#### Formaldehyde: Recommendation - Include

Formaldehyde is a high volume chemical that is released from numerous point and area sources. The NEDS data base and the Organic Species Handbook will be used exclusively to characterize the point source emissions of formaldehyde since nearly 400 SCC (industrial process) codes were identified in the AMS data system as formaldehyde emitters. Area source considerations will be discussed in another memo.

#### Ethylene dichloride (EDC): Recommendation - Include

Most EDC is used as an intermediate in the production of other chemicals, although it is also used in paints, gasoline, and pesticides (GCA 1982c). This pollutant is covered in the Organic Species Handbook and according to the AMS data tape, it is emitted from 45 SCC codes. This should be sufficient for point sources, although if time and money permit, some supplemental work may be performed. To aid in the county selection process, a list of the EDC manufacturers is presented in Attachment 6.

Acrylonitrile: Recommendation - Include

The major end use of acrylonitrile is in the production of acrylic fibers; it is also used in the production of plastics (Radian Corp. 1982). This chemical is well covered in the AMS data tape, and it is doubtful that any additional work will be required for point source emissions. A list of the acrylonitrile manufacturers is presented in Attachment 7.

Carbon Tetrachloride: Recommendation - Include

Carbon tetrachloride is primarily used to manufacture fluorocarbons (GCA 1982a). Attachment 8 is a list of facilities that manufacture carbon tetrachloride. Emissions from manufacturing will be characterized; however, emissions from fluorocarbon production may not be characterized because of the lack of site-specific capacity data.

Chloroform: Recommendation - Include

Chloroform is most commonly used to manufacture fluorocarbon refrigerants and resin intermediates (GCA 1982b). Emissions from manufacturing will be estimated; however, it is expected that emissions from processing will not be determined because of the lack of site-specific capacity data.

Cadmium: Recommendation - Include

Cadmium is mostly used for electroplating, although it is also used in batteries, plastic stabilizers, and pigments. The major sources of atmospheric cadmium emissions are from fossil fuel combustion (68 percent), primary nonferrous smelters (24 percent), and municipal refuse incineration (4 percent) (GCA 1981). The point sources that will be considered in this study are the major utilities, primary lead smelters, and primary copper smelters. The facility names and locations of the lead and copper smelters are presented in Attachments 9 and 10, respectively.

#### Perchloroethylene: Recommendation - Include

Of the total U.S. supply of perchloroethylene, 68 percent is used for drycleaning and textile processing, 17 percent is used for metal degreasing, 12 percent is used for the production of fluorocarbons, and the remainder is used in various miscellaneous applications. Atmospheric releases of perchloroethylene from these uses accounts for 98 percent of the total air emissions; only two percent of this total is released from perchloroethylene production facilities (USEPA 1980b). Consequently, much of the emphasis will be placed on area sources. However, since perchloroethylene is included in the Organic Species Handbook and the AMS data tape, point source emissions can still be calculated using the automated AMS system.

#### Trichloroethylene (TCE): Recommendation - Include

TCE is a ubiquitous chemical in the environment and is widely used as a solvent. Mostly because of its widely scattered solvent use, TCE is emitted in relatively small quantities from a small number of point sources. For example, TCE manufacturing accounts for less than 0.5 percent of all TCE atmospheric emissions (USEPA 1981e). Therefore, since TCE is covered in the Organic Species Handbook, the point source emissions from this chemical will be estimated using the AMS data tape.

#### Asbestos: Recommendation - Exclude

Asbestos is a group of minerals characterized by silicate chemistry and fibrous morphology. The major uses for asbestos include asbestos-cement pipe, paper products, friction materials, floor coverings, packings and gaskets, coatings, asbestos-cement sheet, textiles and asbestos reinforced plastics (Versar 1983).

There are several reasons for not recommending that asbestos be included in this study:

- There are hundreds of processing facilities; the locations and capacities for most of these facilities are unknown.

- Emissions are not known for many types of operations.
- Capacity data are known only for ore mining operation.
- There are different grades and fiber lengths of asbestos which further increases the difficulty in estimating emissions.
- To even very roughly estimate emissions from less than 10 percent of the sources would require a disproportionately large amount of the available funds.

#### Beryllium: Recommendation - Include

Beryllium is primarily used in nuclear and aerospace applications (USEPA 1973). Currently, no useful data have been reviewed for Beryllium; however, it is known that a material balance and a source assessment document were prepared for this chemical. It is therefore tentatively included on the recommended pollutant list pending the development of emissions factors from these documents.

#### Radionuclides: Recommendation - Exclude

Radionuclides include radioactive substances such as tritium argon-41, krypton-85, and antimony-125 (USEPA 1983). It is recommended that radionuclides not be included in this study for the following four reasons:

- There are too many facilities, with unknown locations, that are releasing radionuclides.
- There are too many small sources and background emissions of radionuclides.
- The methodology of characterizing this source is different from all other pollutants.
- It would be very resource-intensive to estimate radionuclide emissions.

#### Arsenic: Recommendation - Include

Arsenic is used in pesticides, wood preservatives, alloys, and during the manufacture of glass. However, most releases occur from

inadvertent sources such as fossil fuel combustion and copper, lead, and zinc production. There is only one arsenic production facility in the U.S.: the ARSARCO smelter in Tacoma, WA (USEPA 1981a). As many of the point sources as possible will be characterized, including the production facility, utilities, and copper production facilities (see Attachment 10).

Benzene: Recommendation - Include

The major use for benzene is as a chemical feedstock. It is released from a large number of sources throughout the country (USEPA 1981c). The point sources are very well covered in NEDS and the Organic Species Handbook; the current AMS data base reports that benzene is released from approximately 450 SCC codes. Consequently, this data base will be used exclusively to estimate benzene emissions from point sources.

Vinyl Chloride: Recommendation - Include

Vinyl chloride is used to make polyvinyl chloride and ethylene dichloride. This chemical is well covered in NEDS and the Organic Species Handbook. Therefore, the AMS data base, which is based on NEDS and the Organic Species Handbook, will be used exclusively to characterize vinyl chloride emissions.

Benzo(a)pyrene (BAP): Recommendation - Include

Benzo(a)pyrene is an unwanted chemical that is inadvertently produced during numerous combustion processes. According to USEPA (1982), over 97 percent of all BAP emissions are from area sources. Furthermore, emissions from all point sources are less than 4 kkg/yr. Therefore, this pollutant will be handled only as an area source.

Benzo(a)anthracene: Recommendation - Include

Benzo(a)anthracene is inadvertently produced during many combustion processes. It is released entirely from area sources (USEPA 1982).



## SCREENED POLLUTANTS FOR REGIONAL AIR TOXICS ANALYSIS

Pollutants from OAOPS List of 50 (Potential Carcinogens)

1,3-Butadiene  
Chromium (VI)  
Diethylphthalate (DEHP)  
4,4-Methylenedianiline (MDA)  
Pentachlorophenol (PCP)  
1,2-Toluene diisocyanate (TDI)  
Ethylene dibromide (EDB)  
Ethylbenzene  
Styrene

Pollutants from List of 37 (Potential Carcinogens)

Dioxin  
Coke Oven Emissions  
Nickel  
Formaldehyde  
Ethylene dichloride  
Acrylonitrile  
Carbon tetrachloride  
Chloroform  
Cadmium  
Perchloroethylene  
Trichloroethylene

NESHAPS Either Proposed or Regulated

Asbestos  
Beryllium  
Radionuclides  
Arsenic  
Benzene  
Vinyl Chloride

Potential Carcinogens Excluded from OAOPS Lists

Benzo(a)pyrene  
Benzo(a)anthracene

## Attachment 2

### References Examined for Pollutant Selection

ESE. 1981. Environmental Science and Engineering, Inc. Environmental assessment for 4,4'-methylenedianiline (MDA). Test rule support documents: Chapters I, II, IV, V. Washington, DC: U.S. Environmental Protection Agency. EPA Contract No. 68-01-6153.

Energy and Environmental Analysis, Inc. 1979. Sources of atmospheric cadmium. Research Triangle Park, NC: U.S. Environmental Protection Agency. EPA-450/5-79-006.

Energy and Environmental Analysis, Inc. 1978. Preliminary assessment of the sources, control, and population exposure to airborne polycyclic organic matter (POM) as indicated by benzo(a)pyrene (BaP). Final Report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

GCA. 1981. Survey of cadmium emission sources. Research Triangle Park, NC: U.S. Environmental Protection Agency. EPA-450/3-81-013.

GCA. 1982. Chloroform materials balance. Draft report. Washington, DC: U.S. Environmental Protection Agency.

GCA. 1982. Locating and estimating air emissions from sources of formaldehyde. Draft final report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

GCA. 1982. Locating and estimating air emissions from sources of chloroform. Draft final report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

GCA. 1982. Locating and estimating air emissions from sources of carbon tetrachloride. Draft final report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

GCA. 1982. Locating and estimating air emissions from sources of ethylene dichloride. Draft final report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

GCA. 1983. Preliminary study of sources of carbon tetrachloride. Final report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

Attachment 2 (continued)

JRB Associates. 1982. Materials balance formaldehyde. Revised draft report. Washington, DC: U.S. Environmental Protection Agency.

Kirk-Othmer. 1983. Encyclopedia of Chemical Technology. Third edition. New York: John Wiley & Sons.

MATHTECH Inc. 1982. Level I economic evaluation of 4,4'-methylenedianiline (MDA). Washington, DC: U.S. Environmental Protection Agency. Contract No. 68-01-5864.

Radian Corp. 1982. Locating and estimating air emissions from sources of acrylonitrile. Draft final report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

Radian Corp. 1982. Preliminary study of sources of inorganic arsenic. Research Triangle Park, NC: U.S. Environmental Protection Agency. EPA-450/45-82-005.

Radian Corp. 1983. Estimates of population exposure to ambient chromium emissions. Final report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

Research Triangle Institute. 1981. Review of national emissions standard for asbestos. Draft. Research Triangle Park, NC: U.S. Environmental Protection Agency.

Smith and LaShelle. 1974. Characterization of atmospheric emissions from polyurethane resin manufacture. Research Triangle Park, NC: U.S. Environmental Protection Agency. PB 237 420.

TRC Environmental Consultants. 1982. A critical review of EPA's background information document for NESHAP on coke oven charging, door leaks, and topside leaks for wet-coal charged batteries. Final report. East Hartford, CT: American Iron and Steel Institute.

Tierney DR, Wilkins GE. 1979. Status Assessment of toxic chemicals: acrylonitrile. Cincinnati, OH: U.S. Environmental Protection Agency. EPA-600/2-79-210a.

USEPA. 1973. Control techniques for beryllium air pollutants. Research Triangle Park, NC: U.S. Environmental Protection Agency.

USEPA. 1976. Investigation of selected potential environmental contaminants: formaldehyde. Washington, DC: U.S. Environmental Protection Agency. EPA-560/2-72-009.

Attachment 2 (continued)

USEPA. 1980. An exposure and risk assessment for pentachlorophenol. Washington, DC: U.S. Environmental Protection Agency. EPA Contract No. 68-01-3857.

USEPA. 1980. An exposure and risk assessment for tetrachloroethylene. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1980. An exposure and risk assessment for phthalate esters. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1981. An exposure and risk assessment for arsenic. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1981. An exposure and risk assessment for nickel. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1981. An exposure and risk assessment for trichloroethylene. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1981. An exposure and risk assessment for benzene. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1981. An exposure and risk assessment for dichloroethanes. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1981. Ethylene dibromide: position document 2/3. Washington, DC: U.S. Environmental Protection Agency. PB81-157851.

USEPA. 1982. An exposure assessment for benzo(a)pyrene and other polycyclic aromatic hydrocarbons. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1983. Background information document proposed standards for radionuclides. Washington, DC: U.S. Environmental Protection Agency. EPA 520/1-83-001.

USEPA. 1983. Coke oven emissions by-product coke oven charging, door leaks, and topside leaks on wet coal charged batteries - background for proposed standards. Draft. Research Triangle Park, NC: U.S. Environmental Protection Agency.

Attachment 2 (continued)

USEPA. 1983. Vinyl chloride - background information for proposed revision of standards. Preliminary draft. Research Triangle Park, NC: U.S. Environmental Protection Agency.

Versar. 1982. Exposure assessment for di(2-ethylhexyl) phthalate (DEHP). Interim draft report. Washington, DC: U.S. Environmental Protection Agency.

Versar. 1983. Exposure assessment for asbestos. Draft final report. Washington, DC: U.S. Environmental Protection Agency.

Versar. 1984. Exposure assessment for 1,3-Butadiene. Unpublished. Washington, DC: U.S. Environmental Protection Agency.

Versar. 1983. Emissions factors handbook version II. Draft. Washington, DC: U.S. Environmental Protection Agency.

## Attachment 3

### Summary of Recommended Pollutants

#### Pollutants from OAQPS List of 50 (Potential Carcinogens)

1,3-Butadiene  
Diethylphthalate (DEHP)  
Ethylbenzene  
Styrene  
Chromium (total)  
Pentachlorophenol (PCP)  
Ethylene Dibromide (EDB)

#### Pollutants from List of 37 (Potential Carcinogens)

Coke Oven Emissions  
Nickel  
Formaldehyde  
Ethylene dichloride  
Acrylonitrile  
Carbon tetrachloride  
Chloroform  
Cadmium  
Perchloroethylene  
Trichloroethylene

#### NESHAPS Either Proposed or Regulated

Beryllium  
Arsenic  
Benzene  
Vinyl Chloride

#### Potential Carcinogens Excluded from OAQPS Lists

Benzo(a)pyrene

# Attachment 4

## 1,3-Butadiene Manufacturers

| Facility                             | Location           | Capacities<br>(10 <sup>3</sup> kkg) | County           |
|--------------------------------------|--------------------|-------------------------------------|------------------|
| 1. Petrotex (Tenneco)                | Houston, TX        | 272                                 | Harris           |
| 2. Union Carbide                     | Seadrift, TX       | 15                                  | Calhoun          |
|                                      | Texas City, TX     | 25                                  | Galveston        |
| 3. Exxon Chemical                    | Baton Rouge, LA    | 141                                 | East Baton Rouge |
|                                      | Baytown, TX        | 109                                 | Harris           |
| 4. Mobil Oil Corp.                   | Beaumont, TX       | 27                                  | Jefferson        |
| 5. Texaco Butadiene Co.              | Port Neches, TX    | 227                                 | Jefferson        |
| 6. Dow Chemical                      | Freeport, TX       | 39                                  | Brazoria         |
| 7. El Paso Products                  | Corpus Christi, TX | 91                                  | Nueces           |
| 8. Corpus Christi<br>Petro Chemicals | Corpus Christi, TX | 91                                  | Nueces           |
| 9. ARCO Chemicals                    | Channelview, TX    | 204                                 | Harris           |
| 10. Conoco (Dupont)                  | Alvin, TX          | 66                                  | Brazoria         |
| 11. Standard Oil (Amoco)             | Alvin, TX          | 82                                  | Brazoria         |
| 12. Shell Chemical Co.               | Deer Park, TX      | 227                                 | Harris           |
|                                      | Norco, LA          | 227                                 | St. Charles      |

Source: Versar 1984.

Attachment 5. U.S. PVC Producers and Their 1980 Capacities

| Company                        | Plant location     | Annual capacity<br>(x 10 <sup>3</sup> kkg) |
|--------------------------------|--------------------|--|
| Air Products and Chems., Inc.  |                    |  |
| Plastics Civ.                  | Calvert City, KY   | 100  |
|                                | Pensacola, FL      | 91   |
| Borden Inc.                    |                    |  |
| Borden Chem. Div.              |                    |  |
| Thermoplastic Products         | Illioopolis, IL    | 154  |
|                                | Leominster, MA     | 84   |
|                                | Lake Charles, LA   | 86   |
| CertainTeed Corp.              |                    |  |
| Conoco Inc.                    |                    |  |
| Conoco Chems. Co. Div.         | Aberdeen, MS       | 152  |
|                                | Oklahoma City, OK  | 98   |
| Diamond Shamrock Corp.         |                    |  |
| Indus. Chems. & Plastics Unit  |                    |  |
| Plastics Div                   | Deer Park, TX      | 213  |
|                                | Delaware City, DE  | 54   |
| Ethyl Corp.                    |                    |  |
| Chems. Group                   | Baton Rouge, LA    | 82   |
| The Gen. Tire & Rubber Co.     |                    |  |
| Chemicals/Plastics/            |                    |  |
| Industrial Products Div.       |                    |  |
| GTR Chem. Co.                  | Ashtabula, OH      | 57   |
|                                | Point Pleasant, WV | 27   |
| Georgia-Pacific Corp.          |                    |  |
| Chem. Div.                     | Plaquemine, LA     | 318  |
| The BF Goodrich Co.            |                    |  |
| BF Goodrich Chem. Group        | Avon Lake, OH      | 136  |
|                                | Henry, IL          | 91   |
|                                | Long Beach, CA     | 68   |
|                                | Louisville, KY     | 170  |
|                                | Pedricktown, NJ    | 68   |
|                                | Plaquemine, LA     | 86   |
| The Goodyear Tire & Rubber Co. |                    |  |
| Chem. Div.                     | Niagara Falls, NY  | 32   |



## Attachment 5. (continued)

| Company  | Plant location                                   | Annual capacity<br>(x 10 <sup>3</sup> kkg) |
|--|--|--|
| Keysor Corp.   | Saugus, CA                                       | 23   |
| Occidental Petroleum Corp.<br>Hooker Chem Corp., subsid.<br>Plastics Group<br>Plastics Div.                      | Addis, LA<br>Perryville, MD<br>Pottstown, PA     | 100<br>118<br>109                          |
| Ruco Div.  | Burlington, NJ                                   | 86   |
| Pantasote Inc.<br>Film/Compound Div.   | Passaic, NJ<br>Point Pleasant, WV                | 25<br>39                                   |
| Rico Chem. Corp.   | Guayanilla, PR                                   | 73   |
| SHINTECH Inc.  | Freeport, TX                                     | 150  |
| Stauffer Chem. Co.<br>Plastics Div.<br>Polymers Delaware City,<br>Delaware<br>Polymers Long Beach,<br>California | Delaware City, DE<br>Carson, CA                  | 127<br>64                                  |
| Talleyrand Chems., Inc.  | New Bedford, MA                                  | 35   |
| Tenneco Inc.<br>Tenneco Chems., Inc.   | Burlington, NJ<br>Flemington, NJ<br>Pasadena, TX | 73<br>48<br>218                            |
| Union Carbide Corp<br>Chems. and Plastics, Div.  | South Charleston, WV<br>Texas City, TX           | 23<br>57                                   |
| Whittaker Corp.<br>Great American Chem.,<br>subsid.  | Fitchburg, MS                                    | 34   |
|  | TOTAL  | 3,569                                      |

Source: Versar 1982.

## Attachment 6

## Production of Ethylene Dichloride

| Manufacturer   | Location   | Annual Capacity <sup>a</sup><br>(x10 <sup>3</sup> kkg) |
|--|--|--|
| Atlantic Richfield Co.<br>ARCO Chem. Co., div.                                       | Port Arthur, TX  | 205  |
| Borden, Inc.<br>Borden Chem. Div.<br>Petrchems. Div.                                 | Geismar, LA  | 230  |
| Dow Chem. U.S.A.   | Freeport, TX<br>Oyster Creek, TX<br>Plaquemine, LA               | 725<br>475<br>860                                      |
| E.I. duPont de Nemours & Co., Inc.<br>Conoco Inc., subsid.<br>Conoco Chems. Co. Div. | Lake Charles, LA   | 525  |
| Ethyl Corp.<br>Chems. Group  | Baton Rouge, LA<br>Pasadena, TX                                  | 320<br>100   |
| Formosa Plastics Corp. U.S.A.  | Baton Rouge, LA  | 250  |
| Georgia-Pacific Corp.<br>Chem. Div.  | Plaquemine, LA   | 750  |
| The BF Goodrich Co.<br>BF Goodrich Chem. Group<br>Convent Chem. Corp., subsid.       | Deer Park, TX<br>La Porte, TX<br>Calvert City, KY<br>Convent, LA | 145<br>720<br>450<br>360                               |
| PPG Indust., Inc.<br>Indust. Chem. Div.  | Lake Charles, LA   | 1,225  |
| Shell Chem. Co.  | Deer Park, TX<br>Norco, LA                                       | 635<br>545   |

Attachment 6 (continued)

Production of Ethylene Dichloride

| Manufacturer  | Location                   | Annual Capacity <sup>a</sup><br>(x10 <sup>3</sup> kkg) |
|---|----------------------------|--|
| Stauffer Chem. Co.<br>Plastics Div.<br>Polymers, Long Beach, California | Carson, CA                 | 155  |
| Union Carbide Corp.<br>Ethylene Oxide Derivatives Div.                  | Taft, LA<br>Texas City, TX | 70 <sup>b</sup><br>70 <sup>b</sup>                     |
| Vulcan Materials Co.<br>Vulcan Chems., div.                             | Geismar, LA                | <u>160</u>   |
| TOTAL   |                            | 8,975  |

<sup>a</sup>Capacities are flexible depending on finishing capacities for vinyl chloride and chlorinated solvents.

<sup>b</sup>Captive use only.

Source: GCA 1982c.

Attachment 7

Acrylonitrile Manufacturers

| Company              | Location        | Capacity<br>(kkg/yr) |
|----------------------|-----------------|----------------------|
| American Cyanamid Co | New Orleans, LA | 91,000               |
| Du Pont Co.          | Beaumont, TX    | 160,000              |
| Du Pont Co.          | Memphis, TN     | 130,000              |
| Monsanto Co.         | Alvin, TX       | 200,000              |
| Monsanto Co.         | Texas City, TX  | 190,000              |
| Vistron Corp.        | Lima, OH        | <u>91,000</u>        |
| TOTALS               |                 | 862,000              |

Source: Tierney and Wilkens 1979.

Attachment 8

Carbon Tetrachloride Production Facilities

| Company                                | Location           | Carbon<br>tetrachloride<br>capacity<br>( $\times 10^3$ kkg) |
|--|--------------------|---|
| Dow Chemical Co.                       | Freeport, TX       | 61  |
|  | Pittsburg, CA      | 36  |
|  | Plaquemine, LA     | 57  |
| E.I. duPont de Nemours<br>and Co.      | Corpus Christi, TX | 154   |
| Linden Chemicals and<br>Plastics, Inc. | Moundsville, WV    | 4   |
| Stauffer Chemical Co.                  | Lemoyne, AL        | 91  |
|  | Louisville, KY     | 32  |
| Vulcan Materials Co.                   | Geismar, LA        | 41  |
|  | Wichita, KS        | 27  |
| Diamond Shamrock Corp                  | Belle, WV          | —   |

Source: GCA 1982a.

Attachment 9

Locations of Primary Lead Smelters

| Company                      | Location        |
|------------------------------|-----------------|
| AMAX-Homestake Lead Trollers | Boss, MO        |
| ASARCO, Inc.                 | East Helena, MT |
| ASARCO, Inc.                 | Glover, MO      |
| ASARCO, Inc.                 | El Paso, TX     |
| The Bunker Hill Co.          | Kellogg, ID     |
| St. Joe Minerals Corp.       | Herculaneum, MO |

Source: GCA 1981.

Attachment 10

Locations of Primary Copper Smelters

| Company                             | Location       |
|-------------------------------------|----------------|
| ASARCO, Inc.                        | El Paso, TX    |
| ASARCO, Inc.                        | Hayden, AZ     |
| ASARCO, Inc.                        | Tacoma, WA     |
| Cities Service Co.                  | Copperhill, TN |
| Inspiration Consolidated Copper Co. | Miami, AZ      |
| Kennecott Copper Corp.              | Garfield, UT   |
| Kennecott Copper Corp.              | Hayden, AZ     |
| Kennecott Copper Corp.              | Hurley, NM     |
| Kennecott Copper Corp.              | McGill, NV     |
| Magma Copper Co.                    | San Manuel, AZ |
| Phelps Dodge Copper Corp.           | Ajo, AZ        |
| Phelps Dodge Copper Corp.           | Douglas, AZ    |
| Phelps Dodge Copper Corp.           | Hildago, NM    |
| Phelps Dodge Copper Corp.           | Morenci, AZ    |
| Copper Range Co.                    | White Pine, MI |

Source: GCA 1982.

## APPENDIX E

### Area Source Emission Factor Documentation

**DRAFT**



## HAPS Area Source Emission Factor Documentation

### INTRODUCTION

County-wide area source emissions of the study pollutants were estimated for the following sources:

- Road Vehicles
- Gasoline Marketing
- Solvent usage (drycleaning, degreasing, surface coating, printing and publishing, and misc.)
- Heating (residential, commercial and institutional, and industrial)
- Pentachlorophenol emissions (cooling towers, treated wood).

Area source emissions were based upon either (a) data provided in NEDS, as listed in the Area Source Reports, or (b) national emissions estimates factored down to the local level. The methods used to estimate each of these sources are documented in the following discussion.

#### (1) Pentachlorophenol (PCP)

There are two major pentachlorophenol area sources - cooling towers and preserved wood.

- Cooling towers - PCPs are used in cooling water systems to inhibit growth of microorganisms. According to ADL (1980) nationwide emissions of PCPs totaled 228 kkg/yr (in 1978). Because there are no known data on the geographical distribution of cooling towers, cooling tower emissions were apportioned based on population density, using the following formula:

$$\frac{(\text{county-wide population})}{\text{national population}} \times (228 \text{ kkg/yr}) = \text{annual county-wide emissions of PCPs from cooling towers}$$

- Preserved wood - According to ADL (1980) in 1978 approximately 344 kkg of PCPs were emitted from treated wood products (fence posts, poles, railroad ties, etc). These emissions were reported to be distributed uniformly with each of five geographical regions of the US (Northeast, Southeast, North central, South central, and

West). Emission densities (kkg/mile<sup>2</sup>) were determined for each region (and state) of the county. Table 1 presents emissions densities for each state. County wide emissions of PCPs can then be estimated using the following formula:

$$(\text{PCP Emission Density}) \times (\text{county area in mile}^2) = \text{annual county-wide emissions of PCP from treated wood.}$$

## (2) Gasoline Marketing

There are three HAPS pollutants emitted from gasoline marketing - benzene, benzene, ethylene dichloride (EDC) and ethylene dibromide (EDB). In addition, a fourth "pollutant" - gasoline vapors - was included in the risk analysis. The following factors were used to estimate these emissions:

|                 |                         |
|-----------------|-------------------------|
| Benzene         | 0.005 kkg/kkg of VOC    |
| EDB             | 0.000005 kkg/kkg of VOC |
| EDC             | 0.00001 kkg/kkg of VOC  |
| Gasoline vapors | 1.000 kkg/kkg of VOC    |

The benzene factor was provided to Versar by Sobotka, Inc (Carpenter 1983). EDC and EDB estimates from estimated based on information found in Misenheimer (1982). Gasoline vapors are considered to be equivalent to Total VOC, as listed in NEDS (Kellam 1984). Although benzene, EDB, and EDC are constituents in the gasoline vapor, the risks due to the constituents and total gasoline vapors are, in fact, additive (Kellam 1984).

## (3) Solvent Use

Solvents are liquid organic compounds that are used for (1) cleaning or (2) product application e.g,m surface coatings or aerosol propellants. Because solvents are used throughout the economy in both the private and industrial sectors, inventorying emissions can be quite complicated. While large sources must be considered as point sources,

smaller sources must be treated as area sources, although these small sources collectively often make up the bulk of the solvent emissions in a typical urban area.

Two solvents, perchloroethylene and trichloroethylene are among the eighteen HAPS pollutants. Perchloroethylene is emitted by degreasers, and drycleaners, with a small amount emitted by the miscellaneous industrial category. (This industrial category does not include degreasers, drycleaners, graphic arts, and rubber and plastics). Trichloroethylene is used almost solely as a degreasing agent.

The following approach was used in estimating these emissions. It was assumed that all solvent that used volatilize on site.

When the NEDS "Special Report" NE099 was available for a county, it was used as the basis for estimating emissions. The report provides a breakdown on solvent usage by category (i.e., solvent use, degreasing, drycleaning, rubber and plastics, graphic arts, miscellaneous, industrial, and nonindustrial. The following factors taken from Mann (1983) were applied to breakdown solvent usage (emissions) by pollutant. All results are in kkg/yr.

- Perchloroethylene

|                  |   |
|------------------|---|
| Drycleaning      | $(0.64) \times (\text{Drycleaning Usage})$      |
| Degreasing       | $(0.10) \times (\text{Degreasing Usage})$       |
| Misc. Industrial | $(0.01) \times (\text{Misc. Industrial Usage})$ |

- Trichloroethylene

|            |   |
|------------|---|
| Degreasing | $(0.21) \times (\text{Degreasing Usage})$ |
|------------|---|

#### (4) Road Vehicles

HAPS pollutants emitted by road vehicles include formaldehyde, benzo(a)pyrene, benzene, ethylene dibromide, 1,3-butadiene, and cadmium. One major assumption was that half of the gasoline consumed in the US is unleaded (Sigsby 1983). This affected emissions of lead and ethylene dibromide, which are found only in leaded gasolines.

Table 1 presents road vehicle emission factors which are multiplied by the vehicle miles travelled (VMT) provided in NEDS. The numerous references that were used in the compilation of these factors are also listed in this table.

(5) Industrial, Commercial and Institutional, and Residential Heating

Emissions from the combustion of fossil fuel and wood for space heating and small industrial boilers are treated as area sources rather than point sources because of their numerous and individually small loadings. Larger sources were treated as point sources. Pollutants emitted during heat generation include benzo(a)pyrene, formaldehyde, beryllium, nickel, arsenic and cadmium.

These factors were derived from a variety of sources as listed in Table 2. Nickel and arsenic factors were derived by dividing total national air emissions by total national fuel usage. Formaldehyde factors except for residential wood stoves and fireplaces were originally presented in JRB (1982). BaP factors came from a variety of sources including a memorandum prepared by EPA especially for this project (McCrillis 1984). McCrillis (1984) also provided formaldehyde factors for wood stoves and fireplaces. DeAngelis (1980) contained most of the remaining metals emission factors for heating.

Residential Wood Consumption was divided between woodburning stoves and fireplaces based upon data provided by DeAngelis et al. (1980b). These percentages are presented in Table 3.

Table 1. Road Vehicle Emission Factors

A. Light Duty Gas (includes light duty gasoline powered automobile and light duty gasoline powered trucks)

|                    |  |                       |
|--------------------|--|-----------------------|
| → Benzo(a)pyrene   | $(1.17 \times 10^{-8} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{LV Gas}})$ | (Lang et al. 1981)    |
| Benzene            | $(1.3 \times 10^{-4} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{LV Gas}})$  | (Black et al. 1980)   |
| Ethylene dibromide | $(1.3 \times 10^{-7} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{LV Gas}})$  | (Sigsby et al. 1982)  |
| Formaldehyde       | $(2.68 \times 10^{-5} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{LV Gas}})$ | (Carey 1981)          |
| 1,3-Butadiene      | $(1.00 \times 10^{-6} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{LV Gas}})$ | (Black and High 1977) |
| Cadmium            | $(9.0 \times 10^{-9} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{LV Gas}})$  | (USEPA 1979)          |

B. Heavy Duty Gas

|                    |   |                        |
|--------------------|---|------------------------|
| Benzo(a)pyrene     | $(8.31 \times 10^{-8} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{HDV Gas}})$ | (Lang et al. 1981)     |
| Benzene            | $(3.3 \times 10^{-4} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{HDV Gas}})$  | (Dietzman et al. 1980) |
| Ethylene dibromide | $(3.1 \times 10^{-7} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{HDV Gas}})$  | (Stump et al. 1982)    |
| Formaldehyde       | $(1.12 \times 10^{-4} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{HDV Gas}})$ | (Carey 1981)           |
| 1,3-Butadiene      | $(2.50 \times 10^{-6} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{HDV Gas}})$ | (Black & High 1977)    |
| Cadmium            | $(9.0 \times 10^{-9} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{HDV Gas}})$  | (USEPA 1979)           |

C. Heavy Duty Diesel

|                |   |                                     |
|----------------|---|-------------------------------------|
| Benzo(a)pyrene | $(5.01 \times 10^{-8} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{HDV DES}})$ | (Braddock 1982, Gabele et al. 1982) |
| Formaldehyde   | $(8.0 \times 10^{-5} \text{ kkg/1000 VMT}) \times (1000 \text{ VMT}_{\text{HDV DES}})$  | (Carey 1981)                        |

NOTE: Whenever VMT (vehicle miles travelled) data are not available for a specific area, the following factors were used to estimate vehicle miles travelled. Multiply the gasoline consumption in each category, GVAR, by its respective miles per gallon.

For Light Duty Gas Vehicles (LV Gas):  $1000 \text{ VMT}_{\text{LV Gas}} = 15.1 \text{ mpg} \times \text{LDV Gas}$   
 For Heavy Duty Gas Vehicles (HDV Gas):  $1000 \text{ VMT}_{\text{HDV Gas}} = 6.4 \text{ mpg} \times \text{HDV Gas}$   
 For Heavy Duty Diesel Vehicles (HDV DES):  $1000 \text{ VMT}_{\text{HDV Diesel}} = 5.9 \text{ mpg} \times \text{HDV Diesel}$

NOTE: These average MPG values were calculated based upon national fuel consumption and national VMT, as supplied by NEDS.

Table 2. Heating Emission Factors

A. Residential

I Coal

|                |   |                            |
|----------------|---|----------------------------|
| Benzo(a)pyrene | $(6.8 \times 10^{-7} \text{ kkg/ton of coal}) \times (\text{RES ANT} + \text{RES BIT})$ | (White & Vanderslice 1980) |
| Arsenic        | $(6.2 \times 10^{-9} \text{ kkg/ton of coal}) \times (\text{RES ANT} + \text{RES BIT})$ | (Scow et al. 1981)         |
| Nickel         | $(4.5 \times 10^{-6} \text{ kkg/ton of coal}) \times (\text{RES ANT} + \text{RES BIT})$ | (McNamara et al. 1981)     |
| Formaldehyde   | $(2.2 \times 10^{-6} \text{ kkg/ton of coal}) \times (\text{RES ANT} + \text{RES BIT})$ | (JRB 1982)                 |
| Cadmium        | $(8.8 \times 10^{-7} \text{ kkg/ton of coal}) \times (\text{RES ANT} + \text{RES BIT})$ | (GCA 1981)                 |

II Oil

|                |   |                    |
|----------------|---|--------------------|
| Benzo(a)pyrene | $(5.7 \times 10^{-11} \text{ kkg/1000 gallons}) \times (\text{RES DIS} + \text{RES RESD})$  | (Shih et al. 1982) |
| Cadmium        | $(7.2 \times 10^{-10} \text{ kkg/1000 gallons of distillate}) \times (\text{RES DIS}) +$<br>$(7.9 \times 10^{-10} \text{ kkg/1000 gallons of residual}) \times (\text{RES RESD})$ | (GCA 1981)         |
| Arsenic        | $(1.3 \times 10^{-10} \text{ kkg/1000 gallons of distillate}) \times (\text{RES DIS})$  | (Scow et al. 1981) |
| Formaldehyde   | $(7.1 \times 10^{-4} \text{ kkg/1000 gallons of residual}) \times (\text{RES RESD}) +$<br>$(2.9 \times 10^{-4} \text{ kkg/1000 gallons of distillate}) \times (\text{RES DIS})$   | (JRB 1982)         |

III Gas

|              |   |            |
|--------------|---|------------|
| Formaldehyde | $(3.4 \times 10^{-3} \text{ kkg/million cubic feet}) \times (\text{RES N GAS})$ | (JRB 1982) |
|--------------|---|------------|

IV Wood

a. Fireplaces

|                |  |                         |
|----------------|--|-------------------------|
| Benzo(a)pyrene | $(5.9 \times 10^{-7} \text{ kkg/ton}) \times (\text{FP Factor})^* \times (\text{RES WOOD})$  | (McCrillis 1984)        |
| Formaldehyde   | $(1.36 \times 10^{-3} \text{ kkg/ton}) \times (\text{FP Factor})^* \times (\text{RES WOOD})$ | (McCrillis 1984)        |
| Beryllium      | $(1.3 \times 10^{-10} \text{ kkg/ton}) \times (\text{FP Factor})^* \times (\text{RES WOOD})$ | (DeAngelis et al. 1980) |
| Nickel         | $(1.5 \times 10^{-6} \text{ kkg/ton}) \times (\text{FP Factor})^* \times (\text{RES WOOD})$  | (DeAngelis et al. 1980) |
| Cadmium        | $(3.2 \times 10^{-8} \text{ kkg/ton}) \times (\text{FP Factor})^* \times (\text{RES WOOD})$  | (DeAngelis et al. 1980) |
| Arsenic        | $(1.2 \times 10^{-7} \text{ kkg/ton}) \times (\text{FP Factor})^* \times (\text{RES WOOD})$  | (DeAngelis et al. 1980) |

\*See Table 4

NOTE: No emission factors have been identified for Beryllium, Nickel, Cadmium, and Arsenic emission factors for fireplaces. Consequently, these factors are being considered by default, identical to those for woodburning stoves. These factors will be revised should better data become available.

**b. Wood Burning Stoves**

|                |  |                  |
|----------------|--|------------------|
| Benzo(a)pyrene | $(3.6 \times 10^{-6} \text{ kkg/ton}) \times (\text{WS Factor})^* \times (\text{RES WOOD})$  | (Perwak 1982)    |
| Formaldehyde   | $(2.1 \times 10^{-4} \text{ kkg/ton}) \times (\text{WS Factor})^* \times (\text{RES WOOD})$  | (McCrillis 1984) |
| Beryllium      | $(1.3 \times 10^{-10} \text{ kkg/ton}) \times (\text{WS Factor})^* \times (\text{RES WOOD})$ | (DeAngelis 1980) |
| Nickel         | $(1.5 \times 10^{-6} \text{ kkg/ton}) \times (\text{WS Factor})^* \times (\text{RES WOOD})$  | (DeAngelis 1980) |
| Cadmium        | $(3.2 \times 10^{-8} \text{ kkg/ton}) \times (\text{WS Factor})^* \times (\text{RES WOOD})$  | (DeAngelis 1980) |
| Arsenic        | $(1.2 \times 10^{-7} \text{ kkg/ton}) \times (\text{WS Factor})^* \times (\text{RES WOOD})$  | (DeAngelis 1980) |

**B. Commercial & Institutional**

**I Coal**

|                |  |                              |
|----------------|--|------------------------------|
| Formaldehyde   | $(2.2 \times 10^{-6} \text{ kkg/ton}) \times (\text{CI ANT} + \text{CI BIT})$  | (JRB 1982)                   |
| Arsenic        | $(6.2 \times 10^{-9} \text{ kkg/ton}) \times (\text{CI ANT} + \text{CI BIT})$  | (Scow et al. 1981)           |
| Nickel         | $(4.5 \times 10^{-6} \text{ kkg/ton}) \times (\text{CI ANT} + \text{CI BIT})$  | (McNamara et al. 1981)       |
| Benzo(a)pyrene | $(8.4 \times 10^{-13} \text{ kkg/ton}) \times (\text{CI ANT} + \text{CI BIT})$ | (White and Vanderslice 1980) |
| Cadmium        | $(8.8 \times 10^{-7} \text{ kkg/ton}) \times (\text{CI ANT} + \text{CI BIT})$  | (GCA 1981)                   |

**II Oil**

|                |   |                    |
|----------------|---|--------------------|
| Benzo(a)pyrene | $(5.7 \times 10^{-11} \text{ kkg/1000 gallons}) \times (\text{CI DIS} + \text{CI RESD})$  | (Shih et al. 1982) |
| Formaldehyde   | $(7.1 \times 10^{-4} \text{ kkg/1000 gallons of residual}) \times (\text{CI RESD}) +$<br>$(2.9 \times 10^{-4} \text{ kkg/1000 gallons of distillate}) \times (\text{CI DIS})$ | (JRB 1982)         |
| Cadmium        | $(5.7 \times 10^{-10} \text{ kkg/1000 gallons}) \times (\text{CI DIS} + \text{CI RESD})$  | (GCA 1981)         |
| Arsenic        | $(1.3 \times 10^{-10} \text{ kkg/1000 gallons of distillate}) \times (\text{CI DIS})$   | (Scow et al. 1981) |

**III Gas**

|              |  |            |
|--------------|--|------------|
| Formaldehyde | $(2.8 \times 10^{-4} \text{ kkg/million cubic feet}) \times (\text{CI N GAS})$ | (JRB 1982) |
|--------------|--|------------|

\*see Table.4

Table 2 (continued)

**C Industrial****I. Coal**

|                |  |                            |
|----------------|--|----------------------------|
| Benzo(a)pyrene | $(8.0 \times 10^{-13} \text{ kkg/ton}) \times (\text{IND ANT} + \text{IND BIT})$ | (White & Vanderslice 1980) |
| Formaldehyde   | $(2.2 \times 10^{-6} \text{ kkg/ton}) \times (\text{IND ANT} + \text{IND BIT})$  | (JRB 1982)                 |
| Nickel         | $(4.1 \times 10^{-9} \text{ kkg/ton}) \times (\text{IND ANT} + \text{IND BIT})$  | (McNamara et al. 1981)     |
| Arsenic        | $(6.7 \times 10^{-9} \text{ kkg/ton}) \times (\text{IND ANT} + \text{IND BIT})$  | (Scow et al. 1981)         |
| Cadmium        | $(8.3 \times 10^{-7} \text{ kkg/ton}) \times (\text{IND ANT} + \text{IND BIT})$  | (GCA 1981)                 |

**II Oil**

|                |   |                              |
|----------------|---|------------------------------|
| Benzo(a)pyrene | $(5.7 \times 10^{-11} \text{ kkg/1000 gallons}) \times (\text{IND RESD} + \text{IND BIT})$  | (White and Vanderslice 1980) |
| Formaldehyde   | $(7.1 \times 10^{-4} \text{ kkg/1000 gallons of residual}) \times (\text{IND RESD}) +$<br>$(2.4 \times 10^{-4} \text{ kkg/1000 gallons of distillate}) \times (\text{IND DIS})$   | (JRB 1982)                   |
| Arsenic        | $(8.7 \times 10^{-10} \text{ kkg/1000 gallons of residual}) \times (\text{IND RESD}) +$<br>$(1.1 \times 10^{-10} \text{ kkg/1000 gallons of distillate}) \times (\text{IND DIS})$ | (Scow et al. 1981)           |
| Cadmium        | $(3.4 \times 10^{-7} \text{ kkg/1000 gallons of residual}) \times (\text{IND RESD}) +$<br>$(1.3 \times 10^{-8} \text{ kkg/1000 gallons of distillate}) \times (\text{IND RESD})$  | (GCA 1981)                   |
| Nickel         | $(1.5 \times 10^{-7} \text{ kkg/1000 gallons of residual}) \times (\text{IND RESD})$  | (McNamara et al. 1981)       |

**III Gas**

|              |   |            |
|--------------|---|------------|
| Formaldehyde | $(9.1 \times 10^{-4} \text{ kkg/million cubic feet}) \times (\text{IND N GAS})$ | (JRB 1982) |
|--------------|---|------------|

**Code:** RES ANT - Residential Anthracite Coal  
 RES BIT - Residential Bituminous Coal  
 RES DIS - Residential Distillate Oil  
 RES RESD - Residential Residual Oil  
 RES N GAS - Residential Natural Gas  
 RES WOOD - Residential Wood  
 FP FACTOR - Fireplace Factor (see Table I-5)  
 WS FACTOR - Wood Stove Factor (see Table I-5)  
 CI ANT - Commercial and Institutional Anthracite Coal

CI BIT - Commercial and Institutional Bituminous Coal  
 CI DIS - Commercial and Institutional Distillate Oil  
 CI RESD - Commercial and Institutional Residual Oil  
 CI N GAS - Commercial and Institutional Natural Gas  
 IND ANT - Industrial Anthracite Coal  
 IND BIT - Industrial Bituminous Coal  
 IND DIS - Industrial Distillate Oil  
 IND RESD - Industrial Residual Oil  
 IND N GAS - Industrial Natural Gas



Table 3.

Apportionment of Residential Wood Consumption Between  
Fireplaces (FP) and Wood Stoves (WS) for the Year 1976

| State                   |    | FP  | WS  |
|-------------------------|----|-----|-----|
| Alabama                 | AL | .08 | .92 |
| Alaska                  | AK | .14 | .86 |
| Arizona                 | AZ | .57 | .43 |
| Arkansas                | AR | .17 | .83 |
| California              | CA | .57 | .43 |
| Colorado                | CO | .40 | .60 |
| Connecticut             | CT | .26 | .74 |
| Delaware                | DE | .28 | .72 |
| District of<br>Columbia | DC | .29 | .71 |
| Florida                 | FL | .30 | .70 |
| Georgia                 | GA | .17 | .83 |
| Hawaii                  | HI | .57 | .43 |
| Idaho                   | ID | .39 | .61 |
| Illinois                | IL | .32 | .68 |
| Indiana                 | IN | .33 | .67 |
| Iowa                    | IA | .32 | .68 |
| Kansas                  | KS | .32 | .68 |
| Kentucky                | KY | .16 | .84 |
| Louisiana               | LA | .29 | .71 |
| Maine                   | ME | .04 | .96 |
| Maryland                | MD | .29 | .71 |
| Massachusetts           | MA | .25 | .75 |
| Michigan                | MI | .19 | .81 |
| Minnesota               | MN | .11 | .89 |
| Mississippi             | MS | .16 | .84 |
| Missouri                | MO | .19 | .81 |
| Montana                 | MT | .40 | .60 |
| Nebraska                | NE | .32 | .68 |
| Nevada                  | NV | .56 | .44 |
| New Hampshire           | NH | .04 | .96 |
| New Jersey              | NJ | .40 | .60 |
| New Mexico              | NM | .73 | .27 |
| New York                | NY | .25 | .75 |
| North Carolina          | NC | .30 | .70 |
| North Dakota            | ND | .33 | .67 |
| Ohio                    | OH | .32 | .68 |

Table 3. (continued)

| State          |    | FP         | WS         |
|----------------|----|------------|------------|
| Oklahoma       | OK | .45        | .55        |
| Oregon         | OR | .13        | .87        |
| Pennsylvania   | PA | .40        | .60        |
| Rhode Island   | RI | .40        | .60        |
| South Carolina | SC | .30        | .70        |
| South Dakota   | SD | .30        | .70        |
| Tennessee      | TN | .05        | .95        |
| Texas          | TX | .29        | .71        |
| Utah           | UT | .42        | .58        |
| Vermont        | VT | .04        | .96        |
| Virginia       | VA | .30        | .70        |
| Washington     | WA | .13        | .87        |
| West Virginia  | WV | .30        | .70        |
| Wisconsin      | WI | .19        | .81        |
| Wyoming        | WY | .40        | .60        |
|                |    | <u>.24</u> | <u>.76</u> |

Source: DeAngelis et al. (1980b).

## REFERENCES

ADL. 1980. Arthur D. Little, Inc. An exposure and risk assessment for pentachlorophenol. Washington, D.C.: USEPA Office of Water Regulators and Standards. EPA contract #68-01-3857.

Black F, High L. 1977. Automotive hydrocarbon emission patterns in the measurement of nonmethane hydrocarbon emission rates. Proceedings of the International Automotive Engineering Congress and Exposition. Detroit, MI: Society of Automotive Engineers.

Braddock JN. 1982. Impact of low ambient temperature on diesel passenger car emissions. Warrendale, PA: SAE Technical Paper Series. Society of Automotive Engineers, Inc.

Carey PM. 1981. Mobile source emissions of formaldehyde and other aldehydes. Ann Arbor, MI: U.S. Environmental Protection Agency. EPA/AA/CTAB/PA/81-11.

Carpenter C. Versar 1983. Memorandum to D. Taylor and J. Williams, USEPA. Springfield, VA: Versar Inc. March 11, 1983.

DeAngelis D, Ruffin D, Reznik R. 1980a. Monsanto Research Corp. Preliminary characterization of emissions from wood fuel residential combustion equipment. Research Triangle Park, NC: USEPA, Office of Research and Development. EPA-600/7-80-040.

DeAngelis D, Ruffin D, Peters J, Reznik R. 1980b. Monsanto Research Corp. Source Assessment: Residential combustion of wood. Research Triangle Park, NC: USEPA, Office of Research and Development. EPA-600/2-80-042b.

Dietzmann HE, Parness MA, Bradow RL. 1981. Emissions from gasoline and diesel delivery trucks by chassis transient cycle. New York, NY: American Society of Mechanical Engineers, Diesel and Gas Energy Power Division, ASME Publication No. 81-DGP-6.

Dietzmann HE, Parness MA, Bradow RL. 1980. Emissions from trucks by chassis version of 1983 transient procedure. Warrendale, PA: SAE Technical Paper Series. Society of Automotive Engineers, Inc.

GCA Corporation. 1981. Survey of cadmium emission sources. Research Triangle Park, NC: USEPA, Office of Air Quality Planning and Standards. EPA 450/3-81-013.

Gabele PA, Zweidinger R, Black F. 1982. Passenger car exhaust emission patterns: petroleum and oil shale derived diesel fuels. Warrendale, PA: SAE Technical Paper Series. Society of Automotive Engineers, Inc.

JRB Associates. 1982. Materials balance formaldehyde. Revised draft report. Washington, DC: USEPA, Office of Pesticides and Toxic Substances. EPA Contract 68-01-5793.

Lang JM, Snow L, Carlson R, Black F, Sweidinger R, Tejada S. 1981. Characterization of particulate emissions from in-use gasoline-fueled motor vehicles. Warrendale, PA: SAE Technical Paper Series. Society of Automotive Engineers, Inc.

McCrillis, R.C. March 30, 1984. Memorandum to Elaine Haemesseger IEMD, Research Triangle Park, NC USEPA IERL.

McNamara P, M Byrne, B Goodwin, K Scow, W Steber, R Thomas, M Wood. Arthur D Little, Inc. 1981. An exposure and risk assessment for nickel. Final draft report. Washington, DC: USEPA, Monitoring and Data Support Division. EPA Contract 68-01-6017.

Misenheimer D, Battye W. GCA Corporation. 1982a. Locating and estimating air emissions from sources of ethylene dichloride. Draft final report. Research Triangle Park, NC: Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency.

Perwak J, Byrne M, Coons S, Goyer M, Harris J. Arthur D. Little, Inc. 1982. An exposure and risk assessment for benzo(a)pyrene and other polycyclic aromatic hydrocarbons. Washington, DC: USEPA. Monitoring and Data Support Division. EPA Contract 68-01-6160.

Scow K, Byrne M, Goyer M, Nelken L, Perwak J, Wood M, Young S. Arthur D. Little, Inc. 1982. An exposure and risk assessment for arsenic. Final draft report. Washington, Dc: USEPA, Monitoring and Data Support Division. EPA Contract 68-01-6017.

Shih C, Ackerman D, Scinto L, Moar E, Fisher E. 1980. POM emissions from stationary conventional combustion processes, with emphasis on polychlorinated compounds of PCDDs, PDBS, and PCDs. Research Triangle Park, NC: USEPA.

Sigsby J, Dropkin D, Brodow R, and Lardy J. 1982. Automotive emissions of ethylene dibromide. Warrendale, PA: SAE Technical Paper Series. Society of Automotive Engineers, Inc.

Stump F, Brodow R, Ray W, Dropkin D, Zweidinger R, Sigsby J, Snow R. 1982. Trapping gaseous hydrocarbons for mutagenic testing. Warrendale, PA: SAE Technical Paper Series. Society of Automotive Engineers.

USEPA. 1977 and later. Completion of Air Pollution Emission Factors and Supplements 1-13. Research Triangle Park, NC: USEPA Office of Air Quality Planning and Standards.

USEPA. 1979. Sources of atmospheric cadmium. Research Triangle Park, NC: USEPA, Office of Air Quality Planning and Standards. EPA 450/5-79-006.

White J. Vanderslice R. Research Triangle Institute. 1980. POM source and ambient concentration data review and analysis. Research Triangle Park, NC: USEPA Office of Environmental Engineering and Technology. EPA 600/7-80-044.

**APPENDIX F**  
**Non-Traditional Sources**

- F-1 Waste Oil**
- F-2 Publicly Owned Treatment Works**
- F-3 Treatment Storage and Disposal Facilities  
and Superfund Sites**

**DRAFT**

APPENDIX F-1  
Documentation for Waste Oil Emission Factors

One of the objectives of the Regional air toxics study is the characterization of pollutants, attributable to the combustion of waste oils in boilers. This Appendix provides the method by which the emissions released from the burning of waste oil were estimated on a county by county basis.

Every year, about 1148 million gallons of waste oil are generated in the United States (Franklin Associates, 1983). The sources of this oil range from automotive and industrial service, such as repair shops, service stations, airports, docks, recycling centers, to other categories including spills, tank cleaning, etc. A major portion of the waste oil generated (upwards of 500 million gallons) is burned in boilers, kilns, diesel engines, and waste oil heaters (PEDCo Environmental, 1983); the remainder is re-refined, used as dust suppressants, land filled, or dumped.

EPA's Office of Solid Wastes (OSW) has compiled a data base on the country-wide distribution of waste oil. It is estimated that the waste oil burned in boilers ranges from a low 374,000 gallons in Alaska to a high 43,698,000 gallons in Texas. Table 1 provides the OSW estimates of waste oil burned in boilers for all the states in the country.

Composition

Waste oils contain a variety of contaminants including heavy metals, polynuclear aromatic compounds, chlorinated solvents, PCBs, and other toxic compounds. However, available data suggest that only 11 pollutants included in the Regional air toxics study would be released by burning waste oils in boilers.

A number of studies have been performed to characterize the contaminant concentrations in waste oil. Franklin Associates (1983), in a report entitled "Waste Oil Management and Composition", has provided a

detailed analysis of the typical contaminant concentrations in waste oil. Extensive sampling was carried out, as a part of the study, for each source of oil and its end-use application.

The range of concentrations, determined in the study, varied from virtually zero to very high for most contaminants. This variability is only to be expected since the contaminating factors are numerous and they affect the oil composition to a great extent. The variations in composition can generally occur based upon the types of oil, or due to the additives which are used to enhance the performance characteristics of the oil.

For the purposes of this analysis, average concentrations of contaminants were derived using the sampling results for burner oil, where applicable. However, in the absence of burner oil data, the overall averages of all the samples were used to represent typical contaminant concentrations. Table 2 lists the average concentrations of the 11 pollutants applicable to the Regional study.

### Burning

The major concern about using waste oil as fuel is related to the potential for harmful emissions. The available literature indicates that waste oil is currently burned in various facilities or types of equipment, including in boilers, waste oil heaters, and cement kilns. The efficiencies and the products of combustion are dependent on the type of application. However, of all the waste oil burned, 92% was estimated to be burned in boilers (PEDCo Environmental, 1983). This analysis attempts to characterize the emissions released only for the burning of waste oils in boilers.

Waste oil is often pretreated prior to burning. The pretreatment includes (1) reprocessing of waste oil, (2) re-refining of waste oil, and (3) blending of virgin or clean fuel oil with waste oil. It was estimated that approximately 44% of the total waste oil generated in 1982, underwent some form of processing (Franklin Associates, 1983). The



oil fired boilers consuming waste oil include small residential boilers, intermediate commercial and institutional boilers, and large industrial boilers.

Typically, industrial boilers are larger in size and achieve high combustion efficiency at higher burner temperatures. But, the factors that affect the quality of combustion are not as carefully controlled in smaller boilers. These conditions impose a tremendous variability in the level of metal emissions from boilers, the average metal emissions ranging from 31 to 75 percent of the metal composition. However, to be on the conservative side, a 75% emission rate for metals would be assumed (PEDCo Environmental, 1983), in this analysis.

Test data indicate destruction efficiencies for organics ranging from 97% to 99.99%. Higher combustion temperatures in industrial boilers dictate higher destruction efficiencies. Hence, a 99.9% destruction efficiency for organics in industrial boilers would be a reasonable estimate. In residential, commercial and institutional (RIC) boilers, poorer quality of combustion results in comparatively lower destruction efficiencies for organics. This would be used as the basis for the selection of a 99% destruction efficiency for organics in RIC boilers.

The boilers using waste oil as a fuel vastly differ in their characteristics. This prevents any attempt at a simple quantification of boiler population, fuel blending or oil consumption. OSW has estimated that about 100 million gallons of waste oil are burned in RIC boilers (23%), and about 330 million gallons in industrial boilers (77%). It has also been indicated that waste oil is more likely to be burned at facilities that currently burn residual oil rather than at those that burn distillate oil (PEDCo Environmental, 1983).

Combining the above factors, it could be concluded that a very reasonable estimate of waste oil distribution by county could be made, if residual oil consumption data at the county level are available. The National Emissions Data System (NEDS) provides such data on distillate

and residual oil consumption patterns by RIC and industrial boilers for most of the counties in the country.

#### Estimation Technique

In this analysis, emissions from the burning of waste oil will only be estimated on an area source basis. Waste oil distribution by county will be estimated by using the residual oil consumption data from NEDS, where applicable. Distillate oil consumption data will be used for the states with no residual oil data. The method described below could be used with the available information resources, to estimate the regional distribution of the applicable toxic chemicals.

Step 1: Read the data on waste oil burned in each state from Table 1.

Step 2: For each state, read the total residual oil consumption data (TOT\_RESD) from NEDS. If TOT\_RESD is not zero follow (a), and if zero follow (b) given below, to compute the amount of waste oil burned in boilers in each county.

#### (a) Waste oil burned, based on residual oil consumption:

- (1) Calculate waste oil burned in RIC boilers (RIC\_WO) as,  
$$\text{RIC\_WO} = \frac{\text{Residual oil consumed in county (RES\_RESD + CI\_RESD + IND\_RESD)}}{\text{(TOT\_RESD for state)}} \times \frac{23}{100} \times \text{waste oil burned in state from Table 1 (gallons)}.$$
- (11) Calculate waste oil burned in industrial boilers (IND\_WO) as,  
$$\text{IND\_WO} = \frac{\text{Residual oil consumed in county (RES\_RESD + CI\_RESD + IND\_RESD)}}{\text{(TOT\_RESD for state)}} \times \frac{77}{100} \times \text{waste oil burned in state from Table 1 (gallons)}.$$

#### (b) Waste oil burned, based on distillate oil consumption:

- (1) Calculate waste oil burned in RIC boilers as,  
$$\text{RIC\_WO} = \frac{\text{Distillate oil consumed in county (RES\_DIS + CI\_DIS + IND\_DIS)}}{\text{(TOT\_DIS for state)}} \times \frac{23}{100} \times \text{waste oil burned in state from Table 1 (gallons)}.$$

(11) Calculate waste oil burned in industrial boilers as,  

$$\text{IND\_WO} = (\text{RES\_DIS} + \text{CI\_DIS} + \text{IND\_DIS})$$

$$+ (\text{TOT\_DIS for state})$$

$$\times 77/100$$

$$\times \text{waste oil burned in state from Table 1 (gallons)}.$$

Step 3: Read average concentrations in waste oil for the 11 contaminants from Table 2.

Step 4: Compute metal and organics emissions as follows:

(a) Metal (Chromium, Nickel, Cadmium, Beryllium & Arsenic) Emissions:

For each county, calculate the metals emissions (for example, Cadmium) as,

$$\text{Cadmium\_EMIS} = (\text{RIC\_WO} + \text{IND\_WO}) \text{ for county (gallons)}$$

$$\times (\text{Metals emission rate}) 75/100$$

$$\times 3391.36 \times 10^{-6} \text{ kkg of oil/gallon of waste oil}$$

$$\times (\text{Cadmium concentration}) 2.7 \times 10^{-6} \text{ kkg/kkg of oil}.$$

(b) Organics Emissions:

For each county, calculate the organics emissions (for example, Benzene) as,

$$\text{Benzene\_EMIS} = (\text{RIC\_WO} \times 0.01) + (\text{IND\_WO} \times 0.001)$$

$$\text{for county (gallons)}$$

$$\times 3391.36 \times 10^{-6} \text{ kkg of oil/gallon of waste oil}$$

$$\times (\text{Benzene concentration}) 160 \times 10^{-6} \text{ kkg/kkg of oil}.$$

In summary, due to the complex nature of the waste oil characteristics, this analysis should only be considered as a screening level approach. However, the emissions estimated for the burning of waste oil in boilers using the method presented in this analysis, would be helpful in the OAQPS regional air toxics study in placing this source category in perspective.

## References

Franklin Associates, 1983. Waste oil management and composition. Revised Draft Report. Office of Solid Wastes, EPA, Washington, DC.

OSW. Personal communication between Shiv Krishnan, Versar, and Mike Petruska, Office of Solid Wastes, EPA, Washington, DC.

OSW. Personal communication between Hope Pillsbury, EPA and Eric Males, OSW, EPA, Washington, DC.

PEDCo Environmental, 1983. A Risk Assessment of Waste Oil Burning in Boilers and Space Heaters. Final Draft Report. Office of Solid Wastes, EPA, Washington, DC.

Table 1

Waste Oil Consumption by State

| State               | Waste Oil Burned<br>(gallons) | State          | Waste Oil Burned<br>(gallons) |
|---------------------|-------------------------------|----------------|-------------------------------|
| Alabama             | 6678000                       | Nebraska       | 5362000                       |
| Alaska              | 374000                        | Nevada         | 1069000                       |
| Arizona             | 5130000                       | New Hampshire  | 855000                        |
| Arkansas            | 6946000                       | New Jersey     | 22641000                      |
| California          | 36053000                      | New Mexico     | 2563000                       |
| Colorado            | 6080000                       | New York       | 16503000                      |
| Connecticut         | 3610000                       | North Carolina | 9856000                       |
| Delaware            | 1606000                       | North Dakota   | 665000                        |
| Florida             | 10640000                      | Ohio           | 9405000                       |
| Georgia             | 8542000                       | Oklahoma       | 12806000                      |
| Hawaii              | 608000                        | Oregon         | 5653000                       |
| Idaho               | 570000                        | Pennsylvania   | 32797000                      |
| Illinois            | 19419000                      | Rhode Island   | 2166000                       |
| Indiana             | 6707000                       | South Carolina | 4367000                       |
| Iowa                | 4151000                       | South Dakota   | 739000                        |
| Kansas              | 8220000                       | Tennessee      | 10947000                      |
| Kentucky            | 5075000                       | Texas          | 43698000                      |
| Louisiana           | 17233000                      | Utah           | 2660000                       |
| Maine               | 2098000                       | Vermont        | 470000                        |
| Maryland            | 6287000                       | Virginia       | 7429000                       |
| Massachusetts       | 8550000                       | Wash DC        | 556000                        |
| Michigan            | 24397000                      | Washington     | 9063000                       |
| Minnesota           | 7373000                       | West Virginia  | 4932000                       |
| Mississippi         | 4431000                       | Wisconsin      | 5013000                       |
| Missouri            | 13590000                      | Wyoming        | 1461000                       |
| Montana             | 969000                        |                |                               |
| Total - 429,014,000 |                               |                |                               |

Source: Communication between Hope Pillsbury, EPA and Eric Males, OSW, EPA.

Table 2

Concentrations of Contaminants in Waste Oils

(Available data indicate that the pollutants listed in this table are the subset of pollutants being evaluated in the Air Toxics Study that are released from the burning of waste oils in boilers)

| Pollutant                       | Total<br>Samples<br>analyzed for<br>Contaminant | Total<br>Samples<br>Detecting<br>Contaminant | Average<br>Concentration<br>(ppm) | Concentration<br>range (ppm) |      |
|---------------------------------|---|--|-----------------------------------|------------------------------|------|
|                                 |   |  |                                   | Low                          | High |
| <u>Metals</u>                   |   |  |                                   |                              |      |
| Arsenic <sup>1</sup>            | 17  | 17   | 12                                | -                            | -    |
| Beryllium <sup>2</sup>          | -   | 23   | 1.2                               | 0.01                         | 7    |
| Cadmium <sup>3</sup>            | 33  | 21   | 2.7                               | 0.3                          | 36   |
| Chromium <sup>3</sup>           | 71  | 59   | 37                                | 1                            | 537  |
| Nickel <sup>2</sup>             | -   | 184  | 12.5                              | 0                            | 627  |
| <u>Organics</u>                 |   |  |                                   |                              |      |
| Benzene <sup>4</sup>            | 1   | 1  | 160                               | 160                          | 160  |
| Benzo(a)anthracene <sup>5</sup> | 17  | 14   | 88                                | 5                            | 660  |
| Benzo(a)pyrene <sup>5</sup>     | 19  | 11   | 59                                | 3.2                          | 405  |
| Ethylbenzene <sup>2,4</sup>     | -   | 17   | 120                               | 0                            | 1150 |
| Perchloroethylene <sup>3</sup>  | 86  | 79   | 448                               | 5                            | 3900 |
| Trichloroethylene <sup>3</sup>  | 101   | 90   | 527                               | 1                            | 7000 |

<sup>1</sup>End uses of waste oils sampled for arsenic were not specified.

<sup>2</sup>All reported values, including "0", were used to calculate average.

<sup>3</sup>Average calculated using burner oil samples.

<sup>4</sup>Twenty-two additional samples were tested for the general category of non halogenated solvents which may include benzene and its derivatives. Nine of the samples were found to contain one or more of these solvents.

<sup>5</sup>Average concentration is representative of all waste oil samples.

Source: Franklin Associates, 1983.

APPENDIX F-2  
Documentation of the Methodology Used to  
Estimate Air Emissions from POTWS

A. Methodology

Our objective was to develop a methodology that could be implemented quickly and inexpensively as part of our Phase I screening exercise. Our Phase I methodology for characterizing POTW volatilization emissions is described in subsections 1 and 2, below. As discussed in subsection 3, we may develop and implement a more refined version of this methodology in Phase II, if the Phase I results indicate that POTW volatilization emissions may account for a relatively large proportion of air toxics-related risk in the 35-50 counties selected for Phase II.

1. Overview

In brief summary, we used the following approach to characterize volatilization of toxics from POTWs:

- Step 1: Identify POTWs which are known to handle industrial discharges. Of the approximately 20,000 POTWs in the U.S., only a relatively small number handle industrial discharges. These are the POTWs that probably account for the largest volumes of volatilization of air toxics. EPA's Industrial Facilities Discharge (IFD) file is the best readily available data base for identifying POTWs that handle industrial discharges. (Some of the IFD data pertaining to POTWs is derived from EPA's NEEDS survey of POTWs.) While not 100% complete and accurate, by using IFD we were able to identify 1,600 POTWs known to have industrial discharges. (While this subset accounts for less than 10% of U.S. POTWs, it does account for about 50% of the flow discharged from POTWs.)

- Step 2A: Array selected readily available data on these POTWs. We extracted readily available data from IFD for each of the POTWs in our set of 1,600. We identified the readily available data that would be useful in developing estimates of volatilization (e.g., flow; % industrial contribution; types of industries that discharge into the POTW, by SIC code; level of treatment, such as primary or secondary). We then created a data set containing as much of this information as was available for each of the POTWs in our set of 1,600.
  
- Step 2B: Develop emission estimation algorithms. In an iterative fashion with step 2A, in step 2B we developed an algorithm for estimating the volatilization of air toxics from POTWs, based on best readily available data. In brief summary, this algorithm first provides criteria for sorting each of the 1,600 POTWs into one of thirteen categories. The sorting criteria were based on the following factors:
  - The percent of inflow to the POTW attributable to industrial dischargers (e.g., 0-20%; between 20 and 30%; etc.);
  - The types of industries that discharge to the POTW (by SIC code); and
  - The type of treatment at the POTW (e.g., primary, advanced primary, secondary, etc.).

We then developed a set of pollutant-specific emission factors for POTWs in each of the categories. We developed these emission factors based on our analysis of a study



recently sponsored by EPA, titled Fate of Priority Pollutants in Publicly Owned Treatment Works, Final Report, Volume I -- EPA 440/1-82-303, published in September, 1982. In this study, sponsored by the Effluents Guideline Division, 50 POTWs were monitored. (This study is sometimes referred to as the "50-POTW" monitoring study.) For each POTW, the key data collected, included: (1) flow, in millions of gallons per day; and (2) loadings of individual pollutants, in Kkg/yr, for each of a range of pollutants, in the influent, effluent and sludge. Based on this data, we developed emission factors based on assumptions regarding the proportions of volatile pollutants in the influent, effluent and sludge of prototype POTWs, and the amounts volatilized. The "50-POTW" study included monitoring data for nine pollutants that are within the scope of our study: benzene; ethylene dichloride; carbon tetrachloride; chloroform; vinyl chloride; trichloroethylene; perchloroethylene; and acrylonitrile.

- Step 3: Estimate Volatilization Emissions Using The Data and Algorithms Developed in Step 2. Using our automated model, HEMIS, we then applied the estimation algorithm to each of the POTWs in our subset of 1,600. For each POTW we estimated emissions of each of the nine pollutants listed above.

## 2. Detailed Description of Key Elements of the Methodology

### a. IFD

As noted above, we used the IFD file to identify 1,600 POTWs with known industrial discharges. We then extracted the following specific data elements for each of these POTWs:

- County and State

- Total POTW Flow

- NEEDS Treatment Code

- 0 = Zero discharge

- 1 = Raw

- 2 = Primary

- 3 = Advanced Primary

- 4 = Secondary

- 5 = Advanced Secondary

- 6 = Tertiary

- % Industrial Flow (NEEDS)

In some cases there were data gaps. In cases where flow was not recorded, no default was assigned and the POTW was excluded from further analysis. For POTWs for which flow data was recorded but there was insufficient data to calculate % industrial flow, we used a default assumption of 25% industrial flow.

In cases where the NEEDS Treatment Code was missing, we assigned a default equating to secondary treatment.

b. Criteria for Assigning POTWs to Prototype Categories

As noted above, we sorted each POTW in our subset of 1,600 into one of thirteen categories. The sorting criteria are depicted in Exhibit 2 on the following page. The sorting criteria were designed based on the data available in the POTW monitoring study cited above.

c. Emission Algorithms

(1) POTWs in Categories X and Y

For POTWs that have a zero discharge (Category X) or discharge raw wastes (Category Y), it was assumed that the loadings to air would be zero, since there would be no removal of pollutants from the wastewater.

(2) POTWs in Category A-1

POTWs in this category have advanced primary, secondary, advanced secondary or tertiary treatment. POTWs in this category do not have any indirect dischargers in a "significant" industrial SIC -- significant being defined as an indirect discharger in one of the major SIC industrial classification (22-24; 28-31; 33-47).

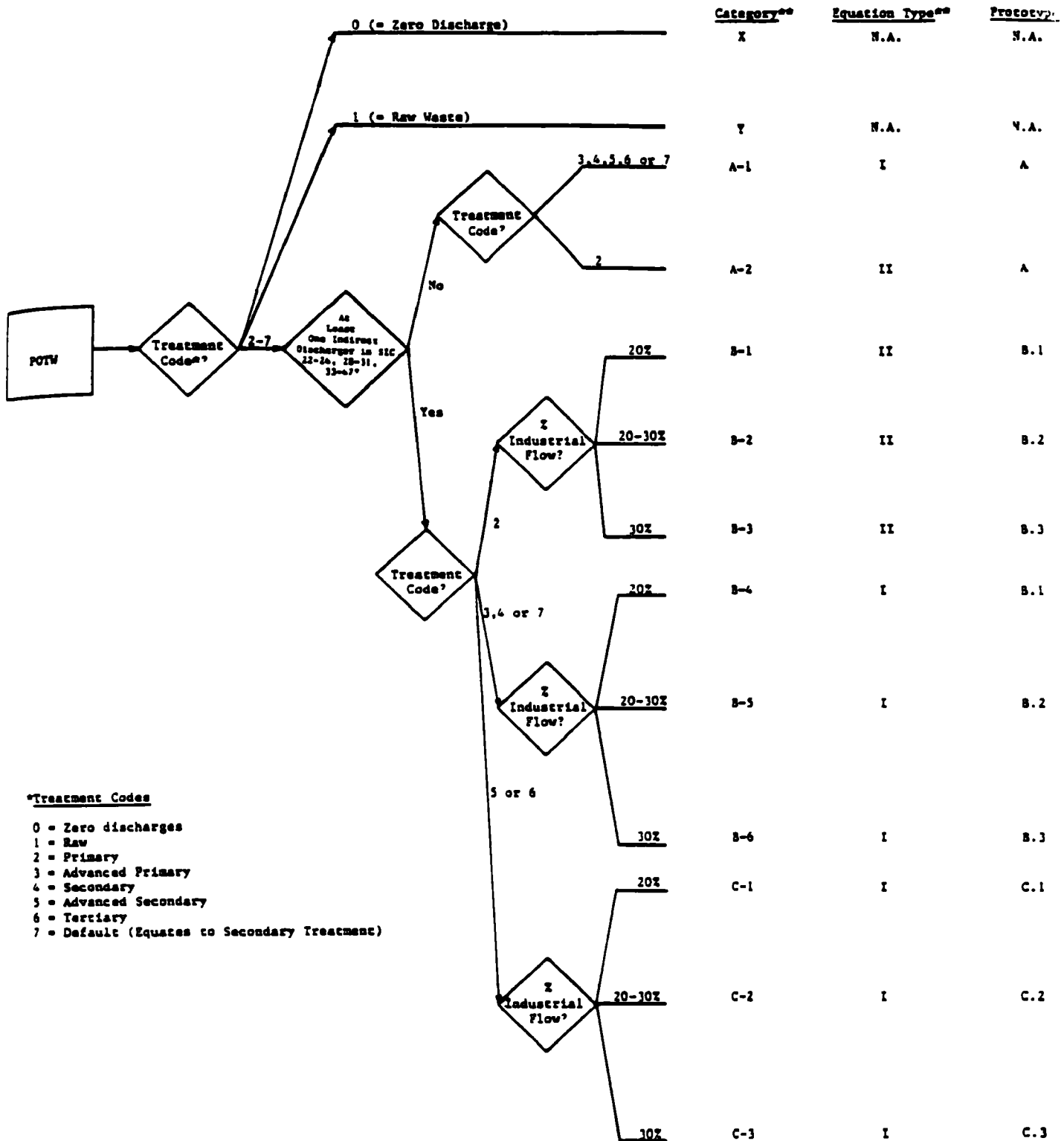
This equation is based on the assumption that the amount of a pollutant that is volatilized to air is the total removed by treatment, minus the portion that remains in the sludge.

The difficulty, of course, is in estimating the influent, effluent and sludge term for each of the POTWs in Category A-1. We estimated these values using the following steps:

- First, from the previously cited monitoring study, we selected two POTWs that best meet the criteria for Category A-1.
- Second, for those two POTWs, we calculated the average values for the following parameters, based on the data from the monitoring study.

## Exhibit 2

### Sorting Criteria for the Phase I Study



\*\* See the text of the Appendix for a description of Categories, Equation Types and Prototypes.

-- Flow, in MGD

-- Influent KKg/Yr for each of nine pollutants;

-- Effluent KKg/Yr for each of these pollutants; and

-- Sludge KKg/Yr for each of these pollutants.

We used these averaged values to define a prototype POTW -- specifically "Prototype A". These values for Prototype A are shown in a table at the end of this appendix.

- Third, for each POTW in Category A-1, we applied Basic Equation I, shown on the following page.

The flow portion of the equation is used to proportion the loading of Prototype A to that of each of the POTWs in category A-1 are being evaluated

### (3) POTWs in Category A-2

POTWs in this category have primary treatment. They do not have any "significant" industrial discharges -- significant being defined as an indirect discharger with a SIC code from one of the major industrial classifications (22-24; 28-31; 33-47).

Monitoring data for POTWs with primary treatment (e.g., POTWs in Category A-2) were not available. For our purposes, we assumed that 50% of the pollutants we are studying would be removed during primary treatment. We also assumed that the amount of a pollutant remaining in the sludge from primary treatment would be equal to the amount remaining following

### Basic Equation I

$$(\text{Annual Air Emissions})_{i,j} = [(\text{Prototype A Influent})_i - (\text{Prototype A Effluent})_i - (\text{Prototype A Sludge})_i] \times [(\text{POTW}_j \text{ Flow}) / (\text{Prototype A Flow})]$$

where

$(\text{Annual Air Emissions})_{i,j}$  = Estimated Volatilization Air Emissions of Pollutant i from POTW j, in KKg/yr

$(\text{Prototype A Influent})_i$  = Influent of Pollutant i into Prototype POTW A, in KKg/yr

$(\text{Prototype A Effluent})_i$  = Effluent of Pollutant i into Prototype POTW A, in KKg/yr

$\text{POTW}_j \text{ Flow}$  = Flow from POTW j, in Millions of Gallons per Day

$\text{Prototype A Flow}$  = Flow from Prototype POTW A, in Millions of Gallons per Day

secondary treatment, with the remainder being volatilized. We estimated these values using Basic Equation II, shown on the next page.

This equation assumes that 50% of the pollutant is removed during treatment and the amount that does not remain in the sludge is volatilized to the air. The flow portion of the equation is used to proportion the loading of the Prototype A to that of the POTW being evaluated.

#### (4) POTWs in Each of the Other Categories

As indicated in Exhibit 2, each of the rest of the POTWs was sorted into one of the nine other categories. As shown in Exhibit 2, we used either Equation I or Equation II to estimate air volatilization emissions from each of these POTWs, using the appropriate prototypes derived from the "50-POTW" monitoring study. (Each prototype is described in a table attached to the end of this Appendix.)

### 3. Phase II Methodology

As described previously, in Phase II we are analyzing 35-50 counties in more depth. As part of this effort we are refining emissions estimates for selected sources and pollutants. We will refine our estimates of POTW volatilization emissions if it appears that such refinements would have a substantial impact on our Phase II results. Our basic approach will be to continue to use Basic Equations I and II. However, we will use an expanded number of prototypes, to more closely match POTWs in the 35-50 counties with prototypes from the "50-POTW" monitoring study. For example, we may attempt to match POTWs and prototypes based on a more refined distinction of the types of industries that are indirect dischargers to the POTWs.

If it appears that there would be a high payoff from developing and implementing a more refined methodology for estimating POTW volatilization in

Basic Equation II

$$(\text{Annual Air Emissions})_{i,j} = [(\text{Prototype A Influent})_i \times (0.5) - (\text{Prototype A Sludge})_i] \times [(\text{POTW}_j \text{ Flow}) / (\text{Prototype A Flow})],$$

where

Annual Air Emissions<sub>i,j</sub> = Volatilization air emissions of pollutant i from POTW j, in KKg/yr

(Prototype A Influent)<sub>i</sub> = Influent to Prototype A of pollutant i, in KKg/yr

(Prototype A Sludge)<sub>i</sub> = Amount of Pollutant i remaining in the sludge for Prototype A

POTW<sub>j</sub> Flow = Amount of Flow for POTW j in Millions of Gallons per Day

Prototype A Flow = Amount of Flow for Prototype A, in Millions of Gallons per Day



phase II, we will document the methodology in a revised version of this appendix.

### c. Alternative Methodologies Considered

Before selecting the methodology described above, we first considered two alternatives:

- JRB's POTW Model. This model was developed to assess pretreatment control options. The model reviews the estimated 2000 POTWs requiring pretreatment, determines and quantifies the pretreatment options for each, and then aggregates the results in order to estimate the national impact. We decided not to use this model primarily because it uses too many generic simplifying assumptions. For example, it assumes that for any POTW:
  - 90% of toxic organics are volatile
  - 80% of volatiles are removed by the POTW
  - 90% of the volatiles removed are released to the atmosphere

In contrast, the methodology we used took advantage of actual monitoring data wherever possible.

- Site Specific Characterization of POTWs. Another alternative we considered was to perform detailed data gathering (e.g., including on-site visits) for selected POTWs. This effort would in part entail collecting information on numerous indirect dischargers to POTWs to assess the sources of volatile organics (i.e., instead of relying on IFD data) and to obtain site-specific monitoring data. We rejected this

option because it would be far too expensive and time consuming to fit within our limited budget and timeframe.

The methodology that we used (described in section B of this appendix) is a screening exercise, and as such has limitations. For example:

- The IFD file does not contain all POTWs which receive industrial dischargers -- only about 90% are identified. Therefore, we may have missed some POTWs with significant volatilization releases.
- We had limited data on the indirect dischargers to POTWs. Only the facilities listed by POTWs in Section 4 or 8 of their permits are in IFD. (For example, one of the Philadelphia POTWs is listed in IFD as having 4 indirect dischargers; site-specific information compiled by the City of Philadelphia indicates that this POTW has over 100 indirect dischargers.)
- The monitoring data in the "50-POTW" study was available only for POTWs with flows greater than 5 MGD. However, in the data base 65 percent of the POTWs discharge less than 5 MGD. There may be a difference in removal rates and operational practices based on size. However, no data are readily available to assess these differences.
- We did not estimate potential volatilization releases from sludge.

Despite these limitations, we felt that on balance the methodology we used was the best available within the budget and timeline constraints, especially considering the key strengths of this approach:

- Our methodology incorporated the most comprehensive available list of POTWs with data on industrial discharges and POTW location (i.e., the IFD file).
- The IFD file is available on-line, which facilitated our data retrieval and manipulation.
- Our equations for estimating releases took into account site-specific data on key factors, such as treatment (e.g., primary, advanced primary, etc.), percent contribution from industry and total flow.
- Our equations also took advantage of actual monitoring data.

## ATTACHMENTS

The following attachments present data for the prototypes derived from the previously cited "50-POTW" Study.

POTW Prototype Code: A

POTW Flow (gal/day):  $29.95 \times 10^6$

| Pollutants           | Influent<br>(KKg/yr) | Effluent<br>(KKg/yr) | Sludge<br>(KKg/yr) |
|----------------------|----------------------|----------------------|--------------------|
| Benzene              | 0.085                | 2.085                | <0.02              |
| Ethyl benzene        | 0.025                | 0.025                | <0.02              |
| Ethylene dichloride  | <0.02                | <0.02                | N.D.               |
| Carbon Tetrachloride | <0.035               | N.D.                 | N.D.               |
| Chloroform           | 0.165                | 0.095                | N.D.               |
| Vinyl Chloride       | N.D.                 | N.D.                 | N.D.               |
| Trichloroethylene    | 1.195                | <0.02                | <0.02              |
| Perchloroethylene    | 0.165                | 0.02                 | <0.02              |
| Acrylonitrile        | N.D.                 | N.D.                 | N.D.               |

POTW Prototype Code: B.1

POTW Flow (gal/day):  $40.4 \times 10^6$

| <u>Pollutants</u>    | <u>Influent</u><br><u>(KKg/yr)</u> | <u>Effluent</u><br><u>(KKg/yr)</u> | <u>Sludge</u><br><u>(KKg/yr)</u> |
|----------------------|------------------------------------|------------------------------------|----------------------------------|
| Benzene              | 0.29                               | <0.02                              | <0.02                            |
| Ethyl benzene        | 2.11                               | 0.04                               | 0.13                             |
| Ethylene dichloride  | 0.03                               | <0.02                              | <0.02                            |
| Carbon Tetrachloride | <0.02                              | <0.02                              | <0.02                            |
| Chloroform           | 0.44                               | 0.22                               | <0.02                            |
| Vinyl Chloride       | 22.11                              | 1.55                               | <0.02                            |
| Trichloroethylene    | 5.01                               | 0.47                               | 0.02                             |
| Perchloroethylene    | 5.39                               | 1.60                               | <0.02                            |
| Acrylonitrile        | 0.15                               | 0.03                               | <0.02                            |

POTW Prototype Code: B.2

POTW Flow (gal/day):  $13.04 \times 10^6$

| Pollutants           | Influent<br>(KKg/yr) | Effluent<br>(KKg/yr) | Sludge<br>(KKg/yr) |
|----------------------|----------------------|----------------------|--------------------|
| Benzene              | 0.95                 | <0.04                | <0.02              |
| Ethyl benzene        | 0.27                 | 0.05                 | <0.02              |
| Ethylene dichloride  | 55.8                 | 6.12                 | 0.16               |
| Carbon Tetrachloride | <0.02                | N.D.                 | N.D.               |
| Chloroform           | 0.31                 | 0.09                 | <0.02              |
| Vinyl Chloride       | 0.24                 | N.D.                 | N.D.               |
| Trichloroethylene    | 1.33                 | 0.02                 | 0.02               |
| Perchloroethylene    | 0.71                 | 0.13                 | 0.03               |
| Acrylonitrile        | N.D.                 | N.D.                 | N.D.               |

POTW Prototype Code: B.3

POTW Flow (gal/day):  $29.7 \times 10^6$

| <u>Pollutants</u>    | <u>Influent</u><br>(KKg/yr) | <u>Effluent</u><br>(KKg/yr) | <u>Sludge</u><br>(KKg/yr) |
|----------------------|-----------------------------|-----------------------------|---------------------------|
| Benzene              | 3.27                        | 0.06                        | <0.02                     |
| Ethyl benzene        | 2.85                        | 0.09                        | 0.16                      |
| Ethylene dichloride  | 77.9                        | 39.28                       | 11.55                     |
| Carbon Tetrachloride | 1.29                        | 0.14                        | 0.32                      |
| Chloroform           | 5.10                        | 0.90                        | 0.16                      |
| Vinyl Chloride       | 0.15                        | N.D.                        | <0.02                     |
| Trichloroethylene    | 7.89                        | 1.0                         | 3.69                      |
| Perchloroethylene    | 29.75                       | 4.06                        | 0.04                      |
| Acrylonitrile        | 1.52                        | 0.09                        | 0.14                      |



1TW Prototype Code: C.1

POTW Flow (gal/day):  $63.6 \times 10^6$

| Pollutants           | Influent<br>(KKg/yr) | Effluent<br>(KKg/yr) | Sludge<br>(KKg/yr) |
|----------------------|----------------------|----------------------|--------------------|
| Benzene              | 1.34                 | <0.02                | 0.04               |
| Ethyl benzene        | 1.45                 | 0.06                 | 0.06               |
| Ethylene dichloride  | 0.02                 | <0.02                | <0.02              |
| Carbon Tetrachloride | 3.28                 | 0.02                 | <0.02              |
| Chloroform           | 1.87                 | 0.36                 | <0.02              |
| Vinyl Chloride       | 0.53                 | N.D.                 | N.D.               |
| Trichloroethylene    | 4.78                 | 0.03                 | 0.19               |
| Perchloroethylene    | 3.56                 | 0.21                 | 0.03               |
| Acrylonitrile        | N.D.                 | N.D.                 | <0.02              |

POTW Prototype Code: C.2

POTW Flow (gal/day):  $15.1 \times 10^6$

| Pollutants           | Influent<br>(KKg/yr) | Effluent<br>(KKg/yr) | Sludge<br>(KKg/yr) |
|----------------------|----------------------|----------------------|--------------------|
| Benzene              | <0.02                | <0.02                | <0.02              |
| Ethyl benzene        | 0.09                 | <0.02                | 0.02               |
| Ethylene dichloride  | N.D.                 | N.D.                 | N.D.               |
| Carbon Tetrachloride | N.D.                 | N.D.                 | N.D.               |
| Chloroform           | 0.05                 | <0.02                | N.D.               |
| Vinyl Chloride       | N.D.                 | N.D.                 | N.D.               |
| Trichloroethylene    | 1.07                 | 0.39                 | N.D.               |
| Perchloroethylene    | 5.64                 | 0.16                 | N.D.               |
| Acrylonitrile        | N.D.                 | N.D.                 | N.D.               |

Table 11. Illustrative Per Capita Risk Associated with Air Toxics Release from TSDFs and Superfund Sites<sup>1</sup>

| Compound                               | Concentration (ug/m <sup>3</sup> ) |       |      | CAG<br>Unit Risk<br>Number | Per Capita Risk      |                         |                      |
|--|------------------------------------|-------|------|----------------------------|----------------------|-------------------------|----------------------|
|  | Max                                | Avg.  | Min  |                            | Max                  | Avg.                    | Min                  |
| Downwind <sup>2</sup> :                |                                    |       |      |                            |                      |                         |                      |
| benzene <sup>3</sup>                   | 319                                | -     | 24.2 | 6.9x10 <sup>-6</sup>       | 2.2x10 <sup>-3</sup> | -                       | 1.7x10 <sup>-4</sup> |
| benzene <sup>4</sup>                   | 3.8                                | -     | 0.0  | 6.9x10 <sup>-6</sup>       | 2.6x10 <sup>-5</sup> | -                       | 0.0                  |
| benzene <sup>4</sup>                   | 1.0                                | -     | 0.0  | 1.0x10 <sup>-5</sup>       | 1.0x10 <sup>-5</sup> | -                       | 0.0                  |
| benzene <sup>4</sup>                   | 12.1                               | -     | 0.0  | 2.61x10 <sup>-6</sup>      | 3.2x10 <sup>-5</sup> | -                       | 0.0                  |
| benzene <sup>4</sup>                   | 6.8                                | -     | 0.0  | 1.7x10 <sup>-6</sup>       | 1.2x10 <sup>-5</sup> | -                       | 0.0                  |
| benzene <sup>4</sup>                   | 5.4                                | -     | 2.1  | 4.1x10 <sup>-6</sup>       | 2.2x10 <sup>-5</sup> | -                       | 8.6x10 <sup>-6</sup> |
| benzene <sup>4</sup>                   | 6.3                                | -     | 0.8  | 7.0x10 <sup>-6</sup>       | 4.4x10 <sup>-5</sup> | -                       | 5.6x10 <sup>-6</sup> |
| Sample location unknown <sup>5</sup> : |                                    |       |      |                            |                      |                         |                      |
| benzene <sup>6</sup>                   | 364                                | 60    | -    | 6.9x10 <sup>-6</sup>       | 2.5x10 <sup>-3</sup> | 4.1x10 <sup>-4</sup>    | -                    |
| benzene <sup>7</sup>                   | -                                  | (9.6) | -    | 6.9x10 <sup>-6</sup>       | -                    | (6.6x10 <sup>-5</sup> ) | -                    |
| benzene <sup>6</sup>                   | 190                                | 15    | -    | 1.0x10 <sup>-5</sup>       | 1.9x10 <sup>-3</sup> | 1.5x10 <sup>-4</sup>    | -                    |
| benzene <sup>8</sup>                   | 28.5                               | 7.4   | -    | 1.0x10 <sup>-5</sup>       | 2.9x10 <sup>-4</sup> | 7.4x10 <sup>-5</sup>    | -                    |
| benzene <sup>8</sup>                   | 13.9                               | 3.2   | -    | 1.5x10 <sup>-5</sup>       | 2.1x10 <sup>-4</sup> | 4.8x10 <sup>-5</sup>    | -                    |
| benzene <sup>9</sup>                   | 36                                 | 14.3  | -    | 4.1x10 <sup>-6</sup>       | 1.5x10 <sup>-4</sup> | 5.9x10 <sup>-5</sup>    | -                    |
| benzene <sup>6</sup>                   | 3.2                                | -     | -    | 2.61x10 <sup>-6</sup>      | 8.4x10 <sup>-6</sup> | -                       | -                    |
| benzene <sup>10</sup>                  | 4896                               | 1229  | -    | 2.61x10 <sup>-6</sup>      | 1.3x10 <sup>-2</sup> | 3.2x10 <sup>-3</sup>    | -                    |

Risk values presented in the table are illustrative in nature. They are based on an assumed lifetime exposure to the indicated chemical concentrations, and thus equate with a worst case scenario. They are not intended to represent an accurate determination of the real world risk experienced by populations in the vicinity of these sites. See text for a more detailed discussion of these data and caveats pertaining to them.

Downwind concentrations are much more likely to approximate expected risk than are on-site concentrations (see text).

Concentration data from Table 7.

Concentration data from Table 6, BKK, CA.

It was not possible to determine the specific sites where samples corresponding with these concentration values were obtained (e.g., on-site vs. off-site, vent vs. ambient air). Thus, these data can not be assumed to represent average, off-site breathing zone concentrations/risk.

Concentration data from Table 4, BKK Corp, CA.

Concentration data from Table 4, Kin-Buc, NJ (only one value reported).

Concentration data from Table 4, Kin-Buc, NJ

Concentration data from Table 4, BKK Corp, CA. Table 4 also reports measured values of 2.1x10<sup>6</sup> and 1.6x10<sup>6</sup>

for trichloroethylene at Kin-Buc, NJ. However, these numbers were not included in this table because they could not be corroborated from the primary source reports.

Concentration data from Table 4, Landfill #2.

**Table 10. Measured Air Toxics Concentrations of Two Superfund Sites**

| Site                    | Waste Management Process | Chemical Species | Concentration (ug/m <sup>3</sup> ) |
|-------------------------|--------------------------|------------------|------------------------------------|
| Kramer NJ <sup>1</sup>  | LF                       | Benzene          | 0.2                                |
|                         |                          | Ethylbenzene     | 0.3                                |
|                         |                          | Styrene          | 0.2                                |
| Gratiot MI <sup>2</sup> | LF                       | Benzene          | 3.2                                |

<sup>1</sup>Sample obtained near entrance to dump.

<sup>2</sup>Sample obtained downwind of site.

Source: Untitled draft paper provided to L.Schultz (Versar Inc.) by Elaine Haemisegger (EPA)

- In many cases, only generic air contaminant data was recorded.
- Many files contained no Remedial Action Master Plan (RAMP) or RI/FS document. This could be due to a state or region taking the lead in site analysis and remediation and thus having possession of relevant documentation, or to EPA headquarters personnel using the report at the time the file review was made. In other cases RAMP or RI/FS documents have not yet been generated.
- In a number of cases, although air release is significant, detailed quantification for releases is not addressed in site documentation because the remediation method planned to control contamination of another medium of primary concern will also control air release (e.g., soil contamination remediation via clay cover will also prevent air release). Generally, Superfund analyses appear to concentrate primarily on water contamination problems, and secondarily on air.
- o Although data quantifying concentrations of specific air toxics at Superfund sites are sparse at present, some data for contaminants of concern in this evaluation are available (reports provided by E. Haemisegger, USEPA). These are summarized in Table 10 for two superfund sites. Note that the concentrations cited in this table are in most cases lower than those found at active TSDFs (see Tables 4,5, and 6). This is not surprising as highly volatile materials will have had ample time to escape from abandoned sites, while their release from active sites would be ongoing. It is interesting, however, that the benzene concentrations obtained downwind from the Gratiot, MI site correspond well with those obtained at two of the residential sampling sites downwind of the BKK Landfill (see Table 6). Note, however, that the Gratiot concentration value is "total" while the BKK concentration is "net" (ambient minus control).

7. Air toxics release from TSDFs may pose significant risk to receptor populations.

- o In order to obtain a perspective on the level of possible risk to receptor populations, air toxics concentration data from preceeding tables have been used with current CAG unit risk numbers to calculate estimates of per capita risk. These data are presented in Table 11 for chemicals with measured concentrations at TSDFs and/or Superfund sites, and for which CAG risk numbers are available. They should only be interpreted as rough screening indicators of risk. It is important to note that interpretation of the risk data presented in Table 11 is subject to the following significant caveats:

parameters in predicting emission of compound classes (see Radian n.d.). Results such as those shown in Table 9 highlight the need for further model development and field validation to generate estimation methods which are sensitive to and account for the range of compounds and conditions actually found at TSD facilities.

6. Uncontrolled hazardous waste facilities (Superfund sites) have been demonstrated to be significant air toxics release sources:
  - Air releases must be "observed" in order for an abandoned site to be listed on the National Priorities List as a Superfund site. This is contrasted against the "potential" for release to surface or ground water to serve as partial grounds for NPL listing (see the National Oil and Hazardous Substances Contingency Plan (NCP): Hazard Ranking System (HRS) - 40 CFR Part 300: Appendix A). The requirement for an observed release for air ranking resulted from a lack of any better method for considering the air route. No good, consistent correlation was found between physical/chemical properties of wastes and air migration potential\*. To date, using the current HRS scoring system, 109 sites have been listed on the NPL due to high air scores. Of these, 43 were listed for particulate, heavy metal, or radium releases. The remaining 67 sites are those with volatile organic releases. This represents a total of 16% of all NPL sites currently listed.
  - Guidance for conducting Remedial Investigations and Feasibility Studies (RI/FS) at listed Superfund sites give equal consideration to air exposure vs other exposure routes (see draft Remedial Investigation Guidance Document (EPA 1984), draft Feasibility Study Guidance Document (EPA 1983), and draft Feasibility Study Background Document (Versar 1983)).
  - In order to obtain air toxics data for uncontrolled hazardous waste facilities to compare with controlled TSDFs, a brief review of the Superfund files at EPA was made. However, the effort did not uncover useful data (i.e., quantitative data for specific contaminant species) for the following reasons:

---

\*Personal communication between Lee Schultz (Versar Inc.), and S. Caldwell (EPA Superfund Remedial Action) June 14, 1984. See also the preamble to the NCP final rule, Federal Register Volume 47, No. 137, wherein comments on the proposed HRS and responses thereto are published.

**Table 9. TSDF Air Emission Measurement/Estimation Comparison Results  
(non-Methane Hydrocarbons)**

| Site | Source                                   | Sampling<br>Technique<br>Used   | Measured<br>Emissions  | Predicted<br>Emissions  | Model<br>Used                      |
|------|--|---------------------------------|------------------------|-------------------------|------------------------------------|
| 2    | Land treatment <sup>a</sup>              | flux chamber<br>method          | 725<br>60.8<br>112     | 47400<br>9480<br>8010   | Thibodeaux and<br>Hwang (1982)     |
|      |  | concentration<br>profile method | 1250<br>963<br>1000    | 13400<br>13000<br>10100 |                                    |
| 5    | Reducing <sup>b</sup><br>lagoon          | flux chamber<br>method          | 9.2<br>14.5            | 35.4<br>32.7            | Thibodeaux<br><u>et al.</u> (n.d.) |
| 5    | Oxidizing <sup>b</sup><br>lagoon         | flux chamber<br>method          | 60.0<br>54.6           | 17000<br>5080           |                                    |
| 5    | Holding pond <sup>b</sup>                | concentration<br>profile method | 0.182<br>2.09<br>0.558 | 5.22<br>5.24<br>0.268   | Thibodeaux<br><u>et al.</u> (n.d.) |
|      |  | flux chamber<br>method          | 2.64<br>3.72           | 5.24<br>0.268           |                                    |
| 6    | Spray evapo- <sup>b</sup><br>ration pond | transect<br>method              | 55.1<br>41.7           | 197<br>197              | Thibodeaux<br><u>et al.</u> (n.d.) |

<sup>a</sup>units = ug-C/m<sup>2</sup>-sec

<sup>b</sup>units = ug/m<sup>2</sup>-sec

Source: Radian (n.d.)

5. Numerous studies have been conducted or are ongoing to address TSDF air release analysis needs:

- Attachment A provides a summary of studies related to the TSDF air release issue. This listing is taken from the proceedings of a workshop on TSDF research held in October, 1983 (see JACA 1983)
- Even in light of the many current and recent TSDF related studies, much work remains to be done to fill in critical data gaps.
  - Attachment B lists continuing source characterization research needs as summarized at the JACA workshop.
  - Attachment C presents a summary of areas requiring additional research in support of EPA/OAQPS responsibility to research and develop standards limiting air emissions from TSDFs (Battye et al. 1984).
- One area requiring significant work is the development of sampling/analysis and estimation procedures for air releases from TSDF processes. It is recognized that air release estimation is still in its infancy. Although models of release from various TSDF sources have been developed (see Farino et al. 1983, Wetherold and Dubose 1982), they generally require further refinement and validation. Validation necessitates development of field methods specific to TSDF sampling and analysis. Work is currently underway (see Radian n.d.) to field test certain air release sampling methods, and to test the TSDF release estimation methods summarized in Farino et al. (1983). Table 9 provides an overview of the results of some of the emission measurement/estimation comparison efforts conducted for total non-methane hydrocarbons at these TSDFs. As can be seen from the data in the table, in some cases the estimated values compare reasonably well with the measured values, while in many others the estimation models performed poorly. For site #5, oxidizing lagoon, the great disparity between measured and estimated values is thought to result from the presence of a sludge/oil/aqueous surface at this lagoon (see Radian n.d.). The difference in measured and predicted emission rates for the spray evaporation pond at site #6 is at least partly due to the predictive model's current inability to consider both evaporative and spray losses (only evaporative loss is modeled at present). In the land treatment evaluation at site 2, predicted and measured values for specific compounds agreed much more than did those for compound classes (e.g., non-methane hydrocarbons). This is probably due to the use of composite



Table 8. TSDF Emissions Estimates:  
Percentage Release by Process

| Process                    | Percent of total<br>estimated TSDF Emissions |
|----------------------------|--|
| Storage Tanks              | 0.6  |
| Aerated-SI                 | 4.0  |
| Treatment Tanks            | 32.5   |
| NSI-Storage <sup>a</sup>   | 26.0   |
| NSI-Treatment <sup>a</sup> | 18.7   |
| NSI-Disposal <sup>a</sup>  | 4.0  |
| Land Application           | 2.7  |
| Landfill                   | <u>11.5</u>                                  |
| Total                      | 100.0  |

<sup>a</sup>NSI = Non-aerated surface impoundment.

Source: Breton et al (1983), GCA Corporation.

Table 7. Concentrations of Two Toxic Volatile Organic Compounds  
Found in the Ambient Air at Hazardous Waste Facilities

| Facility<br>Type <sup>1</sup> | Background<br>Type <sup>2</sup> | Ambient Air Concentrations, ug/m <sup>3</sup> |               |       |                  |               |       |
|-------------------------------|---------------------------------|---|---------------|-------|------------------|---------------|-------|
|                               |                                 | Benzene                                       |               |       | Ethyl<br>Benzene |               |       |
|                               |                                 | Up-<br>wind                                   | Down-<br>wind | Δ     | Up-<br>wind      | Down-<br>wind | Δ     |
| IN/SI                         | R,I                             | 25.5  | 191.4         | 165.9 | 13.3             | 52.2          | 38.9  |
| SI/LA                         | R,I                             | 26.8  | 51.0          | 24.2  | 14.2             | 41.8          | 27.5  |
| LF/SI/LA                      | R                               | 40.2  | 338.2         | 298.0 | 16.1             | 303.6         | 287.5 |
| LF/SI/LA                      | R                               | 89.3  | 146.7         | 57.4  | 99.6             | 113.9         | 14.2  |
| LF <sup>3</sup>               | U                               | 47.8  | 366.9         | 319.0 | 49.8             | 175.5         | 125.7 |

<sup>1</sup>Facility type - SI=surface impoundment, LA=land application, LF=landfill,  
IN=incineration

<sup>2</sup>Background type: R=rural, I=industrial, U=urban.

<sup>3</sup>Codisposal landfill

Source: Ase (1981)

- 70 (16%) of the total 430 disposal facilities land apply  $0.1 \times 10^9$  gallons (1%) of the total  $14.7 \times 10^9$  gallons disposed.

Thus, approximately  $36.7 \times 10^9$  gallons (51%) of total quantity of wastes managed at TSDFs are managed (treated, stored, and/or disposed) in impoundments or in/on the land, with impoundments equating with 50% of all wastes managed.

- It is interesting to note that landfills constitute the largest disposal category (46% of the disposal facilities surveyed reported using landfills), and yet they receive only 5% of the total amount of waste reported as being disposed. Conversely, the majority of wastes disposed (59%) go to injection wells, which were reported as being employed at only 20% of the facilities surveyed.
- The air contamination potential of this situation is reflected in the above numbers and the fact that even compounds with extremely low vapor pressure and low solubility in water can be subject to significant volatilization release when placed in surface impoundments or in landfills [or landfarms] (Hwang 1982).

4. Various studies reflect the potential for toxic VOC release from TSDFs overall (i.e., total aggregate release from a facility).

- A 1981 study of TSDF releases (Ase 1981) measured the ambient downwind and upwind (background) concentrations for the five toxic compounds shown in Table 7. The data clearly indicate an increase in ambient concentrations downwind of the TSDFs.
- Breton et al. (1983) estimated emissions from TSDFs and compared them with stationary and mobile sources. Although the accuracy of their quantitative estimates are quite questionable for a number of good reasons (see EPA/OAQPS comments on Breton et al. 1983), the relative contribution of various TSDF processes (based on the Breton et al. estimates) shown in Table 8 is interesting to note. These data not only further support the significance of surface impoundments as VOC release sources, but also highlight the significant release potential associated with treatment tanks. From the data in No. 1 above (Westat 1984), 609 (41% of the total 1495 treatment facilities) treat  $8.73 \times 10^9$  gallons (18% of the total  $47.5 \times 10^9$  gallons of waste treated) in tanks.

Table 6. Net Increase in Toxic Air Contaminants  
Originating at BKK Landfill, CA<sup>a</sup>.

|                     | Site A<br>(ug/m <sup>3</sup> ) | Site B<br>(ug/m <sup>3</sup> ) | Site E<br>(ug/m <sup>3</sup> ) | Site F<br>(ug/m <sup>3</sup> ) |
|---------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Vinyl Chloride      | 12.1                           | 6.4                            | 0.0                            | 0.0                            |
| Perchloroethylene   | 6.8                            | 3.4                            | -0.7 <sup>b</sup>              | 4.1                            |
| Trichloroethylene   | 3.2                            | 5.4                            | 2.1                            | 3.8                            |
| Ethylene Dichloride | 6.3                            | 4.8                            | 0.8                            | 0.8                            |
| Chloroform          | 0.0                            | 0.5                            | -1.0 <sup>b</sup>              | -1.0 <sup>b</sup>              |
| Benzene             | 3.8                            | 3.2                            | -1.9 <sup>b</sup>              | -1.9 <sup>b</sup>              |

<sup>a</sup>The values presented in this table were obtained by subtracting the average mean control values from the average mean non-control (ambient air in residential areas) values reported in the source document. Sampling was conducted over a three month period.

<sup>b</sup>Negative values indicate that the control value was higher than the non-control value.

Source: CDHS (1983)

Table 5. Examples of Maximum Concentrations of Toxic Air  
Contaminants Found in Air Near Hazardous Waste Sites

| Chemical             | Site  |   |  |
|----------------------|---|---|--|
|                      | Love Canal<br>Niagara Falls, NY<br>(ug/m <sup>3</sup> ) | Kin-Buc<br>Edison, NJ<br>(ug/m <sup>3</sup> ) | Elizabeth,<br>NJ<br>(ug/m <sup>3</sup> ) |
| Benzene              | 5703  | 1550  | 234                                      |
| Acetaldehyde         |   | 245   |  |
| Phenol               |   | 10  |  |
| Chloroform           | 172   | 266   |  |
| Methylene chloride   | 10  | 1250  |  |
| Trichloroethylene    | 270   | 93  | 218                                      |
| Perchloroethylene    | 1140  | 394   | 95                                       |
| Carbon tetrachloride | 5   | 20  |  |
| Chlorobenzene        | 240   | 50  | 16                                       |

Source: Esposito et al. (1981)

Table 4. Concentrations of Toxic Air Pollutants at Hazardous Waste Landfills

| Component            | <u>Source #1</u>                     |      |                                    |      |   |     |                                     |                       | <u>Source #2</u>                    |
|----------------------|--------------------------------------|------|------------------------------------|------|---|-----|-------------------------------------|-----------------------|-------------------------------------|
|                      | BKK Corp, CA<br>(ug/m <sup>3</sup> ) |      | Landfill 2<br>(ug/m <sup>3</sup> ) |      | Caputo Landfill, NY<br>(ug/m <sup>3</sup> ) |     | Kin-Buc, NJ<br>(ug/m <sup>3</sup> ) |                       | Kin-Buc, NJ<br>(ug/m <sup>3</sup> ) |
|                      | Max.                                 | Av.  | Max.                               | Av.  | Max.  | Av. | Max.                                | Av.                   |                                     |
| toluene              | 2400                                 |      |                                    |      |   |     |                                     |                       |                                     |
| ethylbenzene         | 950                                  |      |                                    |      |   |     |                                     |                       | 23.2                                |
| xylene               | 364                                  | 60   |                                    |      |   |     |                                     |                       | 9.6                                 |
| chloroform           | 190                                  | 15   |                                    |      |   |     | 28.5                                | 7.4                   |                                     |
| chlorobenzene        | 242                                  |      |                                    |      |   |     |                                     |                       | 59.6                                |
| carbon Tetrachloride |                                      |      |                                    |      |   |     | 13.9                                | 3.2                   |                                     |
| trichloroethylene    | 36                                   | 14.3 |                                    |      |   |     | 2.1x10 <sup>6</sup> *               | 1.6x10 <sup>6</sup> * |                                     |
| phosgene             | 3.2                                  |      | 4896                               | 1229 |   |     |                                     |                       |                                     |
| nitrogen             |                                      |      |                                    |      | 300   | 130 |                                     |                       |                                     |
| ethylene chloride    |                                      |      |                                    |      |   |     |                                     |                       | 57.4                                |

The magnitude of these values is so great that their accuracy is questionable. They could not be verified from the data presented in the original source references cited in the secondary source from which they were extracted. Therefore, these values may represent typographical or other error, and are not considered to represent ambient air concentrations at or near the site.

Source #1: Huang (1982) - data taken from various sources cited in Huang (1982)

Source #2: USEPA. 1982.

- Other studies report the results of measurement of air concentrations of various toxic air contaminants at several landfills.
  - Table 4 presents a summary of the results of certain studies, as summarized in Hwang (1982). It could not be determined from this source where the exact locations of the sampling points were (i.e., on-site or off-site).
  - Table 5 also summarizes ambient air concentrations of toxic contaminants at or near TSD facilities. The data in that table, however, equate with maximum reported concentrations, and they represent a likely worst case. In addition, the source from which these data were obtained (Esposito et al. 1981) states that it was not possible to determine the exact locations (on- or off-site) from which the samples represented by these data were obtained.
  - Ambient concentrations of certain air toxics have also been reported in detail for residential areas adjacent to BKK landfill in California and at a distant control site. This sampling effort was conducted over a three month period. The results are summarized in condensed form in Table 6, which presents net air contaminant loading assumed to be attributable to the landfill (ambient concentrations in residential areas minus control concentrations).

3. A large proportion of wastes handled at TSDFs are managed in open systems.

- From the data in No. 1 above (Westat 1984):
  - 410 (27%) of the total 1495 treatment facilities impound  $16.6 \times 10^9$  gallons (35%) of the total  $47.5 \times 10^9$  gallons treated.
  - 552 (13%) of the total 4299 storage facilities impound  $14.1 \times 10^9$  gallons (39%) of the total  $36.5 \times 10^9$  gallons stored.
  - 116 (27%) of the total 430 disposal facilities impound  $5.1 \times 10^9$  gallons (35%) of the total  $14.7 \times 10^9$  gallons disposed.
  - 199 (46%) of the total 430 disposal facilities landfill  $0.8 \times 10^9$  gallons (5%) of the total  $14.7 \times 10^9$  gallons disposed.

Table 3. Volatile Organic Emissions from Stationary and Mobile Sources

|   | <u>Tons/year</u>   |                    |
|---|--------------------|--------------------|
|   | <u>Source #1</u>   | <u>Source #2</u>   |
| Industrial Sources                        | $3.5 \times 10^6$  | $9.8 \times 10^6$  |
| Stationary Fuel Combustion                | $1.4 \times 10^6$  | $0.9 \times 10^6$  |
| Open Burning                              | $1.0 \times 10^6$  |                    |
| Miscellaneous<br>(Organic Solvents, etc.) | $13.4 \times 10^6$ | $3.0 \times 10^6$  |
| Mobile Sources                            | $11.7 \times 10^6$ | $7.7 \times 10^6$  |
|   | <hr/>              | <hr/>              |
| Total                                     | $31.0 \times 10^6$ | $21.4 \times 10^6$ |

Stationary  
sources =  
 $19.3 \times 10^6$   
in 1975  
and  
 $13.7 \times 10^6$   
in 1981

---

Source #1: Hwang (1982) based on 1975 data presented in USEPA (1976)

Source #2: USEPA (n.d.), 1981 estimates as cited in Breton et al. (1983).  
Open burning and miscellaneous sources are combined and include  
incineration and open burning of solid waste.



Table 2. Estimated Volatile Organic Emissions from Hazardous Waste Facilities (1982 Estimates)\*

|                           | Tons/year          |                     |
|---------------------------|--------------------|---------------------|
| Surface Impoundments      |                    |                     |
| Disposal                  | $4.0 \times 10^6$  | } $1.9 \times 10^6$ |
| Treatment                 | $7.0 \times 10^6$  |                     |
| Storage                   | $8.0 \times 10^6$  |                     |
| Landfills                 | $4.7 \times 10^6$  |                     |
| Land Treatment Facilities | $1.8 \times 10^6$  |                     |
|                           | <hr/>              |                     |
| Total                     | $25.5 \times 10^6$ |                     |

---

Source: Hwang (1982)

\*Note that Hwang (1982) does not present a detailed explanation of the derivation of these estimates. Thus, their reliability can not be determined.

- Quantity (percent) of the total  $36.5 \times 10^9$  gallons of waste stored by each storage category:\*

|                                |                                 |
|--------------------------------|---------------------------------|
| - storage tanks                | $5.1 \times 10^9$ gallons (14)  |
| - storage containers           | $0.2 \times 10^9$ gallons (<1)  |
| - storage surface impoundments | $14.1 \times 10^9$ gallons (39) |
| - waste piles                  | $0.4 \times 10^9$ gallons (1)   |
| - other                        | $0.3 \times 10^9$ gallons (<1)  |

- Quantity (percent) of the total  $14.7 \times 10^9$  gallons of waste disposed by each disposal category:\*

|                                 |                                 |
|---------------------------------|---------------------------------|
| - injection wells               | $8.6 \times 10^9$ gallons (59)  |
| - landfills                     | $0.8 \times 10^9$ gallons (5)   |
| - disposal surface impoundments | $5.1 \times 10^9$ gallons (35)  |
| - land application              | $0.1 \times 10^9$ gallons (1)   |
| - other                         | $<0.1 \times 10^9$ gallons (<1) |

2. Volatile organic compounds managed in open systems (e.g., impoundments, landfills, etc.) may escape to the air in significant quantities:

- It has been estimated (Hwang 1982) that in 1982 impoundments and land disposal together released a total of approximately  $25.5 \times 10^6$  tons of VOC (see Table 2). This is compared with estimated totals of  $19.3 \times 10^6$  tons released by stationary sources and  $11.7 \times 10^6$  tons released by mobile sources, or a total of  $31.0 \times 10^6$  tons released by non-TSDF sources, in 1975, and  $13.7 \times 10^6$  tons released by stationary sources and  $7.7 \times 10^6$  tons released by mobile sources, or a total of  $21.4 \times 10^6$  tons released by non-TSDF sources, in 1981 (see Table 3). It should be noted that the above TSDF release estimates may be low because they do not consider the increase in emission rate resulting from impoundment aeration or surface turbulence (which would be expected in treatment impoundments). It has been calculated that up to an 80 fold increase in emission rate could result from agitation (adequate to cause surface turbulence) of 10% of an impoundment surface (EPA 1981 as cited in Hwang 1982). While this should not be interpreted to mean that surface impoundments overall release 80 times the level estimated in Table 2, it does provide additional perspective on the release potential associated with impoundments.

\*Number/quantity values rounded to one decimal point. Percent values rounded to whole percent. Also, note that the sum of the disaggregated treatment, storage, and disposal category values (numbers and quantities) are greater than the total number of facilities or quantities reported because some facilities employ multiple processes on-site.

- Number (percent) of the total 430 disposal facilities employing each disposal category:\*

|                                 |          |
|---------------------------------|----------|
| - landfills                     | 199 (46) |
| - disposal surface impoundments | 116 (27) |
| - injection wells               | 87 (20)  |
| - land application              | 70 (16)  |
| - other                         | 7 (2)    |

#### 8. Quantity of waste managed:

- Total quantity of waste managed =  $71.3 \times 10^9$  gallons  
( $264 \times 10^6$  metric tonnes)
- Quantity of waste managed by industry source:
 

|   |     |
|---|-----|
| - chemical and petroleum industries (SIC 28-29) | 85% |
| - Metal related industries (SIC 33-37)          | 7%  |
| - Other industries                              | 8%  |
- Quantity (percent) of the total  $71.3 \times 10^9$  gallons of waste treated, stored and/or disposed:
 

|            |                                 |
|------------|---------------------------------|
| - treated  | $47.5 \times 10^9$ gallons (67) |
| - stored   | $36.5 \times 10^9$ gallons (51) |
| - disposed | $14.7 \times 10^9$ gallons (21) |
- Quantity (percent) of the total  $47.5 \times 10^9$  gallons of waste treated by each treatment category:
 

|                                  |                                 |
|----------------------------------|---------------------------------|
| - treatment tanks                | $8.7 \times 10^9$ gallons (18)  |
| - treatment surface impoundments | $16.6 \times 10^9$ gallons (35) |
| - incinerators                   | $0.5 \times 10^9$ gallons (1)   |
| - other                          | $4.6 \times 10^9$ gallons (10)  |

\*Number/quantity values rounded to one decimal point. Percent values rounded to whole percent. Also, note that the sum of the disaggregated treatment, storage, and disposal category values (numbers and quantities) are greater than the total number of facilities or quantities reported because some facilities employ multiple processes on-site.

Summary of Information and Issues Pertaining to Hazardous  
Waste Treatment, Storage, and Disposal Facilities

1. In the Fall of 1982 and Spring of 1983, an extensive national survey of hazardous waste generators and treatment, storage, and disposal facilities was conducted by Westat, Inc. for EPA/OSW. Collation and tabulation of the data, obtained by questionnaire response and addressing generator and TSDF operations in 1981, has recently been completed, and the results published in a final summary report (Dietz et al. 1984). The following data pertaining to TSDFs have been extracted from that report:

A. Number of facilities:

- Total number of TSDFs = 4818
- Number (percent) of the total 4818 TSDF facilities employing treatment, storage and/or disposal:\*

|             |           |
|-------------|-----------|
| - treatment | 1495 (31) |
| - storage   | 4299 (89) |
| - disposal  | 430 (9)   |

- Number (percent) of the total 1495 treatment facilities employing each treatment category:\*

|                                  |          |
|----------------------------------|----------|
| - treatment tanks                | 609 (41) |
| - treatment surface impoundments | 410 (27) |
| - incinerators                   | 240 (16) |
| - other                          | 392 (26) |

- Number (percent) of the total 4299 storage facilities employing each storage category:\*

|                                |           |
|--------------------------------|-----------|
| - containers                   | 3577 (83) |
| - storage tanks                | 1428 (33) |
| - storage surface impoundments | 552 (13)  |
| - waste piles                  | 174 (4)   |
| - other                        | 139 (3)   |

\*Number/quantity values rounded to one decimal point. Percent values rounded to whole percent. Also, note that the sum of the disaggregated treatment, storage, and disposal category values (numbers and quantities) are greater than the total number of facilities or quantities reported because some facilities employ multiple processes on-site.

Table 1 (continued)

| Compounds                 | <u>Sources</u>             |                           |  |
|---------------------------|----------------------------|---------------------------|--|
|                           | 18 TSDF Study<br>Chemicals | List of 32<br>Carcinogens | 23 Toxics Summary<br>Information Chemicals |
| Hexachlorocyclopentadiene |                            | X                         | x <sup>4</sup>                             |
| Manganese                 |                            | X                         | x <sup>4</sup>                             |
| Methyl ethyl ketone       |                            |                           |  |
| Methylene chloride        |                            | X                         | x <sup>3</sup>                             |
| Methyl chloroform         |                            | X                         | x <sup>4</sup>                             |
| Nickel                    | X                          | X*                        | x <sup>1</sup>                             |
| Nitrobenzene              |                            | X                         |  |
| Nitrosomorpholine         |                            | X                         |  |
| PCBs                      |                            | X                         |  |
| Pentachlorophenol         |                            |                           | --   |
| Perchloroethylene         | X                          | X                         | x <sup>3</sup>                             |
| Phenol                    |                            | X                         |  |
| Phosgene                  |                            | X                         |  |
| Propylene oxide           |                            | X                         |  |
| Styrene                   | X                          |                           |  |
| Trichloroethylene         | X                          | X                         | x <sup>3</sup>                             |
| Vinyl chloride            | X                          |                           |  |
| Vinylidene chloride       |                            | X                         | x <sup>3</sup>                             |

\*Subsulfides and carboniles; oxides and sulfates.

Numerical superscripts indicate type and quality of health evidence:

- <sup>1</sup>human; strong
- <sup>2</sup>animal; strong
- <sup>3</sup>animal; weak
- <sup>4</sup>inadequate evidence

Table 1. Target Chemicals for Consideration in this Evaluation

| Compounds                       | <u>Sources</u>          |                        |   |
|---------------------------------|-------------------------|------------------------|---|
|                                 | 18 TSDF Study Chemicals | List of 32 Carcinogens | 23 Toxics Summary Information Chemicals |
| 1,2-Toluene diisocyanate        |                         |                        |   |
| 1,3-Butadiene                   | X                       |                        | x <sup>2</sup>                          |
| 4,4-Methylene dianiline         |                         |                        |   |
| Acetaldehyde                    |                         | X                      |   |
| Acrylonitrile                   | X                       | X                      | x <sup>2</sup>                          |
| Allyl chloride                  |                         | X                      |   |
| Arsenic                         | X                       |                        |   |
| Benzene                         | X                       |                        |   |
| Benzo(a)pyrene                  | X                       |                        |   |
| Benzyl chloride                 |                         | X                      |   |
| Beryllium                       |                         | X                      | x <sup>2</sup>                          |
| Cadmium                         | X                       | X                      | x <sup>3</sup>                          |
| Carbon disulfide                |                         |                        |   |
| Carbon tetrachloride            | X                       | X                      | x <sup>2</sup>                          |
| Chlorobenzene                   |                         |                        | x <sup>2</sup>                          |
| Chloroform                      | X                       | X                      | x <sup>2</sup>                          |
| Chloroprene                     |                         | X                      |   |
| Chromium                        | X                       |                        | x <sup>1</sup>                          |
| Coke oven emissions             |                         | X                      | x <sup>1</sup>                          |
| Dibenzofuran                    |                         |                        |   |
| Dimethyl nitrosamine            |                         | X                      |   |
| Diethylphthalate                |                         |                        |   |
| Dioxin (2,3,7,8,-TCDD)          |                         | X                      | x <sup>2</sup>                          |
| Epichlorohydrin                 |                         | X                      | x <sup>3</sup>                          |
| Ethyl benzene                   | X                       |                        |   |
| Ethylene bromide                | X                       |                        |   |
| Ethylene chloride               | X                       |                        |   |
| Ethylene dibromide              |                         | X                      |   |
| Ethylene dichloride             |                         | X                      | x <sup>2</sup>                          |
| Ethylene glycol monoethyl ether |                         |                        |   |
| Ethylene oxide                  |                         | X                      | x <sup>3</sup>                          |
| Formaldehyde                    | X                       | X                      |   |

## APPENDIX F-3

### Review of Air Toxics Data for TSDFs and Superfund Sites

This Appendix conveys findings concerning TSDF air toxics release issues. Included is a discussion of Superfund sites which ranked high in the HRS due to air releases of VOC.

Table 1 comprises a listing of those chemicals that were cited in materials provided by EPA (sources cited at the top of the table) as being toxic (due to carcinogenicity, etc.). This listing served as a focus for a review and qualitative evaluation of relevant TSDF reports. The remainder of this Appendix consists of material extracted from the reviewed literature, as well as conclusions drawn from that information. The material is organized into seven statements or observations, with accompanying bulleted items supporting/expanding each statement.

Per capita risk levels are calculated for those chemicals having HAP study unit risk numbers. These data are presented in Table 11. However, it is important to note that even those risk values that are based on the best air concentration available for this evaluation (i.e., net toxics concentration downwind of the TSDF facility - obtained by subtracting upwind/control values from downwind values) must be viewed as representing the worst case (i.e., constant exposure to the indicated concentration over a lifetime). Other values (on-site; maximum; sample site unknown) should be interpreted as extreme worst case - an unlikely scenario as people would not breathe on-site concentrations over a lifetime. Thus, these latter data are presented for illustrative purposes only and should not be interpreted to represent actual, real-world risk experienced by receptor populations.

POTW Prototype Code: C.3

POTW Flow (gal/day):  $19 \times 10^6$

| Pollutants           | Influent<br>(KKg/yr) | Effluent<br>(KKg/yr) | Sludge<br>(KKg/yr) |
|----------------------|----------------------|----------------------|--------------------|
| Benzene              | 0.03                 | 0.12                 | <0.02              |
| Ethyl benzene        | 0.26                 | 0.03                 | 0.06               |
| Ethylene dichloride  | N.D.                 | N.D.                 | N.D.               |
| Carbon Tetrachloride | N.D.                 | N.D.                 | N.D.               |
| Chloroform           | 0.20                 | 0.19                 | N.D.               |
| Vinyl Chloride       | N.D.                 | N.D.                 | 0.04               |
| Trichloroethylene    | 0.53                 | <0.02                | <0.02              |
| Perchloroethylene    | 0.52                 | <0.02                | <0.02              |
| Acrylonitrile        | N.D.                 | N.D.                 | <0.02              |



Table 11. (continued)

| Compound   | CAG                                       |        |     | Unit Risk<br>Number  | Per Capita Risk |                         |     |
|--|---|--------|-----|----------------------|-----------------|-------------------------|-----|
|  | Concentration (ug/m <sup>3</sup> )<br>Max | Avg.   | Min |                      | Max             | Avg.                    | Min |
| 5. Sample location unknown: Maximum (worst possible case) concentrations <sup>11</sup> : |   |        |     |                      |                 |                         |     |
| benzene <sup>12</sup>  | —   | (5703) | —   | 6.9x10 <sup>-6</sup> | —               | (3.9x10 <sup>-2</sup> ) | —   |
| benzene <sup>13</sup>  | —   | (1550) | —   | 6.9x10 <sup>-6</sup> | —               | (1.1x10 <sup>-2</sup> ) | —   |
| benzene <sup>14</sup>  | —   | (234)  | —   | 6.9x10 <sup>-6</sup> | —               | (1.6x10 <sup>-3</sup> ) | —   |
| proform <sup>12</sup>  | —   | (172)  | —   | 1.0x10 <sup>-5</sup> | —               | (1.7x10 <sup>-3</sup> ) | —   |
| proform <sup>13</sup>  | —   | (266)  | —   | 1.0x10 <sup>-5</sup> | —               | (2.7x10 <sup>-3</sup> ) | —   |
| chloroethylene <sup>12</sup>   | —   | (270)  | —   | 4.1x10 <sup>-6</sup> | —               | (1.1x10 <sup>-3</sup> ) | —   |
| chloroethylene <sup>13</sup>   | —   | (93)   | —   | 4.1x10 <sup>-6</sup> | —               | (3.8x10 <sup>-4</sup> ) | —   |
| chloroethylene <sup>14</sup>   | —   | (218)  | —   | 4.1x10 <sup>-6</sup> | —               | (8.9x10 <sup>-4</sup> ) | —   |
| chloroethylene <sup>12</sup>   | —   | (1140) | —   | 1.7x10 <sup>-6</sup> | —               | (1.9x10 <sup>-3</sup> ) | —   |
| chloroethylene <sup>13</sup>   | —   | (394)  | —   | 1.7x10 <sup>-6</sup> | —               | (6.7x10 <sup>-4</sup> ) | —   |
| chloroethylene <sup>14</sup>   | —   | (95)   | —   | 1.7x10 <sup>-6</sup> | —               | (1.6x10 <sup>-4</sup> ) | —   |
| carbon tetrachloride <sup>12</sup>   | —   | (5)    | —   | 1.5x10 <sup>-5</sup> | —               | (7.5x10 <sup>-5</sup> ) | —   |
| carbon tetrachloride <sup>13</sup>   | —   | (20)   | —   | 1.5x10 <sup>-5</sup> | —               | (3.0x10 <sup>-4</sup> ) | —   |

Values, taken from Table 5, represent maximum concentrations found at or near TSD facilities and do not represent average conditions. Also, the sample sites are unknown. Thus the high values may well have been obtained from freshly excavated holes, etc., and can not necessarily be considered representative of ambient air over the area. The risk values associated with these concentrations are presented for illustrative purposes only.

Concentration data from Table 5, Love Canal, NY (only one value reported).

Concentration data from Table 5, Kin-Buc, NJ (only one value reported).

Concentration data from Table 5, Elizabeth, NJ (only one value reported).

- In many cases, it was not possible to determine the location or period of sampling performed at a given site from the literature available for this study. Thus, it is not known whether such data represents ambient or restricted (e.g., in a vent) concentrations, on-site values at one point in time (event), on-site values over time, offsite event values, or offsite values over time.
- In some cases, monitoring data provided upwind/control and downwind data. For these sites, the data in Table 11 are calculated for the estimated net air toxics contribution assumed to be attributable to the facility (i.e., downwind ambient concentration minus upwind/control concentration).
- The estimated risk levels shown in Table 11 represent the level of risk experienced by a person breathing the indicated chemical concentration continuously over a lifetime.
- The representativeness of these data points cannot be assessed.

## REFERENCES

- Ase PK. 1981. Air pollution sampling and monitoring at hazardous waste facilities. Chicago, IL. IIT Research Institute. Prepared for Municipal Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency. Contract No. 68-03-2654.
- Battye W, Breton M, Farino W, Nunno T, Spawn P, Turner M, Warn T. 1984. Status of air emissions regulatory development for area sources in hazardous waste treatment, storage and disposal facilities: draft final report. Chapel Hill, NC. GCA Corporation. Prepared for Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Contract No. 68-01-6871.
- Breton M, Nunno T, Spawn P, Farino W, McInnes R. 1983. Assessment of air emissions from hazardous waste treatment, storage, and disposal facilities (TSDFs): preliminary national emission estimates. Bedford MA. GCA Corporation. Prepared for Office of Solid Waste, U.S. Environmental Protection Agency. Contract No. 68-02-3168.
- CDHS. 1983. Ambient air monitoring and health risk assessment for suspect human carcinogens around the BKK landfill in West Covina. California Department of Health Services, California Air Resources Board, and South Coast Air Quality Management District.
- Dietz S, Emmet M, DiGaetano R, Tuttle D, Vincent D. 1984. National survey of hazardous waste generators and treatment, storage and disposal facilities regulated under RCRA in 1981. Rockville, MD. Westat, Inc. Prepared for Office of Solid Waste, U.S. Environmental Protection Agency. Contract No. 68-01-6861, subcontract No. EPA 33-01.
- Esposito MP, Wagner TJ, Amick RJ. 1981. Ambient air monitoring at hazardous waste disposal sites. Cincinnati OH. PEDCo Environmental Inc. Prepared for Environmental Monitoring and Systems Laboratory, U.S. Environmental Protection Agency, Contract No. 68-02-2722.
- Farino W, Spawn P, Jasinski M, Murphy M. 1983. Evaluation and selection of models for estimating air emissions from hazardous waste treatment, storage, and disposal facilities. Bedford, MA. GCA Corporation. Prepared for Office of Solid Waste, U.S. Environmental Protection Agency. Contract No. 68-02-3168.
- Hwang ST. 1982. An assessment of toxic organic emissions from hazardous waste facilities. Washington, DC. Office of Solid Waste, U.S. Environmental Protection Agency.

#### REFERENCES (continued)

JACA. 1983. Workshop on research in support of OSW regulation of air emissions from hazardous waste treatment, storage, and disposal facilities: Summary of Proceedings. Ft. Washington, PA. JACA Corp. Workshop held in Cincinnati, OH. October 19-20.

Radian. not dated. Evaluation of air emissions from hazardous waste treatment, storage and disposal facilities in support of the RCRA Air emission regulatory impact analyses (RIA). Austin, TX. Radian Corporation. Prepared for Office of Research and Development, U.S. Environmental Protection Agency. Contract No. 68-02-3171.

Thibodeaux, LJ and Hwang ST. 1982. Landfarming of petroleum wastes -- modeling the air emission problem, Environmental Progress, 1 (1), 42-46 (February 1982).

Thibodeaux LJ, Parker DG, and Heck, HH. not dated. Measurement of volatile chemical emissions from wastewater basins. Cincinnati, Ohio. U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory.

USEPA. 1976. Control of volatile organic emissions from existing stationary sources-volume I; control methods for surface-coating operations. Research Triangle Park, NC, U.S. Environmental Protection Agency.

USEPA. 1982. Site status report: Kin-Buc landfill/pool C. Edison, NJ. Region III, U.S. Environmental Protection Agency.

USEPA. 1983. Superfund feasibility study guidance document. Washington, DC, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Final draft dated August 5, 1983.

USEPA. 1984. Superfund remedial investigation guidance document. Washington, DC, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. First draft dated March 28, 1984.

Versar. 1983. Superfund feasibility study background document: source release, environmental fate, exposed population, and integrated exposure analyses: preliminary draft. Versar Inc. Springfield, VA. prepared for Office of Emergency and Remedial Response. U.S. Environmental Protection Agency. Contract No. 68-01-6271.

Wetherold RG and Dubose DA. 1982. A review of selected theoretical models for estimating and describing atmospheric emissions from waste disposal operations: draft interim report. Austin, TX. Radian Corporation. Prepared for Office of Research and Development, U.S. Environmental Protection Agency. Contract No. 68-03-3038.

Attachment A: TSDF Workshop Research  
Project Summary

I. SAMPLING AND ANALYSIS METHODS DEVELOPMENT

|       |   |            |          |
|-------|---|------------|----------|
| SA-1  | Sampling Methods for Characterization of Hazardous Waste Sites<br>P.O. - Charles Fitzsimmons  | EMSL-LV    | 545-2359 |
| SA-2  | Development of an Air Monitoring System Complete with a QA Manual and QA Workshop for Use at Superfund Hazardous Waste Sites<br>P.O. - Joseph R. Gearo, Jr. | OERR-DC    | 475-8103 |
| SA-3  | Development of Protocols for Ambient Air Sampling and Monitoring at Hazardous Waste Facilities<br>P.O. - Seong Hwang  | OSW/LDB-DC | 382-4685 |
| SA-4  | Fugitive Organic Emissions from Incineration<br>P.O. - Merrill Jackson  | IERL-RTP   | 629-2559 |
| SA-5  | Tenax GC/MS System for Sampling and Analysis of Volatile Organic Compounds<br>P.O. - J. F. Walling  | EMSL/RTP   | 629-7954 |
| SA-6  | Technical Assistance Document for Sampling and Analysis of Organic Compounds in Ambient Air<br>P.O. - Larry Purdue  | EMSL/RTP   | 629-2665 |
| SA-7  | Compendium of Methods for Measuring Toxic Organic Compounds in Ambient Air<br>P.O. - Larry Purdue   | EMSL/RTP   | 629-2665 |
| SA-8  | Synthesis and Evaluation of Polymeric Sorbents for Collection of Volatile Organic Compounds<br>P.O. - Jim Mulik   | EMSL/RTP   | 629-3067 |
| SA-9  | Air Sampling Methods for Chlorinated Dioxins<br>P.O. - Robert Lewis   | EMSL/RTP   | 629-3067 |
| SA-10 | Evaluate Chemometric Methods for Analysis of Analytical Outputs<br>P.O. - Donald R. Scott   | EMSL/RTP   | 629-7948 |
| SA-11 | Evaluate TALMS for Analysis of Volatile Organic Compounds<br>P.O. - Donald R. Scott   | EMSL/RTP   | 629-7948 |
| SA-12 | Develop Methods for Metal Species in Particulate Matter<br>P.O. - Donald R. Scott   | EMSL/RTP   | 629-7948 |
| SA-13 | Evaluate New GC Techniques<br>P.O. - Stan Kopczynski  | EMSL/RTP   | 629-3066 |
| SA-14 | Evaluate Supercritical Fluid Chromatography for Analysis of Nonvolatile Organic Compounds<br>P.O. - Robert Lewis  | EMSL/RTP   | 629-3067 |
| SA-15 | Evaluation of GC/FTIR and GC/FTIR/MS for Analysis of Volatile Organic Compounds<br>P.O. - J. Walling/W. McClenny  | EMSL/RTP   | 629-7954 |

Source: JACA 1983

Attachment A (cont.)

|       |   |                   |
|-------|---|-------------------|
| SA-16 | Evaluation of LC/MS for Analysis of Nonvolatile Organic Compounds           |                   |
|       | P.O. - Ken Krost  | EMSL/RTP 629-7969 |
| SA-17 | Cryogenic Concentration of Volatile Organic Compounds                       |                   |
|       | P.O. - William A. McClenny  | EMSL/RTP 629-3158 |
| SA-18 | Evaluation of Passive Samplers for Collection of Volatile Organic Compounds |                   |
|       | P.O. - Robert Lewis   | EMSL/RTP 629-3067 |

**II. SOURCE CHARACTERIZATION**

|       |  |                  |          |
|-------|--|------------------|----------|
| SC-1  | Evaluation of Air Emissions from Hazardous Waste TSD Facilities in Support of the RCRA Air Emission RIA<br>P.O. - Paul dePercin          | MERL-C1          | 684-7871 |
| SC-2  | Investigation and Evaluation of Air Emissions from Hazardous Waste Treatment, Storage and Disposal<br>P.O. - Karen Walker                | OSW/TB-DC        | 382-4790 |
| SC-3  | Measurement of Air Emissions from Hazardous Waste TSD Facilities<br>P.O. - Karen Walker  | OSW/TB-DC        | 382-4790 |
| SC-4  | Soil Gas Sampling Techniques of Chemicals for Exposure Assessment<br>P.O. - Shelly Williamson  | EMSL-LV          | 545-2208 |
| SC-5  | Detection of Leachate Plumes in Groundwater with Geophysics<br>P.O. - Jeffrey van Ee   | EMSL-LV          | 545-2254 |
| SC-6  | Atmospheric Measurements of Trace Hazardous Organic Chemicals<br>P.O. - Larry Cupitt   | ESRL-RTP         | 629-2878 |
| SC-7  | Study of Source-Receptor Measurements Methodology for Some Chlorinated Hydrocarbons<br>P.O. - James Cheney                               | ESRL-RTP         | 629-3085 |
| SC-8  | Technical Report Concerning Production, Migration and Hazards Associated with Toxic Gases at Remedial Action Sites<br>P.O. - Steve James | MERL-C1          | 684-7871 |
| SC-9  | Locating and Estimating Emissions from Sources of (9 compounds now in preparation)<br>P.O. - Thomas F. Lohre                             | OAQPS            | 629-5585 |
| SC-10 | Land Treatment Research Project<br>P.O. - James P. Law, Jr.  | ERL-Ada          | 743-2300 |
| SC-11 | Land Treatment of Petroleum Refinery Sludges<br>P.O. - Don Kampbell  | ERL-Ada          | 743-2332 |
| SC-12 | Assessment of Air Emissions from Land Treatment of Refinery Oily Sludges<br>P.O. - Fred Pfeffer  | MERL & OEPER-Ada | 743-2305 |
| SC-13 | Identify Volatilization Mechanism and Parameters, and Develop Measurement Techniques for these Parameters<br>P.O. - Steve James          | MERL-C1          | 684-7871 |

Attachment A (cont.)

- SC-14 Evaluation and Selection of Models for Estimating Air Emissions from  
Hazardous Waste Treatment, Storage and Disposal Facilities  
P.O. - Seong Hwang OSW/LDB-DC 382-4685
- SC-15 Evaluation of Volatilization of Hazardous Constituents at Hazardous  
Waste Land Treatment Sites  
P.O. - Fred Pfeffer MERL/ERL 743-2305
- SC-16 Methods for Assessing Exposure to Particulate Emissions from Surface  
Contamination Sources  
P.O. - John Schaum OHEA/EAG 382-7353



Attachment A (cont.)

III. CONTROL TECHNOLOGIES

|       |  |             |          |
|-------|--|-------------|----------|
| CT-1  | Evaluation of Control Techniques and Associated Costs to Reduce Toxic Air Emissions from Hazardous Waste TSDFs<br>P.O. - Seong Hwang | OSW/LDB-DC  | 382-4685 |
| CT-2  | Investigation of VOC Emissions Control Technology Methods<br>P.O. - Steve James  | MERL-C1     | 684-7871 |
| CT-3  | Field Verification of Methane Movement Predictions and Methane Control Systems for Landfills<br>P.O. - Mike Roulter                  | MERL-C1     | 684-7871 |
| CT-4  | Develop Mobile Collection/Treatment System for Spilled Volatile and Gaseous Materials<br>P.O. - Mike Royer                           | MERL-Edison | 340-6633 |
| CT-5  | Evaluation/Development of Foams for Mitigating Air Pollution from Hazardous Spills<br>P.O. - Dr. John Brugger                        | MERL-Edison | 340-6634 |
| CT-6  | Preliminary Assessment of Hazardous Waste Pretreatment as an Air Pollution Control Technique<br>P.O. - Ben Blaney                    | IERL-C1     | 684-7696 |
| CT-7  | Assessments of Control Techniques for Air Emissions from TSDF Facilities<br>P.O. - Ben Blaney  | IERL-C1     | 684-7696 |
| CT-8  | Catalytic Oxidation: Industrial Flares<br>P.O. - Bruce Tichenor  | IERL-RTP    | 629-2745 |
| CT-9  | HAP - Control Technology<br>P.O. - Bruce Tichenor  | IERL-RTP    | 629-2745 |
| CT-10 | HAP - Source Assessment<br>P.O. - Bruce Tichenor   | IERL-RTP    | 629-2745 |

Attachment A (cont.)

IV. FATE AND EFFECTS

|       |  |              |          |
|-------|--|--------------|----------|
| FE-1  | Assessment of Air Emissions from Hazardous Waste TSDFs, and Determination of Human Health Impacts<br>P.O. - Seong Hwang    | OSW/LDB-DC   | 382-4685 |
| FE-2  | Evaluation of Hazardous Waste Sites and Accompanying Health Effects<br>P.O. - Karen Walker                                 | OSW/TB-DC    | 382-4790 |
| FE-3  | Use of the W-E-T Model to Estimate Impacts of TSDF Air Emissions<br>P.O. - Curtis Haymore/Frank Smith                      | OSW/EPAB-DC  | 382-4646 |
| FE-4  | Applications of Inhalation Exposure Methodology (IEM) to Hazardous Waste Air Emissions<br>P.O. - Ben Blaney                | IERL-C1      | 684-7696 |
| FE-5  | Methods for Assessing Exposure to Wind-Blown Particulates<br>P.O. - John Schaum  | OHEA/EAG     | 382-7353 |
| FE-6  | Risk Assessment Methodology<br>P.O. - Mike Dourson   | OHEA/ECAO-C1 | 684-7572 |
| FE-7  | Health Effects Assessments<br>P.O. - Mike Dourson  | OHEA/ECAO-C1 | 684-7572 |
| FE-8  | Ambient Air/Source Transport and Transformation Relationship for Selected Hazardous Air Pollutants<br>P.O. - Bill Lonneman | ESRL-RTP     | 629-2829 |
| FE-9  | Update Data Base on Volatile Organic Chemicals in the Ambient Atmosphere<br>P.O. - Larry Cupitt                            | ESRL-RTP     | 629-2878 |
| FE-10 | Use of Structure Activity Relationships to Predict Formation of HAPS as Secondary Products<br>P.O. - Larry Cupitt          | ESRL-RTP     | 629-2878 |
| FE-11 | Hazardous Air Pollutants in the Urban Environment<br>P.O. - Marijon Bufalini   | ESRL-RTP     | 629-2949 |
| FE-12 | Ecological Risk Analysis<br>P.O. - Al Moghissi   | OEPR-DC      | 382-5945 |

## Attachment B

### Summary of Source Characterization Research Needs

| <u>OSW Needs</u>                  | <u>Comments</u>   |
|-----------------------------------|---|
| <u>Near Term</u>                  |   |
| 1. Field Assessment               | Waste piles, drum storage, tanks (data input from previous work)                              |
| 2. Emission Models                | Validation needed   |
| 3. Waste Stream Characterization  | (Incidental to other monitoring) some data available -- needs to be collected and coordinated |
| <u>Long Term</u>                  |   |
|                                   | Effect of Landfill Ban  |
| 1. Emiss. Model Guidance Document | Update -- one to two years  |
| 2. Waste Pile Emission Data       |   |
| 3. Other VOC Emission Data        | Waste characterization (chemical groupings) eg, BaP as representative of PAH                  |

Source: JACA 1983

**Attachment C: TSDF Data Needs Not Presently Being Addressed  
by Research Programs**

- Site visits to TSDFs and analysis of wastestreams and composite wastewater samples,
- Model plant and waste parameter development,
- Review of data on competing removal mechanisms,
- Additional review of TSDF emission models,
- Assessment of potential controls,
- Review of ambient concentration data around TSDFs,
- Review of health effects data for TSDF pollutants, and
- Review of economic data on the industry.

**Source: Battye et al. (1984)**

**APPENDIX G**

**Phase II Point Source Emissions Data**

**DRAFT**

Appendix G presents point source emissions data developed during Phase II. This appendix is divided into three sections: (1) Versar generated data, (2) SAI data, and (3) supplemental data.

(1) Versar generated data

This section of Appendix G contains a listing of the estimated point source emissions and emission factors for the Air Toxics Study as developed by Versar, Inc.

Emissions estimates have been based on plant capacities. A plant's capacity is its maximum production rate. Capacities will be used to estimate emissions for the following reasons:

- Actual projection rates are rarely known for individual facilities.
- Actual production rates will vary between product lines and individual plants.
- Capacity data offer the most flexibility to the automated data system. For example, if the actual production rate for a given product line is known (e.g., 80 percent of capacity), the emissions estimates can be easily revised.
- Capacities offer conservative estimates in the absence of more accurate data.

The first part of this section of Appendix G presents information on each of the pollutants that have been examined. At the conclusion of that discussion the data determined as being most reliable and was used in Phase II is presented. The second part presents the recommended methodology for estimating emissions from utilities.

EMISSIONS DATA FOR SPECIFIC POLLUTANTS:

Acrylonitrile:

According to Tierney and Wilkens (1979), acrylonitrile is produced by four companies at six locations. Total air emissions from

acrylonitrile production were estimated to be 0.807 kg/kg produced. The acrylonitrile emissions were estimated by multiplying this emissions factor by the plant capacity. The company names, locations, capacities, and estimated acrylonitrile emissions from production are presented in Table 1.

Acrylonitrile is used to make acrylic fibers and plastics (Radian Corp. 1982). Emissions from all these facilities are important; however, only emissions from acrylic fiber manufacturing and nitrile elastomers could be estimated because of the lack of emissions factors for specific plastic facilities and process operations. Acrylonitrile emissions from fiber production are presented in Table 2. Emissions from nitrile elastomer operators, as estimated by industry, are also included in Table 2.

#### Chloroform:

Chloroform is manufactured by two major processes in the U.S. Uncontrolled emission factors for various operations within these processes have been estimated by GCA (1982). These emissions factors along with capacity data were used to estimate emissions. The major chloroform producers, their capacities, and estimated emissions are presented in Table 3.

#### Cadmium:

Atmospheric cadmium is emitted from combustion processes, primary smelters, municipal refuse incineration, wastewater sludge incineration, and iron and steel production. Emissions from the major point sources, i.e., utilities and copper and lead smelters, have been estimated; these sources account for approximately 90 percent of all atmospheric cadmium emissions from point sources (GCA 1981). Furthermore, the other sources either could not be calculated or were so small, numerous, and widely scattered that it was not practical to estimate their emissions for this screening analysis.

Table 1. Acrylonitrile Emissions from Production Facilities

| Company               | Location        | County    | Capacity<br>(kkg/yr) | Emissions<br>(kkg/yr) |
|-----------------------|-----------------|-----------|----------------------|-----------------------|
| American Cyanamid Co. | New Orleans, LA | Orleans   | 91,000               | 73                    |
| Du Pont Co.           | Beaumont, TX    | Jefferson | 160,000              | 130                   |
| Du Pont Co.           | Memphis, TN     | Shelby    | 130,000              | 100                   |
| Monsanto Co.          | Alvin, TX       | Brazoria  | 200,000              | 160                   |
| Monsanto Co.          | Texas City, TX  | Galveston | 190,000              | 150                   |
| Vistron Corp.         | Lima, OH        | Allen     | 91,000               | 73                    |

Source: Tierney and Wilkins 1979.



Table 2. Acrylonitrile Emissions from Acrylic Fiber Producers  
and Nitrile Elastomer Operations

| Acrylic Fiber Producers              |                  |                   |                          |                              |
|--------------------------------------|------------------|-------------------|--------------------------|------------------------------|
| Company                              | Location         | County            | Annual capacity (kkg/yr) | Estimated emissions (kkg/yr) |
| American Cyanamid Co.                | Milton, FL       | Santa Rosa        | 59,000                   | 197                          |
| Badische Corporation                 | Williamsburg, VA | Williamsburg City | 34,000                   | 113                          |
| E.I. duPont de Nemours and Co., Inc. | Camden, SC       | Kershaw           | 71,500 <sup>1</sup>      | 238                          |
|                                      | Waynesboro, VA   | Waynesboro City   | 71,500 <sup>1</sup>      | 238                          |
| Tennessee Eastman Co.                | Kingsport, TN    | Sullivan          | 11,000                   | 37                           |
| Monsanto Co.                         | Decatur, AL      | Morgan            | 143,000                  | 477                          |

<sup>1</sup>These are estimated capacities based on a total capacity of 143,000 kkg for all E.I. duPont de Nemours and Co., acrylic fiber operations.

Source: Radian Corp. 1982.

#### Nitrile Elastomer Operations

| <u>Company Name</u>        | <u>County</u>        | <u>Estimated emissions (kkg/yr)</u> |
|----------------------------|----------------------|-------------------------------------|
| Goodyear Tire & Rubber Co. | Harris, TX           | 2.4                                 |
| Copolymer Rubber           | East Baton Rouge, LA | 4.3                                 |
| Goodyear Tire & Rubber Co. | Summit, OH           | 26.3                                |
| Goodrich                   |                      | 34.0                                |
| Goodrich                   | Jefferson, KY        | 141.3                               |

Source: Industry Emission Estimates (1983). Presented in a letter from Joseph E. Hadley Jr., LaRoe, Winn and Moerman, Attorneys at Law to Deborah Taylor, U.S. Environmental Protection Agency, Washington, DC, dated March 19, 1984.

Table 3. Emissions from Chloroform Production Facilities

| Company                             | Location        | County    | Chloroform capacity (kkg/yr) | Chloroform emissions <sup>1</sup> (kkg/yr) |
|-------------------------------------|-----------------|-----------|------------------------------|--|
| Diamond Shamrock Corp.              | Belle, WV       | Kanawha   | 18,000                       | 53   |
| Dow Chemical                        | Freeport, TX    | Brazoria  | 45,000                       | 110  |
|                                     | Plaquemine, LA  | Iberville | 45,000                       | 105  |
| Linden Chemicals and Plastics, Inc. | Moundsville, WV | Marshall  | 14,000                       | 47   |
| Stauffer Chemical Co.               | Louisville, KY  | Jefferson | 34,000                       | 72   |
| Vulcan Materials Co.                | Geismar, LA     | Ascension | 28,000                       | 64   |
|                                     | Wichita, KS     | Sedgwick  | 50,000                       | 100  |

<sup>1</sup>Process emissions were weighted by production process; fugitive emissions were based on 8,760 hrs of operation per year.

Source: GCA 1982.

Atmospheric cadmium emissions data from primary lead and copper smelters were extracted directly from GCA (1981). This information is presented in Tables 4 and 5. /

The atmospheric cadmium emissions factors for utilities burning coal were extracted from GCA (1981). However, it was necessary to derive a cadmium emissions factor for utilities burning residual oil. This emissions factor was based on the following data:

U.S. consumption of residual oil in utilities:  $493 \times 10^6$  bbl/yr (GCA 1981)

Heating value of residual oil: 140,000 Btu/gal (Versar 1981)

Cadmium emissions from residual oil-fired utilities: 133 kkg/yr (GCA 1981)

The first step towards estimating the emissions factor is to determine the total amount of Btus produced by residual oil-fired utilities:

$$493 \times 10^6 \text{ bbl} \times 42 \text{ gal/bbl} \times 140,000 \text{ Btu/gal} = 2.899 \times 10^5 \text{ Btu}$$

The emissions factor is simply total cadmium emissions divided by total Btu production:

$$\frac{133 \text{ kkg/yr}}{2.899 \times 10^{15} \text{ Btu}}$$

or

$$\frac{0.046 \text{ kkg/yr}}{10^{12} \text{ Btu}}$$

A list of all the atmospheric cadmium emissions factors for utilities along with information on their use is presented in Part 2 of this section of Appendix G.

#### Perchloroethylene:

Although perchloroethylene production facilities only account for approximately 2 percent of total perchloroethylene air emissions (USEPA 1980) they should be characterized since major point sources can cause

Table 4. Cadmium Emissions from Primary Lead Smelters

| Company                      | Location        | County        | Emissions<br>(kkg/yr) |
|------------------------------|-----------------|---------------|-----------------------|
| AMAX-Homestake Lead Trollers | Boss, MO        | Dent          | 7.9 - 28              |
| ASARCO, Inc.                 | East Helena, MT | Lewis & Clark | 3.8                   |
| ASARCO, Inc.                 | Glover, MO      | Iron          | 0.9                   |
| ASARCO, Inc.                 | El Paso, TX     | El Paso       | 4.3                   |
| The Bunker Hill Co.          | Kellogg, ID     | Shoshone      | 47.0                  |
| St. Joe Minerals Corp.       | Herculaneum, MO | Jefferson     | 9.8 - 13.0            |

Source: GCA 1981.

Table 5. Cadmium Emissions from Primary Copper Smelters

| Company                                | Location       | County     | Emissions<br>(kkg/yr) |
|--|----------------|------------|-----------------------|
| ASARCO, Inc.                           | El Paso, TX    | El Paso    | 0.2                   |
| ASARCO, Inc.                           | Hayden, AZ     | Gila       | 3.7                   |
| ASARCO, Inc.                           | Tacoma, WA     | Pierce     | 1.5                   |
| Cities Service Co.                     | Copperhill, TN | Polk       | 0.3                   |
| Cities Service Co.                     | Anaconda, MT   | Deer Lodge | N/A                   |
| Inspiration Consolidated<br>Copper Co. | Miami, AZ      | Gila       | 2.1                   |
| Kennecott Copper Corp.                 | Garfield, UT   | Salt Lake  | 3.9                   |
| Kennecott Copper Corp.                 | Hayden, AZ     | Gila       | 1.2                   |
| Kennecott Copper Corp.                 | Hurley, NM     | Grant      | 1.9                   |
| Kennecott Copper Corp.                 | McGill, NV     | White Pine | 5.1                   |
| Magma Copper Co.                       | San Manuel, AZ | Pinal      | 3.5                   |
| Phelps Dodge Copper Corp.              | Ajo, AZ        | Pima       | 2.4                   |
| Phelps Dodge Copper Corp.              | Douglas, AZ    | Cochise    | 3.9                   |
| Phelps Dodge Copper Corp.              | Hildago, NM    | Hildago    | 2.0                   |
| Phelps Dodge Copper Corp.              | Morenci, AZ    | Greenlee   | 7.5                   |
| Copper Range Co.                       | White Pine, MI | Ontonagon  | 4.4                   |

N/A: Not available

Source: GCA 1981.

substantial localized impacts. Perchloroethylene is manufactured by three processes, and thus air emissions may vary among plants using different processes. However, since no further data were known, total air emissions from production were simply allocated to individual plants based on their capacities. The capacity data and total air emissions data from production (3,000 kkg/yr) were extracted from USEPA (1980). This information and the estimated emissions are given in Table 6.

#### Trichloroethylene (TCE):

The TCE emissions from production were extracted directly from USEPA (1981a) and are presented in Table 7. Air emissions from degreasing operations are considerably more significant; however, they will be characterized using the existing NEDS data tape and during the area source analysis.

#### Arsenic:

Most of the point source air emissions of arsenic are inadvertently produced. The largest point sources are primary copper and lead smelters and utilities. The estimated atmospheric emissions data from copper smelters were extracted directly from USEPA (1981b) and are presented in Table 8.

The estimated arsenic releases from lead smelters were calculated based on the lead smelter capacities (GCA 1981) and the total amount of atmospheric arsenic emissions from lead smelters USEPA (1981b). These release estimates are presented in Table 9.

It was found that atmospheric arsenic emissions from utility boilers burning bituminous coal are by far the most significant; they account for nearly 98 percent of all arsenic air emissions from utilities (USEPA 1981b). For utilities burning bituminous coal, emission factors were estimated based on the total amount of bituminous coal burned in utility boilers (USEPA 1981b), the heating value of the coal (GCA 1981), and the

Table 6. Perchloroethylene Emissions

| Manufacturer                        | Location            | County        | Production capacity (kkg/yr) | Perchloroethylene emissions (kkg/yr) |
|-------------------------------------|---------------------|---------------|------------------------------|--------------------------------------|
| Diamond Shamrock                    | Deer Park, TX       | Harris        | 90,700                       | 496                                  |
| Dow Chemical                        | Freeport, TX        | Brazoria      | 54,400                       | 297                                  |
|                                     | Pittsburg, CA       | Contra Costa  | 9,100                        | 50                                   |
|                                     | Plaquemine, LA      | Iberville     | 68,000                       | 372                                  |
| E.I. duPont de Nemours              | Corpus Christie, TX | Nueces        | 72,700                       | 397                                  |
| Ethyl Corporation                   | Baton Rouge, LA     | E.Baton Rouge | 22,700                       | 124                                  |
| Occidental Petroleum Corp. (Hooker) | Taft, LA            | St. Charles   | 18,100                       | 99                                   |
| PPG Industries                      | Lake Charles, LA    | Calcasieu     | 90,700                       | 496                                  |
| Stauffer Chemicals                  | Louisville, KY      | Jefferson     | 31,800                       | 174                                  |
| Vulcan Chemicals                    | Geismar, LA         | Ascension     | 68,000                       | 372                                  |
|                                     | Wichita, TX         | Wichita       | 22,700                       | 124                                  |

Source: USEPA 1980.

Table 7. TCE Emissions from Production

| Company            | Location         | County        | Capacity<br>(kkg/yr) | Air emissions<br>(kkg/yr) |
|--------------------|------------------|---------------|----------------------|---------------------------|
| Dow Chemical Corp. | Freeport, TX     | Brazoria      | 68,000               | 110                       |
| Ethyl Corp.        | Baton Rouge, LA  | E.Baton Rouge | 20,000               | 30                        |
| PPG Industries     | Lake Charles, LA | Calcasieu     | 91,000               | 140                       |

Source: USEPA 1981a.



Table 8. Arsenic Emissions from Primary Copper Smelters

| Company                                | Location       | County     | Emissions<br>(kkg/yr) |
|--|----------------|------------|-----------------------|
| ASARCO, Inc.                           | El Paso, TX    | El Paso    | 40                    |
| ASARCO, Inc.                           | Hayden, AZ     | Gila       | 210                   |
| ASARCO, Inc.                           | Tacoma, WA     | Pierce     | 210                   |
| Cities Service Co.                     | Anaconda, MT   | Deer Lodge | 180                   |
| Cities Service Co.                     | Copperhill, TN | Polk       | -                     |
| Inspiration Consolidated<br>Copper Co. | Miami, AZ      | Gila       | 6                     |
| Kennecott Copper Corp.                 | Garfield, UT   | Salt Lake  | 8                     |
| Kennecott Copper Corp.                 | Hayden, AZ     | Gila       | 36                    |
| Kennecott Copper Corp.                 | Hurley, NM     | Grant      | 5                     |
| Kennecott Copper Corp.                 | McGill, NV     | White Pine | 58                    |
| Magma Copper Co.                       | San Manuel, AZ | Pinal      | 25                    |
| Phelps Dodge Copper Corp.              | Ajo, AZ        | Pima       | 310                   |
| Phelps Dodge Copper Corp.              | Douglas, AZ    | Cochise    | 37                    |
| Phelps Dodge Copper Corp.              | Hildago, NM    | Hildago    | 6                     |
| Phelps Dodge Copper Corp.              | Morenci, AZ    | Greenlee   | 30                    |
| Copper Range Co.                       | White Pine, MI | Ontonagon  | 4                     |

Source: USEPA 1981b.

Table 9. Arsenic Emissions from Primary Lead Smelters

| Company                         | Location        | County        | Emissions<br>(kkg/yr) |
|---------------------------------|-----------------|---------------|-----------------------|
| AMAX-Homestake<br>Lead Trollers | Boss, MO        | Dent          | 38.1                  |
| ASARCO, Inc.                    | East Helena, MT | Lewis & Clark | 32.7                  |
| ASARCO, Inc.                    | Glover, MO      | Iron          | 30.0                  |
| ASARCO, Inc.                    | El Paso, TX     | El Paso       | 32.7                  |
| The Bunker Hill Co.             | Kellogg, ID     | Shoshone      | 35.4                  |
| St.Joe Minerals<br>Corp.        | Herculaneum, MO | Jefferson     | 61.2                  |

Source: GCA 1981 and USEPA 1981b.

Table 10 1,3-Butadiene Emissions from Manufacturing

| Facilities                           | Location           | County           | Emissions<br>(kkg/yr) |
|--------------------------------------|--------------------|------------------|-----------------------|
| 1. Petrotex (Tenneco)                | Houston, TX        | Harris           | 24.7                  |
| 2. Union Carbide                     | Seadrift, TX       | Calhoun          | 1.4                   |
|                                      | Texas City, TX     | Galveston        | 2.6                   |
| 3. Exxon Chemical                    | Baton Rouge, LA    | East Baton Rouge | 12.8                  |
|                                      | Baytown, TX        | Harris           | 9.9                   |
| 4. Mobil Oil Corp.                   | Beaumont, TX       | Jefferson        | 2.5                   |
| 5. Texaco Butadiene Co.              | Port Neches, TX    | Jefferson        | 20.6                  |
| 6. Dow Chemical                      | Freeport, TX       | Brazoria         | 3.5                   |
| 7. El Paso Products                  | Corpus Christi, TX | Nueces           | 4.7                   |
| 8. Corpus Christi<br>Petro Chemicals | Corpus Christi, TX | Nueces           | 8.2                   |
| 9. ARCO Chemicals                    | Channelview, TX    | Harris           | 18.5                  |
| 10. Conoco (Dupont)                  | Alvin, TX          | Brazoria         | 6.0                   |
| 11. Standard Oil (Amoco)             | Alvin, TX          | Brazoria         | 7.4                   |
| 12. Shell Chemical Co.               | Deer Park, TX      | Harris           | 20.6                  |
|                                      | Norco, LA          | St. Charles      | 20.6                  |

Source: Versar 1984.

Table 11 1,3-Butadiene Emissions from SBR Production<sup>a</sup>

| Facilities                        | Location         |                  | Emissions<br>(kkg/yr) |
|-----------------------------------|------------------|------------------|-----------------------|
|                                   | City             | County           |                       |
| Goodyear Tire and Rubber Company  | Houston, TX      | Harris           | 151.7                 |
| B.F. Goodrich Co.                 | Port Neches, TX  | Jefferson        | 59.9                  |
| Copolymer Rubber & Chemical Corp. | Baton Rouge, LA  | East Baton Rouge | 50.5                  |
| American Synthetic Rubber Corp.   | Louisville, KY   | Jefferson        | 28.7                  |
| Firestone Tire and Rubber Co.     | Lake Charles, LA | Calcasieu        | 78.8                  |
| General Tire and Rubber Co.       | Borger, TX       | Hutchinson       | 37.8                  |
|                                   | Odessa, TX       | Ector            | 34.7                  |

<sup>a</sup>There are four other SBR production facilities; however, emissions could not be estimated from these plants.

Source: Versar 1984.

total arsenic emissions from all utility boilers burning bituminous coal (USEPA 1981b). The calculation procedure for this emission factor and other arsenic emission factors for utilities is identical to the procedure used to derive the utility emissions factors for cadmium.

#### 1,3-Butadiene:

Atmospheric emissions of 1,3-butadiene come from many sources including manufacturing, second-tier processing, tire wear, municipal incineration, and cigarette smoke (Versar 1984). However, the major point source emissions come from manufacturing the second-tier processing. Second-tier processing includes the manufacture of elastomers such as styrene-butadiene rubber (SBR), polybutadiene, styrene-butadiene copolymer latexes, polychloroprene, and acrylonitrile-butadiene-styrene resins (Versar 1984). SBR is the major second-tier use of 1,3-butadiene, and it is the only use where 1,3-butadiene emissions have been quantified (Versar 1984).

Airborne 1,3-butadiene emissions from manufacturing and SBR production are presented in Table 10 and 11, respectively.

#### Total Chromium:

Total chromium emissions from point sources can be characterized as being emitted from direct sources or from inadvertent sources. Direct sources include chromite ore refining, ferrochromium production, refractory manufacture, chromium chemicals manufacture, chromium plating, steel production, electric arc furnaces, basic oxygen process furnaces, open hearth furnaces, and leather tanning.

Indirect sources of chromium are coal and oil combustion, cement production, municipal refuse and sewage sludge incineration, cooling towers, and asbestos mining and milling.

One study (Viviani et al. 1982) listed the following percentages of total anthropogenic air emissions: 73 percent from ferrochromium

refining, 8.6 percent from coal combustion, 3.7 percent from the iron and steel industry, 2.0 percent from oil combustion, and 0.9 percent from incineration; 11.8 percent is unidentified. However, these data are based on a 1970 source and the relative percentages are known to have changed drastically since it was reported that in early 1983, 95 percent of the ferrochromium consumed in the U.S. was imported (USEPA 1983). Consequently, the current percentage of total emissions from each of the sources listed above is unknown.

Only two sets of emissions data could be developed for total chromium releases: emissions from sodium dichromate manufacturing and chromium emissions factors from utilities. Sodium dichromate manufacturing emissions are presented in Table 12 while the total chromium emissions factors for utilities are given with the other trace metal emission factors for utilities in the second part of this section of Appendix G.

#### Pentachlorophenol (PCP):

PCP is used as a fungicide in wood preservatives and cooling towers. Atmospheric releases of PCP have been estimated to 50 kkg from production, 344 kkg from preserved wood, and 228 from cooling towers (USEPA 1980). Emissions estimates from PCP production facilities are presented in Table 13. The other two sources are area sources and are discussed in Appendix G.

#### Ethylene Dibromide (EDB):

The EPA has recently imposed an emergency suspension on nearly all uses of EDB. The effected uses include preplant soil fumigation and the fumigation of grain, citrus, and felled logs. Within one year, a law will go into effect permanently banning these uses.\*<sup>†</sup>

---

\*Telephone conversation between John Doria, Versar and Joseph Reinert, Chemist, Health Effects Division, U.S. Environmental Protection Agency on April 19, 1984.

Table 12 Chromium Emissions from Sodium Chromate and  
Sodium Dichromate Manufacturing Plants

| Plant                                | Location           |             | Emissions<br>(kkg/yr) |
|--------------------------------------|--------------------|-------------|-----------------------|
|                                      | City               | County      |                       |
| Allied Corp.                         | Baltimore, MD      | Baltimore   | 3.5                   |
| American Chrome<br>& Chemicals, Inc. | Corpus Christi, TX | Nueces      | 2.5                   |
| Diamond Shamrock                     | Castle Hayne, NC   | New Hanover | 12.4                  |

Source: USEPA 1983.

Table 13 Pentachlorophenol Emissions from Production Facilities

| Company               | City        | Location<br>County | Annual<br>Capacity<br>(kkg/yr) | Emissions<br>(kkg/yr) |
|-----------------------|-------------|--------------------|--------------------------------|-----------------------|
| Dow Chemical Co.      | Midland, MI | Bay                | 12,000                         | 21                    |
| Reichhold Chem., Inc. | Tacoma, WA  | Pierce             | 8,500                          | 15                    |
| Vulcan Co.            | Wichita, KA | Sedgwick           | 8,500                          | 15                    |

Source: USEPA 1980.



The only two remaining applications of any consequence are the use of EDB as a beehive fumigant and as a lead scavenger in gasoline.<sup>\*,†</sup> Use as a beehive fumigant is very limited and thus the releases are expected to be quite small. Releases from the use of EDB in leaded gasoline were covered in Appendix G.

EDB production should be significantly reduced as a result of the restrictions imposed by the EPA. Consequently, releases from production should also be significantly reduced, although the actual quantity of releases could not be estimated.

### Beryllium

One report (Viviani et al. 1982) estimates that nearly 97 percent of all atmospheric beryllium emissions are generated from coal and oil combustion. Emission factors for the major point source emissions in this category, i.e., utilities, are presented in the second part of this section of Appendix G. Other non-combustion point source emissions were relatively insignificant and/or difficult to characterize, and therefore they were not estimated.

### SUMMARY OF PHASE II POINT SOURCE DATA

In Table 14, a summary is presented of the supplemental point source data that were entered into HEMIS. These data are organized by county; a plant number from NEDS is given for easy identification. When the plant number is unknown, the supplemental data could not be matched to a specific plant in NEDS. In all cases, the original source of the data is

---

<sup>†</sup>Telephone conversation between John Doria, Versar and Roger Holtorf, Economist, Benefits and Use Division, U.S. Environmental Protection Agency on April 19, 1984.

Table 14. Supplemental Point Source Data Entered  
Into HEMIS

| <u>County</u>  | <u>Company Name</u>           | <u>Plant No.</u> | <u>Stack No.</u> | <u>Pollutant</u>     | <u>Emissions</u> | <u>Sources</u> |
|----------------|-------------------------------|------------------|------------------|----------------------|------------------|----------------|
| Burlington, NJ |                               |                  |                  |                      |                  |                |
|                | Tenneco                       | 0407             | unknown          | Vinyl chloride       | 62.0             | Versar         |
|                | Hooker                        | 0430             | unknown          | Vinyl chloride       | 886              | Versar         |
| Harris, TX     |                               |                  |                  |                      |                  |                |
|                | Diamond Shamrock              | 0009             | unknown          | Perchloroethylene    | 496              | Versar         |
|                | Petrotex                      | 0031             | unknown          | 1,3-Butadiene        | 24.7             | Versar         |
|                | Exxon Chemicals               | 0014             | unknown          | 1,3-Butadiene        | 9.9              | Versar         |
|                | Shell Chemical Co.            | 0036             | unknown          | 1,3-Butadiene        | 20.6             | Versar         |
|                | ARCO                          | 0075             | unknown          | 1,3-Butadiene        | 18.5             | Versar         |
|                | Goodyear Tire &<br>Rubber Co. | 0088             | unknown          | 1,3-Butadiene        | 151.7            | Versar         |
|                | DuPont                        | 0011             | unknown          | Formaldehyde         | 33.6             | SAI            |
|                | Reichold Chemicals            | 0033             | 05               | Formaldehyde         | 20.5             | SAI            |
| Jefferson, TX  |                               |                  |                  |                      |                  |                |
|                | DuPont                        | 0003             | 30               | Acrylonitrile        | 130              | Versar         |
|                | Texaco                        | 0006             | unknown          | 1,3-Butadiene        | 20.6             | Versar         |
|                | Mobil                         | 0009             | unknown          | 1,3-Butadiene        | 2.5              | Versar         |
|                | B.F. Goodrich Co.             | 0034             | 02               | 1,3-Butadiene        | 59.9             | Versar         |
| Kanawaha, WV   |                               |                  |                  |                      |                  |                |
|                | FMC Corp.                     | 0002             | unknown          | Carbon tetrachloride | 991              | SAI            |
|                | Diamond Shamrock              | 0034             | unknown          | Chloroform           | 14.5             | SAI            |
|                | Diamond Shamrock              | 0034             | unknown          | Chloroform           | 53               | Versar         |
|                | DuPont                        | 0001             | unknown          | Formaldehyde         | 52.8             | SAI            |
| Sedgewick, KS  |                               |                  |                  |                      |                  |                |
|                | Vulcan                        | 0070             | unknown          | Carbon tetrachloride | 30.5             | SAI            |
|                | Vulcan                        | 0070             | unknown          | Chloroform           | 100              | Versar         |
|                | Vulcan                        | 0070             | unknown          | Chloroform           | 36.6             | SAI            |
|                | Vulcan                        | 0070             | unknown          | Pentachlorophenol    | 15               | Versar         |
| Essex, NJ      |                               |                  |                  |                      |                  |                |
|                | Celanese Chem. Co.            | 1039             | unknown          | Formaldehyde         | 20.0             | SAI            |

Table 14 (continued)

| <u>County</u> | <u>Company Name</u>       | <u>Plant No.</u> | <u>Stack No.</u> | <u>Pollutant</u>     | <u>Emissions</u> | <u>Sources</u> |
|---------------|---------------------------|------------------|------------------|----------------------|------------------|----------------|
| Jefferson, KY | Stauffer Chem.            | 0216             | unknown          | Carbon tetrachloride | 17.7             | SAI            |
|               | Stauffer Chem.            | 0216             | unknown          | Chloroform           | 27.3             | SAI            |
|               | Stauffer Chem.            | 0216             | unknown          | Chloroform           | 72               | Versar         |
|               | Stauffer Chem.            | 0216             | unknown          | Perchloroethylene    | 174              | Versar         |
|               | American Synthetic Rubber | 0011             | 03               | 1,3-Butadiene        | 28.7             | Versar         |
|               | Borden Chem. Co.          | 0028             | unknown          | Formaldehyde         | 8.4              | SAI            |
|               |                           |                  |                  |                      |                  |                |
| Grazoria, TX  | Dow Chemical Co.          | 0004             | unknown          | Carbon tetrachloride | 6.4              | SAI            |
|               | Dow Chemical Co.          | 0004             | unknown          | Chloroform           | 110              | Versar         |
|               | Dow Chemical Co.          | 0004             | unknown          | Chloroform           | 13.7             | SAI            |
|               | Dow Chemical Co.          | 0004             | unknown          | Trichloroethylene    | 110              | Versar         |
|               | Dow Chemical Co.          | 0004             | unknown          | Trichloroethylene    | 145              | SAI            |
|               | Monsanto                  | 0009             | unknown          | Acrylonitrile        | 160              | Versar         |
|               | Dow Chemical Co.          | 0004             | unknown          | Perchloroethylene    | 297              | Versar         |
|               | Dow Chemical Co.          | 004              | unknown          | 1,3-Butadiene        | 3.5              | Versar         |
|               | Amoco                     | 0014             | unknown          | 1,3-Butadiene        | 7.4              | Versar         |
|               | Conoco (DuPont)           | unknown          | unknown          | 1,3-Butadiene        | 6.0              | Versar         |
|               | Monsanto                  | 0009             | unknown          | Formaldehyde         | 3.7              | SAI            |
| Calcasieu, LA | PPG Industries            | 0004             | unknown          | Trichloroethylene    | 140              | Versar         |
|               | PPG Industries            | 0004             | unknown          | Trichloroethylene    | 154              | SAI            |
|               | PPG Industries            | 0004             | unknown          | Perchloroethylene    | 496              | Versar         |
|               | Firestone Rubber & Tire   | 0007             | unknown          | 1,3-Butadiene        | 78.8             | Versar         |
|               |                           |                  |                  |                      |                  |                |
| Baltimore, MD | Allied Corp.              | unknown*         | unknown          | Total Chromium       | 3.5              | Versar         |
|               |                           |                  |                  |                      |                  |                |

\*The UTM coordinates for this plant are as follows:  
UTMX - 363.3, UTM Y - 4349.2.

Table 14 (continued)

| <u>County</u>        | <u>Company Name</u>   | <u>Plant No.</u> | <u>Stack No.</u> | <u>Pollutant</u>  | <u>Emissions</u> |        |
|----------------------|-----------------------|------------------|------------------|-------------------|------------------|--------|
| East Baton Rouge, LA |                       |                  |                  |                   |                  |        |
|                      | Ethyl Corp.           | 0017             | unknown          | Trichloroethylene | 30               | Vers.  |
|                      | Ethyl Corp.           | 0017             | unknown          | Trichloroethylene | 34.8             | SAI    |
|                      | Ethyl Corp.           | 0017             | unknown          | Perchloroethylene | 124              | Vers.  |
|                      | Copolymer Rubber Co.  | 0008             | unknown          | 1,3-Butadiene     | 50.5             | Vers.  |
|                      | Exxon Chemical        | 0014             | unknown          | 1,3-Butadiene     | 12.8             | Vers.  |
| Sullivan, TN         |                       |                  |                  |                   |                  |        |
|                      | Tennessee Eastman Co. | 0003             | unknown          | Acrylonitrile     | 37               | Versar |
| Galveston, TX        |                       |                  |                  |                   |                  |        |
|                      | Monsanto Co.          | 0010             | 88               | Acrylonitrile     | 150              | Versar |
|                      | Union Carbide         | 0015             | unknown          | 1,3-Butadiene     | 26               | Versar |

given. When data from more than one source are listed, the priority of the data is as follows: (1) SAI, (2) Versar, and (3) NEDS.

#### METHOD FOR ESTIMATING EMISSIONS FROM UTILITIES

Most of the VOC emissions from utility boilers can be automatically apportioned using the NEDS data tapes. For utilities where specific VOC emissions cannot be easily estimated, additional emissions factors can be developed at a later date depending on their relative importance and the constraints of this study.

However, trace element emissions, i.e., arsenic, beryllium, cadmium, and nickel, from utilities cannot be directly estimated using only the NEDS data tapes. To estimate these emissions, the annual operating rate and fuel heat content will have to be extracted from the NEDS point source listing and multiplied by an emissions factor. The general method is as follows:

Annual Operating Rate x Fuel Heat Content x Emissions Factor = Emissions (kg/yr)

The units for the annual operating rate and fuel heat content (e.g., 8600 1000 gallons burned and 147 million Btu/1000 gallons burned) will vary for the different fuel types; however, the product of these two values will always yield the total quantity of Btus produced at a given utility. Utility emissions factors will always be in kg/10<sup>12</sup> Btu.

These emissions factors depend on the type of fuel being combusted and, for bituminous coal, the type of boiler (e.g., pulverized dry bottom and stoker). This information will also have to be extracted from the NEDS listing (by SCC codes) for the proper emissions factor to be selected. In the literature, emissions factors do not change for different boiler sizes (e.g., 10-100 MMBtu compared to >100 MMBtu).

The emissions factors, by type of fuel burned, are summarized below:

## Bituminous Coal:

### Pulverized dry bottom -

|                |  |                           |
|----------------|--|---------------------------|
| Arsenic        | $2.9 \times 10^{-1} \text{ kkg}/10^{12} \text{ Btu}$ | (USEPA 1981b, GCA 1981)   |
| Beryllium      | $2.3 \times 10^{-3} \text{ kkg}/10^{12} \text{ Btu}$ | (Versar 1983)             |
| Cadmium        | $3.8 \times 10^{-3} \text{ kkg}/10^{12} \text{ Btu}$ | (GCA 1981)                |
| Nickel         | $6.5 \times 10^{-2} \text{ kkg}/10^{12} \text{ Btu}$ | (Versar 1983)             |
| Total Chromium | $1.8 \times 10^{-1} \text{ kkg}/10^{12} \text{ Btu}$ | (USEPA 1983, Versar 1981) |

### Pulverized wet bottom -

|                |  |                           |
|----------------|--|---------------------------|
| Arsenic        | $3.0 \times 10^{-1} \text{ kkg}/10^{12} \text{ Btu}$ | (USEPA 1981b, GCA 1981)   |
| Beryllium      | $1.9 \times 10^{-3} \text{ kkg}/10^{12} \text{ Btu}$ | (Versar 1983)             |
| Cadmium        | $9.4 \times 10^{-4} \text{ kkg}/10^{12} \text{ Btu}$ | (GCA 1981)                |
| Nickel         | $5.3 \times 10^{-2} \text{ kkg}/10^{12} \text{ Btu}$ | (Versar 1983)             |
| Total Chromium | $1.8 \times 10^{-1} \text{ kkg}/10^{12} \text{ Btu}$ | (USEPA 1983, Versar 1981) |

### Cyclone -

|                |  |                           |
|----------------|--|---------------------------|
| Arsenic        | $2.3 \times 10^{-1} \text{ kkg}/10^{12} \text{ Btu}$ | (USEPA 1981b, GCA 1981)   |
| Beryllium      | $3.9 \times 10^{-4} \text{ kkg}/10^{12} \text{ Btu}$ | (Versar 1983)             |
| Cadmium        | $9.8 \times 10^{-5} \text{ kkg}/10^{12} \text{ Btu}$ | (GCA 1981)                |
| Nickel         | $1.2 \times 10^{-2} \text{ kkg}/10^{12} \text{ Btu}$ | (Versar 1983)             |
| Total Chromium | $3.6 \times 10^{-2} \text{ kkg}/10^{12} \text{ Btu}$ | (USEPA 1983, Versar 1981) |

### Stokers -

|                |  |                           |
|----------------|--|---------------------------|
| Arsenic        | $2.7 \times 10^{-1} \text{ kkg}/10^{12} \text{ Btu}$ | (USEPA 1981b, GCA 1981)   |
| Beryllium      | $5.8 \times 10^{-3} \text{ kkg}/10^{12} \text{ Btu}$ | (Versar 1983)             |
| Cadmium        | $1.3 \times 10^{-4} \text{ kkg}/10^{12} \text{ Btu}$ | (GCA 1981)                |
| Nickel         | $1.5 \times 10^0 \text{ kkg}/10^{12} \text{ Btu}$    | (Versar 1983)             |
| Total Chromium | $2.2 \times 10^{-2} \text{ kkg}/10^{12} \text{ Btu}$ | (USEPA 1983, Versar 1981) |

## Lignite (all types of boilers):

|                |  |                           |
|----------------|--|---------------------------|
| Arsenic        | $7.0 \times 10^{-2} \text{ kkg}/10^{12} \text{ Btu}$ | (USEPA 1981b)             |
| Beryllium      | $2.6 \times 10^{-2} \text{ kkg}/10^{12} \text{ Btu}$ | (Versar 1983)             |
| Cadmium        | negligible   | (GCA 1981)                |
| Nickel         | $7.2 \times 10^{-2} \text{ kkg}/10^{12} \text{ Btu}$ | (Versar 1983)             |
| Total Chromium | negligible   | (USEPA 1983, Versar 1981) |

**Anthracite:**

All trace  
elements            negligible

**Residual oil (all types of boilers):**

|                |  |                            |
|----------------|--|----------------------------|
| Arsenic        | $9.9 \times 10^{-4} \text{ kkg/10}^{12} \text{ Btu}$ | (USEPA 1981b, Versar 1981) |
| Beryllium      | $2.5 \times 10^{-3} \text{ kkg/10}^{12} \text{ Btu}$ | (Versar 1983)              |
| Cadmium        | $4.6 \times 10^{-2} \text{ kkg/10}^{12} \text{ Btu}$ | (GCA 1981, Versar 1981)    |
| Nickel         | $4.5 \times 10^{-1} \text{ kkg/10}^{12} \text{ Btu}$ | (Versar 1983)              |
| Total Chromium | $2.2 \times 10^{-2} \text{ kkg/10}^{12} \text{ Btu}$ | (USEPA 1983, GCA 1981)     |

**Distillate oil:**

All trace  
elements            negligible

**Gas-Fired Utilities:**

|                |  |               |
|----------------|--|---------------|
| Arsenic        | negligible   | (USEPA 1981b) |
| Beryllium      | negligible   | (Versar 1983) |
| Cadmium        | negligible   | (GCA 1981b)   |
| Nickel         | $4.4 \times 10^{-2} \text{ kkg/10}^{12} \text{ Btu}$ | (Versar 1983) |
| Total Chromium | negligible   | (USEPA 1983)  |

**THE STACK-SELECTION PROGRAM FOR UTILITIES**

Originally, stack selection for utilities was based on only one set of stack data. If these data were missing or recorded as zero, the worst case default values were used. This led to an over dependence on default stack parameters (for example, in Wayne, Michigan, seven out of nine facilities used worst case default stack parameters) because of the lack of stack data in NEDS.

To improve this situation, a scheme was developed to select only those stacks with good data (when stack data exist for the facility). The stack selection was prioritized by the quantity of VOC, i.e., stack

data associated with the largest quantity of VOC emissions were checked first, followed by the stack data for the second largest quantity of VOC emissions, etc. Of course if no data exist for a given facility, it will still be necessary to use default values.

## (2) SAI Data

This section of Appendix E presents point source emissions data extracted directly from the report, "Human Exposure to Atmospheric Concentrations of Selected Chemicals," Volume II, dated February 1982. This report was prepared by Systems Applications, Incorporated (SAI) for the Office of Air Quality Planning and Standards (OAQPS).

Data are presented for six chemicals: carbon tetrachloride, nickel, formaldehyde, chloroform, trichloroethylene, and beryllium. Information is given on the company name, location, SAROAD Code, and estimated emissions (in kkg/yr).

These data were developed by SAI and they have not gained full acceptance by industry and EPA. Consequently, a special code was entered with the SAI data so that they could be easily distinguished.

## (3) Supplemental Data

This appendix contains supplemental point source data (seven new data points) that were into HEMIS. The first data set, which contains industry emission estimates, was obtained by EPA. The second group of data comes from an earlier Versar study that dealt with Kanawha, WV; these data greatly enhance the NEDS data for this county.



## REFERENCES

GCA. 1981. Survey of cadmium emission sources. Research Triangle Park, NC: U.S. Environmental Protection Agency. EPA-450/3-81-013.

GCA. 1982. Locating and estimating air emissions from sources of chloroform. Draft final report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

Radian Corp. 1982. Locating and estimating air emissions from sources of acrylonitrile. Draft final report. Research Triangle Park, NC: U.S. Environmental Protection Agency.

Tierney DR, Wilkins GE. 1979. Status Assessment of toxic chemicals: acrylonitrile. Cincinnati, OH. U.S. Environmental Protection Agency. EPA-600/2-79-210a.

USEPA. 1980. An exposure and risk assessment for tetrachloroethylene. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1980. An exposure and risk assessment for pentachlorophenol. Washington, DC: U.S. Environmental Protection Agency. EPA Contract No. 68-01-3857.

USEPA. 1981a. An exposure and risk assessment for trichloroethylene. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1981b. An exposure and risk assessment for arsenic. Final draft report. Washington, DC: U.S. Environmental Protection Agency.

USEPA. 1983. Locating and estimating air emissions from sources of chromium. Preliminary draft report. Washington, DC: U.S. Environmental Protection Agency.

Versar. 1981. Evaluation of the coal-limestone pellet fuel for residential applications. Draft report. Research Triangle Park, NC: U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory. EPA Contract No. 68-02-3181.

Versar. 1983. Emissions factors handbook version II. Draft. Washington, DC: U.S. Environmental Protection Agency.

Versar. 1984. Exposure assessment for 1,3-Butadiene. Unpublished. Washington, DC: U.S. Environmental Protection Agency.

Viviani, Kayser, Sterling. 1982. Toxic metals and metalloids: an analytic comparison of emissions and agency controls by industry categories. Washington, DC: Office of Toxic Substances, U.S. Environmental Protection Agency.

## APPENDIX H

### Procedures for the Selection of Stack Parameters

**DRAFT**

As part of its input, GAMS requires stack parameters (height, diameter, velocity, and exit temperature). Since NEDS may list different stack parameters for each stack at a multi-stack facility, HEMIS selected the set of stack data to use according to the following algorithm:

- Distinguish between those stacks where NEDS lists height and diameter from those where either parameter is missing.
- From those with complete stack parameters, sort stacks in order of the quantity of VOC emissions. Use the stack parameter of the stack emitting the highest quantity of VOC emissions.
- If NEDS lists no height or diameter for any stack, use whatever stack parameters are available for the stack emitting the highest quantity VOC emissions.
- For the chosen stack, if either height or diameter is missing, set the height equal to 10 meters and the diameter equal to 0.1 meters. If flow is missing, set the velocity equal to 0.1 meters/second; otherwise, the velocity is equal to  $\text{flow} / (3.14159 \times \text{Radius}^2)$ . If exit temperature is missing, set the exit temperature equal to 300 degrees K.

HEMIS then creates records in the format required by GAMS, using the stack parameters determined from the above algorithm. HEMIS simultaneously converts UTM coordinates into latitudes and longitudes.

For the 180 utilities in the 35 counties, HEMIS follows the same procedures, except that the default height and diameter are 52.4 and 1.70 meters, respectively; default velocity is 20 meters/second; and default exit temperature is 491 K. Furthermore, if the diameter exceeds height x 0.075 then diameter in meters equals  $(\text{height} - 1.8) / 58.8$ .

For POTW volatilization, the algorithm is simpler. Emissions are calculated for each POTW, and stack parameters are uniform: height equals 10 meters; diameter equals 0.1 meters; velocity equals 0.1 meters/second; and exit temperature equals 300 K.

**APPENDIX I**

**Annual Incidence of Cancer for Coke Oven Plants**

DRAFT

Annual Incidence of Cancer for Coke Oven Plants  
Contained in the 35 County Study

| County        | Number of<br>Plants | Annual Cancer<br>Incidence | Lifetime Cancer<br>Incidence |
|---------------|---------------------|----------------------------|------------------------------|
| Cook, IL      | 2                   | .25                        | 17.5                         |
| Marion, IN    | 1                   | 26                         | 18.2                         |
| Baltimore, MD | 1                   | .18                        | 12.6                         |
| Wayne, MI     | 2                   | .34                        | 23.8                         |
| Allegheny, PA | 2                   | .71                        | 49.7                         |
| Cuyahoga, OH  | 1                   | .69                        | 48.3                         |
|               |                     |                            | <hr/> 170.1                  |

Source: USEPA, Office of Air Quality Planning and Standards.

## APPENDIX J

Raw Outputs from HEMIS

**DRAFT**

Appendix J is forthcoming in a separately bound volume