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COMPARATIVE RISK ANALYSIS OF TOXIC RELEASE INVENTORY DATA FOR CARCINOGENS: DOES QUANTITY REDUCTION NECESSARILY MEAN LESS RISK? A MICHIGAN CASE STUDY

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COMPARATIVE RISK ANALYSIS OF TOXIC RELEASE INVENTORY DATA FOR CARCINOGENS: DOES QUANTITY REDUCTION NECESSARILY INDICATE LESS RISK? A MICHIGAN CASE STUDY

By

Michael Aloysius McMenamin

A DISSERTATION

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ABSTRACT

COMPARATIVE RISK ANALYSIS OF
TOXIC RELEASE INVENTORY DATA FOR CARCINOGENS:
DOES QUANTITY REDUCTION NECESSARILY INDICATE LESS RISK?
A MICHIGAN CASE STUDY

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In recognition of the disastrous effects of the accidental release by industry of toxic chemicals around the globe, the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) was enacted. The EPCRA requires owners and operators of manufacturing facilities to submit reports on toxic chemical storage and release. One purpose of the EPCRA is to decrease total quantities of toxic chemicals and to provide local citizenry with the information necessary to protect themselves from the hazards presented by toxic chemicals.

Under the EPCRA, toxic chemical data is presented in quantities, without the incorporation of critical factors such as toxicity and exposure. Presenting data in this format is inaccurate and misleading and does not allow the average citizen to assess potential risk presented by the toxic chemicals. Further, with data presented in this format, accurate assessment of efforts to decrease total toxic chemicals is difficult.

Fundamental principles of toxicology illustrate that a direct correlation between quantity and risk, without consideration of other critical factors, does not necessarily exist. Therefore, a reduction in chemical quantity may not correspond to a decrease in the potential risk posed by that chemical. Recognition of this concept indicates that factors

other than quantity must be used in determining whether the efforts to decrease toxic chemical quantities are directed appropriately.

Using Michigan as a case study, the dissertation focuses on specific carcinogens and extracts chemical data for reporting years 1987 through 1994. A hazard valuation algorithm, that integrates quantities with known toxicity values and accepted exposure assumptions to arrive at an estimated "hazard value," is applied to the Michigan data for the specific carcinogens. Evaluation of the correlation between the total quantities reported under the EPCRA and the total hazard values as calculated by the algorithm illustrates the EPCRA's limitations for both evaluating toxic chemical data and assessing whether the efforts to decrease toxic chemical quantities are directed appropriately.

It is the thesis of this dissertation that analysis of the EPCRA toxic chemical data, using total quantity as the only analysis parameter, is not useful in assessing whether efforts to decrease toxic chemical quantities are directed appropriately.

The stars seemed to get brighter the more we climbed . . . .
Flat on my back, I stared straight up at the magnificent firmament, glorying in the time I was making, in how far I had come from sad Bear Mountain after all, and tingling with kicks at the thought of what lay ahead of me . . . -whatever, whatever it would be.

JACK KEROUAC, *ON THE ROAD*

This dissertation is dedicated to my Mom,
who has been ABD for more than 20 years.
While she was always ahead of her time, she only recently got a computer!
She taught me to put the sad times behind me, to keep climbing and
to keep looking forward to what lay *on the road* ahead of me.
Thanks Mom. You are more than I can ever hope to be!

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My sister Mary, brother Tommy and the rest of my family have supported me for all my life (even when others would not have) and were a constant source of encouragement. During this process they were only eleven digits away and always in my heart.

Daniel Bronstein and Michael Kamrin have supported me on every imaginable level and at every turn in the road since my first visit to the campus in the summer of 1992. While I often stumbled through the process or got lost completely, they have consistently been a source of wisdom and guidance. Without their patience, help and good humor I would not have realized this goal. I owe them my future.

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Dr. Barry Hart Dubner has been a constant source of advice and counsel during this process. As a mentor he kept me constantly grounded in reality and helped me to keep writing.

The friends I have made deserve more than simple acknowledgment. Their tolerance, humor, advice and friendship are more important to me than they can ever know and I would not have completed this undertaking without them. John Abbott is a better friend than I deserve who has taught me alot about myself and what is important in life. Paul Groll is a good friend who's humor and advice are only surpassed by his ability to keep my computer working with voodoo and Band-Aids. Dr. Marsha Crawford deserves special thanks for having the decency to have gone through the doctoral process before me so that she could provide sound counsel in my moments of existential angst. Mike Kaplowitz is the best rabbi a doctoral student could hope for. Dan, Sue & Bob, Steve & Cheryl, and Robb & Chris through their friendship, have all made the project less onerous than it could have been and are responsible for my sanity. Thanks, guys.

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TABLE OF CONTENTS

Part II

Part II **LITERATURE REVIEW**

CHAPTER THREE: APPLICABLE RISK ASSESSMENT LITERATURE

Part III **DATA COMPILATION**

CHAPTER FOUR: TRI DATA

CHAPTER FIVE: HAZARD VALUE SCORING METHOD

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

> Mr. President, I would like to continue my commentary with a few remarks about the Community Right-to-Know provisions of this bill.
>
> * * *
>
> The Bhopal disaster focused public attention on the fact that extremely dangerous chemicals are present at chemical manufacturing plants and other facilities in communities all across America. The title of the Superfund bill recognizes a basic fact: that citizens have a right to know about these chemicals-what they are, where they are, and how much of them is present.[1]

Senator Stafford's commentary on how right-to-know principles apply to "extremely dangerous chemicals" (*i.e.*, toxic) is deficient in one fundamental concern. A plain reading of the Senator's comments concerning this specific piece of legislation, and indeed the congressional record concerning right-to-know issues prior to the enactment of the legislation, clearly lacks any commentary on risk.[2] Lacking this direct commentary, it is possible to infer that this specific right-to-know legislation was not intended to incorporate factors of risk and therefore should not be used as a tool for risk assessment.

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[1] 132 CONG. REC. S14895-02. (daily ed. Oct. 3, 1986) (statement of Sen. Stafford).

[2] Commentary on risk in relation to right-to-know issues during these debates and testimony is conspicuous in its absence. The reasons for this lack of commentary can not be known, and may range the full gambit from simple oversight to political dealmaking.

However, since the enactment of the right-to-know legislation concerning "extremely dangerous chemicals," it has been commonly recognized that this specific right-to-know legislation incorporates factors of risk. Also, the use of this right-to-know legislation is assessing risk is commonly recognized. For example, Senator Kerry stated:

> In 1986, Congress passed the Emergency Planning and Community Right- to-Know Act, or EPCRA, which is also known as Title III of the Superfund Amendments and Reauthorization Act. This recognized the public's right to know about the risks that are posed by a number of private-sector facilities which produce certain toxic chemicals.[3]

Further, this specific right-to-know legislation only addresses "extremely dangerous chemicals." Therefore, factors of risk are inherently incorporated into the selection process for determining which chemicals fall within the confines of the law.

Regarding "extremely dangerous" or toxic chemicals, citizens have the right to know what, where and how much, but they also need to have some degree of understanding of the relative potency (*i.e.*, how toxic) of each of these chemicals in order to determine both the absolute and the relative risk presented by possible exposure to each chemical.

A) Study Purpose and Objectives

It must not be inferred from the thesis of this dissertation that the reporting requirements of the EPCRA are of no value. Quite to the contrary, the reporting requirements of the EPCRA are the foundation for the production of the TRI database

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[3] 139 CONG. REC. S3411-01. (daily ed. Mar. 23, 1993) (statement of Senator Kerry).

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which is a resource of almost immeasurable value. It is not the purpose or objective of this dissertation to criticize the structure of the EPCRA, the infrastructure on which it relies or the use of the TRI as a tool to decrease toxic chemicals in the environment. Further, this dissertation does not propose a new paradigm for community right-to-know in the arena of toxic chemical reporting similar to that currently existing under the EPCRA.

The purpose of this dissertation is to show that the implementation of the EPCRA's reporting requirements does not succeed in achieving the recognized goals of the EPCRA in Michigan. The ultimate objective of this dissertation is to illustrate that the recognized goal of decreasing overall risk by reducing the amounts of toxic chemicals stored or discharged into the environment is not achieved by the EPCRA's current reporting requirements. Therefore, the dissertation suggests that efforts to decrease risk by reducing toxic chemicals in the environment are not directed appropriately. The dissertation illustrates that TRI data analysis must incorporate factors other than quantity if toxics reduction efforts are to be made efficient by focusing on those specific chemicals that pose the greatest risk due to their inherent toxicity. This re-focusing of toxics reductions efforts will accelerate the rate at which the recognized goals of the EPCRA will be achieved, if they are to be achieved at all.

A further objective of the dissertation is to suggest a more appropriate method for TRI data compilation and analysis that will result in a more useful format for the presentation of the data to the average citizen. The dissertation illustrates that the adaptation and application of existing risk assessment principles to the TRI data not only produces a more sophisticated analysis of the data, but also provides information that is

critical for achieving the recognized goals of the EPCRA. Presentation of the TRI data in the appropriate format can empower the average citizen with the information necessary to evaluate the potential risks presented by the presence of TRI chemicals to which they may be exposed. This information will also enable the average citizen to engage in informed, intelligent decision-making concerning those toxic chemicals and possible exposures. It is through this empowerment of the average citizen through presentation of the EPCRA data in a format that incorporates fundamental risk assessment principles that the recognized goals of the EPCRA may best be achieved. The dissertation proposes that these goals may be better accomplished by integrating the principles of existing risk assessment paradigms with the TRI data and that a more appropriate method of TRI data analysis and presentation is necessary.

B) Study Organization and Data Collection

The dissertation contains seven chapters separated into four general parts. The four general parts are: Background, Literature Review, Data Compilation and Data Analysis and Conclusions.

Part One of the dissertation contains two chapters. Chapter One will provide background information on events such as the disaster at Bhopal, India. It was the Bhopal disaster that provided the impetus for U.S. legislators to implement assorted Right-To-Know legislation. Further, this part will provide detailed background on the EPCRA and the TRI set against the broad background of right-to-know legislation. Chapter Two will outline the problem statement, methods used and the design of this dissertation.

Part Two of the dissertation contains one chapter. Chapter Three will provide a general review of the existing literature regarding fundamental risk assessment concepts. This chapter includes the review of literature addressing the use of hazard value scoring methods in assessing risk. The purpose of this section is to provide the necessary breadth of review of existing risk assessment alternatives to allow for the reasonable selection of an appropriate tool to perform an analysis of the TRI data.

Part Three of the dissertation contains two chapters. Chapter Four reviews the structure and conceptual framework of the TRI database. Also, this chapter outlines the process for the selection of specific toxic chemicals to be analyzed and the use of on-line computer resources as a method of data collection to be used in the dissertation. Finally, this chapter includes the compilation of the appropriate TRI data for each selected toxic chemical. Chapter Five adapts the hazard value scoring method selected in Part Two, Chapter Three for use in the analysis of the toxic chemicals selected. The adapted hazard value scoring method is then be applied to the specific TRI data compiled in Chapter Four. The resulting data is compiled in this chapter for analysis.

Part Four of the dissertation contains two chapters. Chapter Six of the dissertation compares the quantity data provided in the TRI with the computed hazard value data for the specific toxic chemicals compiled in Chapter Five. Also, this chapter provides the analysis of the compiled data. Considering this analysis, Chapter Seven presents the conclusions of the dissertation. Based on these conclusions, this chapter makes recommendations for future research.

Part I

BACKGROUND, PROBLEM STATEMENT, AND METHODS

CHAPTER ONE

A) Background

1. 1984 Bhopal Disaster

The most catastrophic toxic chemical release recorded occurred on December 4, 1984 at a Union Carbide pesticide manufacturing facility in Bhopal, India.[4] The Union Carbide facility in Bhopal released approximately 20 tons of methyl isocyanate ("MIC"), an extremely toxic intermediate used in the production of pesticides, into the atmosphere.[5] The gas cloud spread over the shantytowns surrounding the facility killing more than 2,000 and seriously injuring more than 200,000 others.[6]

2. Toxic Chemicals in the United States

The risks presented by the use, storage and discharge of toxic chemicals are not unknown in the United States. Concomitant with the presence of toxic chemicals is the inevitability of accidental release.[7] For example, it is estimated that between 1982 and 1986 there were more than 11,048 accidental releases of hazardous substances that

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[4] *The Bhopal Tragedy: Social and Legal Issue: A Symposium*, 20 TEX. INT'L L.J. 267 (1985).

[5] Sidney M. Wolf, *Fear And Loathing About The Public Right To Know: The Surprising Success Of The Emergency Planning And Community Right-To-Know Act*, 11 J. LAND USE & ENVTL. L. 217 (1996).

[6] Bradford C. Mank, *Preventing Bhopal: "Dead Zones" and Toxic Death Risk Index Taxes*, 53 OHIO ST. L.J. 761 (1992); *see also* Richard Schwadron, *The Bhopal Incident: How the Courts have Faced Complex International Litigation*, 5 B.U. INT'L L.J. 445 (1987).

[7] A broad review of the accidental releases of toxic chemicals is provided in the U.S.E.P.A.'s *Accidental Release Information Program, available in* INTERNET, <http://www.epa.gov//swercepp/tool/arip.html>.

directly caused 309 deaths, over 11,000 injuries and the evacuation of almost one half a million people.[8]

Several accidental releases gained more notoriety than others. For example, a series of 15 reported releases (over an 18 week period) of various toxic chemicals from chemical plants on Staten Island, New York received considerable notoriety. These releases threatened cities in New Jersey and necessitated the dispatch of the environmental and medical response teams into Union and Middlesex Counties.[9]

The most notable single release in the United States occurred in August 1985, in Institute, West Virginia at a pesticide plant which produced the same pesticide that the Bhopal plant produced. The release was caused by a leak in a 500 gallon storage tank containing aldicarb oximine.[10] While no deaths occurred, the release produced a toxic cloud which drifted over Institute, West Virginia and other local communities causing eye, throat and lung irritation in 135 people.[11] Aside from the similarity in the pesticide end-product produced, this release probably gained such notoriety since it, like the Bhopal release, was from a facility owned by Union Carbide.[12]

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[8] *See* S. REP. NO. 228, 101-228, at 134 (1989); *id.*

[9] Hearing on P.L. 99-499 *Before the Committee on Small Business*, 99th Cong., (June 18, 1985). Inquiry concerning the details of the 15 releases and the risks posed to citizens of both New York and New Jersey was the focus of a line of questioning by the U.S. Senator from the State of New York, Alphonse D'Amato.

[10] *See* Jayne S.A. Pritchard, Comment, *A Closer Look at Title III of SARA: Emergency Planning and Community Right-to-Know Act of 1986*, 6 PACE ENVTL. L. REV. 203, 203-04 (1988); *Steam in Chemical Storage Tank Named As Likely Cause of Union Carbide Accident*, 16 ENV'T REP. (BNA) 635 (Aug. 16, 1985) [hereinafter Union Carbide Accident]; (Aldicarb oximine is an intermediate used with MIC to produce a pesticide. The Union Carbide facility in Institute, West Virginia is the only manufacturer of MIC in the United States).

[11] *See* Pritchard, *id.* at 203; Union Carbide Accident, *id.* at 635.

[12] Casey Bukro, *Carbide Plant Leaks*, 150 CHI. TRIB. 1 (1985).

3. The Political Debate

During the debates in the United States Congress regarding community right-to-know legislation, a parallel was drawn between the Bhopal facility and American facilities. This parallel was expanded by including a review of the number of chemicals produced in this country and an estimate of accidents involving toxic chemicals in the United States.[13] Finally, in an attempt to increase public concern, one Congressman extended the parallel and predicted the inevitability of "corpses in the street."[14]

While predicting "corpses in the street" may have been extreme and unnecessary, the Congressional testimony in support of right-to-know indicated that the primary

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[13] In testimony at the *Hearing on P.L. 99-499 Before the Sub-Comm on Commerce, Transportation and Tourism of the Comm on Energy and Commerce*, 99th Cong., 10 (1985), Congressman Sikorski stated:

> Just 1 year ago, 1 year ago and 2 weeks, the worst chemical disaster in history left over 2,000 people dead and over 200,000 people injured in India . . ..
>
> That was in India, but an American company was operating that facility, a replica of an American facility. And in America today, 60,000 chemicals are produced in over 6,000 communities, and last year 5,700 toxic chemical accidents occurred.

Id.

[14] *Id.* Congressman Sikorski reduced the above estimates to the absurd and stated:

> The effect of these chemicals--the dioxin, PCB's, asbestos, benzenes--is often not clear overnight. The corpses are not in far-distant country streets. The corpses are waiting in America's hospitals and hospices, and they come from American playgrounds, they come from American blue collar neighborhoods and factories, they come from American suburban homes that are built in areas that were the dumping grounds 20 and 30 years ago for industries.
>
> Now despite 20 years of environmental regulation of toxic substances, thousands of pages of data and cases of brain cancer, liver cancer, and mutations and birth defects, we still cannot answer basic questions about even the most common and deadly toxic chemicals.

Id.

purpose of the legislation was to protect the "fundamental rights" of the citizenry by providing them with information concerning toxic chemicals to which they might be exposed.[15]

B) Right-to-Know Legislation in the United States

Right-To-Know ("RTK") legislation is designed to provide information to the common citizen that will allow that citizen to understand ongoing activities that may personally affect him/her.[16] The ultimate goal of RTK legislation is to allow each citizen to make better decisions regarding those activities that do personally affect him/her and to become more active in community and/or personal decision-making processes.[17]

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[15] *Id.* Congressman Sikorski described community right-to-know as a "fundamental right" and stated:

> Millions of Americans in thousands of neighborhoods exposed to toxic chemicals have a simple, fundamental right to know about what chemicals, toxic chemicals, are being released into their environment hour after hour, day after day, year after year. The House bill, through our efforts, guarantees that Americans will be provided with this information.

Id.

[16] *See also* SUSAN HADDEN, A CITIZEN'S RIGHT TO KNOW: RISK COMMUNICATION AND PUBLIC POLICY (Westview Press 1989) (providing a broad view of right-to-know legislation). For example, Professor Hadden uses the practice of food labeling in the United States to demonstrate RTK laws stating that "the government requires manufacturers to list ingredients but leaves it to consumers to determine whether the risks of any ingredients are unacceptable to them."

[17] *Id.* at 16. Further, Professor Hadden states that the once the government provides the citizenry with new information, it is only reasonable that the government provide that citizenry with a venue through which it can participate in the decision-making process. *Id.* Expanding on the concept of "information as power," Professor Hadden states that this system increases the burden placed on the public "to evaluate information and actually make choices rather than leaving them to government or industry." *Id.* Whether the average citizen has the ability to "actually make choices" or even if actual "choices" exist are foundation issues in "Right-To-Act" movements and legislation that are a logical, and necessary, extension to RTK legislation. As Paulette L. Stenzel stated, right-to-act

(footnote continued)

However, merely providing a citizen with raw information does not indicate that the citizen will be able to intelligently participate or contribute in a positive way to any decision-making processes. The nexus between full information and effective decision-making requires that the citizen has reached a certain level of understanding of the information provided. The mere provision of information does not necessarily imply that the citizen has either the ability or the resources to reach a useful level of understanding of that raw information. The underlying and unanswered question in the area of RTK law is "Right-To-Know what?"[18]

A fundamental problem with some RTK legislation is that the average citizen does not have, nor is the citizen provided the tools necessary to understand the information supplied by that legislation. However, it would clearly not be possible to provide every citizen with the tools necessary to understand all information provided through RTK legislation. The result of this inadequacy in RTK legislation is a potential for misinterpretation of the information provided, which could produce a negative impact on participation in decision-making processes. The answer to this quandary is not that RTK legislation should not be enacted. Rather, the information provided through the legislation must be in a format (*i.e.*, a format described by Hadden as "understandable and

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legislation is "designed to empower workers and other community residents to 'do something' about the hazards to which they are exposed." Paulette L. Stenzel, *Right To Act: Advancing The Common Interests Of Labor And Environmentalists*, 57 ALB. L. REV. 1 (1993).

[18] Achieving the stated goals or purposes of RTK legislation:

> requires not only that the information be available but that it be understandable and appropriate. Thus government may have to help citizens interpret or manipulate the data they obtain in order to make it germane to community decisions, not just to ensure its availability.

HADDEN, *supra* note 16, at 16 (emphasis added).

appropriate") that would allow the average citizen to reach a level of comprehension sufficient to make those decisions that would protect his/her own interests.[19] In turn, this heightened level of comprehension of complex issues allows for the indirect influence of industry and government to self-regulate thereby furthering the interests of the citizenry.[20]

C) Emergency Planning and Community Right-to-Know Act (SARA, Title III; 42 USC §§ 11001 *et seq.*)

The Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA") was passed by the U.S. Congress in 1980.[21] The CERCLA was amended by

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[19] The interplay between a citizen's fundamental understanding of complex issues and how that citizen should be afforded the opportunity to impact upon those issues in a society has been a profound source of tension throughout history. In the American democratic system, this issue was eloquently addressed by Thomas Jefferson in an often quoted letter to William Charles Jarvis:

> I know no safe depository of the ultimate powers of the society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion.

Letter from Thomas Jefferson (Sept. 28, 1820) (*quoted in* Natural Resources Defense Council v. Nuclear Regulatory Comm'n, 547 F.2d 633, 655 (D.C. Cir. 1976)

[20] Professor Hadden states:

> Policies that emphasize information provision may also serve as indirect incentives to self-regulation. Thus, facilities that must report emissions to the environment or the fact that they store extremely volatile and hazardous chemicals might prefer to reduce the emissions or change the substances they use rather than make public information that could damage their reputations.

HADDEN, *supra* note 16, at 16.

How the citizenry chooses to influence industry and government in furtherance of individual interests varies. Whether citizens choose to exert their influence through simple "green boycotts" or through the extremism of "eco-terrorism," the power the informed citizen wields is undeniable. *See, e.g.*, THE GREENING OF AMERICAN BUSINESS: MAKING BOTTOM-LINE SENSE OF ENVIRONMENTAL RESPONSIBILITY (THOMAS S.P. SULLIVAN *ed.*, Government Institutes, Inc. 1992).

[21] 42 USC § 9601 *et seq.* (1988).

Congress through the Superfund Amendments and Reauthorization Act ("SARA") in 1986.[22] The Emergency Planning and Community Right-to-Know Act ("EPCRA") was incorporated into SARA as Title III of those amendments.[23]

Expansion of the goals of the CERCLA through the incorporation of the EPCRA into the SARA was a result of two critical factors. First, there were the early efforts of environmental groups in addressing local events similar to those in New Jersey and West Virginia described above and second, there was the general post-Bhopal recognition of the risks presented by the use, storage and discharge of toxic chemicals.[24] The drafters of EPCRA and other similar RTK legislation specifically related to toxic chemicals stated that a primary goal of the legislation was to provide citizens with a higher degree of safety than existing systems in either the United States or India had demonstrated. Senator Lautenberg (New Jersey), a member of the Environment and Public Works Committee stated:

> The right to know means public information about what hazardous substances are being stored and released into the environment in our communities. It means planning for emergency releases before they happen. It means that our citizens ... will be safer and better prepared for the threats from chemical releases. It means that this Nation will not tolerate Bhopal- or Chernobyl-type tragedies.[25]

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[22] Superfund Amendments and Reauthorization Act, Pub. L. No. 99-499, 100 Stat. 1613 (codified in part at 42 U.S.C. §§ 9601-75 (1988)) [hereinafter *SARA*].

[23] Emergency Planning and Community Right-to-Know Act, Pub. L. No. 99-499, §§ 300-30, 100 Stat. 1613, 1728-58 (codified at 42 U.S.C. §§ 11,001-050 (1988)) [hereinafter *EPCRA*].

[24] 131 CONG. REC. D1471. Senator Lautenberg defended the inclusion of the EPCRA in the SARA amendments when he stated:

> In response to Bhopal and Institute, W.Va., crises, Title III of our bill provides for comprehensive community right-to-know and emergency response programs.

Id. (statement of Sen. Lautenberg).

[25] 132 CONG. REC. S14895-02 (daily ed. Oct. 3 1986) (statement of Sen. Lautenberg).

The amendment of the CERCLA through RTK legislation relating to toxic chemicals such as the EPCRA was not intended to alter the ultimate goals of the existing legislation, but rather enhance the efficacy of that legislation by increasing citizen safety through the provision of information.[26]

EPCRA is divided into three major divisions. The first being the "Emergency Planning and Notification" provisions ("Subchapter I") which mandate the creation of various state and local emergency planning and response committees.[27] The second major division contains the "Reporting Requirements" provisions ("Subchapter II") which requires industry to provide specific information concerning toxic chemical usage and releases.[28] Within the Reporting Requirements, the section containing provisions relating to toxic chemicals is commonly known as the "Community Right-To-Know" section.[29] The third major division of the EPCRA is the "General Provisions" section which

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[26] 131 CONG. REC. D1471 (daily ed. Sept. 7 1985). Discussing the use of the SARA and the EPCRA to expand the CERCLA, Senator Lautenberg stated:

> Congress enacted [CERCLA] to give the Federal Government the authority it needed to . . . protect public health and the environment from releases of manmade hazardous substances. The legislation before us today does not change the basic thrust of [that] Program. Instead, the consensus bill amends and refines the program to reflect what 5 years of experience and detailed analysis have taught us.

Id. (statement of Sen. Lautenberg).

[27] EPCRA, *supra* note 23, §§ 301-05.

[28] *Id.* §§ 311-13

[29] *Id.* § 313.

addresses issues such as trade secrets, enforcement and citizen suits.[30] The focus of this dissertation is on the "Community Right-To-Know" provisions of the EPCRA.[31]

The right-to-know provisions of the EPCRA only apply to certain facilities. First, the facility must fall within Standard Industrial Classification ("SIC") Codes 20-39.[32]

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[30] *Id.* §§ 321-30.

[31] The distinction between the provisions within the first two divisions of the EPCRA is quite clear. For example, while crossover may occur, the chemicals addressed by the "Emergency Planning" provisions EPCRA, *supra* note 21, § 302 are not necessarily those addressed by the "Community Right-To-Know" provisions at § 313. While less acutely toxic, the category of chemicals addressed in the "Community Right-To-Know" provisions of the EPCRA pose serious risks to the environment and public health and can easily separated for purposes of this dissertation. Further, the third major division of the EPCRA focuses on mechanical legal issues that are unrelated to the focus of this dissertation and therefore, also easily separated from the analysis herein.

[32] *Id.* § 313(b)(1)(A). SIC Codes 20-39 include the following industries:

SIC 20-Food and Kindred Products
SIC 21-Tobacco Products
SIC 22-Textile Mill Products
SIC 23-Apparel and Other Finished Products made from Fabrics and Other Similar Materials
SIC 24-Lumber and Wood Products, Except Furniture
SIC 25-Furniture and Fixtures
SIC 26-Paper and Allied Products
SIC 27-Printing, Publishing, and Allied Industries
SIC 28-Chemicals and Allied Products
SIC 29-Petroleum Refining and Related Industries
SIC 30-Rubber and Miscellaneous Plastics Products
SIC 31-Leather and Leather Products
SIC 32-Stone, Clay, Glass and Concrete Products
SIC 33-Primary Metal Industries
SIC 34-Fabricated Metal Products, except Machinery and Transportation Equipment
SIC 35-Industrial and Commercial Machinery and Computer Equipment
SIC 36-Electronic and Other Electrical Equipment and Components, Except Computer Equipment
SIC 37-Transportation Equipment
SIC 38-Measuring, Analyzing, and Controlling Instruments; Photographic, Medical and Optical Goods; Watches and Clocks
SIC 39-Miscellaneous Manufacturing Industries

These classification codes are broad and could be construed as covering almost any manufacturing facility. This breadth is most apparent in SIC Code 30 which includes facilities that fall within the "miscellaneous manufacturing industries" class.[33] Second, the facility must have ten or more full-time employees.[34] Third, the EPCRA only applies to the manufacture, process or use of those toxic chemicals on the Extremely Hazardous Substances List (the "List")[35] by a facility in the normal course of business.[36] Finally, the facility must store or discharge a quantity of the toxic chemical in excess of the threshold quantities published by the U.S. Environmental Protection Agency ("U.S.E.P.A.").[37] The

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[33] Further, under President Clinton's direction, Exec.Order No. 12,856, 58 Fed.Reg. 41,981 required federal agencies (SIC Codes 91-97) to comply with the EPCRA beginning in 1994. SIC Codes 91-97 include the following industries:

SIC 91-Executive, Legislative, and General Government, Except Finance
SIC 92-Justice, Public Order, and Safety
SIC 93-Public Finance, Taxation, and Monetary Policy
SIC 94-Administration of Human Resource Programs
SIC 95-Administration of Environmental Quality and Housing Programs
SIC 96-Administration of Economic Programs
SIC 97-National Security and International Affairs

The addition of these new SIC Codes dramatically broadened the EPCRA classification system.

[34] *Id.*

[35] A complete list of EPCRA §313 chemicals appears at 40 C.F.R. §372.65 (1995). *See also* 42 U.S.C. §11,002(b)(1); 40 C.F.R. §302.4 (1995). This list is subject to revision and has been amended since it was published in 1987.

[36] This "normal course of business" parameter is distinctly different from the emergency release situation addressed in the Emergency Planning provisions of the EPCRA.

[37] These threshold quantities are:

A) 10,000 pounds of each toxic chemical used at the facility; or
B) 25,000 pounds of each toxic chemical processed or manufactured at the facility in each year after 1989.

EPCRA, supra note 23, § 313(f)(1).

conceptual illustration of the applicability of the EPCRA to a facility is provided in Figure 1 on the following page.[38]

The original List contained 320 toxic chemicals.[39] The EPCRA also provides for the addition or deletion of specific chemicals from the List.[40] While there have been several deletions and additions of toxic chemicals since it was first drafted, a substantial number of toxic chemicals were recently added to the list putting the total number of toxic chemicals covered by the EPCRA at over 600.[41] The EPCRA requires that covered facilities file annual reports regarding toxic chemicals.[42]

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[38] U.S.E.P.A. Office Of Pollution Prevention and Toxics, *Toxic Chemical Release Inventory Reporting Form R and Instructions:Revised 1995 Version* 6, *Figure 1*, EPA/745/K-96-001 [hereinafter *Form R Instructions*].

[39] The EPCRA provides that:

> [t]he toxic chemicals subject to [its requirements] are those chemicals on the list in Committee Print Number 99-169 of the Senate Committee on Environment and Public Works and is entitled "Toxic Chemicals Subject to Section 313 of the Emergency Planning and Community Right to Know Act of 1986." [42 U.S.C. §11023](including any revised version of the list as may be made pursuant to subsection (d) or (e) of this section).

EPCRA, *supra* note 23, § 313(c).

[40] *Id.* § 313(d).

[41] 40 C.F.R. §372. The number of chemicals on the list immediately prior to the 1994 addition was 368. In 1994, 286 chemicals were added bringing the total number of toxic chemicals subject to the EPCRA to 654.

While this number may appear significant, it is actually a relatively small portion of the total number of chemicals in commercial use. The total number of chemicals in commercial use was estimated in 1984 to be approximately 60,000. *See* NATIONAL ACADEMY OF SCIENCES, TOXICITY TESTING: STRATEGIES TO DETERMINE NEEDS AND PRIORITIES (1984).

[42] EPCRA, *supra* note 23, § 313.

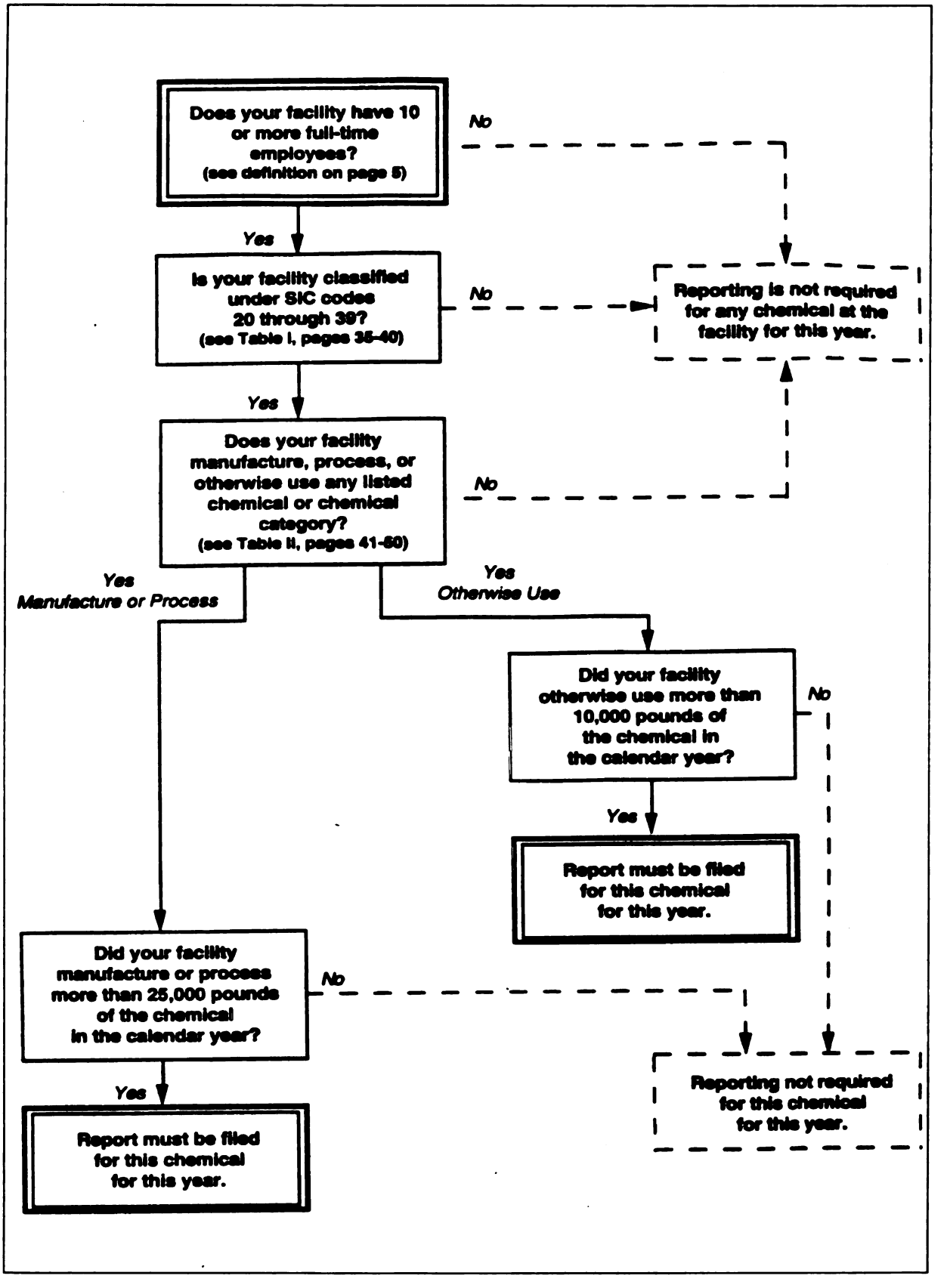

Figure 1. *Determining Applicability of the EPCRA Section 313*[38]

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Clearly, the annual reports filed by covered facilities are the cornerstone of the EPCRA. Due to the sheer volume of toxic chemicals used by manufacturing facilities in the United States, a significant body of data is contained in these reports.[43] The EPCRA provides that the task of data management falls to the U.S.E.P.A. This considerable task is accomplished by creating an inventory of toxic chemicals reports from which information is extracted and then compiled and centrally located in a national repository. As required by the EPCRA, this national repository, holding all toxic chemical data reported, is compiled into a national computer database known as the Toxic Release Inventory ("TRI").[44] The TRI is the first chemical specific accounting or inventory of toxic chemicals mandated by federal law in the United States.

D) TRI Conceptual Framework and Structure

1. Reporting TRI Data

Reporting of toxic chemicals data under the EPCRA is accomplished through the submission of a toxic chemical release form commonly known as "Form R."[45] The EPCRA mandates that the U.S.E.P.A. create Form R and that it include information concerning the type, location and amount of toxic chemicals stored or released, including the fate (*e.g.*, incineration or release into a public sewer) of the chemicals after use and

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[43] The first annual report issued by the U.S.E.P.A. stated that over 20 billion pounds of toxic chemicals were reported under the EPCRA for 1987. This amount was more than expected by anyone and was considered to be both "staggering" and "startling." *See, Data From EPCRA Emissions Reporting Called 'Startling' by Environmental Agency*, 19 ENV'T REP. (BNA) 2628, 2629 (April 21, 1989).

[44] EPCRA, *supra* note 23, § 313(j).

[45] *Id.* § 313(a).

disposal.[46] The U.S.E.P.A. publishes Form R in the Federal Register and has provided various mechanisms for its submission by industry.[47] Even with the U.S.E.P.A.'s attempts to facilitate compliance with the reporting requirements of the EPCRA, one limitation of the TRI has been the failure of industry to submit toxic chemical data.[48] This remains true despite the EPCRA's provision for civil penalties of $25,000.00 per day for each failure to comply with its reporting requirements.[49]

The EPCRA provides that compliance with its Form R reporting requirements can be accomplished using "readily available data."[50] The EPCRA does not include enhanced monitoring or measurement requirements beyond what is required under existing statutes applicable to toxic chemicals.[51] Regarding toxic chemical quantities that must be reported

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[46] *Id.* § 313(g)(1).

[47] The U.S.E.P.A. published Form R at 40 C.F.R. § 372.85 (1995); *see* Appendix A; *see also Form R Instructions*, *supra* note 38. Submission of Form R by computer can be accomplished using the U.S.E.P.A.'s *Tier II Reporting and Inventory System* <http://www.epa.gov//swercepp/tools.html>.

[48] Regarding this limitation:

> Anyone who works with TRI DATA is aware of its limitations. In 1988, an estimated 29,000 facilities should have reported, but only approximately 19,000 facilities actually did. There are even more facilities that are not required to report under EPCRA although information from them is needed for a comprehensive picture of pollution in our communities.

Gary D. Bass & Alair MacLean, *Enhancing the Public's Right-to-Know About Environmental Issues*, 4 VILL. ENVTL. L.J. 287, 300 (1993).

[49] EPCRA, *supra* note 23, § 325(c).

[50] *Id.* § 313(g)(2).

[51] *Id.* The Form R Instructions provided by the U.S.E.P.A. serve as a guideline for the estimation of toxic chemical quantities. *Form R Instructions, supra* note 38, at 24-42. For example, with respect to total on-site releases the Form R Instructions state:

> No additional monitoring or measurement of the quantities or concentrations of any toxic chemical released into the environment, or of the frequency of such releases beyond that which is required

(footnote continued)

on Form R, the EPCRA only requires an "estimate" of the total quantities in pounds.[52] Also, calculating the concentration and weight of the toxic chemical if it is only a part of a mixture is also estimated.[53] These estimates are typically performed by engineers or environmental specialists at the facility and are "certified" for accuracy and completeness by a senior official.[54] The use of estimates by industry in reporting total quantities of toxic chemicals has been questioned by the environmental community.[55]

> under the provisions of law or regulation or as part of routine plant operations, is required for the purpose of completing Form R.

Id. at 28.

[52] For example, again with respect to estimation of total on-site releases, the *Form R Instructions* state:

> You must estimate, as accurately as possible, the quantity (in pounds) of the toxic chemical or chemical category that is released annually to each environmental medium.

Id.

[53] *See* 40 CFR 372.30(b) (1994). These estimates may often create a significant burden on industry. For example, it is possible that the only method of calculation of toxic chemical quantities could include complex mass balance equations. It is also interesting to note that these mass balance equations may be based on assumptions and estimates of the efficiency of treatment programs, making the resulting numbers even "softer." *See* EPA, *Estimating Release And Waste Treatment Efficiencies For The Toxic Chemical Release Inventory Form*, EPA 560/4-88-002 (Dec. 1982).

[54] EPCRA, *supra* note 23, § 325(c).

[55] Concerning the limitations of toxic chemical quantity estimation by industry:

> Manufacturers report their own emissions based on their own estimates, and the reported emissions may, therefore, be underestimated. EPA requires no standardization in methods of estimation, creating wide variance in reporting between similar types of companies. Furthermore, there is little opportunity to verify the estimates that are reported. Actual formaldehyde emissions tests at a California factory owned by Louisiana-Pacific, for example, revealed that the company had only reported half the volume of their releases in 1989.

Bass & MacLean, *supra* note 48, at 301 (citations omitted).

2. Compilation of Data into TRI Database

The EPCRA not only requires that all nationwide toxic chemical data reported to the EPA through the submission of Form R be compiled annually, but it also requires that the data compiled into the TRI be made publicly available through the computer database.[56] Further, the EPCRA mandates that this computer database be accessible to the public on a cost only basis.[57]

3. TRI Framework

The TRI data available on-line is divided into six major categories.[58] Each of these categories provides detailed data regarding the storage, use and discharge of toxic chemicals.[59]

The TRI data is presented from various perspectives. It is possible to perform a simple search of the TRI data for an individual chemical or a specific facility, but the TRI also provides lists containing specific "categories." For example, the TRI provides a list

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[56] EPCRA, *supra* note 23, § 313(d).

[57] *Id.*

[58] The broad categories within the TRI are:

Facility Identification
Substance Identification
Environmental Releases of Chemical
Waste Treatment
Off-Site Waste Transfer
Source Reduction and recycling

[59] *The Toxic Chemical Release Inventory Fact Sheet* states:

> The data include the names, addresses and public contacts of plants manufacturing, processing or using the reported chemicals, the maximum amount stored on site, the estimated quantity emitted into the air (point and non-point emissions), discharged into bodies of water, injected underground, or released to land, methods used in waste treatment and their efficiency, and data on the transfer of chemicals off-site for treatment/disposal, either to publicly owned treatment works or elsewhere.

INTERNET <http://nlm.nih.gov> (last modified Nov. 16, 1994).

of the "Top 50 Facilities with the Largest Increase In Air/Water/Land Releases" for each reporting year.[60] Unfortunately, without further detailed analysis of the releases themselves, the TRI data user may equate the companies on this list with being the "least environmentally conscious" or "worst" companies. While this may not have been the intended end use of the TRI data in its present format, it is an apparent inevitability.

E) Use of TRI Data

The EPCRA states that Form R data is intended to provide information to the Federal, State, and local governments and the public, including citizens of communities surrounding covered facilities.[61] Further, the EPCRA provides that the Form R data submitted under Title III shall be used to inform the citizenry about releases of toxic chemicals to the environment; to assist governmental agencies, researchers, and other persons in the conduct of research and data gathering; to aid in the development of appropriate regulations, guidelines, and standards; and for other similar purposes.[62]

It is apparent that the TRI data obtained through Form R submission by industry is used by a number of groups quite effectively. The incentive to industry to reduce the amounts of toxic chemicals stored or discharged is through the avoidance of the

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[60] *Id.* It should be noted that the TRI also provides a list of the "Top 50 Facilities with the Largest Decrease In Air/Water/Land Releases" (the "best" companies). Other examples of categorical lists provided by the TRI and *available in* TOXNET are: the "Top 50 Facilities with the Largest Total Releases;" the "Top 10 Parent Companies with the Largest Total Releases" and the "Top 10 Chemicals with Largest Land Releases."

[61] EPCRA, *supra* note 23, § 313(h).

[62] *Id.*

embarrassment and bad image realized by a particular company by being listed in the popular press as less than environmentally conscious.[63]

The use of the TRI data to influence industry and government has been clearly effective for both toxic chemical use reduction and other forms of "regulation."[64] The groups that use the TRI data most effectively have been environmental and citizen organizations, environmental activists and the press. For example, one environmental organization publishes a comprehensive three volume set examining TRI releases across the country, by state and providing a "report card" on several facilities with the highest TRI releases.[65] Examples of environmental activists using the TRI data can be cited across the country.[66] The popular press has been perceived as being a major user of the TRI, which may be the best current use of this data.[67] The members of the press generally

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[63] *See, e.g.*, Mary Beth Regan, *An Embarrassment of Clean Air*, BUSINESS WEEK, May 31, 1993, at 34 (referring to the use of TRI data as a form of "regulation by embarrassment"); F. Rice, FORTUNE, July 26, 1993, at 114-22 (listing of 10 best and 10 worst environmentally conscious corporations based on TRI ranking).

[64] Kevin J. Finto, *Regulation by Information Through EPCRA*, 4 NAT. RESOURCES & ENV'T. 13 (1990); *see also* EPA Office Of Pesticides & Toxic Substances, *Toxics In The Community: National And Local Perspectives, The 1989 Toxics Release Inventory National Report* 307, EPA/560/4-91-014 (pointing to the use of TRI data by the press and citizen's groups to mobilize public response to specific problems).

[65] Citizens Fund, CITIZENS FUND POISONS IN OUR NEIGHBORHOODS: TOXIC POLLUTION IN THE U.S., VOL. 1: NATIONAL OVERVIEW, VOL. 2: TOXIC WASTE IN THE STATES, ALABAMA - MICHIGAN, VOL. 3: TOXIC WASTE IN THE STATES, MINNESOTA - WYOMING (Nov. 1993).

[66] *See* Wolf, *supra* note 5, at 217 (describing the utilization of TRI data by activists: in California to convince IBM to phase out use of CFCs; in Lima, Ohio to obtain funding for the first state airborne toxic substances monitoring project; in New Jersey to induce a company to adopt a chemical hazard accident plan; in North Carolina to support the passage of airborne toxic substances legislation and in Massachusetts to persuade a defense contractor to replace ozone depleting chemicals).

[67] United States General Accounting Office, Report To Congress, TOXIC CHEMICALS: EPA'S TOXIC RELEASE INVENTORY IS USEFUL BUT CAN BE IMPROVED 26 (June 1991) (GAO/RCED-91-121).

(footnote continued)

perceive the TRI as a useful tool.[68] However, rather than performing their own, independent analysis of the TRI data, most members of the press incorporate into press articles a second hand analysis of the data performed by outside groups. It is possible that a second hand analysis may be performed by an outside group with an unknown, unique bias or specific agenda. As the outside group performing the analysis of the TRI data may have a unique bias or specific agenda, which may not be accurate, congruent with that of the popular press and possibly even unknown, this use of the TRI data may be critically flawed.[69]

Whatever the use of the TRI data by the average citizen, either intended by the EPCRA or actual, a concern remains regarding the public's ability to understand the TRI

The perception that the press may be the "highest use" of the TRI data at this time does not imply that the press presents the TRI data in an enhanced format or superior format, but that the press serves as the best tool to "inform the discretion" of the people at this time; *see supra* note 19.

[68] Bud Ward, *American Journalism Has A New Arrow In Its Quiver*, ENVTL. HEALTH, Feb. 1992, at 63.

[69] Alair MacLean & Paul Orum, PROGRESS REPORT: COMMUNITY RIGHT-TO-KNOW 13 (July 1992). Less than twenty percent of reporters accessed the TRI while most reporters only relied on second hand information received from alternative sources or environmental groups. *Id.* at 8. The Right-To-Know Computer Network ("RTK-NET") is an on-line computer database operated by Unison Institute and OMB Watch which publish papers and assorted documents concerning public right-to-know issues. RTK-NET is funded through private donations and government funds, including monetary support from the U.S.E.P.A.. Both Unison Institute and OMB Watch are members of the consortium of numerous local, state and national environmental groups that published the PROGRESS REPORT which, in turn, cites the RTK-NET as an alternative source used by various environmental groups. *See* INTERNET <http://rtk.net/www/data/tri_gen.html> or *see also* TELNET <rtknet.org> (TELNET requires the use of an access code and password, available at no cost).

data as it is presented in the current format.[70] All parties concerned have an interest in assuring that the TRI data is used appropriately. For example, the Chemical Manufacturers Association ("CMA"), whose members are responsible for a significant portion of the toxic chemicals reported under the EPCRA, claims that the TRI data does not provide the average citizen the proper context to judge the dangers posed by toxic chemical releases. In a statement before the U.S. Senate Committee on Environment and Public Works, the CMA stated:

> The public has a right to understand what the [TRI] release data does, and does not, mean. For instance, they have the right to understand the meaning of the [TRI] data in terms of actual, real-life risks. The [TRI] program does not give them the type of information that is necessary to understand these actual risks.[71]

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[70] A.Horvath *et al.*, *Toxic Emissions Indices for Green Design and Inventory*, 29(2) ENVT'L.SCI.TECH. 86A (1995) stated:

> The Toxics Release Inventory (TRI) is the most comprehensive and widely reported information on hazardous discharges to the environment in the United States. Unfortunately, the fledgling nature of the TRI may lead to simplistic interpretations of the results.

Id. at 86A. This dissertation is predicated, in part, on a similar theory.

[71] Statement of the Chemical Manufacturers Association on the *Proposed "Right To Know More Act"* (June 27, 1991); *see* Bass & MacLean, *supra* note 48, at 302.

CHAPTER TWO

PROBLEM STATEMENT AND METHODS

A) Problem Statement

Achieving recognized goals through full public access to information is an underlying principle in the right-to-know paradigm. The EPCRA is a typical example of RTK legislation. The recognized goals of the EPCRA are two-fold. One immediate goal of the EPCRA was to provide local citizenry with the information necessary to make informed, rational decisions about the presence of toxic chemicals to which they may ultimately be exposed. Further, the reporting requirements of the EPCRA were designed to achieve a second, recognized goal of decreasing the risk posed by the catastrophic release of toxic chemicals such as occurred at Bhopal by providing an incentive to industry to reduce the amounts of toxic chemicals stored or discharged into the environment.

Attempting to achieve the first goal, the EPCRA requires the reporting of toxic chemical data (*e.g.*, data regarding toxic chemicals other than common chemical name and CAS number) in terms of total quantities. However, provision of this toxic chemicals data to the community in this format alone does not allow the average citizen to readily make an informed assessment regarding the potential risks presented by the existence of the toxic chemicals listed. By only supplying the public with a single critical factor on which an analysis can be based, the average citizen will only be capable of performing a limited

one-dimensional assessment based on that singular factor.[72] Assessment of the presence of toxic chemicals and issues of potential exposure clearly present a multi-dimensional problem.[73] Presentation of this data in this format severely limits the ability of the average citizen to reach valid conclusions concerning the presence of toxic chemicals to which he/she may ultimately be exposed. Thus the average citizen may easily draw erroneous conclusions based on a the limited information that is provided and, at best, may be able to arrive at a simple answer to a complex problem.[74] In the extreme, a citizen's use of the

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[72] The EPCRA requires that Material Safety Data Sheets ("MSDSs") be submitted, when available, by each facility for each toxic chemical. EPCRA, *supra* note 23, § 311. It has been suggested that these MSDSs serve as a primary source of health effects information for evaluating the TRI data. However, the MSDSs were designed to be utilized by workers, not the average citizen, they are typically too technical and generally do not address key issues of concern. When considering the use of MSDSs as a tool for TRI data analysis:

> The usefulness of the MSDSs is limited, however. MSDSs are often confusing because brief MSDSs tend to contain difficult to understand abbreviations and longer MSDSs tend to include various types of data in large quantities. Further, MSDSs present this data with no evaluation and fail to provide a full risk assessment.

Stenzel, *supra* note 17, at 9 (citation omitted).
A similar argument applies to the toxicological profiles prepared by the Agency for Toxic Substances and Disease Registry under SARA. *See* 42 U.S.C § 9604(I) (1994).

[73] *See, e.g.*, C.Q. Jia *et al.*, *Toxic Release Inventories: Opportunities for Improved Presentation and Interpretation,* 30(2) ENVTL. SCI. TECH. 86A-91A (1996).

[74] An example of this level of gross inefficiency is found in the following example:

> [I]t is grossly inefficient for the United States to spend $6 billion or more annually cleaning up hazardous waste sites, which EPA estimates together probably cause fewer than 500 excess cancer deaths per year, when we are spending only approximately $100 million per year to control indoor radon, which may cause a s many as 20,000 excess annual cancer deaths.

J. Main, *The Big Cleanup Gets It Wrong*, FORTUNE, May 20, 1991; *see also*, WORST THINGS FIRST: THE DEBATE OVER RISK-BASED NATIONAL ENVIRONMENTAL PRIORITIES (Finkel, A.M. & Golding, D., *eds.*, Resources for the Future, 1995).

information currently presented by the EPCRA's incomplete and thus misleading format could exacerbate the risks presented by the presence of the toxic chemicals.[75]

Further, the EPCRA was designed, in part, to achieve the more concrete goal of decreasing the risks posed to the local citizenry by providing an incentive to industry to reduce the amounts of toxic chemicals stored or discharged into the environment. With regard to the use of the EPCRA as a tool for reduction of total quantities, Senator Kerry stated:

> An important avenue to encourage pollution prevention has been something known as the multimedia data base, the toxics release inventory, or the TRI, as it is known in shorthand. This requires businesses to report on their toxic emissions to the air, land, and water.
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> * * *
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> So we have recognized this right, that the private sector has to live up to, and we have understood that very valuable information is compiled by the Environmental Protection Agency in its TRI data base.[76]

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[75] For example, lacking adequate information concerning the toxic chemicals being used at the Union Carbide pesticide plant, the citizens of Bhopal ran towards the plant when the alarm was sounded. This increased their exposure to the methyl isocyanate being released from the plant into the air. This lack of information and fundamental understanding was responsible for increased levels of fatality. *See* Hearing on P.L. 99-499 Before the Comm on Small Business, 99th Cong. (1985) (statement of Dr. Moore).

[76] *Supra* note 2. A clear demonstration of the recognized goal of directly reducing amounts of toxic chemicals is the "33/50 Program." This program addressed a list of 17 "priority chemicals" calling for reduction in their total emissions 33% by 1992 and 50% by 1995. The goal of reducing risk by reducing toxic chemical amounts is apparent in the enactment of the Pollution Prevention Act of 1990, Pub.L.No. 101-508, §§6601-6610, 104 Stat. 1388, 1388-321 to 1388-327 (codified at 42 U.S.C. §§13,101-13,109 (1991)), which was designed to provide incentive to industry improve source reduction efforts. The relative merit in using specific legislation, such as the EPCRA, to reduce the use of toxic chemicals has been addressed by various authors. *See, e.g.*, Francine Laden, *Toxics Use Reduction: Pro and Con*, 4 RISK I.H.S. 213 (1993).

However, the EPCRA does not include any aspects of classic risk assessment paradigms that would allow for estimating any decrease in overall risk.[77] By only presenting the data concerning releases in the one-dimensional format of total quantity, the EPCRA does not allow for a realistic or reliable evaluation of the success of this endeavor. While the data presented by the EPCRA will readily state whether there has been a decrease in total quantity of toxic chemicals discharged, this information does not provide a means of determining if there has been an improvement in the form of a decrease in the overall risk potential or potential for impact to the environment. It is possible that the decreases in total quantities of toxic chemicals reported under the EPCRA may represent a decrease in total risk, but it is also possible that the same decrease in total quantities may correspond to a direct increase in total risk.[78] As a correlation between a decrease in total quantity of toxic chemicals reported under the EPCRA and a decrease in the potential risks presented by those chemicals does not necessarily exist, an alternative to the

[77] This is similar to the situation presented in note 74, in which a policy decision is made without incorporating risk assessment principles and resources (there in the form of money) are expended in an arguably inefficient manner. No single paradigm exists that can solve every problem that involves risk assessment issues. However, various useful methodologies (*e.g.*, comparative risk assessment) in setting priorities in environmental policy, such as the EPCRA, currently exist. *See* WORST THINGS FIRST, *supra* note 74, for a general overview of issues relating to reducing "the worst risks first" with a review of the setting of national health and environmental priorities by the U.S.E.P.A. utilizing risk-based priority methodologies.

[78] *See* Jia, *supra* note 73, at 86A. Jia presents a scenario suggested by Horvath in which the quantity of chemicals discharged to the atmosphere by company A is larger, by an order of magnitude, than the quantity of chemicals discharged by company B, but once the respective discharges are adjusted to incorporate toxicological considerations such as toxicity and exposure factors, the toxicity index for company B's discharges is greater than company A's by a factor of 4-5. This example demonstrates that there is no direct correlation between quantity and risk potential or possible impact.

presentation of the EPCRA data in its current format is absolutely essential if it is to be the most useful tool for the local citizenry.[79]

The presentation of the EPCRA data in the one-dimensional format of total quantity is inadequate to serve its intended purposes. In order to optimize the use of the EPCRA both as a useful resource that will empower citizen to engage in informed, intelligent decision-making and as a practical risk assessment tool useful for efficiently directing resources towards reducing the amounts of toxic chemicals stored or discharged into the environment, a multi-dimensional analysis of the TRI data is absolutely essential.

B) Study Design and Approach

The dissertation approaches the problem presented by performing a multi-dimensional analysis of the toxic chemical data for carcinogens compiled in the TRI.

The dissertation uses Michigan as a case study and uses only a portion of the toxic chemicals listed for the study. Specific carcinogens will be selected (based on IARC and OSHA categories and the availability of data) and the appropriate TRI data compiled for reporting years 1987 through 1994.

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[79] It is possible to theorize that the drafters of the EPCRA only intended to decrease total quantities of toxic chemicals without consideration for the overall risks presented by exposure to the total toxics remaining. However, this theory would, by necessity, be premised on the concept of federal legislators accepting the possibility of an increased risk to their constituents from implementation of the EPCRA. It is not probable that this premise is true, nor is its veracity supported by the Congressional testimony regarding the passage of the EPCRA. The more probable assumption is that the drafters of the EPCRA legislation did not consider the various dimensions of risk assessment in drafting the legislation.

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The existing literature will be reviewed to select an appropriate algorithm which will be effective in performing an analysis of the TRI data. The algorithm selected will incorporate relevant toxicological factors such as toxicity and exposure factors with reported quantities to determine a total hazard value that can be used for the purposes of comparison.

The selected algorithm will be applied to the Michigan data to calculate relative total hazard values for each toxic chemical in the study. Finally, the comparison of the total calculated hazard values and the total quantities released for the select group of toxic chemicals in each reporting year will be performed.

The goal of this comparison is to evaluate the correlation between the total quantities of the selected toxic chemicals in Michigan ("quantity") and the hazard values as calculated by the modified algorithm ("risk"). The correlation illustrated by this comparison will support the conclusion that observed decreases in the total quantity of TRI chemicals does not correspond to a decrease in overall risk from carcinogens. Based on this conclusion, the dissertation suggests that the recognized goals of the EPCRA are not being achieved, that efforts to decrease risk by reducing toxic chemicals in the environment are not directed appropriately and that a more appropriate method of TRI data analysis and presentation is necessary.

Part II

LITERATURE REVIEW

CHAPTER THREE

APPLICABLE RISK ASSESSMENT LITERATURE

A) General Risk Assessment Concepts

"Risk Assessment," a fundamental principle in toxicology, is defined as "the characterization of the potential for adverse health effects of human exposures to environmental hazards."[80] More specifically, risk assessment may be defined as:

> a process whereby relevant biological, dose-response, and exposure data are combined to produce a qualitative or quantitative estimate of adverse outcome from a defined activity or chemical agent.[81]

In its current format, the TRI data compilation does not incorporate any "biological, dose-response, or exposure data."

The larger rubric known as "Risk Assessment" is typically separated into four distinct components: hazard identification, dose-response analysis, exposure assessment and risk characterization.[82]

Hazard identification is the first and most easily recognized step in risk assessment. It is the process of using data from human or animal studies to determine whether exposure to a substance could cause a disease or other adverse health effect. Further, the

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[80] CASARETT AND DOULL'S TOXICOLOGY: THE BASIC SCIENCE OF POISONS 37 (M. O. Amdur *et al.* eds., 4th ed. 1991) (quoting NAS: *Risk Assessment in the Federal Government: Managing the Process*, National Academy Press, Washington D.C. (1983)) [*hereinafter* CASARETT AND DOULL'S TOXICOLOGY].

[81] *Id* at 986.

[82] NAS, *Risk Assessment in the Federal Government: Managing the Process* (1983). Also, the EPA incorporates into most of its risk assessment guidelines the following description: 'Risk assessment includes one or more of the following components: hazard identification, dose-response assessment, exposure assessment, and risk characterization." *Guidelines for Carcinogen Risk Assessment*, 51 Fed. Reg. 33,992, 33,993 (1986).

specific disease or adverse health effect (*i.e.*, the toxicological endpoint of the possible exposure) is also determined at this stage. The toxicological endpoints observed in experimental studies range from simple allergic reactions to increased mortality and incidence of cancer.[83]

The dose-response relationship is considered "the most fundamental and pervasive concept in toxicology."[84] A dose-response analysis builds on the hazard identification step of risk assessment by quantifying the relationship between the dose of an agent and the probability and/or severity of a specific adverse effect in laboratory animals. On its simplest level, a dose-response relationship is "characterized by a dose-related increase in the severity of the response."[85]

Exposure assessment quantifies the exposure and uptake of a substance by a specific population using field measurements and other estimates. Specific components of exposure include "intensity; frequency; schedule; route and duration of the exposure [through any combination of oral, inhalation and/or dermal routes of exposure]; and the

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[83] *See* CASARETT AND DOULL'S TOXICOLOGY, *supra* note 80, at 988. The text states that "[t]he key element in this step is the linking of the agent or activity with the effect and reflects the strength and plausibility of the association." *Id.*

[84] *Id* at 18.

[85] *Id.* Further, in practical applications:

> there are two types of dose-response relationships: (1) that which describes the response of an *individual* to varying doses of a chemical, often referred to as "graded" responses because the measured effect is continuous over a range of doses, and (2) that which characterizes the distribution of responses to different doses in a *population* of individuals.

Id. (emphasis added).

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nature, size, and makeup of the potential (or actually) exposed population."[86] These data are combined to estimate the potential uptake of the substance by the exposed population.

The most important part of a risk assessment, the risk characterization, summarizes and interprets the information collected from previous activities, identifies and quantifies the probability of risk in a specific population. It is at this final stage that the limitations and the uncertainties in estimating risk are presented and various social and/or political judgments (*e.g.*, safety factors) are incorporated.[87]

B) Alternative Hazard Value Scoring Methods

Several weighting systems for performing a comparative analysis of toxic chemicals have been proposed. All the systems proposed suffer from similar deficiencies that limit their usefulness. First, missing or incomplete data prevent all proposed weighting systems from being broadly applicable. Second, each system requires subjective decisions in determining data input which mitigate against any single system becoming universally accepted. To varying degrees, these deficiencies have prevented any one system from being recognized as the definitive risk assessment tool in this arena. Below are several of the alternative hazard value scoring systems that have been proposed as being applicable to TRI data.

Further, this aspect of risk assessment is referred to as the "most neglected aspect of the k assessment process." *Id.* at 988.

EPA has published guidelines for many stages and types of risk assessment. *See, e.g.*, *idelines for Carcinogen Risk Assessment*, 51 Fed. Reg. 33,992 (1986); *Guidelines for imating Exposures*, 51 Fed. Reg. 34,042 (1986); *Guidelines for the Health Assessment Suspect Developmental Toxicants*, 51 Fed. Reg. 34,028 (1986); *Guidelines for the ulth Risk Assessment of Chemical Mixtures*, 51 Fed. Reg. 34,014 (1986); and *delines for Mutagenicity Risk Assessment*, 51 Fed. Reg. 34,006 (1986).

1. Interagency Testing Committee Workshop *(Welch & Ross)*

An early scoring system for toxic chemicals was developed by the Toxic Substances Control Act-Interagency Testing Committee ("ITC").[88] That system was reviewed by a group of experts from academia, government and industry in February 1979.[89] A three day workshop sponsored by the U.S.E.P.A.'s Office of Toxic Substances and the ITC was held in August 1979 to further review of the principles of this scoring system. The results of this second workshop and the final iteration of the scoring system were subsequently reported by Welch & Ross.[90]

In this study, the authors recognized the need for the integration of a scoring method for setting priorities when dealing with "problem chemicals" that present the greatest possible risk (assuming some exposure). Welch & Ross stated:

> When dealing with a large number of problem chemicals, the use of a systematic method is one approach to insure that those chemicals with the greatest potential risk are identified and reviewed first. Scoring can be viewed as a tool to provide a framework for the consistent evaluation of information used in the early stages of the chemical assessment process. The purpose of scoring is to select from the large number of existing chemicals those chemicals that have a high probability of requiring review for control or testing.

Toxic Substances Control Act-Interagency Testing Committee, *Initial Report to the dministrator*, EPA 560/10-78/001, U.S. Environmental Protection Agency: Washington, C., February 1977.

R. H. Welch & J. L. Welch, *Proceedings of the EPA Workshop on the Environmental oring of Chemicals*, EPA 560/11-80-010, U.S. Environmental Protection Agency: ashington, D.C., February 1979.

J. L. Welch & R. H. Ross, *An Approach To Scoring Of Toxic Chemicals for vironmental Effects*, 1 ENVTL. TOXICOL. CHEM. 95 (1982).

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[8] *Id.* at

[9] *Id.*

[10] Welch &

Id. at 10

The EPCRA, in focusing on toxic chemicals with the goal of reducing potential risk, also "deals with a large number of problem chemicals." However, the approach suggested by Welch & Ross (or a similar approach) was not included in the requirements of the EPCRA and therefore, there is no way of knowing whether the overall risk has been decreased or if the implementation of the EPCRA is efficient (*i.e.*, if those chemicals with "the greatest potential risk" are addressed first).

The ITC scoring system addressed various environmental effects "that covered seven subfactors dealing with human health and ecological concerns."[91] The scoring system "consisted of three segments: environmental (biotic) effects, environmental fate, and ecosystem effects" and incorporated parameters such as lethal dose, persistence and mobility.[92] However, the system had several distinct "drawbacks."[93]

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[91] *Id.* at 96.

[92] *Id.*

[93] Welch & Ross stated:

> The proposed approach is reasonable in concept, but there are several drawbacks to the system. The system does not address abiotic effects or effects on ecosystem processes.
>
> . . . .
>
> Another drawback is the lack of systematic identification of specific areas that may require testing, but it was felt that further study of chemicals with high scores would identify data voids and testing needs.
>
> . . . .
>
> In closely examining the system after the workshop adjourned, several problem areas became evident. The mobility concept needs further clarification and better definition of criteria for scoring. In addition, combining the toxicity with appropriate exposure media needs more thought. Exposure route in the effects tests should be linked more closely to environmental exposure routes.

at 100-101.

For the purposes of this dissertation, one drawback to using the scoring system is that it did not provide a quantitative analysis of the toxicity for each chemical. The scoring system only grouped chemicals generally according to relative concern (*e.g.*, "high, medium, and low concern") and did not quantitatively rank each chemical independently.[94] Further, the Welch & Ross scoring system proposed substituted expert opinion when data was completely unavailable.[95] Welch & Ross perceived the incorporation of expert opinion to be a distinct advantage for their scoring system.[96] However, for the purposes of this dissertation, the reliance on the incorporation of expert opinion is not an option and therefore is a drawback to using the Welch & Ross scoring system.

The use of general groupings based on relative concern and the reliance on subjective opinion in place of available data makes this system less than desirable for

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[94] *Id.* at 102. The approach taken by Welch & Ross only provided a comparative analysis of the chemicals included in the study and therefore, the scoring system was not useful in analysis of individual chemicals outside the system. Welch & Ross, *id.* at 102, recognizing his, stated:

> it is important to emphasize that the utility of a chemical's score is not so much the score itself, but in enabling one to compare it with other chemicals. Scoring is a tool to sort chemicals into several groups (for example, high, medium, and low concern) with chemicals in each group being of relatively similar degree of concern; the actual ranking is less important.

*. at 102 (emphasis added).

Id. at 100. A lack of experimental data was not perceived by Welch and Ross to be oblematic. The authors, *id.*, simply state that: "Expert scorers will use their professional lgment in generating a score even if some information is not available." *Id.*

Id. at 100. Welch & Ross, *id.*, in illustrating this perspective state: "[The model's] vantages are it simplicity, minimal information requirements, and reliance on fessional judgment." *Id.*

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assessing risk on an individual chemical basis.[97] As one of the earliest chemical scoring systems proposed, Welch & Ross admitted to and reviewed the inherent limitations of their system. Therefore, the Welch & Ross scoring system is not useful for fully assessing risk, nor is it the single best analysis paradigm available for assessing TRI data.

2. U.S.E.P.A. Conference (*Forman, et al.)*

A system designed specifically for Maryland TRI data analysis was proposed by Forman in 1993.[98] This system indexed the toxic chemicals by rank order based on relative toxicity. The ranking system was applied to both carcinogens and non-carcinogens and used oral reference doses (RfDs) and cancer potency factors (CPFs) in setting toxicity levels. This system is limited in that it only provides a relative ranking of chemicals by toxicity without quantifying the specific risk presented by each chemical nor attempting to account for exposure factors.

While the chemical ranking system proposed by Forman *et al.* might be useful for e one-dimensional analysis of Michigan data, it is not useful for fully assessing risk. erefore, this chemical scoring system is not the single best analysis paradigm available assessing TRI data.

later system was proposed by Ross in conjunction with O'Bryan that incorporated en parameters, included measures of hazard and exposure such as mutagenicity, ogenicity and lethal doses, in determining the relative ranking of toxic chemicals. system also included expert opinion when other data was unavailable. *See*, T. R. yan & R. H. Ross, *Chemical Scoring System for Hazard and Exposure ification*, 1 J.TOXIC.ENVTL.HEALTH 119 (1988).

L. Forman *et al.*, *Proceedings of the Toxics Release Inventory (TRI) Data Use rence, March 29-31, 1993, Chicago, IL*, EPA/745-R-93-004, U.S. Environmental ction Agency: Washington, D.C., July 1993.

3. University of Tennessee Study *(CCPCT; Davis, et al.)*

A study done by the University of Tennessee's Center for Clean Products and Clean Technologies ("CCPCT Study") also proposed a chemical scoring system.[99] The purpose of the CCPCT Study was to propose a system that would "support the design and development of products whose manufacture, use, recycle and disposal represent reduced impacts on the environment."[100]

The chemical scoring system proposed by the CCPCT Study (the "CCPCT System") built on the chemical scoring systems suggested in the existing literature but integrated aspects of relative risk assessment. On the issue of risk assessment and the CCPCT System, the CCPCT Study provides that:

> Risk-based chemical ranking and scoring combines an assessment of both the toxic effects of chemicals and the potential exposure to those chemicals, to provide a relative evaluation of risk. Risk assessment is an integral part of the environmental equation for successful protection and sustainability.[101]

The CCPCT System addressed issues of both human health and environmental risk from direct chemical exposure and evaluated "the potential hazard of TRI releases to humans, terrestrial animals and fish."[102] The conceptual illustration of the CCPCT System proposed in the CCPCT Study is provided in Figure 2 on the following page.[103]

G. A. Davis *et al.*, *Chemical Hazard Evaluation for Management Strategies: A Method for Ranking and Scoring Chemicals by Potential Human Health and Environmental Impacts*, EPA/600/R-94/177, U.S. Environmental Protection Agency, Washington, D.C., Oct. 1994 [*hereinafter* CCPCT Study].

Id. at iii.

Id.

Id. at 19.

Id. at 20.

Human and Environmental Toxicity

Chronic

Potential for Exposure

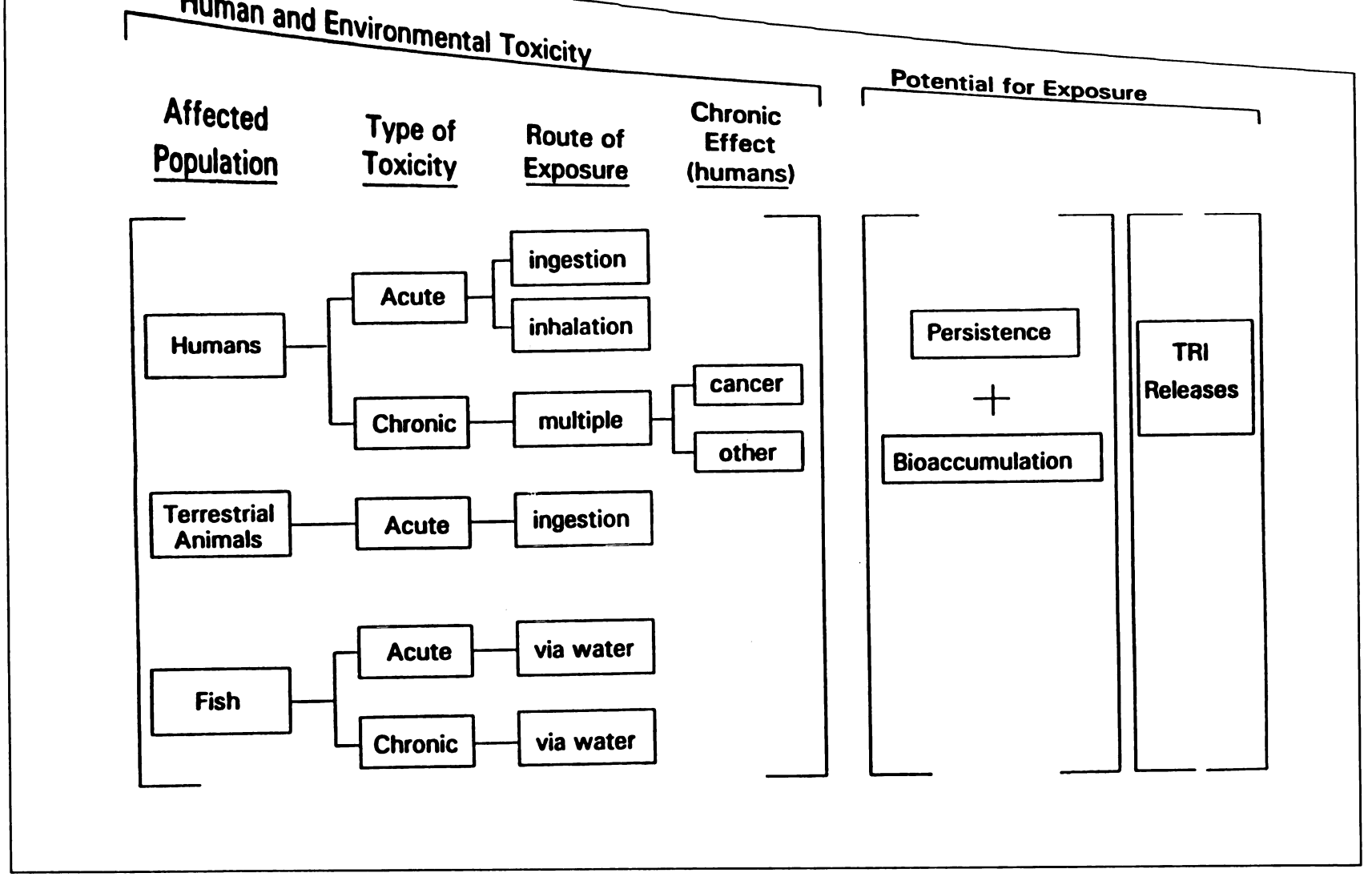

Figure 2. *Conceptual Model of Chemical Ranking Hazard Method*[103]

Hazard values used in the CCPCT System for each chemical were derived using data on "seven toxicological endpoints and exposure assessments."[104] Simply stated, the seven toxicological endpoints used in the CCPCT Study to determine hazard values are "human health effects data [that] include acute oral and inhalation toxicity, carcinogenicity, and other specific effects," and "environmental effects [that] include acute mammal and fish mortality and chronic sublethal effects in fish."[105] Each of these seven toxicological endpoints was assigned a hazard value between zero and five and effects were treated as additive.[106]

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[104] *Id.* at 21; *see also id.*, at 10, tbl. 2.

[105] *Id.* at 9. "Other specific effects" are defined in the CCPCT study as mutagenicity, developmental toxicity, reproductive toxicity, chronic toxicity and/or neurotoxicity. *See id.*, app. A, at A-10. The CCPCT Study further defines these terms as:

> *Mutagenicity*: Chemicals are indicated as possible mutagens in humans if positive results in bioassays are reported in the reference source (ICF, 1989).
>
> *Developmental Toxicity*: Chemicals are indicated as exhibiting developmental toxicity if data in the reference source support concern that the chemical may cause embryotoxicity, fetotoxicity or teratogenicity in humans (ICF, 1989).
>
> *Reproductive Toxicity*: Chemicals are indicated as exhibiting reproductive effects if data in the reference source support concern that the chemical has adverse effects on male or female reproductive performance (ICF, 1989).
>
> *Chronic Toxicity*: Chemicals are indicated as exhibiting chronic toxicity if adverse effects other than cancer occur at doses less than or equal to 1 g/kg/day following inhalation, oral or dermal exposure for more than 90 days (ICF, 1989).
>
> *Neurotoxicity*: Chemicals are indicated as neurotoxic if chronic (at least 90 days) inhalation, oral or dermal exposure to doses less than or equal to 1 g/kg/day results in neurotoxic effects (ICF, 1989).

Id. at 21. The CCPCT System incorporates the use of decision trees in assigning cific hazard values. *See id.* at app. A. A hazard value of zero indicates that the mical is nontoxic while a hazard value of five indicates that the chemical is extremely ic. *Id.*

The CCPCT System incorporated a Release Weighting Factor (RWF), defined as "a multiplicative used to weight toxicity hazard values for each chemical according to the amount of its annual releases or transfers to air and water."[107] This weighting system was necessary to ensure that neither the hazard values nor the release amounts dominated the algorithm.[108] Four weighting systems were evaluated for calculating the RWF. The authors selected a scheme that "[multiplied] specific hazard values by the natural log of the releases to air, water, or the sum of air and water."[109] A cutoff point of 60,000 pounds was selected for the CCPCT study.[110] This cutoff point was obtained by subtracting ten from the natural log of the releases in calculating the RWF.[111] The RWFs were applied to the hazard values determined for the toxicological endpoints for each type of release.[112]

Potential exposure parameters used in the CCPCT System for each chemical "includes persistence and bioaccumulation along with annual TRI releases as an overall measure."[113] Persistence and bioaccumulation factors were considered "pivotal" and were

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[107] *Id.* at 24.

[108] *Id.* at 23.

[109] *Id.* at app. A, at A-24. The use of the natural log "gives the data a normal distribution [with] a range of 10 integers over the range of release amounts." *Id.*

[110] *Id.*

[111] *Id.* Subtracting ten from the natural log of any releases below 60,000 pounds will result in a weighting factor that is always equal to one for those releases.

[112] *Id.* In the CCPCT System the RWFs were applied in the following manner:

- The weighting factor for air releases (RWF_{air}) was applied to the hazard value assigned for the inhalation rodent LC_{50}.
- The weighting factor for water releases (RWF_{water}) was applied to the oral rodent LD_{50}, fish LC_{50}, and fish NOEL.
- The weighting factor for the total air and water releases (RWF_{total}) was applied to the chronic toxicological endpoints for carcinogenicity and other specific effects.

Id.

[113] *Id.* at 13.

refore included as multiplicative factors with hazard values between one and two and e-half.[114] Also, while not including them in the CCPCT System, the CCPCT Study ated that the incorporation of "fate and transport models" (*i.e.*, multi-media models, *ifra*) was "pivotal" and could be included in site-specific exposure assessments.[115]

The CCPCT System used peer-reviewed experimental data whenever those data were available.[116] However, as with all chemical ranking systems reviewed in this study, certain toxicological data were unavailable. For missing experimental data, the CCPCT System used both qualitative and quantitative structure analysis (SAR and QSAR, respectively) to estimate toxicological endpoints.[117] Lacking experimental data, or SAR or QSAR analyses the CCPCT System assumed minimum and maximum hazard values for each toxicological endpoint.[118] By performing calculations using both the minimum and maximum hazard values, the CCPCT study provided a range of the total hazard value (THVs) for the missing toxicological data.

As its analysis tool, the CCPCT System utilizes an algorithm that equates the THV of a specific chemical with the sum of the human health effects and environmental effects

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[114] *Id.* at 21. A hazard value of one indicates that the chemical is not persistent or it does not bioaccumulate while a hazard value of two and one-half indicates that the chemical is highly persistent or has a high tendency to bioaccumulate. *Id.*

[115] *Id.* at 13.

[116] *Id.* at 5. The CCPCT study uses the Hazardous Substances Data Bank (HSDB) as an example of a source of peer-reviewed experimental data used "whenever possible." *Id.*

[117] *Id.*

[118] *Id.* Originally, the hazard value for an endpoint that was missing data was set to zero. *See id.*, app. A, at 1. However, in the final analysis of data in the CCPCT System, the hazard value for the endpoints with missing data were set to the minimum and maximum values (*i.e.*, zero and five, respectively) for comparison. *Id.* at 26.

:iplied by the exposure potential.[119] In determining the individual hazard values for ıan health effects, environmental effects and exposure potentials, the CCPCT System l various decision tree analysis to assess available data.[120]

The variables representing the hazard values incorporated into the CCPCT System ·rithm are listed and defined as:

$HV_{oral\ LD50}$ = Hazard Value for the oral rodent LD_{50}
$HV_{inhalation\ LC50}$ = Hazard Value for the inhalation rodent LC_{50}
$HV_{carcin.}$ = Hazard Value for Carcinogenicity
HV_{other} = Hazard Value for "other specific effects"
$HV_{fish\ LC50}$ = Hazard Value for Fish LC_{50}
$HV_{fish\ NOEL}$ = Hazard Value for Fish No Observed Effect Level
HV_{BOD} = Hazard Value for Biological Oxygen Demand Half-Life
$HV_{hydrolosis}$ = Hazard Value for Hydrolysis Half-Life
HV_{BCF} = Hazard Value for Aquatic Bioconcentration Factor[121]

Id. at 19. A general discussion of the Algorithm and its components is found in the CPCT Study, *see supra* at Chapter 4.

Id., app. A.

Id. See also Chapter 3. The CCPCT Study defines the following terms:

$HV_{oral\ LD50}$: The concentration of a substance, expressed in mass of the substance per mass of the animal, that will kill half of a group of rodents within 14 days when administered orally as a single dose.

$HV_{inhalation\ LC50}$: The concentration of a substance in air (gas or dust) that will kill half of a group of rodents when inhaled continuously for 8 hours or less, scaled to 4 hours.

$HV_{fish\ LC50}$: The concentration of a chemical, in water, that causes death of 50 percent of the fish tested.

$HV_{fish\ NOEL}$: The highest dose administered that does not produce toxic effects (Casarett and Doull, 1986).

HV_{BOD} = The BOD half-life is the time (in days) required for a chemical to biodegrade such that its BOD in water is decreased to half of the original amount.

$HV_{hydrolosis}$: The hydrolysis half-life is the time (in days) required for the amount of a substance to decrease to one-half of the original amount through hydrolysis reaction in water at pH 7.

HV_{BCF} : The ratio of the concentration of a chemical in fish to its concentration in water at steady-state conditions. This factor is a measure of the chemical's ability to bioaccumulate and is typically reported in log units.

Id. at app. A.

Illustration of the CCPCT System algorithm and its individual components is provided in Figure 3 on the following page.[122]

While the CCPCT System was not explicitly designed for the analysis of TRI data, 140 TRI chemicals were included in the CCPCT study.[123] Further, the incorporation of potential exposure factors and toxicity values for each chemical into the chemical ranking algorithm make the CCPCT System a useful tool for performing the type of multi-dimensional analysis proposed in this dissertation.

4. Carnegie Mellon University *(Horvath, et al)*

Horvath, *et al.* recently proposed a scoring system designed specifically for the analysis of TRI data.[124] This scoring system proposed a method for weighting TRI release using threshold limit values (TLVs).[125] The TLVs used in the study were developed by the American Conference of Governmental Industrial Hygienists (ACGIH).[126] The

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[122] *Id.* at 22.

[123] *Id.* at 6-7. The 140 TRI chemicals were selected from the 1989 TRI report which listed 270 total chemicals. TRI chemicals incorporated in the CCPCT study were selected based on total quantities released. TRI chemicals that constituted 99 percent of the total releases or transfers reported were included in the CCPCT study. Twenty-one high volume pesticides were also included in the study. *See id.*

[124] *See* Horvath, *supra* note 70.

[125] *Id.* at 88A.

[126] *Id.* With regard to the derivation of the ACGIH TLVs, Horvath stated:

> [t]he ACGIH TLV-TWA [Total Weighted Average] has the same meaning as the Occupational Safety and Health Administration's (OSHA) permissible exposure limit-time-weighted average (PEL-TWA). Indeed, nearly all of OSHA's PELs were adopted from the ACGIH TLV index:

The algorithm is:

$$\textit{Total Hazard Value} = (\textit{Human Health Effects} + \textit{Environmental Effects}) \times \textit{Exposure Potential}$$

where:

$$\textit{Human Health Effects} = HV_{\text{oral LD50}} + HV_{\text{inhalation LC50}} + HV_{\text{carcin.}} + HV_{\text{other}} \qquad (\textit{max.} = 20)$$

$$\textit{Environmental Effects} = HV_{\text{oral LD50}} + HV_{\text{fish LC50}} + HV_{\text{fish NOEL}} \qquad (\textit{max.} = 15)$$

$$\textit{Exposure Factor} = HV_{BOD} + HV_{\text{hydrolysis}} + HV_{BCF} \qquad (\textit{max.} = 7.5)$$

and:

HV_x = *Hazard Value for endpoint x*

Figure 3. *The CCPCT Algorithm*[122]

ACGIH TLVs were designed as a tool for the protection of workers exposed, through inhalation, to various chemicals over varying periods of time.[127]

The approach taken by Horvath *et al.* has merit and is enlightening. Further, it may be directly applicable to the Michigan TRI data. However, the use of TLVs to weight toxicity factors and the incorporation of inhalation as the only exposure factor indicate that this approach may be limited in application. Therefore, the chemical scoring system proposed by Horvath *et al.* is not the single best analysis paradigm available for assessing TRI data.

5. University of Toronto *(Jia, et al)*

In 1996 Jia, *et al.*, building on past efforts, proposed a more complicated chemical scoring system designed specifically for the analysis of TRI data.[128] In the 1996 paper, Jia *et al.* recognized that the TRI database is an inefficiently utilized resource presented in a format that may by misleading.[129]

Id. at 88A.

[127] *Id.*

[128] Jia, *supra* note 73.

[129] *Id.* Jia states that:

> Considerable effort and expense are devoted to the acquisition and publication of Toxics Release Inventory (TRI) data, but it is suggested that this invaluable resource is underexploited and can be misinterpreted. A more accurate expression of the impact of these discharges can be developed through indices that combine the emission data with toxicity, environmental persistence, and the potential for multimedia partitioning.

Id. at 86A.

By integrating "toxicity, environmental persistence, and the potential for multimedia partitioning" (*i.e.*, factors that are necessary to assessing risk), it was the goal of Jia that the "TRI data may be better interpreted, and thus may play a more effective role in chemical stewardship." *Id.* This, of course, is one objective of this dissertation.

The system proposed by Jia *et al.* is divided into four indices; two proposed in the previous literature and two new. The first two indices, which were carried over from the previous literature, are the analysis of emissions using total quantity (*i.e.*, the current TRI format) and the analysis of the emissions using both total quantity and a weighted toxicity factor (*i.e.*, the approach adopted by Horvath, *et al.*). The two new indices proposed by Jia, *et al.* are:

a) the analysis of the emissions using total quantity, a weighted toxicity factor and incorporating the persistence of the chemical; and

b) analysis of the emissions using total quantity, a weighted toxicity factor, persistence and incorporating environmental mobility (i.e., incorporation of multi-media fate modeling).

The incorporation of chemical persistence is a useful addition to the paradigms suggested by the earlier literature. Subsequent systems, including the CCPCT System suggested by Davis *et al.*, generally included some persistence factor.[130] However, while the incorporation of multi-media fate models may prove to be useful to future risk assessment practices, the current status of the technology and lack of acceptable data indicate that they are of limited utility. It has been suggested that these models are not useful tools without "decades of funding research, monitoring, and assessment."[131] Until

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[130] The CCPCT System uses biological demand half-life and hydrolysis half-life as parameters to measure persistence. *See*, CCPCT Study, *supra* note 99, at 14.

[131] *Id.* Jia makes extremely optimistic predictions about the use of multi-media fate models, however, these predictions illustrate the current limitations of their use as a risk assessment tool. For example, Jia states:

> Implementing [the use of multi-media fate models] will require the environmental science community to arrive at some level of agreement about the key properties of chemicals. We regard this as

(footnote continued)

ose "decades of funding research, monitoring, and assessment" for all chemicals have een realized, these models remain of limited utility.[132] Therefore, the chemical scoring iodel proposed by Jia *et al.* is not the single best analysis paradigm available for assessing 'RI data.

C) Multi-media Fate Models

The Society for Environmental Toxicology and Chemistry ("SETAC") recently reviewed various multi-media fate models.[133] While multi-media fate models were not incorporated into earlier chemical scoring systems, the principles on which they are based are recognized as having significant utility in enhancing chemical scoring systems.[134]

> feasible, at least for the well-studied, high-volume chemicals for which there are extensive fate and effects data. Surely, this is possible after the decades of funding research, monitoring, and assessment.

Id. at 91A.

This prediction is hopeful at best, and if true, presently only applies to a small number of chemicals. Therefore, multi-media fate models are currently of limited utility. *Id.*

[132] The University of Toronto study only used pentachlorobenzene and styrene to illustrate the approach of the proposed model. For these 2 chemicals, Jia estimated persistence using various sources. However, Jia recognized that persistence data, while available to some extent, are incomplete and stated:

> Extensive compilations of atmospheric reaction persistences, or half lives, are now available as a result of the studies by Atkinson (*Citation omitted*). Persistences in other media are less well documented, but estimates are becoming available (*Citation omitted*). Reaction persistences can also be estimated from multimedia environmental models.

Id. at 88A.

[133] SOCIETY OF ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY (SETAC), THE MULTI-MEDIA FATE MODEL: A VITAL TOOL FOR PREDICTING THE FATE OF CHEMICALS, (Cowan, C.E., *et al. eds.*, SETAC Press 1995) [hereinafter SETAC REVIEW].

[134] *See, e.g.*, CCPCT Study, *supra* note 99.

Further, these types of models are often integral to and required by the more sophisticated and recent chemical hazard evaluation systems if they are to be effectively utilized at some time in the future (*e.g.*, see the fourth index discussed above by Jia, *et al.)*.

Multi-media fate models combine:

> a chemical's intrinsic properties and emission patterns ... with the characteristics of the environment into which it is released to predict how advective and inter-media transport and transformation processes will affect the distribution of the chemical among the various environmental media, and thus the concentrations that will result in each medium.[135]

The goal of this type of model is to provide detailed chemical data in a format that, when taken in combination with adverse effects information, will allow for the assessment of risk to human health and the environment.

While it is recognized that at some point in the future multi-media fate models may be widely used as a risk assessment tool, the existing lack of review by the scientific community prevents effective implementation in current risk assessment endeavors.[136] Further, the level of sophistication presently found in these models coupled with the lack

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[135] *Id.* at 1.

[136] Addressing the lack of peer review, the SETAC Review stated:

> Despite the recognition that multi-media fate models are vital and even essential tools for assessing the fate of chemicals released to the environment, there has never been a systematic, international evaluation of their strengths, limitations and precision, and accuracy when used to address the specific needs of organizations and scientists in their various assessment activities.

SETAC REVIEW, *supra* note 133, at 2.

of data necessary for their effective utilization also prohibit their widespread use.[137] For these reasons, the use of multi-media fate models is not incorporated into this study.

D) Selection of Hazard Value Scoring Method

1. The CCPCT System

Each of the chemical scoring systems discussed in this chapter is imperfect in some respect. Further, the deficiencies inherent in each chemical scoring system indicates that no individual system is the single best analysis paradigm available for assessing TRI data. However, review of the CCPCT System proposed by Davis *et al.* clearly demonstrates that it is superior to the other chemical scoring systems reviewed. The CCPCT System is superior to other chemical scoring systems because of its incorporation of human health and environmental risk factors in combination with direct chemical exposure data using the broadest, most complete experimental data available. The selection by other researchers of the CCPCT System for the analysis of TRI data supports the proposition that it is the superior chemical scoring system and analysis tool.

2. University of New Orleans *(Lea, et al)*

A group at the University of New Orleans undertook an analysis of TRI data using n approach similar to that used in this dissertation.[138] The New Orleans group

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In the SETAC review of multi-media fate models, several recommendations were made ncerning the need for further development of specific components of existing models it are currently deficient. *Id* at x-xi. Until issues such as harmonization of different dels, documentation, validation and inclusion of more detailed input parameters in each del compartment can be addressed, the acceptance of a single model for practical risk essment applications is not possible.

questioned the validity of the TRI as an indicator of environmental quality or as a useful tool for assessing toxic chemical releases to the environment. The group adapted the CCPCT System suggested by Davis, *et al.* and used Louisiana specific TRI data for reporting years 1987-1990 to demonstrate the inadequacy of the existing TRI data presentation. Lea *et al.* concluded that the TRI data, as currently presented, fails to assess the impact of toxic chemicals on human health and to the environment.[139]

The New Orleans study was too narrow in some respects for it to be useful in assessing the long term success of the EPCRA. For example, the study only reviewed Louisiana TRI data for a 3 year reporting period. While some end users (*e.g.*, the average citizen) may only analyze TRI data on a "year to year" basis, accurately assessing the long term success of the EPCRA and the resulting trends in the affected industries requires that the largest reporting period available be reviewed.

The selection of the CCPCT System (proposed by Davis, *et al.*) by Lea *et al.* for TRI data analysis suggests that it is as the preferred chemical scoring system for that type of data. Therefore, adaptation of the CCPCT System in a fashion similar to that attempted by Lea *et al.*, using select Michigan specific TRI data, is likely to provide the most

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[138] W. R. Lea *et al.*, *Comparative Risk Analysis of the TRI Data as an Environmental Indicator -A Louisiana Case Study*; Paper presented to the Air & Waste Management Association's 88th Annual Meeting & Exhibition, San Antonio, Texas, June 18-23, 1995.

[139] In conclusion, Lea stated:

> The traditional method of analyzing the TRI data fails to address the true concerns about chemical emission to the environment: human health effects, environmental effects, persistence in the environment, and bioaccumulation. Furthermore, the TRI "top polluters" lists are intentionally or unintentionally punitive in their failure to address the actual impact to the environment and human health.

at 8.

effective method for performing the type of multi-dimensional analysis that is necessary to achieve the objectives of this dissertation.

Part III

DATA COMPILATION

CHAPTER FOUR

TRI DATA

A) Method of Data Collection

1. TRI Data Availability

Text versions of TRI data for all reporting years are readily available from the U.S.E.P.A. National Center for Environmental Publications and Information ("NCEPI") with support for usage of the printed volumes from Toxic Release Inventory User Support.[140] Further, the EPCRA mandate that the TRI data be compiled into a publicly accessible computer database has resulted in various other computer accessible forms of the TRI data being made available.[141] For example, TRI data are available on floppy diskette (5.25 and 3.5 inch), CD-ROM and magnetic tape from National Technical Information Service ("NTIS") in dBase and Lotus formats.[142] Environmental groups, such as those responsible for RTK-NET, also provide free remote computer access to TRI data through the Internet.[143] Further, the TRI is publicly accessible using personal computers through the National Library of Medicine's ("NLM's") Toxicological Data Network("TOXNET").[144] NLM's TOXNET is a subpart of the NLM's Medical

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[140] To obtain this information, contact: NCEPI, Attn: Publications Orders, P.O. Box 2419, Cincinnati, OH 45242-2419.

[141] *See supra* note 38.

[142] To obtain this information, contact: NTIS, 5285 Port Royal Road, Springfield, VA 2161. (Only reporting years 1987-1992 are currently available through this service.)

[143] *See supra* note 69. To obtain this information, contact: Right-to-Know Computer etwork, 1742 Connecticut Avenue, NW, Washington, D.C. 20009-1171.

[144] TOXNET, National Library of Medicine, Specialized Information Services, 8600 ckville Pike, Bethesda, MD 20894. *See also* INTERNET <http://nlm.nih.gov> or *see o* TELNET <medlars.nlm.nih.gov> (access code and password required, subject to a).

Literature Analysis and Retrieval System ("MEDLARS") which also contains files on toxicology, hazardous chemicals and other related topics.[145] The TRI data publicly accessible through MEDLARS on TOXNET are fully searchable using a free text search and full Boolean logic.[146]

2. INTERNET Collection of TRI Data

All methods of data collection listed above provide similar access to the same information, however the presentation of the data is different for each. Factors such as cost, accessibility and ease of use were taken into consideration in selecting a search tool for collecting data for this dissertation. The most current form of the TRI data is provided through the INTERNET resources.[147]

Initial TRI data review for this study was performed on-line using TELNET to access TOXNET through MEDLARS.[148] At that time, direct on-line access to TOXNET using MEDLARS was the superior means of data collection due to the relative

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[145] NLM, *TOXicology Data NETwork: A Brief Guide To Searching Its Files* (October 1995). (TOXNET contains the following databases: the Hazardous Substances Data Bank (HSDB); the Registry of Toxic Effects of Chemical Substances (RTECS); the Chemical Carcinogenesis Research Information System (CCRIS); the Integrated Risk Information System (IRIS); GENE-TOX; the Environmental Mutagen Information Center-Front and Back Files (EMIC/EMICBACK); the Developmental and Reproductive Toxicology Database/Environmental Teratology Information Center Backfile (DART/ETICBACK); the Toxic Chemical Release Inventory (TRI) and the Toxic Chemicals Release Inventory Facts Sheets (TRIFACTS)).

[146] *Id.*

[147] Francis M. Lynn & Jack D. Kartez, *Environmental Democracy In Action: The Toxics Release Inventory*, 18(4) ENVTL. MGMT. 511 (1994).

[148] Initial TRI data review was performed in October/November 1995.

sophistication of its search capabilities. The final TRI data used in this study were updated and recompiled using the RTK-NET on-line resource.[149]

B) Collection and Compilation of Michigan TRI Quantity Data

1. Carcinogens

Between 1987 and 1994, the TRI required reporting of specific data on approximately 320 toxic chemicals.[150] To maintain a reasonable level of manageability, the toxic chemicals addressed in this dissertation can not include all 320 TRI chemicals and therefore, the field must be restricted.[151]

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[149] The RTK-NET is recognized as a reliable on-line source of TRI data. For example, the U.S.E.P.A. only lists NLM's TOXNET and the RTK-NET as sources of available on-line TRI data in its yearly TRI public data release. *See, e.g., 1993 Toxics Release Inventory - Public Release Data*, EPA 745-R-95-010. In the period of time between the initial review of the TRI data and the final data compilation for this study, the RTK-NET was redesigned. The redesigned RTK-NET has improved interactive search and retrieval capabilities which made it the superior tool for collecting the specific TRI data desired.

Another software search tool not yet discussed is "Grateful Med." Grateful Med software provides an alternative search engine for searching NLM's TOXNET. However, the current INTERNET version of Grateful Med ("IGM") does not provide for this type of focused search. Therefore, Grateful Med was not selected as a research tool for this study. Grateful Med does intend to provide this service in the near future.

[150] *Id.* This number is only an estimate for all reporting years. For example, while the original list contained 320 chemicals, through additions and deletions, the 1993 list contained 316 chemicals and 20 chemical categories. Further, while the number of toxic chemicals on the list may appear to be static, the combination of additions and deletions indicates that the individual chemicals listed may be distinctly different. *Id.*

[151] This reality presents a quandry in that while narrowing the field of chemicals to be reviewed is desirable, it directly limits the applicability of the study in future analysis. However, the purpose of this study is to assess the overall success of the EPCRA in achieving its recognized goals using a narrow field of chemicals as indicators of that success. The purpose of this study is not to definitively state the total hazard values or risk that the TRI data represents. Further, as a practical matter, analysis of all TRI chemicals is problematical due to the absence of detailed toxicological data for each chemical. This absence of data requires that numerous assumptions be embedded in the analysis, which bring the validity of the paradigm into question.

All chemicals subject to the EPCRA and listed in the TRI are "toxic" by definition. Therefore, there is a certain level of risk realized by an individual if that individual were to be exposed to any of these TRI chemicals. However, even a cursory analysis of the approximately 320 toxic chemicals subject to the reporting requirements of the EPCRA indicates that they are not "equal" in all respects. One factor recognized by toxicologists to distinguishes between toxic chemicals is the response, or adverse effect, observed from exposure to that chemical in clinical tests.[152] As discussed earlier, the possible spectrum of observed adverse effects may be quite broad.[153] It is possible to narrow the field of toxic chemicals by selecting a single adverse effect and only addressing toxic chemicals which produce that specific toxicological endpoint. For example, after analyzing the 1994 TRI data, the Greater Boston Physicians for Social Responsibility and the Massachusetts Public Interest Research Group Education Fund (Greater Boston Physicians Study) issued a report focusing on "known or suspected reproductive hazards."[154] Any observed adverse effect (*e.g.*, "known or suspected reproductive hazards") may serve as a parameter for narrowing this study. In discussing why the Greater Boston Physicians Study chose "known or suspected reproductive hazards" as the toxicological endpoint for purposes of that study, Dr. Gina Solomon stated that "...people have traditionally focused on the cancer risks from toxic chemicals."[155] Carcinogenicity as an adverse effect or toxicological endpoint is "traditionally" selected by toxicologists as a parameter for

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[152] *See* Pt. II, Ch. 3, Sec. A for discussion of risk assessment paradigm. *See also,* CASARETT AND DOULL'S TOXICOLOGY, *supra* note 80 at 987-988 (discussion of the principles of hazard identification and "typical end points").

[153] *Id.*

[154] *See* PLASTICIZERS, PESTICIDES, METALS RELEASES FLAYED BY PUBLIC INTEREST GROUPS AS REPRODUCTIVE HAZARDS, 6 PEST.TOX.CHEM.NEWS 4101.

narrowing fields of chemicals for study since it is one of the effects "most feared" by the public.[156] Whether this fear is justified is often brought into question. For example, narrowing the field of chemicals to only carcinogens will exclude the chemical that caused the deaths at Bhopal from review in this study. The obvious limitations of taking this approach in this study were considered. It is recognized by the author that the limitations of the study may restrict the application of the results and/or conclusions stated herein outside the four corners of this dissertation. However, as the purpose of this study is not to definitively state the total hazard values or total risk that the TRI data represents, but rather to assess the overall success of the EPCRA in achieving its recognized goals, using a narrow field of chemicals as indicators of that success is appropriate and serves the purposes of this study.[157] Therefore, the toxicological endpoint selected as a parameter for narrowing the field of review in this dissertation is carcinogenicity.

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[155] *Id.*

[156] W. Brock Neely, INTRODUCTION TO CHEMICAL EXPOSURE AND RISK ASSESSMENT, 43 (Lewis Publishers, 1994). Regarding the use of carcinogenicity as an adverse effect or toxicological endpoint as a parameter for narrowing fields of chemicals for study, Neely states that:

> Among the effects of chemicals on biological systems (Chapter 3), one of the most feared is the initiation of cancer. The presence of such chemicals (known as carcinogens) in the environment has become synonymous with environmental contamination.

Id. (emphasis added).

[157] Narrowing the field of chemicals to only review carcinogens does not completely disregard the concerns of the Congress in enacting the EPCRA. Congress recognized that addressing Bhopal type releases was not the primary focus of the EPCRA. In testimony before Congress concerning community right-to-know legislation, Representative Sikorski, focusing on chemical quantity production and estimates of toxic chemical accidents, indicated that Bhopal-like releases were not perceived as endangering citizens in America today. Representative Sikorski states:

> Those releases and those accidents were not the dramatic Bhopal-like kind of releases.

(footnote continued)

The definition of a carcinogen varies for numerous reasons.[158] The definition of carcinogen used in this dissertation, is:

> ...all neoplasm-inducing agents.
>
> Chemical carcinogens are defined operationally by their ability to induce neoplasms. Four types of response have generally been accepted as evidence of induction of neoplasms: (1) an increase in the incidence of tumor types that occur in controls; (2) the development of tumors earlier than in controls; (3) the presence of types of tumors not seen in controls; and (4) an increased multiplicity of tumors.[159]

Simply stated, like toxic chemicals in general, all carcinogens are not "equal" in all respects. Even within carcinogens as a smaller subset of toxic chemicals, there is a more finite hierarchy. This hierarchical classification is also based on specific adverse effects observed from exposure to that chemical in clinical tests. Classification of carcinogens within hierarchical systems is performed by various state and federal agencies. However, the categories within each classification system are fairly similar.[160] Again, to maintain a

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They were others that even more endangered our citizens.

Supra note 13.

[158] Regarding the definition of carcinogen, CASARETT AND DOULL'S TOXICOLOGY states:

> The term *carcinogen* literally means giving rise to carcinomas, *i.e.*, epithelial malignancies. This definition, however, is not adhered to for several reasons. First, the suffix *gen* implies *ab initio* genesis, but in fact the responses to a chemical that are accepted as evidence of carcinogenesis include increases in the occurrence of cryptogenic neoplasms. Also, agents that produce sarcomas of mesenchymal origin are generally called carcinogens, although the term *sarcomagen* or *oncogen* would be more correct. In practice, carcinogen is used for any agent that induces malignancies.

Supra note 80 at 129.

[159] *Id.*

[160] Two agencies that provide alternative classification systems for carcinogens are the International Agency for Research on Cancer ("IARC") and the Occupational Safety and Health Administration ("OSHA"). As examples of the similarities between the systems: the IARC Group 1 and the OSHA Group A agents are *carcinogenic to humans;* the IARC

(footnote continued)

reasonable level of manageability, this study only focuses on toxic chemicals recognized in the TRI data as "known or suspect" carcinogens.[161]

2. Selection of Specific Carcinogens for Analysis

The TRI provides data on 78 individual chemicals or groups classified as known or suspect carcinogens.[162] Of these 78 individual TRI chemicals or groups, review of RTK-NET files revealed that 28 had no reported releases in Michigan for any reporting year.[163] These 28 chemicals were therefore excluded from this study. Chemicals that had any reported releases, even if the releases reported were zero, were retained in the study.[164] However, four more individual chemicals that had no reported release for the most recent six reporting years were deleted from the study.[165] Since its inception, the TRI list of chemicals has been in almost constant flux. Recognition of the changing status of the TRI list has prompted the regulated community to propose that 1997 be used as a new

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Group 2A and the OSHA Group B agents are *probably carcinogenic to humans* and the IARC Group 2B and the OSHA Group C agents are *possibly carcinogenic to humans*.

[161] TRI classification of a specific toxic chemical as a "known or suspect" carcinogen is derived from, and congruent with, various alternative classification systems, including those outlined by the IARC and the OSHA classification schemes.

[162] *TRI Releases of Known or Suspect Carcinogens to Air, Water, and Land (1993), supra* note 149 at tbl. 1-43. *See* app. B.

[163] *See* app. C.

[164] A report of zero releases for a reporting year indicates that a company did submit an EPCRA Form R for that chemical for that year, even though the EPCRA does not require this type of action. Reports of zero releases have no impact or effect on the calculations in the algorithm or the results of this study. These chemicals were only retained in this study to facilitate future analysis.

[165] The four chemicals excluded from the study are 1,4-dichlorobenzene, 1,4-dioxane, beta-napthylamine, and nitrilotriacetic acid. There have been no reported releases of beta-napthylamine since 1987, no reported releases of 1,4-dichlorobenzene since 1989; no reported releases of 1,4-dioxane or nitrilotriacetic acid since 1990.

baseline.[166] This state of flux and proposed new baseline year supports the exclusion of chemicals that show no reported releases in six years. Further, the exclusion of these four chemicals from this study is justified as these chemicals represent only a minor percentage of either the total environmental releases of all known or suspect carcinogens or the total hazard value calculated for all known or suspect carcinogens.[167] The remaining 46 specific known or suspect carcinogens are the focus of this study.[168]

The TRI data for the 46 specific carcinogens addressed in this study could be compiled and assessed for any state or on a national level. However, proof of the thesis of this dissertation does not require that such an extensive undertaking be attempted. Therefore, for purposes of manageability, the data for the 46 specific carcinogens analyzed in this study is limited to Michigan specific TRI reports. Limiting the breadth of the study to only Michigan source data insures that the study is narrow enough to maintain its manageability while broad enough to retain its integrity and test the thesis of the dissertation.

Further, the TRI data is now available for the years 1987-1994. Therefore, it is possible to compile and assess the TRI data for the 46 specific carcinogens addressed in

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[166] David J. Hansen, *Toxics Release Inventory Report Shows Chemical Emissions Continuing To Fall*, CHEM.ENV.NEWS 29 (July 15, 1996).

[167] The total Michigan releases for 1,4-dichlorobenzene, 1,4-dioxane, alpha-napthylamine, and nitrilotriacetic acid for all reporting years is 39,105 pounds. This represents on 4.57 x 10^{-2} percent of all environmental releases of known or suspect carcinogens (which were 85,631,328 pounds) during the same period. Further, the calculated THV for 1,4-dichlorobenzene, 1,4-dioxane, alpha-napthylamine, and nitrilotriacetic acid for the same period is 5597.94 which is only 2% of the calculated THV for all environmental releases of known or suspect carcinogens (which was 231,990.08) during the same period. Therefore, exclusion of these chemicals will not dramatically affect the conclusions of this study.

[168] *Id.*

this study for all eight years of available data. In order to accurately assess the long term, overall success of the EPCRA and the resulting trends, the Michigan TRI source data regarding the 46 specific carcinogens for all eight reporting years will be analyzed in this study. This breadth of review helps to ensure the validity of this study.

3. Compilation of TRI Quantity Data for Specific Carcinogens

Not all TRI data available in RTK-NET for each specific carcinogen was needed for this study. However, selection of the RTK-NET standard format that provided the level of detail necessary to this study also presented a significant amount of detail beyond what was useful.[169]

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[169] The RTK-NET presents the TRI data in several (Summary, Low, Medium and High) formats, each providing an increased level of detail. A "medium level" of report presentation, which gives a basic summary of all data plus a breakdown of releases by chemical for each facility, was used for this study.

An RTK-NET "medium level" presentation of TRI data consists of the following data points:

> facility id; state; region; facility closure status; facility name; alternative facility name; street; alternative street; city; county; zip; parent corporation; parent (Dun & Bradstreet id); U.S.E.P.A. id; Dun & Bradstreet id; primary SIC; federal facility type; federal agency affiliation; mailing name; mailing street; mailing city; mailing state; mailing zip; alternative mailing name; alternative mailing street; latitude; longitude; reason change; reporting year; public contact name; public contact phone; technical contact name; technical contact phone; control number; reporting year; trade secret; CAS; chemical name; alternative public contact name; alternative public contact phone; mixture composition name; recycling on-site -current year; recycling off-site -current year; energy recovery on-site -current year; energy recovery off-site -current year; treatment on-site -current year; treatment off-site -current year; release off-site -current year; remedial releases; production index; SIC 1; NPDES id 1; NPDES id 2; NPDES id 3; NPDES id 4; NPDES id 5; source reduction activity 1; source reduction activity 2; source reduction activity 3; source reduction activity 4; source reduction activity 5; source reduction activity 6; release 1 (fugitive air); release 2 (stack air); release 3 (water releases); release 4 (underground injection);

(footnote continued)

An individual on-line search was performed through the RTK-NET for all Michigan data regarding each of the 46 specific carcinogens for each reporting year. This search produced data on a total of 4,627 individual reported releases spanning the reporting years 1987-1994. The TRI data produced by the search was compiled incorporating all the detail presented in an RTK-NET medium detail reporting format. Limited summaries of this TRI data, including only the specific release and transfer data necessary to the study, were compiled for each of the specific carcinogens.[170] The limited summaries compiled for and used in this study contained the following data for each release: facility identification; state; facility name; reporting year; total fugitive air releases; total stack air releases; total water releases; total underground injections; total land releases; total transfers to POTWs; total off-site transfers and total environmental releases.[171]

Reformatting the TRI data compiled in the limited summaries into a format that was compatible with the CCPCT System was necessary. Therefore, the limited summary for each specific carcinogen was further refined and re-compiled. The refinement of the limited summaries was accomplished by combining the specific categories of release into

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release 5 (land releases); release 6 (transfers to POTWs); release 7 (off-site transfers); total releases; source reduction code; waste generated -previous year; waste generated -current year; all waste generated; SIC all (12 possible); all chemical id; TRI code change translation; SIC translation; maximum amount TRI submission.

Supra note 69.

[170] Compilation of this data, even in this abridged form, is voluminous and is therefore not provided as an appendix to this study.

[171] The eight individual data points regarding the specific type of release (*i.e.*, specific media or release endpoint) were compiled for each of the 4,627 individual TRI chemical reports resulting in a total of 37,016 individual data points. These 37,016 data points serve as the primary data for this study and were incorporated into this dissertation.

the more general and more appropriate categories of release. The narrow categories of total fugitive air releases and total stack air releases were combined into the general category of "air releases;" the general categories of total water releases, total underground injections and total land releases were combined into the general category of "water releases," and the general category of "total releases" was created by subtracting the total transfers to POTWs and the total off-site transfers from the total environmental releases.[172] The air releases, water releases and total releases for each of the 46 specific chemicals in each reporting year were then re-compiled in a CCPCT System compatible format for use in this study. This re-compiled and reformatted data is presented, *infra*, in Tables 4-49.[173]

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[172] This re-categorization of releases into broader or more general categories is similar to the approach taken in the CCPCT Study. The CCPCT Study stated:

> To determine the release amount assigned to air and water categories, the following scheme was applied to the release data. It was assumed that:
>
> • stack and fugitive releases went to air;
>
> • land, injection, water and POTW release went to water;
>
> • annual pesticide usage amounts were assigned to the water release category;
>
> • off-site transfers to an incineration facility were assumed to be destroyed and transfers to a recycling facility were assumed reused and therefore not released to the environment; and
>
> • all other off-site transfers (land, injection, etc.) were assumed released to water. Incineration and recycling amounts were subtracted from total off-site transfers to determine the remainder of off-site transfers released to water.

Supra note 99, at 24.

[173] *See* app. D.

CHAPTER FIVE

HAZARD VALUE SCORING METHOD

A) Adaptation of CCPCT Study Algorithm to Michigan Specific Data

Limited modification of the algorithm proposed in the CCPCT System is necessary to accommodate the Michigan specific data used in this study. The hazard values presented in the CCPCT Study, with the exception of estimates used for missing data, are appropriate for use in this study Also, the release weighting factors used in the CCPCT Study are appropriate, however they require modification. The modifications are discussed below.

1. Hazard Values (HVs)

The hazard values presented in the CCPCT System, calculated using various toxicological endpoints and exposure assessments including human health effects, environmental effects and exposure factors, are appropriate for use in this study and generally do not require modification.[174]

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[174] Human health effects include acute oral and inhalation toxicity, carcinogenicity, and other specific effects. Environmental effects include acute mammal and fish mortality and chronic sublethal effects in fish. Potential exposure parameters include persistence and bioaccumulation. These factors include:

Oral Hazard Value (Oral HV)
Inhalation Hazard Value (Inhalation HV)
Carcinogenic Hazard Value (Carc. HV)
Other Hazard Value (Other HV)
Fish Hazard Value (Fish HV)
Fish NOEL Hazard Value (Fish NOEL HV)
Biological Oxygen Demand Hazard Value (BOD HV)
Hydrolysis Hazard Value (Hydrolysis HV)
Bioconcentration Factor Hazard Value (BCF HV)

Id. p. 44.

The specific hazard values are provided in the CCPCT Study. *Id.*, app. C, RANKING RESULTS: HORIZONTAL TABLES.

(footnote continued)

In addressing missing data, the CCPCT Study assigned minimum and maximum hazard values.[175] This approach provided a hazard range, based on the assigned hazard values, which allowed for a comparison of the chemicals addressed in the CCPCT Study. It is not disputed that the relative hazard presented by individual chemicals within any discreet class of chemicals may be represented by a range. Further, as the CCPCT Study addressed a broad array of chemicals, which may present a wide spectrum of relative hazard, this approach may have been valid in that application. In a manner similar to the CCPCT Study, a range of hazard values might have been assigned to the toxicological endpoints and exposure assessments which lacked supporting data in this study. However, this study only focuses on chemicals that are known or suspect carcinogens. This study assumes that, relative to all EPCRA chemicals, the known or suspect carcinogens addressed herein are the most potent toxics and therefore present the highest level of inherent hazard.[176] The potency of, or inherent hazard presented by, known or suspect carcinogens suggests that the use of a range of hazard values is not necessary and may be misleading. Therefore, this study assigns maximum hazard values when necessary data is missing.[177]

In this study, as in the CCPCT System, Oral HV, Inhalation HV, Carc. HV, Other HV, Fish HV and Fish NOEL HV were assigned a hazard value between zero and five and treated as additive effects while BOD HV, Hydrolysis HV and BCF HV were assigned hazard values between one and two and one-half and treated as multiplicative factors. *See id.*, app. C.

[175] *Id. See supra*, note 118.

[176] This assumption disregards any type of quantity or exposure data (*e.g.*, acute exposures such as occurred at Bhopal).

[177] An assumed hazard value of 5 is assigned to the Oral HV, Inhalation HV, Carc. HV, Other HV, Fish HV, and Fish NOEL HV if data is missing for those calculations. A hazard value of 2.5 is assigned to BOD HV, Hydrolysis HV and BCF HV if data is

(footnote continued)

2. Release Weighting Factors (RWFs)

The CCPCT System algorithm incorporated RWFs to ensure that neither hazard values nor release amounts dominated the calculations.[178] The CCPCT System scheme for weighting releases incorporated the use of the natural log in the RWF.[179] The RWF scheme in the CCPCT System provided for calculation of a cutoff point for releases of 60,000 pounds by subtracting ten from the natural log of the releases.[180] However, since one objective of this study is to assess total hazard by analyzing all releases of each of 46 specific carcinogens in all reporting years, a cutoff point for releases of 60,000 pounds or assigning a weighted hazard value of zero or below (*i.e.*, a negative number) to any release is not appropriate.[181]

The method of calculating the RWF in the CCPCT System is easily adapted to the purposes of this study. Using the natural log of the release and not adjusting the calculation by subtracting ten will provide an analysis of all releases without producing hazard values that are either zero or less or dominated by the release quantity.[182] The

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missing for those calculations. Chemicals with missing data are denoted by an "*" in the appropriate appendix. *Infra*, app. E.

To test the sensitivity of this analysis scheme, a second series of calculations were performed assigning a hazard value of 2 to the Oral HV, Inhalation HV, Carc. HV, Other HV, Fish HV, and Fish NOEL HV and a hazard value of 1 to BOD HV, Hydrolysis HV and BCF HV if data is missing for those values.

[178] *See supra* notes 107-112 and accompanying text.

[179] *Id.*

[180] *See supra* note 110 and accompanying text.

[181] Applying the CCPCT System approach in calculating RWFs for releases less than 22,026 pounds would result in a weighted hazard value below zero (*i.e.*, a negative number) which is clearly not appropriate in either the CCPCT Study or this study.

[182] While not incorporating a weighting scheme for releases will result in a risk assessment that is driven solely by release quantities, incorporating a weighting scheme may also contain limitations. For example, if the natural log is used to weight releases, a one hundred percent increase in release quantity will not result in a one hundred percent

(footnote continued)

Release Weighting Factor Equation can be applied to values that are specific to a particular media. Figure 4, below, shows the general method of calculating the RWF used in this study to evaluate Michigan releases of specific carcinogens.

RWF = ln release

Figure 4. *Release Weighting Factor Equation*

TRI data for lead releases illustrates the use of the modified Release Weighting Factor Equation in the dissertation.[183] Individual releases of lead to all media in Michigan in 1987 reported under the EPCRA were compiled. These data were totaled by category ("Air Releases," "Water Releases" and "Total Releases") and recompiled.[184] Air Releases of lead in 1987 were reported to be 20,719 pounds; Water Releases were reported to be 1,303 pounds; and Total Releases were calculated to be 22,022 pounds.[185] The RWFs derived by applying the modified Release Weighting Factor Equation to the reported release values are provided in Figure 5 on the following page.

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increase in risk (*e.g.*, if a specific reported release increases from 100 pounds to 200 pounds, the calculated RWF, incorporating the natural log, will only increase from 4.61 to 5.3).

[183] Any toxic chemical addressed in this study may be selected to illustrate the calculations made using the modified CCPCT algorithm. Lead was selected at random.

[184] *See supra* note 172 and accompanying text.

[185] *See infra* tbl. 34, app. D.

$$\mathbf{RWF_{water}\ (lead) = ln\ (1{,}303) = 7.17}$$

$$\mathbf{RWF_{air}\ (lead) = ln\ (20{,}719) = 9.94}$$

$$\mathbf{RWF_{total}\ (lead) = ln\ (22{,}022) = 10.00}$$

Figure 5. *1987 Release Weighting Factors for Lead*

RWFs for each general category of release were calculated, as illustrated using lead as an example, for each of the 46 specific carcinogens addressed in this study.

Total Releases of carcinogens in Michigan addressed in this study ranged between zero and 10,633,270 pounds. Therefore, the use of the modified Release Weighting Factor Equation resulted in RWFs ranging between zero and 16.18 in this study. This range is appropriate for the purposes of this study.

B) Compilation of Hazard Value Data and
Michigan TRI Quantity Data for Specific Carcinogens

Total Michigan Water Releases, Total Michigan Air Releases and Total Michigan Releases for each of the 46 specific carcinogens addressed in this study were compiled for each reporting year.[186] Further, based on the above revisions to the CCPCT System, the appropriate hazard values for the 46 carcinogens addressed in this study release were compiled for each reporting year. Also, the RWFs for each general category of release were calculated, as illustrated above, for each of the 46 specific carcinogens addressed in this study compiled for each reporting year. These data are combined and presented in Tables 50-57 for further analysis.[187]

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[186] *See supra* note 149 and accompanying text.
[187] *See* app. E.

C) Application of Modified Hazard Value Scoring Method to Specific Carcinogens

The CCPCT System algorithm is applied to the Michigan release data for each individual release of the 46 specific carcinogens and each reporting year addressed in this study. The application of the algorithm integrated the RWFs adapted to the Michigan specific data and the modified CCPCT System hazard values. As stated, *supra*, the CCPCT System algorithm utilizes an algorithm that equates the THV of a specific chemical with the sum of the human health effects (HHE) and environmental effects (EE) multiplied by the exposure potential factor (EF). Each component of the CCPCT algorithm, as it is used in this study, is described below.

1. Weighted Human Health Effects (WHHE)

Figure 6, below, shows the Weighted Human Health Effects (WHHE) equation used in this study. The WHHE is used to estimate the human health effects resulting from Michigan releases of specific carcinogens.[188]

$$\mathbf{WHHE = (Oral\ HV)*(RWF_{water}) + (Inhalation\ HV)*(RWF_{air}) + (Carc.\ HV + Other\ HV) * (RWF_{total})}$$

where:

RWF_{water} = Release Weighting Factor for Water Releases
RWF_{air} = Release Weighting Factor for Air Releases
RWF_{total} = Release Weighting Factor for Total Releases

Figure 6. *WHHE Equation*[189]

[188] This estimate does not include exposure data.

The 1987 Michigan data compiled for lead illustrates the use of the WHHE Equation in this study. The RWFs for water, air and total lead releases, *supra* Figure 5, are 7.17, 9.94 and 10.00 respectively. The Oral Hazard Value, Inhalation Hazard Value, Carcinogenic Hazard Value and Other Hazard Value variables in the WHHE Equation are derived and presented in the CCPCT Study and are appropriate for use in this study.[190] Hazard values for lead required in the WHHE Equation are presented below in Figure 7.

Oral Hazard Value (lead) = Oral HV (lead) = 0.9

Inhalation Hazard Value (lead) = Inhalation HV (lead) = 5.0

Carcinogenic Hazard Value (lead) = Carcinogenic HV (lead) = 3.5

Other Hazard Value (lead) = Other HV (lead) = 4.0

Figure 7. *Human Health Hazard Values for Lead*

These Human Health Hazard Values for lead along with the 1987 Michigan RWFs for lead are incorporated into the WHHE Equation to derive a 1987 Michigan lead WHHE of 131.15 in Figure 8 below.[191]

WHHE (lead) = [(0.9)*(7.17)]+[(5.0)*(9.94)]+[(3.5+4.0)*(10.00)] = 131.15

Figure 8. *1987 WHHE Calculation for Lead*

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[189] The WHHE equation is the same as that used in the CCPCT System, however the underlying data (*i.e.*, the hazard values and the RWFs) have been modified. *See supra* note 99, app. A, at A-25.

[190] *See supra* note 174 and accompanying text. *See also* app. E.

[191] All "effects" and other "hazard" values in this study are unitless.

2. Weighted Environmental Effects (WEE)

Figure 9, below, shows the Weighted Environmental Effects (WEE) equation used in this study. The WEE is used to estimate the environmental effects resulting from the Michigan releases of specific carcinogens.[192]

WEE = (Oral HV + Fish HV + Fish NOEL HV)*(RWF_{water})

where: RWF_{water} = Release Weighting Factor for Water Releases

Figure 9. *WEE Equation*[193]

The 1987 Michigan data compiled for lead illustrates the use of the WEE Equation in this study. The RWF for lead releases to water in Michigan, *supra* Figure 5, is 7.17. The Oral Hazard Value, Fish Hazard Value and Fish NOEL Hazard Value variables in the WEE Equation are derived and presented in the CCPCT Study and are appropriate for use in this study.[194] The hazard values for lead required in the WEE Equation are presented below in Figure 10.

Oral Hazard Value (lead) = Oral HV (lead) = 0.9

Fish Hazard Value (lead) = Fish HV (lead) = 3.8

Fish NOEL Hazard Value (lead) = Fish NOEL HV (lead) = 4.3

Figure 10. *Environmental Hazard Values for Lead*

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[192] *Supra* note 188.

[193] The WEE equation is the same as that used in the CCPCT System, however the underlying data (*i.e.* the hazard values and the RWFs) have been modified. *See supra* note 99, app. A, at A-25.

[194] *See supra* note 174 and accompanying text. *See also* app. E.

In Figure 11, below, the Environmental Hazard Values for lead along with the 1987 RWF for water releases of lead in Michigan are incorporated into the WEE Equation to derive a 1987 Michigan lead WEE of 64.53.

WEE (lead) = [(0.9) + (3.8) + (4.3)] * (7.17) = 64.53

Figure 11. *1987 WEE Calculation for Lead*

3. Exposure Factor (EF)

This study uses the equation proposed in the CCPCT System to calculate the Exposure Factor (EF). That equation, as proposed in the CCPCT System and without unique weighting or further adaptation of the variables therein is shown below in Figure 12.

EF = BOD HV + Hydrolysis HV + BCF HV

Figure 12. *EF Equation*[195]

The Michigan data compiled for lead illustrates the calculation of the EF in this study. The Biological Oxygen Demand Hazard Value, Hydrolysis Hazard Value and the Bioconcentration Factor Hazard Value variables in the EF Equation are derived and

[195] *Id. See The CCPCT Algorithm, supra* note 122, fig. 3.

presented in the CCPCT Study and are appropriate for use in this study.[196] The hazard values for lead required in the EF Equation are presented below in Figure 13.

Biological Oxygen Demand Hazard Value (lead) = BOD HV (lead) = 2.5

Hydrolysis Hazard Value (lead) = Hydrolysis HV (lead) = 2.5

Bioconcentration Factor Hazard Value (lead) = BCF HV (lead) = 1.39

Figure 13. *Exposure Potential Hazard Values for Lead*

These Exposure Potential Hazard Values for lead are incorporated into the EF Equation to derive a EF for lead of 6.39 in Figure 14 below.

EF (lead) = (2.5) + (2.5) + (1.39) = 6.39

Figure 14. *EF Calculation for Lead*

4. Total Hazard Value (THV)

The equations for WHHE, WEE and EF, *supra*, provide the basis for calculating the relative total hazard value (THV) presented by each of the 46 specific carcinogens addressed in this study.

[196] *See supra* note 174 and accompanying text. *See also* app. E.

This study uses the equation proposed in the CCPCT System to calculate the THV. That equation, as proposed in the CCPCT System and without unique weighting or further adaptation of the variables therein is shown below in Figure 15.

THV = (WHHE + WEE) * EF

Figure 15. *THV Equation*[197]

The 1987 Michigan data compiled for lead illustrates the calculation of the THV in this study. The WHHE, WEE and the EF variables calculated, *supra*, for the 1987 Michigan releases of lead and required in the THV Equation are presented below in Figure 16.

WHHE (lead) = 131.15

WEE (lead) = 64.53

EF (lead) = 6.39

Figure 16. *Algorithm Variables for Lead*

These values for lead are incorporated into the THV Equation to derive a 1987 Michigan THV for lead of approximately 1,250.40 in Figure 17 below.

THV (lead) = [(131.15) + (64.53)] * (6.39) = 1,250.40

Figure 17. *THV Calculation for Lead*

[197] *See supra* note 189.

D) Compilation of Total Releases and THVs

The adapted CCPCT System algorithm is applied to the Michigan specific primary chemical data and hazard values compiled in Appendix E, Tables 50-57. The WHHE, WEE, EF and THV for the Michigan releases of each of the 46 specific carcinogens are calculated in each reporting year, the values compiled and presented in Tables 58-65.[198]

The sum of the Total Michigan Releases for all 46 specific carcinogens, as compiled and presented in Appendix E, were re-compiled for each reporting year addressed in this study. The sum of the THVs for all 46 specific carcinogens, as compiled and presented in Appendix F, were re-compiled for each reporting year addressed in this study. Further, total releases of all chemicals reported under the EPCRA were compiled and totaled for each reporting year addressed in this study.[199] These data are re-compiled in Table 66 on the following page.

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[198] *See* app. F.

[199] These data, referred to as "Total TRI Releases," were compiled directly through on-line computer sources. None of the values were manipulated after being compiled. *See supra* note 99.

Table 66 - Total Releases and Hazard Values for All Reporting Years[200]

year	TOTAL TRI RELEASES (in pounds)[201]	TOTAL RELEASES OF CARCINOGENS (in pounds)[202]	TOTAL HAZARD VALUE FOR CARCINOGENS[203]
1987	174,884,325	16,009,348	25,108
1988	114,433,091	13,704,405	23,200
1989	123,076,468	20,625,808	27,190
1990	102,362,394	9,677,906	26,492
1991	93,934,593	8,583,453	26,257
1992	84,820,383	5,798,956	24,596
1993	81,637,986	5,477,251	26,245
1994	82,620,035	5,715,096	26,285

[200] All data contained in this table are Michigan specific.
[201] This column contains the total sum reported under the EPCRA for each reporting year, in pounds, of all toxic chemicals released to all media.
[202] This column contains the total sum reported under the EPCRA for each reporting year, in pounds, of the 46 specific carcinogens addressed in this study released to all media.
[203] The Total Hazard Values listed in this column are unitless.

Using the low end HV assumption for purposes of comparison, a second series of calculations were performed. *See supra* note 177. The data produced through these calculations are presented in Table 67 below.

Table 67 - Total Hazard Values for All Reporting Years (Minimum HV)

year	TOTAL HAZARD VALUE FOR CARCINOGENS (low range HV)
1987	21,851
1988	20,744
1989	22,218
1990	23,188
1991	22,659
1992	21,320
1993	22,019
1994	22,053

Part IV

DATA ANALYSIS AND CONCLUSIONS

CHAPTER SIX

ANALYSIS OF MICHIGAN TRI DATA

A) Comparison of Michigan TRI Quantity Data (Quantity Analysis) and Computed Michigan Hazard Value Data ("Risk") for Specific Carcinogens

1. Total TRI Releases

The inclusion of Total TRI Releases in Table 66 serves two purposes. First, these data illustrate that there is an overall decrease in the total quantity of TRI chemicals released into the environment. These data are presented to the general public by proponents of the reporting requirements of the EPCRA (*e.g.*, the U.S.E.P.A.) to show the "success" of the EPCRA concerning the decrease in total releases of TRI chemicals.[204] This "success" and the misleading nature of the presentation of these data to the general public in this format is one focus of this study. Second, these data are included in Table 66 to support the accuracy of the data collection in this study. A numerical analysis of these data shows a 52.76 per cent decrease in total releases of all TRI chemicals reported in the State of Michigan under the EPCRA. Using 1988 as the baseline year for purposes of analysis, in accord with U.S.E.P.A. practices,[205] the data presented in Table 66 shows a 27.80 per cent decrease in total releases of all TRI chemicals reported in Michigan under the EPCRA.[206] The 1993 Annual TRI Report issued by the U.S.E.P.A. states that the

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[204] *See supra* note 166.

[205] The U.S.E.P.A. selected to use 1988 as the baseline year due to the problems inherent in industry "estimating" releases. *See* Chapter 1(D), TRI Conceptual Framework and Structure. The Introduction of the 1993 Annual TRI Report states: "Although the first data were collected for calendar year 1987, 1988 has been selected as the baseline year because of concerns about the data quality of industry's first year submissions." *Supra* note 149. This study uses 1987 as the baseline year unless otherwise noted. *Id.*

[206] *Supra* note 149 at tbl. 3-4.

decrease in total releases in Michigan for all TRI chemicals between reporting years 1988 and 1993 is 27.50 per cent.[207] As the decrease in total releases in Michigan for all TRI chemicals determined in this study is effectively the same as the value presented to the public by the U.S.E.P.A., it is reasonable to assume that the method of data collection and the resulting data set used in this study were appropriate.

The graphical representation of the data presented in Table 66 for Total TRI Releases is provided below in Figure 18.

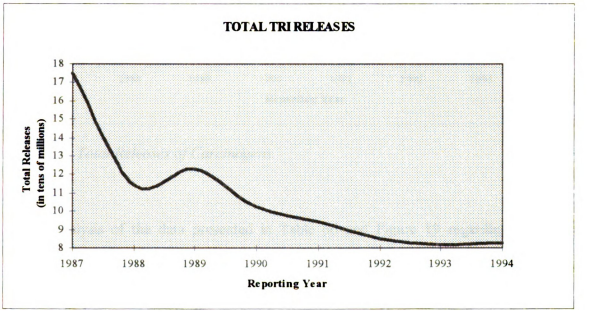

Figure 18. *Total TRI Releases*

[207] The 3/10 of one percent discrepancy in these values is not significant. However, the data provided in Table 3-4 is qualified as "not including data for aluminum oxide, delisted chemicals, or chemicals added in 1990 and 1991" which accounts for the discrepancy. *Id.*

2. Total Releases of Carcinogens

The graphical representation of the data presented in Table 66 for Total Releases of Carcinogens is provided below in Figure 19.

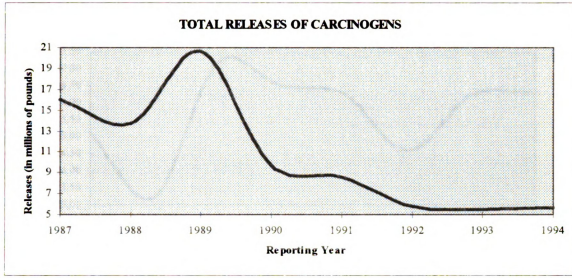

Figure 19. *Total Releases of Carcinogens*

Analysis of the data presented in Table 66 and Figure 19 regarding the Total Releases of Carcinogens shows a 64.30 per cent decrease in these specific releases reported in Michigan under the EPCRA. Again using 1988 as the baseline year for purposes of analysis, Table 66 shows a 58.30 per cent decrease in Total Releases of Carcinogens reported in Michigan. As the percentage decrease in the Total Releases of Carcinogens is greater than the percentage decrease in Total TRI Releases, Table 66 and Figure 19 suggest that efforts to decrease the releases of individual toxic chemicals are directed appropriately.

3. Total Hazard Values

Graphical representation of the Total Hazard Value data for carcinogens presented in Table 66 is provided below in Figure 20. [208]

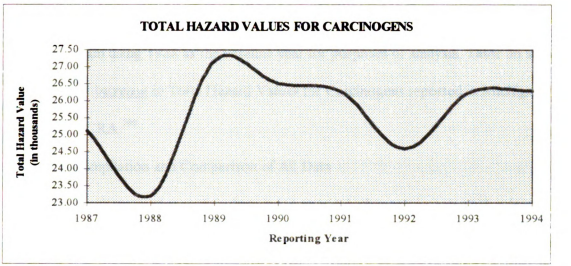

Figure 20. *Total Hazard Values for Carcinogens*

[208] Using the low end HV assumption for purposes of comparison, the graphical representation of the Total Hazard Value data for carcinogens, in contrast to the data presented in Table 66 and Figure 20, is provided below in Figure 21. *See supra* note 177.

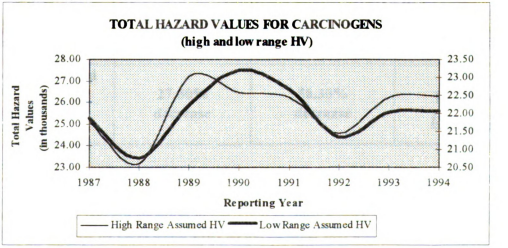

Figure 21. *Total Hazard Values for Carcinogens (high and low range HV)*

Analysis of the Total Hazard Value data for carcinogens presented in Table 66 and Figure 20 does not show a decrease similar to those observed for Total TRI Releases or Total Releases of Carcinogens. Conversely, analysis of these data show a 4.69 per cent *increase* in the Total Hazard Values for carcinogens reported in Michigan under the EPCRA. Again using 1988 as the baseline year for purposes of analysis, Table 66 shows a 13.30 percent *increase* in Total Hazard Values for Carcinogens reported in Michigan under the EPCRA.[209]

4. Compilation and Comparison of All Data

To facilitate analysis, the observed numerical changes in reported releases and calculated hazard values addressed in this study and discussed in the previous section are calculated and compiled below in Table 68.

Table 68 - Observed Numerical Changes in Releases[210]

	TOTAL TRI RELEASES (in pounds)	**TOTAL RELEASES OF CARCINOGENS (in pounds)**	**TOTAL HAZARD VALUE FOR CARCINOGENS**
Overall Numerical Change (1987 baseline)	**52.76% decrease**	**64.30% decrease**	**4.69% *increase***
Overall Numerical Change (1988 baseline)	**27.80% decrease**	**58.30% decrease**	**13.30% *increase***

[209] *See infra* Table 68. Using the low end HV assumption for purposes of comparison, *supra* note 177, a 1 percent *increase* in the Total Hazard Values for carcinogens reported in Michigan under the EPCRA using 1987 as the baseline year and a 5.94 percent *increase* in Total Hazard Values for Carcinogens reported in Michigan using 1988 as the baseline.

[210] All data contained in this table is Michigan specific.

Table 68 suggests that some relationship between overall decreases in Total TRI Releases and Total Releases of Carcinogens exists. However, Table 68 does not suggest any correlation between the decrease in total releases ("quantity") and a decrease in total hazard values ("risk") for carcinogens in Michigan.[211]

The decrease in both the Total TRI Releases and the Total Releases of Carcinogens shown in Table 66 suggests that efforts to decrease the release of individual toxic chemicals may be directed appropriately. However, the increase in the Total Hazard Values for Carcinogens reported in Michigan suggests that this conclusion is specious.

Graphical representation of the Total Releases of Carcinogens and the Total Hazard Values for Carcinogens data provided in Table 66 is provided in Figure 22 on the following page. As suggested by the data presented in Table 68, Figure 22 illustrates that while Total Releases of Carcinogens appear to decrease between the reporting years of 1987 through 1994 there is no corresponding decrease in the Total Hazard Values for Carcinogens observed in the same reporting years. To the contrary, the numerical data analysis indicates an increase in the Total Hazard Values for Carcinogens occurring in the same reporting period. This analysis is supported by the graph in Figure 22 on the following page.[212]

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[211] Based on the data presented in Table 68, it could be inferred that an inverse relationship between quantity and risk exists.

[212] Using the low end HV assumption for purposes of comparison, the graphical representation of the Total Hazard Value data for carcinogens, in contrast to the data presented in Table 66 and Figure 22, is provided in Figure 23 on the following page. *See supra* note 177.

(footnote continued)

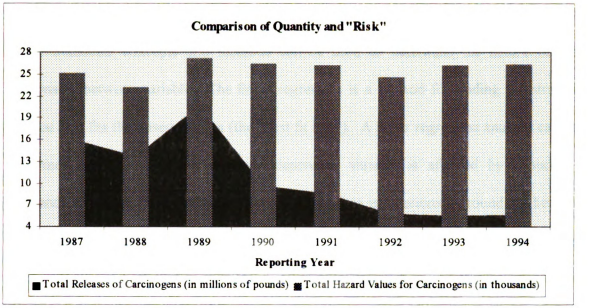

Figure 22. *Comparison of Quantity and "Risk"*

As suggested by the data presented in Tables 66 and 68, Figure 22 suggests that there is no correlation between the decrease in total releases ("quantity") and a decrease in total hazard values ("risk") for carcinogens on Michigan.

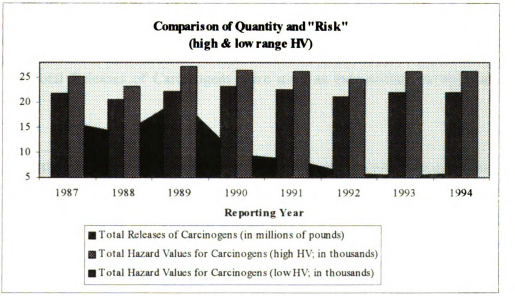

Figure 23. *Comparison of Quantity and "Risk" (high and low range HV)*

B) Statistical Analysis of Quantity and "Risk" for TRI Data

Statistical concepts and methods can be used to determine the nature of the relationship between variables. The linear regression is a method for finding the straight line that best fits the observed data (the "best fit line"). A linear regression analysis can be performed to determine how a single dependent variable is affected by a second, independent variable.[213] How closely the observed data is "scattered" around the best fit line is used to determine the association between the two variables. A large amount of scatter about the best fit line indicates a weak association between the two variables. Conversely, a small amount of scatter about the best fit line indicates a strong association between the two variables.[214] Using statistics, the "numerical measure of [the relationship between the observed data scattered about the best fit line] is called the *sample correlation coefficient* or, sometimes, *Pearson's product moment correlation coefficient*."[215]

1. Linear Regression Analysis and the Correlation Coefficient

A second, separate analysis of the Michigan TRI data addressed in this study was performed using a linear regression analysis. Using the values presented in Table 66, *supra*, the Total Releases of Carcinogens were used as independent variables and the

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[213] Gouri K. Bhattacharyya & Richard A. Johnson, STATISTICAL CONCEPTS AND METHODS 334 (John Wiley & Sons, 1977), states:

> Regression analysis is a body of statistical methods dealing with the formulation of mathematical models that depict relationships among variables, and the use of these modeled relationships for the purpose of prediction and other statistical inferences.

Id.

[214] *Id.* at 402.

[215] *Id.*

Total Hazard Values for Carcinogens were used as dependent variables.[216] These variables and the resulting line plot produced by the regression analysis are presented in Figure 24 below.

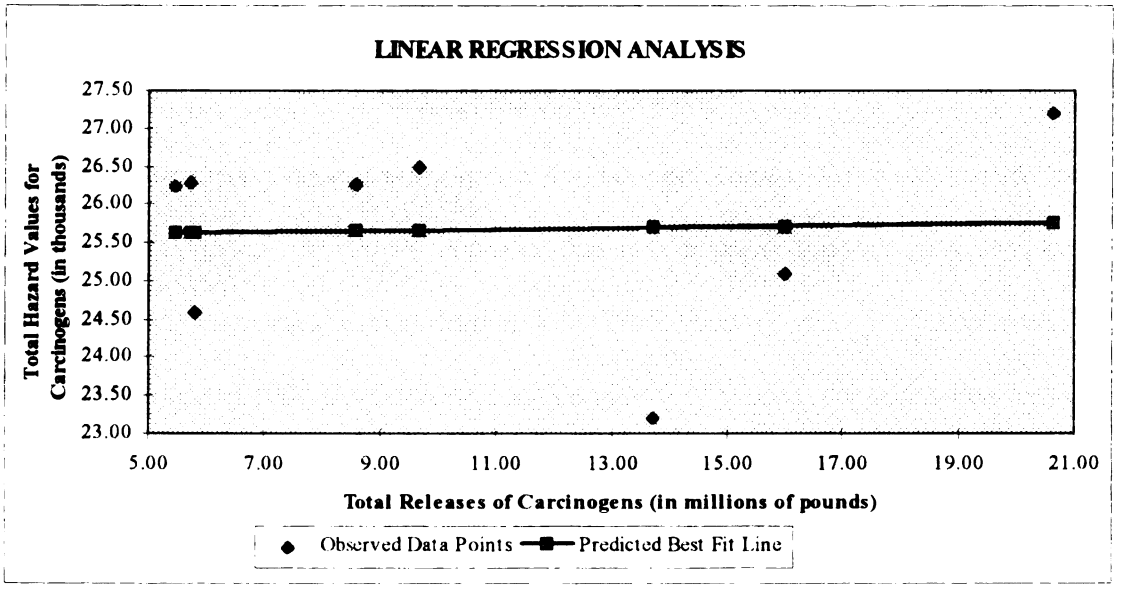

Figure 24. *Linear Regression Analysis*

Using the data derived from the linear regression analysis presented in Figure 24, the sample correlation coefficient (r) was calculated. An r value of 0.04 was derived for the specific data presented in this dissertation regarding Total Hazard Values and Total

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[216] The Total Releases of Carcinogens presented in Table 66 are not classic examples of independent variables (*i.e.*, they were not set by the author). However, due to the nature of the variables, the Total Releases of Carcinogens may be considered to be an independent variable.

For example, in addressing "what to do if the predictor variable can not be controlled by the experimenter," Bhattacharyya & Johnson state:

> as long as x is viewed as the causal variable that influences y and the objective of sampling is to make predictions about y from the value of x, the operational steps of analysis are the same . . . .

Bhattacharyya & Johnson, *supra* note 213, at 357.

Releases of Carcinogens. Again, using 1988 as the baseline year for purposes of analysis, an r value of 0.11 was derived for the same data.[217]

2. Analysis of the Correlation Coefficient

The value of r has a range of $-1 \leq r \leq 1$. An r value equal to or near either -1 or 1 indicates a strong correlation between the variables being tested. Conversely, an r value equal to or near 0 indicates a weak correlation between the variables being tested. An r value of 0.04, as derived above, indicates that only a weak correlation, if any, exists between Total Releases of Carcinogens and the Total Hazard Values for Carcinogens. If the baseline year of 1988 and the resulting r value of 0.11 is used, the correlation between Total Releases of Carcinogens and the Total Hazard Values for Carcinogens, if any, is also weak.

C) Summary

The numerical, graphical and statistical analyses of the Total Releases of Carcinogens and the Total Hazard Values for Carcinogens data in Michigan presented in this chapter support two propositions.

First, the data clearly shows a decrease in Total TRI Releases, a decrease in Total Releases of Known or Suspect Carcinogens and an increase in Total Hazard Values for

[217] Using the low end HV assumption for purposes of comparison, an r value of -0.07 was derived for the specific TRI data presented in this dissertation regarding Total Hazard Values and Total Releases of Carcinogens using 1987 as the baseline year and an r value of -0.04 was derived for the same data using 1988 as the baseline year. *See supra* note 177. These derived r values also indicate that only a weak correlation, if any, exists between Total Releases of Carcinogens and the Total Hazard Values for Carcinogens.

Known or Suspect Carcinogens reported under the EPCRA, in Michigan, between 1987 and 1994.

Second, the correlation, if any, between the decrease in Total Releases of Known or Suspect Carcinogens ("quantity") and the decrease in Total Hazard Values for Known or Suspect Carcinogens ("risk") is weak.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

A) Conclusions

One recognized goal of the U.S. Congress in implementing the EPCRA was to improve the relative safety of the population by decreasing the risks posed by the presence of toxic chemicals in industrial processes. The Congress chose to achieve this goal by imposing reporting requirements on industry that would provide an incentive to reduce the amounts of toxic chemicals stored or discharged into the environment. Based on a glossary analysis of the TRI data as it is currently presented, it is commonly recognized that the reporting requirements of the EPCRA have achieved the intermediate goal of reducing the amounts of toxic chemicals stored or discharged into the environment. The success of the EPCRA in achieving this intermediate goal may be a reasonable conclusion. However, it is not possible to extrapolate this analysis to support the proposition that the reporting requirements of the EPCRA have achieved the higher, recognized goal of decreasing the risks posed by the presence of toxic chemicals. The analysis of the TRI data simply does not support this proposition.

The analysis of Michigan specific TRI data performed in this dissertation suggests that the EPCRA has not achieved the recognized goal of decreasing risk by reducing the amount of toxic chemicals stored or discharged into the environment in Michigan. To the contrary, the analysis performed in this dissertation suggests that the reduction of total toxic chemicals without attention to individual reductions of specific toxic chemicals resulted in an overall increase in risk. At a minimum, analysis of these data generally

indicates that there is no correlation between reducing the amount of toxic chemicals stored or discharged into the environment ("quantity") and decreasing risk ("risk") in Michigan.

The thesis of this dissertation is that TRI toxic chemical data reported in compliance with the EPCRA does not demonstrate an improvement in the form of decreased risks posed by the presence of toxic chemicals in Michigan. The analysis performed supports this thesis. Further, the analysis of select carcinogens in Michigan using a algorithm modified for hazard valuation indicates a significant misallocation of resources in the effort to improve the relative safety of the population by reducing the amounts of toxic chemicals stored or discharged into the environment by industry.

The dissertation also suggests that presentation and evaluation of the TRI toxic chemical data reported in compliance with the EPCRA, using total quantity as the only analysis parameter, is inappropriate and misleading. Presentation of these data in this one dimensional format does not provide the information necessary to evaluate the success of the EPCRA and it generally limits the ability of the end user (*e.g.*, the average citizen or other stakeholder) to perform an accurate assessment of the EPCRA data and the potential risks presented by the TRI chemicals. Examples of the deficiencies of the TRI data presentation are as follows:

1) First, presentation of the TRI data in the format currently used does not allow the average citizen to determine which geographic area is most affected by toxic chemicals. Lacking an analysis based on region TRI reports, the EPCRA is not useful to

the average citizen in determining individual exposures or resulting risk. Even the data as presented in this dissertation does not include a regional analysis.

2) Second, presentation of the TRI data in the format currently used does not allow the end user to determine whether a specific industry classification presents the most risk due to toxic chemical storage and release. It is possible that one specific class of industry is responsible for storage and/or release of the majority of TRI chemical quantities, thereby driving the observed total risk. More narrowly, presentation of the TRI data in the format currently used does not allow the end user to make a similar determination concerning a specific company or companies which may be responsible for driving the overall observed risk.

3) Third, presentation of the TRI data in the format currently used does not indicate which specific toxic chemicals represent the highest degree of risk. For example, the data presented in this dissertation does not indicate which specific carcinogens are responsible for the observed increase in overall risk presented by the group of carcinogens. It is possible, and in fact likely, that the more potent carcinogens are driving the observed increase in total risk.

Without the increased level of detail and heightened analysis described above, it is impossible to appropriately allocate resources toward reducing the amount of the specific toxic chemicals, stored or discharged into the environment, that would efficiently advance the recognized goal of decreasing risk.[218] If the EPCRA is to be used efficiently by the

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[218] It is important to note that this "increased level of detail" currently exists. Form R provides the level of detail that would allow for a "heightened analysis" of the TRI data. *See* note 59 and Form R, Appendix A. *See also* note 169.

public as a tool for understanding the risks to which they are exposed, so that some action to decrease those risks may be taken (*e.g.*, exertion of pressure upon government and industry), that action should be directed toward the specific toxic chemicals, entities and geographic areas which present the most significant overall risk.

B) Recommendations for Future Research

1. Study Containing More Complete Detail

All Michigan TRI data available on-line for every chemical in every reporting year should be compiled at the highest level of detail available. The algorithm used as an analysis tool in this dissertation should then be applied to each of these releases to generate a useful set of analysis parameters. These parameters should be used to reasonably assess the various successes or failures of the EPCRA (*e.g.*, the decrease of risk through the reduction of total quantity of toxic chemicals stored or discharged into the environment) in Michigan.

This study was limited to the analysis of carcinogens which restricts the application of the results and/or conclusions stated herein outside the four corners of this dissertation. Recognizing this limitation, future research should be broadened to include all TRI chemicals. Further, future research should narrow the focus of analysis to specific categories. Future studies should incorporate parameters that serve to narrow chemical classifications so that the direct correlation, if any, can be determined between specific TRI chemicals or groups and specific environmental effects. For example, at a minimum, TRI chemical data should be analyzed in future studies using chemical type, total chemical

volumes or chemical structure; industrial classification of the reporting industry; specific companies; and specific media. Limiting the scope of review to only include carcinogens in Michigan was useful for the purposes of this dissertation, broad application of the conclusions reached in this study can only be accomplished after future research that incorporates more complete detail.

2. Focusing on Local Areas of Concerns

If done properly, the TRI data as compiled could be a useful tool for assessing risks to individuals by region. The TRI data provides specific location information (including longitude and latitude) for total amounts of TRI chemicals. Incorporating the use of geographic information systems ("GIS") in TRI data analysis would be effective in indicating localized regions that demonstrated inordinately high levels of toxic chemicals reported as stored and/or released into the environment (*i.e.*, "hotspots"). Overlaying readily available census data (*e.g.*, population, gender, race and economic status) with this TRI data concerning hotspots, using GIS, will be useful in determining whether specific individuals and/or discrete groups are exposed to increased risk.

3. Review of the Utility of Chemical Use Initiatives

The current legislative trends towards chemical use analysis needs to be reassessed. The U.S.E.P.A.'s movement towards requiring chemical use data as a means of advancing the recognized goals of the EPCRA are not useful. While chemical use data may be of marginal use in reducing overall quantities of toxic chemicals stored or released into the environment by specific industry (and thereby affect overall risk), this method

does nothing to increase the efficiency of the allocation of resources in the efforts to decrease risk. As Senator Lott stated on this issue:

> the addition of chemical use data would not further EPCRA'S goal of reducing chemical releases. Chemical use bears no direct relationship to emissions, waste generation, health risks or environmental hazards. Risk is a function of hazard and exposure. Chemical use will not indicate exposure. Furthermore, EPA's plans to expand regulatory requirements under the Toxic Substances Control Act to gather chemical use data is equally inappropriate.
>
> For all of these reasons, I believe that this program requires reexamination and redirection-not expansion along the lines that EPA intends. Clearly, there is an immediate need to first compare the reduction in risks by recent substantial reductions in emissions, before simply adding new informational requirements or facilities. Risks now need to be evaluated on a benefit-to-cost or a risk-to-risk basis.[219]

This refocusing on risk is absolutely necessary and can be furthered by research indicating the limited utility of focusing limited resources on chemical use reporting.

4. Refocusing on Risk Issues by the U.S.E.P.A.

Congruent with the efforts suggested in the preceding section, a general refocusing on risk issues is of paramount concern. Evaluation of the utilization of existing right-to-know laws by the public, similar to the effort made in this dissertation, is absolutely necessary to insure that the public's right-to-know laws continue to serve a practical purpose. Research regarding the effectiveness of right-to-know initiatives is paramount to insure that the laws are utilized to the fullest extent possible. Decreasing overall risk and enhancing communication between government agencies and the public can be more

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[219] 141 CONG. REC. S14366-03. (daily ed. Sept. 27, 1995) (statement of Sen. Lott).

efficiently achieved by maximizing the use of the data available rather than attempting to implement new approaches to right-to know paradigms. Reviewing the U.S.E.P.A.'s on this issue, Representative Lewis issued the following directive:

> Despite new information-gathering initiatives, EPA has proposed no improvement in the collection, analysis, and communication of information to the public on its own priorities, performance, or the effectiveness of such initiatives in improving the public's "right-to-know." Moreover, EPA has not sufficiently considered options to maximize the use of information already reported by facilities and available to citizens locally under the federal Emergency Planning and Community Right-to-Know Act (EPCRA) in its efforts to expand TRI to include more data on chemical uses.
>
> The conferees thus direct a study by the General Accounting Office to:
>
> > (1) Identify options for improving the right-to-know program to more effectively address community concerns regarding risks associated with chemicals and to communicate risks to the public; . . .[220]

[220] 142 CONG. REC. H10733-01. (daily ed. Sept. 20, 1996) (statement of Rep. Lewis).

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APPENDICES

Appendix A

EPCRA Form R

Appendix A
EPCRA Form R

(IMPORTANT: Type or print; read instructions before completing form)

Form Approved OMB Number: 2070-0093
Approval Expires: 11/92

EPA United States Environmental Protection Agency

FORM R TOXIC CHEMICAL RELEASE INVENTORY REPORTING FORM

Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986, also known as Title III of the Superfund Amendments and Reauthorization Act

TRI FACILITY ID NUMBER

Toxic Chemical, Category, or Generic Name

WHERE TO SEND COMPLETED FORMS:

1. EPCRA Reporting Center
P.O. Box 3348
Merrifield, VA 22116-3348
ATTN: TOXIC CHEMICAL RELEASE INVENTORY

2. APPROPRIATE STATE OFFICE (See instructions in Appendix F)

Enter "X" here if this is a revision

IMPORTANT: See instructions to determine when "Not Applicable (NA)" boxes should be checked.

For EPA use only

PART I. FACILITY IDENTIFICATION INFORMATION

SECTION 1. REPORTING YEAR

19 ____

SECTION 2. TRADE SECRET INFORMATION

2.1 Are you claiming the toxic chemical identified on page 3 trade secret?

☐ Yes (Answer question 2.2; Attach substantiation forms) ☐ No (Do not answer 2.2; Go to Section 3)

2.2 If yes in 2.1, is this copy: ☐ Sanitized ☐ Unsanitized

SECTION 3. CERTIFICATION (Important: Read and sign after completing all form sections.)

I hereby certify that I have reviewed the attached documents and that, to the best of my knowledge and belief, the submitted information is true and complete and that the amounts and values in this report are accurate based on reasonable estimates using data available to the preparers of this report.

Name and official title of owner/operator or senior management official

Signature | Date Signed

SECTION 4. FACILITY IDENTIFICATION

4.1

Facility or Establishment Name | TRI Facility ID Number

Street Address

City | County

State | Zip Code

Mailing Address (if different from street address)

City

State | Zip Code

PUT LABEL HERE

Appendix A
EPCRA Form R

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EPA FORM R

PART I. FACILITY IDENTIFICATION INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER
Toxic Chemical, Category, or Generic Name

SECTION 4. FACILITY IDENTIFICATION (Continued)

4.2	This report contains information for: (Important: check a or b; check c if applicable)	a. ☐ An entire facility	b. ☐ Part of a facility	c. ☐ A Federal facility				
4.3	Technical Contact	Name				Telephone Number (include area code)		
4.4	Public Contact	Name				Telephone Number (include area code)		
4.5	SIC Code (4-digit)	a.	b.	c.	d.	e.	f.	
4.6	Latitude and Longitude	Latitude			Longitude			
		Degrees	Minutes	Seconds	Degrees	Minutes	Seconds	

4.7	Dun & Bradstreet Number(s) (9 digits)	a. b.
4.8	EPA Identification Number(s) (RCRA I.D. No.) (12 characters)	a. b.
4.9	Facility NPDES Permit Number(s) (9 characters)	a. b.
4.10	Underground Injection Well Code (UIC) I.D. Number(s) (12 digits)	a. b.

SECTION 5. PARENT COMPANY INFORMATION

5.1	Name of Parent Company ☐ NA	
5.2	Parent Company's Dun & Bradstreet Number ☐ NA	(9 digits)

Appendix A
EPCRA Form R

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PART II. CHEMICAL-SPECIFIC INFORMATION

TRI FACILITY ID NUMBER

Toxic Chemical, Category, or Generic Name

SECTION 1. TOXIC CHEMICAL IDENTITY (Important: DO NOT complete this section if you complete Section 2 below.)

1.1	CAS Number (Important: Enter only one number exactly as it appears on the Section 313 list. Enter category code if reporting a chemical category.)
1.2	Toxic Chemical or Chemical Category Name (Important: Enter only one name exactly as it appears on the Section 313 list.)
1.3	Generic Chemical Name (Important: Complete only if Part I, Section 2.1 is checked "yes." Generic Name must be structurally descriptive.)

SECTION 2. MIXTURE COMPONENT IDENTITY (Important: DO NOT complete this section if you complete Section 1 above.)

2.1	Generic Chemical Name Provided by Supplier (Important: Maximum of 70 characters, including numbers,letters, spaces, and punctuation.)

SECTION 3. ACTIVITIES AND USES OF THE TOXIC CHEMICAL AT THE FACILITY (Important: Check all that apply.)

3.1	Manufacture the toxic chemical:	a. ☐ Produce b. ☐ Import	If produce or import: c. ☐ For on-site use/processing d. ☐ For sale/distribution e. ☐ As a byproduct f. ☐ As an impurity
3.2	Process the toxic chemical:	a. ☐ As a reactant b. ☐ As a formulation component	c. ☐ As an article component d. ☐ Repackaging
3.3	Otherwise use the toxic chemical:	a. ☐ As a chemical processing aid b. ☐ As a manufacturing aid	c. ☐ Ancillary or other use

SECTION 4. MAXIMUM AMOUNT OF THE TOXIC CHEMICAL ON-SITE AT ANY TIME DURING THE CALENDAR YEAR

4.1	☐ (Enter two-digit code from instruction package.)	

EPA Form 9350-1(Rev. 12/94) - Previous editions are obsolete.

Appendix A
EPCRA Form R

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EPA FORM R

PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER

Toxic Chemical, Category, or Generic Name

SECTION 5. RELEASES OF THE TOXIC CHEMICAL TO THE ENVIRONMENT ON-SITE

			A. Total Release (pounds/ year) (enter range code from instructions or estimate)	B. Basis of Estimate (enter code)	C. % From Stormwater
5.1	Fugitive or non-point air emissions	☐ NA			
5.2	Stack or point air emissions	☐ NA			
5.3	Discharges to receiving streams or water bodies (enter one name per box)				
5.3.1	Stream or Water Body Name				
5.3.2	Stream or Water Body Name				
5.3.3	Stream or Water Body Name				
5.4	Underground injections on-site	☐ NA			
5.5	Releases to land on-site				
5.5.1	Landfill	☐ NA			
5.5.2	Land treatment/ application farming	☐ NA			
5.5.3	Surface impoundment	☐ NA			
5.5.4	Other disposal	☐ NA			

☐ Check here only if additional Section 5.3 information is provided on page 5 of this form.

EPA Form 9350-1 (Rev. 12/94) - Previous editions are obsolete.

Range Codes: A = 1 - 10 pounds; B = 11 - 499 pounds; C = 500 - 999 pounds.

Appendix A
EPCRA Form R

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EPA FORM R

PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER
Toxic Chemical, Category, or Generic Name

SECTION 5.3 ADDITIONAL INFORMATION ON RELEASES OF THE TOXIC CHEMICAL TO THE ENVIRONMENT ON-SITE

5.3	Discharges to receiving streams or water bodies (enter one name per box)	A. Total Release (pounds/year) (enter range code from instructions or estimate)	B. Basis of Estimate (enter code)	C. % From Stormwater
5.3.__	Stream or Water Body Name			
5.3.__	Stream or Water Body Name			
5.3.__	Stream or Water Body Name			

SECTION 6. TRANSFERS OF THE TOXIC CHEMICAL IN WASTES TO OFF-SITE LOCATIONS

6.1 DISCHARGES TO PUBLICLY OWNED TREATMENT WORKS (POTW)

6.1.A Total Quantity Transferred to POTWs and Basis of Estimate

6.1.A.1 Total Transfers (pounds/year) (enter range code or estimate)	6.1.A.2 Basis of Estimate (enter code)

6.1.B POTW Name and Location Information

6.1.B.__ POTW Name		6.1.B.__ POTW Name	
Street Address		Street Address	
City	County	City	County
State	Zip Code	State	Zip Code

If additional pages of Part II, Sections 5.3 and/or 6.1 are attached, indicate the total number of pages in this box [ ] and indicate which Part II, Sections 5.3/6.1 page this is, here. [ ]
(example: 1, 2, 3, etc.)

Range Codes: A = 1 - 10 pounds; B = 11 - 499 pounds; C = 500 - 999 pounds.

Appendix A
EPCRA Form R

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EPA FORM R

PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER

Toxic Chemical, Category, or Generic Name

SECTION 6.2 TRANSFERS TO OTHER OFF-SITE LOCATIONS

6.2. ___ Off-site EPA Identification Number (RCRA ID No.)

Off-Site Location Name

Street Address

City | County

State | Zip Code | Is location under control of reporting facility or parent company? ☐ Yes ☐ No

A. Total Transfers (pounds/year) (enter range code or estimate)	B. Basis of Estimate (enter code)	C. Type of Waste Treatment/Disposal/ Recycling/Energy Recovery (enter code)
1.	1.	1. M
2.	2.	2. M
3.	3.	3. M
4.	4.	4. M

SECTION 6.2 TRANSFERS TO OTHER OFF-SITE LOCATIONS

6.2. ___ Off-site EPA Identification Number (RCRA ID No.)

Off-Site Location Name

Street Address

City | County

State | Zip Code | Is location under control of reporting facility or parent company? ☐ Yes ☐ No

A. Total Transfers (pounds/year) (enter range code or estimate)	B. Basis of Estimate (enter code)	C. Type of Waste Treatment/Disposal/ Recycling/Energy Recovery (enter code)
1.	1.	1. M
2.	2.	2. M
3.	3.	3. M
4.	4.	4. M

If additional pages of Part II, Section 6.2 are attached, indicate the total number of pages in this box ☐ and indicate which Part II, Section 6.2 page this is, here. ☐ (example: 1, 2, 3, etc.)

EPA Form 9350-1 (Rev. 12/94) - Previous editions are obsolete.

Range Codes: A = 1 - 10 pounds; B = 11 - 499 pounds; C = 500 - 999 pounds.

Appendix A
EPCRA Form R

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EPA FORM R

PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER
Toxic Chemical, Category, or Generic Name

SECTION 7A. ON-SITE WASTE TREATMENT METHODS AND EFFICIENCY

☐ **Not Applicable (NA) - Check here if no on-site waste treatment is applied to any waste stream containing the toxic chemical or chemical category.**

a. General Waste Stream (enter code)	b. Waste Treatment Method(s) Sequence (enter 3-character code(s))	c. Range of Influent Concentration	d. Waste Treatment Efficiency Estimate	e. Based on Operating Data?
7A.1a	7A.1b 1 2 3 4 5 6 7 8	7A.1c	7A.1d	7A.1e
			%	Yes ☐ No ☐
7A.2a	7A.2b 1 2 3 4 5 6 7 8	7A.2c	7A.2d	7A.2e
			%	Yes ☐ No ☐
7A.3a	7A.3b 1 2 3 4 5 6 7 8	7A.3c	7A.3d	7A.3e
			%	Yes ☐ No ☐
7A.4a	7A.4b 1 2 3 4 5 6 7 8	7A.4c	7A.4d	7A.4e
			%	Yes ☐ No ☐
7A.5a	7A.5b 1 2 3 4 5 6 7 8	7A.5c	7A.5d	7A.5e
			%	Yes ☐ No ☐

If additional copies of page 7 are attached, indicate the total number of pages in this box ☐ and indicate which page 7 this is, here. ☐ (example: 1, 2, 3, etc.)

Appendix A
EPCRA Form R

EPA
United States Environmental Protection Agency

EPA FORM R

PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER
Toxic Chemical, Category, or Generic Name

SECTION 7B. ON-SITE ENERGY RECOVERY PROCESSES

☐ Not Applicable (NA) - Check here if no on-site energy recovery is applied to any waste stream containing the toxic chemical or chemical category.

Energy Recovery Methods [enter 3-character code(s)]

1 ☐ 2 ☐ 3 ☐ 4 ☐

SECTION 7C. ON-SITE RECYCLING PROCESSES

☐ Not Applicable (NA) - Check here if no on-site recycling is applied to any waste stream containing the toxic chemical or chemical category.

Recycling Methods [enter 3-character code(s)]

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Appendix A
EPCRA Form R

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EPA FORM R

PART II. CHEMICAL-SPECIFIC INFORMATION (CONTINUED)

TRI FACILITY ID NUMBER
Chemical, Category, or Generic Name

SECTION 8. SOURCE REDUCTION AND RECYCLING ACTIVITIES

	All quantity estimates can be reported using up to two significant figures.	Column A Prior Year (pounds/year)	Column B Current Reporting Year (pounds/year)	Column C Following Year (pounds/year)	Column D Second Following Year (pounds/year)
8.1	Quantity released *				
8.2	Quantity used for energy recovery on-site				
8.3	Quantity used for energy recovery off-site				
8.4	Quantity recycled on-site				
8.5	Quantity recycled off-site				
8.6	Quantity treated on-site				
8.7	Quantity treated off-site				
8.8	Quantity released to the environment as a result of remedial actions, catastrophic events, or one-time events not associated with production processes (pounds/year)				
8.9	Production ratio or activity index				

8.10	Did your facility engage in any source reduction activities for this chemical during the reporting year? If not, enter "NA" in Section 8.10.1 and answer Section 8.11.			
	Source Reduction Activities [enter code(s)]	Methods to Identify Activity (enter codes)		
8.10.1		a.	b.	c.
8.10.2		a.	b.	c.
8.10.3		a.	b.	c.
8.10.4		a.	b.	c.

		YES	NO
8.11	Is additional optional information on source reduction, recycling, or pollution control activities included with this report? (Check one box)	☐	☐

* Report releases pursuant to EPCRA Section 329(8) including "any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment." Do not include any quantity treated on-site or off-site.

EPA Form 9350 - 1 (Rev. 12/94) - Previous editions are obsolete.

Appendix B

TRI Releases of Known or Suspect Carcinogens (1993)

Appendix B

TRI Releases of Known or Suspect Carcinogens (1993)

Table 1 - TRI Releases of Known or Suspect Carcinogens (1993).[a]

CAS Number*	Chemical	Total Air Emissions Pounds	Surface Water Discharges Pounds	Releases to Land Pounds	Total Air Water/Land Releases Pounds
75-07-0	Acetaldehyde	6,507,137	35,127	951	6,543,215
60-35-5	Acetamide	15	1	0	16
79-06-1	Acrylamide	28,558	2,261	168	30,987
107-13-1	Acrylonitrile	1,393,618	3,078	6,934	1,403,630
60-09-3	4-Aminoazobenzene	1	0	0	1
92-67-1	4-Aminobiphenyl	0	0	0	0
90-04-0	o-Anisidine	877	81	116	1,074
7440-38-2	Arsenic	33,988	1,643	311,263	346,894
1332-21-4	Asbestos (friable)	8,383	255	537,783	546,421
71-43-2	Benzene	10,799,125	18,793	27,515	10,845,433
92-87-5	Benzidine	16	0	0	16
98-07-7	Benzoic trichloride	6,135	0	0	6,135
7440-41-7	Beryllium	903	24	14,594	15,521
542-88-1	Bis(chloromethyl) ether	255	0	0	255
106-99-0	1,3-Butadiene	3,274,316	7,595	350	3,282,261
7440-43-9	Cadmium	15,290	412	56,665	72,367
56-23-5	Carbon tetrachloride	2,228,909	1,453	79	2,230,441
67-66-3	Chloroform	13,808,692	451,362	32,926	14,292,980
107-30-2	Chloromethyl methyl ether	2,241	5	0	2,246
XX	Chlorophenols	9,906	34	0	9,940
7440-47-3	Chromium	426,198	21,960	1,157,200	1,605,358
8001-58-9	Creosote	1,152,129	8,039	1,528	1,161,696
120-71-8	p-Cresidine	410	5	85	500
135-20-6	Cupferron	59	0	0	59
615-05-4	2,4-Diaminoanisole	13	0	0	13
101-80-4	4,4'-Diaminodiphenyl ether	119	2,137	5	2,261
25376-45-8	Diaminotoluene (mixed isomers)	17,364	989	113	18,466
95-80-7	2,4-Diaminotoluene	1,790	0	0	1,790
106-93-4	1,2-Dibromoethane	25,199	80	254	25,533
25321-22-6	Dichlorobenzene (mixed isomers)	6,886	0	30	6,916
106-46-7	1,4-Dichlorobenzene	357,891	1,265	1,112	360,268
91-94-1	3,3'-Dichlorobenzidine	10	0	0	10

Appendix B

TRI Releases of Known or Suspect Carcinogens (1993)

Table 1 (con't)

107-06-2	1,2-Dichloroethane	2,304,877	6,806	303	2,311,986
75-09-2	Dichloromethane	64,313,211	62,909	78,267	64,454,387
542-75-6	1,3-Dichloropropylene	33,164	2	0	33,166
117-81-7	Di-(2-ethylhexyl) phthalate	578,940	1,118	92,887	672,945
64-67-5	Diethyl sulfate	22,016	5	5	22,026
119-90-4	3,3'-Dimethoxybenzidine	0	4	0	4
57-14-7	1,1-Dimethyl hydrazine	194	0	0	194
77-78-1	Dimethyl sulfate	5,755	0	5	5,760
123-91-1	1,4-Dioxane	434,017	477,896	2,236	914,149
106-89-8	Epichlorohydrin	384,132	3,642	2,356	390,130
140-88-5	Ethyl acrylate	186,391	1,200	21	187,612
151-56-4	Ethyleneimine	0	0	0	0
75-21-8	Ethylene oxide	1,147,222	2,634	11,222	1,161,078
96-45-7	Ethylene thiourea	270	0	0	270
50-00-0	Formaldehyde	11,371,021	418,503	418,220	12,207,744
118-74-1	Hexachlorobenzene	636	476	0	1,112
302-01-2	Hydrazine	16,452	784	5	17,241
10034-93-2	Hydrazine sulfate	1	0	0	1
7439-92-1	Lead	695,894	24,575	3,336,155	4,056,624
58-89-9	Lindane	575	0	5	580
101-14-4	4,4'-Methylenebis (2-chloroaniline)	15	0	0	15
101-77-9	4,4'-Methylenedianiline	18,274	291	135	18,700
90-94-8	Michler's ketone	1,542	0	0	1,542
134-32-7	alpha-Naphthylamine	10	0	0	10
7440-02-0	Nickel	321,926	38,098	427,911	787,935
XX	Nickel compounds	178,880	56,096	2,864,701	3,099,677
139-13-9	Nitrilotriacetic acid	12	6,442	0	6,454
79-46-9	2-Nitropropane	48,328	1,200	0	49,528
XX	Polybrominated biphenyls	0	0	0	0
1336-36-3	Polychlorinated biphenyls (PCBs)	0	0	265	265
1120-71-4	Propane sultone	250	0	0	250
75-55-8	Propyleneimine	339	0	0	339
75-56-9	Propylene oxide	1,123,896	6,390	6,197	1,136,483
81-07-2	Saccharin (manufacturing)	301	0	0	301
100-42-5	Styrene	32,570,591	28,274	177,580	32,776,445
96-09-3	Styrene oxide	344	0	0	344
127-18-4	Tetrachloroethylene	10,942,019	10,152	618,026	11,570,197
62-56-6	Thiourea	1,372	2,611	288	4,271

Appendix B

TRI Releases of Known or Suspect Carcinogens (1993)

Table 1 (con't)

584-84-9	Toluene-2,4-diisocyanate	58,869	0	0	58,869
91-08-7	Toluene-2,6-diisocyanate	6,695	0	0	6,695
26471-62-5	Toluenediisocyanate (mixed isomers)	42,223	0	288	42,511
95-53-4	o-Toluidine	18,401	1,266	7	19,674
88-06-2	2,4,6-Trichlorophenol	69	56	0	125
51-79-6	Urethane	12,200	0	0	12,200
593-60-2	Vinyl bromide	1,657	0	0	1,657
75-01-4	Vinyl chloride	1,013,962	277	6	1,014,245
	Subtotal	167,963,376	1,708,306	10,186,762	179,858,444
	Total for All TRI Chemicals	1,672,127,735	271,152,864	289,052,581	2,232,333,180

* Compund categories do not have CAS numbers (XX).

[a] Source: *1993 Toxics Release Inventory - Public Release Data*, Table 1-43, EPA 745-R-95-010.

Appendix C

Known or Suspect Carcinogens in Michigan

Appendix C

Known or Suspect Carcinogens In Michigan

Table 2 - Known or Suspect Carcinogens With Reported Releases in Michigan

CAS Number	Chemical Name
75-07-0	Acetaldehyde
79-06-1	Acrylamide
107-13-1	Acrylonitrile
7440-38-2	Arsenic
1332-21-4	Asbestos (friable)
71-43-2	Benzene
7440-41-7	Beryllium
542-88-1	Bis(chloromethyl) ether
106-99-0	1,3-Butadiene
7440-43-9	Cadmium
56-23-5	Carbon tetrachloride
67-66-3	Chloroform
107-30-2	Chloromethyl methyl ether
XX	Chlorophenols (mixed isomers)
7440-47-3	Chromium
8001-58-9	Creosote
25376-45-8	Diaminotoluene
106-93-4	1,2-Dibromoethane
106-46-7	1,4-Dichlorobenzene
91-94-1	3,3'-Dichlorobenzidine
107-06-2	1,2-Dichloroethane
75-09-2	Dichloromethane
542-75-6	1,3-Dichloropropylene
117-81-7	Di-(2-ethylhexyl) phthalate
77-78-1	Dimethyl sulfate

Appendix C

Known or Suspect Carcinogens In Michigan

Table 2 (con't)

123-91-1	1,4-Dioxane
106-89-8	Epichlorohydrin
140-88-5	Ethyl acrylate
75-21-8	Ethylene oxide
96-45-7	Ethylene thiourea
50-00-0	Formaldehyde
302-01-2	Hydrazine
7439-92-1	Lead
134-32-7	alpha-Naphthylamine
7440-02-0	Nickel
N495	Nickel compounds
139-13-9	Nitrilotriacetic acid
79-46-9	2-Nitropropane
1336-36-3	Polychlorinated biphenyls
75-56-9	Propylene oxide
100-42-5	Styrene
127-18-4	Tetrachloroethylene
62-56-6	Thiourea
584-84-9	Toluene-2,4-diisocyanate
91-08-7	Toluene-2,6-diisocyanate
26471-62-5	Toluenediisocyanate
95-53-4	o-Toluidine
88-06-2	2,4,6-Trichlorophenol
51-79-6	Urethane
75-01-4	Vinyl chloride

Appendix C

Known or Suspect Carcinogens In Michigan

Table 3 - Known or Suspect Carcinogens With No Reported Releases in Michigan

60-35-5	Acetamide
60-09-3	4-Aminoazobenzene
92-67-1	4-Aminobiphenyl
90-04-0	o-Anisidine
92-87-5	Benzidine
98-07-7	Benzoic trichloride
120-71-8	p-Cresidine
135-20-6	Cupferron
615-05-4	2,4-Diaminoanisole
101-80-4	4,4'-Diaminodiphenyl ether
95-80-7	2,4-Diaminotoluene
25321-22-6	Dichlorobenzene
64-67-5	Diethyl sulfate
119-90-4	3,3'-Dimethoxybenzidine
57-14-7	1,1-Dimethyl hydrazine
151-56-4	Ethyleneimine
118-74-1	Hexachlorobenzene
10034-93-2	Hydrazine sulfate
58-89-9	Lindane
101-14-4	4,4'-Methylenebis
101-77-9	4,4'-Methylenedianiline
90-94-8	Michler's ketone
N575	Polybrominated biphenyls
1120-71-4	Propane sultone
75-55-8	Propyleneimine
81-07-2	Saccharin (manufacturing)
96-09-3	Styrene oxide
593-60-2	Vinyl bromide

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 4 - Total Acetaldehyde Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	183766	326	184092
1988	79100	30	79130
1989	71566	33	71599
1990	37584	31	37615
1991	10575	10	10585
1992	8360	8	8368
1993	7527	0	7527
1994	11458	5	11463

Table 5 - Total Acrylamide Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	750	3030	3770
1988	551	800	1351
1989	539	4005	4544
1990	5122	1752	6874
1991	933	1924	2857
1992	1034	0	1034
1993	1054	689	1743
1994	1432	630	2062

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 6 - Total Acrylonitrile Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	35684	750	36434
	1988	29098	600	29698
	1989	53677	629	54306
	1990	16938	406	17344
	1991	11508	168	11676
	1992	20053	243	20296
	1993	21633	145	21778
	1994	19516	145	19661

Table 7 - Total Arsenic Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	127	0	127
	1989	0	0	0
	1990	12	2050	2062
	1991	9	1455	1464
	1992	12	826	838
	1993	26	1420	1446
	1994	33	1220	1253

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 8 - Total Asbestos (friable) Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	1251	0	1251
1988	1250	0	1250
1989	750	0	750
1990	0	0	0
1991	0	0	0
1992	0	0	0
1993	0	0	0
1994	0	0	0

Table 9 - Total Benzene Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	762682	1891	764573
1988	658656	4533	663189
1989	574900	6643	581543
1990	528700	13291	541991
1991	481307	11890	493197
1992	234372	5729	240101
1993	182152	14735	196887
1994	190372	8730	199102

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 10 - Total Beryllium Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	0	0	0
	1989	250	0	250
	1990	255	5	260
	1991	250	1000	1250
	1992	750	0	750
	1993	5	0	5
	1994	5	0	5

Table 11 - Total Bis (chloromethyl) ether Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	0	0	0
	1989	0	0	0
	1990	0	0	0
	1991	0	0	0
	1992	0	0	0
	1993	0	0	0
	1994	0	0	0

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 12 - Total 1,3-Butadiene Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	63472	0	63472
	1988	34300	0	34300
	1989	15990	0	15990
	1990	30373	2	30375
	1991	28359	0	28359
	1992	47709	73	47782
	1993	10415	0	10415
	1994	20176	0	20176

Table 13 - Total Cadmium Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	500	250	750
	1988	1250	0	1250
	1989	500	0	500
	1990	3035	6350	9385
	1991	534	2700	3234
	1992	347	1045	1392
	1993	328	721	1304
	1994	320	2514	2834

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 14 - Total Carbon tetrachloride Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	183766	326	184092
	1988	79100	30	79130
	1989	71566	33	71599
	1990	37584	31	37615
	1991	10575	10	10585
	1992	8360	8	8368
	1993	7527	0	7527
	1994	11458	5	11463

Table 15 - Total Chloroform Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	540334	10038	550372
	1988	320989	11755	332744
	1989	365130	3547	368677
	1990	296246	2296	298542
	1991	190387	1688	192075
	1992	133061	1299	134360
	1993	123607	1464	125071
	1994	99173	706	99879

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 16 - Total Chloromethyl methyl ether Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	250	0	250
	1988	0	0	0
	1989	1	0	1
	1990	0	0	0
	1991	0	0	0
	1992	0	0	0
	1993	15	0	15
	1994	6	0	6

Table 17 - Total Chlorophenols (mixed isomers) Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	0	0	0
	1989	380	17	397
	1990	330	17	347
	1991	342	74	416
	1992	349	19	368
	1993	333	20	353
	1994	334	20	354

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 18 - Total Chromium Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	17388	38832	56220
	1988	33609	75287	108896
	1989	18550	92061	110611
	1990	12661	90821	103482
	1991	17050	83430	100480
	1992	13546	48076	61622
	1993	23230	60456	83686
	1994	26406	47311	73717

Table 19 - Total Creosote Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	0	0	0
	1989	0	0	0
	1990	0	0	0
	1991	0	0	0
	1992	0	0	0
	1993	7519	0	7519
	1994	7818	0	7818

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 20 - Total Diaminotoluene Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	500	500	1000
	1988	500	500	1000
	1989	500	360	860
	1990	10	115	125
	1991	10	64	74
	1992	10	52	62
	1993	10	255	265
	1994	10	255	265

Table 21 - Total 1,2-Dibromoethane Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	0	0	0
	1989	0	0	0
	1990	0	0	0
	1991	0	0	0
	1992	0	0	0
	1993	0	0	0
	1994	0	0	0

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 22 - Total 3,3'-Dichlorobenzidine Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	3	2	5
	1988	251	2	253
	1989	251	1	252
	1990	10	1	11
	1991	10	0	10
	1992	10	0	10
	1993	10	0	10
	1994	10	0	10

Table 23 - Total 1,2-Dichloroethane Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	239503	24000	263503
	1988	201249	3500	204749
	1989	139854	20050	159904
	1990	98373	44311	142684
	1991	37759	905	38664
	1992	12386	945	13331
	1993	24159	990	25149
	1994	25548	405	25953

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 24 - Total Dichloromethane Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	10259612	373658	10633270
	1988	8163900	273808	8437708
	1989	15754293	612640	16366933
	1990	5349136	175261	5524397
	1991	4596324	354893	4951217
	1992	2485426	193094	2678520
	1993	1963318	169862	2133180
	1994	2279695	98601	2378296

Table 25 - Total 1,3-Dichloropropylene Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	500	0	500
	1988	600	0	600
	1989	292	0	292
	1990	227	0	227
	1991	224	0	224
	1992	224	0	224
	1993	231	0	231
	1994	235	0	235

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 26 - Total Di-(2-ethylhexyl) phthalate Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	24539	0	24539
	1988	3561	0	3561
	1989	65030	0	65030
	1990	382279	0	382279
	1991	370118	10	370128
	1992	10285	0	10285
	1993	25124	250	25374
	1994	31502	0	31502

Table 27 - Total Dimethyl sulfate Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	0	0	0
	1989	250	0	251
	1990	0	0	0
	1991	0	0	0
	1992	33	0	33
	1993	33	0	33
	1994	250	0	250

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 28 - Total Epichlorohydrin Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	7680	0	7680
	1988	1560	0	1560
	1989	2719	0	2719
	1990	3085	5	3090
	1991	5223	251	5473
	1992	4931	0	4931
	1993	2306	0	2306
	1994	2010	0	2010

Table 29 - Total Ethyl acrylate Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	812	0	812
	1988	329	0	329
	1989	40	0	40
	1990	379	0	379
	1991	371	0	371
	1992	145	0	145
	1993	136	0	136
	1994	936	0	936

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 30 - Total Ethylene oxide Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	55350	2050	57400
	1988	57780	1460	59240
	1989	43635	1000	44635
	1990	43655	256	43911
	1991	19208	405	19613
	1992	13157	255	13412
	1993	13105	255	13360
	1994	12260	255	12515

Table 31 - Total Ethylene thiourea Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	0	0	0
	1989	0	0	0
	1990	0	0	0
	1991	0	0	0
	1992	0	0	0
	1993	0	0	0
	1994	0	0	0

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 32 - Total Formaldehyde Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	531656	101598	633254
	1988	938786	19657	958443
	1989	401849	24114	425963
	1990	483391	15049	498440
	1991	395712	11701	407413
	1992	417739	10949	428688
	1993	380590	12296	392886
	1994	265769	5549	271318

Table 33 - Total Hydrazine Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	3	0	3
	1989	500	0	500
	1990	10	0	10
	1991	10	0	10
	1992	0	0	0
	1993	0	0	0
	1994	0	0	0

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 34 - Total Lead Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	20719	1303	22022
1988	26207	105635	131842
1989	44608	238072	282680
1990	27911	226228	254139
1991	21603	162507	184110
1992	15451	79229	94680
1993	15133	133902	149035
1994	16509	183344	199853

Table 35 - Total Nickel Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	16412	12563	28975
1988	15004	10025	25029
1989	16937	39436	56373
1990	14198	10854	25052
1991	14095	22415	36510
1992	13165	21436	34601
1993	18228	14625	32853
1994	19156	4930	24086

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 36 - Total Nickel Compounds Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	9650	4250	13900
1988	12364	4831	17195
1989	11507	4720	16227
1990	8130	5268	13398
1991	6963	2650	9613
1992	6346	2563	8909
1993	5329	346	5675
1994	11440	103	11543

Table 37 - Total 2-Nitropropane Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	18250	0	18250
1988	13000	0	13000
1989	10500	0	10500
1990	5	0	5
1991	0	0	0
1992	32	0	32
1993	0	0	0
1994	0	0	0

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 38 - Total Polychlorinated biphenyls Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	250	0	250
	1988	0	1	1
	1989	0	0	0
	1990	0	0	0
	1991	0	0	0
	1992	0	0	0
	1993	0	0	0
	1994	0	0	0

Table 39 - Total Propylene oxide Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	158791	382000	540791
	1988	144458	93950	238408
	1989	132796	75350	208146
	1990	73921	66250	140171
	1991	56584	5050	61634
	1992	49981	1250	31981
	1993	23083	500	23583
	1994	27165	500	27665

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 40 - Total Styrene Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	1361539	750	1362289
	1988	1636020	6580	1642600
	1989	1406354	578	1406932
	1990	1472907	345	1473252
	1991	1377353	405	1377758
	1992	1669769	1778	1671547
	1993	1980224	4480	1984704
	1994	1994876	3385	1998261

Table 41 - Total Tetrachloroethylene Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	729900	250	730150
	1988	710820	80	710900
	1989	343302	386	343688
	1990	104139	80	104219
	1991	154572	2	154574
	1992	163834	0	163834
	1993	118433	2	118435
	1994	122710	34	122744

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 42 - Total Thiourea Releases (in pounds)

MEDIA	YEAR	air releases	water releases	total releases
	1987	0	0	0
	1988	0	0	0
	1989	500	0	500
	1990	510	0	510
	1991	505	0	505
	1992	505	0	505
	1993	510	0	510
	1994	10	0	10

Table 43 - Total Toluene-2,4-diisocyanate Releases (in pounds)

MEDIA	YEAR	air releases	water releases	total releases
	1987	2413	250	2663
	1988	2907	250	3157
	1989	3882	2950	6832
	1990	777	0	777
	1991	1021	0	1021
	1992	364	0	364
	1993	434	0	434
	1994	197	0	197

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 44 - Total Toluene-2,6-diisocyanate Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	1258	250	1508
	1988	1792	0	1792
	1989	3287	11150	14437
	1990	13771	0	13771
	1991	1022	0	1022
	1992	301	0	301
	1993	317	0	317
	1994	312	0	312

Table 45 - Total Toluenediisocyanate Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	0	0	0
	1988	0	0	0
	1989	0	0	0
	1990	7428	250	7678
	1991	1485	5	1490
	1992	1501	250	1751
	1993	1411	250	1661
	1994	2138	250	2388

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 46 - Total o-Toluidine Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	0	0	0
1988	0	0	0
1989	250	250	500
1990	0	0	0
1991	0	0	0
1992	10	10	20
1993	10	10	20
1994	10	10	20

Table 47 - Total 2,4,6-Trichlorophenol Releases (in pounds)

MEDIA / *YEAR*	air releases	water releases	total releases
1987	0	250	250
1988	250	50	300
1989	113	14	127
1990	78	79	157
1991	80	2	82
1992	86	1	87
1993	69	56	125
1994	199	65	264

Appendix D

CCPCT Compatible Summaries for Specific Chemicals

Table 48 - Total Urethane Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	2950	0	2950
	1988	0	0	0
	1989	0	0	0
	1990	0	0	0
	1991	0	0	0
	1992	0	0	0
	1993	0	0	0
	1994	0	0	0

Table 49 - Total Vinyl Chloride Releases (in pounds)

MEDIA	*YEAR*	air releases	water releases	total releases
	1987	2203	0	2203
	1988	800	0	800
	1989	2308	11	2319
	1990	923	24	947
	1991	5084	0	5084
	1992	7032	0	7032
	1993	6240	0	6240
	1994	6230	0	6230

Appendix E

Primary Chemical Data With Hazard Values

Table 50 - 1987 Primary Chemical Data With Hazard Values

CAS Number	Chemical	Oral HV	Michigan Water Releases	RWF Water	Inhalation HV	Michigan Air Releases	RWF Air	Carc. HV	Other HV	Michigan Total Releases	RWF Total	Fish HV	Fish NOEL HV	BOD HV	Hydrolysis HV	BCF HV
75-07-0	Acetaldehyde	0.7	0	0	1.6	0	0	3.5	0	0	0	2.4	1.6	1.15	2.5	1
79-06-1	Acrylamide	2.8	3030	8.02	2	750	6.62	3.5	4	3770	8.23	1.6	0.9	1.25	2.4	1
107-13-1	Acrylonitrile	3	750	6.62	2.5	35684	10.48	4	3	36434	10.50	3.3	2.7	1.07	1	1
7440-38-2	Arsenic	4.7	0	0	5	0	0	5	3	0	0	2.5	3	2.5	2.5	1.75
1332-21-4	Asbestos (friable)	0	0	0	0	1251	7.13	5	1	1251	7.13	0	0	2.5	2.5	1
71-43-2	Benzene	0	1891	7.54	0	762682	13.54	5	3	764573	13.55	2.9	2.3	1.27	2.5	1.06
7440-41-7	Beryllium*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
542-88-1	Bis(chloromethyl)ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-99-0	1,3-Butadiene	0.3	0	0	0	63472	11.06	3.5	4	63472	11.06	4	3.3	2.5	2.5	1.01
7440-43-9	Cadmium	2.9	250	5.52	3	500	6.21	4	3	750	6.62	5	5	2.5	2.5	2.25
56-23-5	Carbon Tetrachloride	0.4	326	5.79	0	183766	12.12	3.5	3	184092	12.12	2.3	2.2	2.5	1.63	1.39
67-66-3	Chloroform	1.2	10038	9.21	0.5	540334	13.20	3.5	3	550372	13.22	1.9	1.3	2.5	1.63	1
107-30-2	Chloromethyl methyl ether*	5	0	0	5	250	5.52	5	5	250	5.52	5	5	2.5	2.5	2.5
NX	Chlorophenols (mixed isomers)	2.1	0	0	4	0	0	3.5	3	0	0	2.9	2.4	1.13	2.5	1.15
7440-47-3	Chromium	2.9	38832	10.57	5	17388	9.76	5	1	56220	10.94	2.5	3	2.5	2.5	1.65
8001-58-9	Creosote*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
25376-45-8	Diaminotoluene	2.1	500	6.21	4	500	6.21	3.5	2	1000	6.91	2.4	1.7	2.5	2.5	1
106-93-4	1,2-Dibromoethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
91-94-1	3,3'-Dichlorobenzidine*	5	2	0.69	5	3	1.10	5	5	5	1.61	5	5	2.5	2.5	2.5
107-06-2	1,2-Dichloroethane	1.3	24000	10.09	1.4	239503	12.39	3.5	4	263503	12.48	1.4	0.8	2.5	1.63	1
75-09-2	Dichloromethane	0.8	373658	12.83	0	10259612	16.14	3.5	1	10633270	16.18	0.8	0.1	2.5	1.83	1
542-75-6	1,3-Dichloropropylene*	5	0	0	5	500	6.21	5	5	500	6.21	5	5	2.5	2.5	2.5
117-81-7	Di-(2-ethylhexyl) pthalate	0	0	0	5	24539	10.11	3.5	4	24539	10.11	4.7	5	1.23	2.43	2.31
77-78-1	Dimethyl sulfate*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-89-8	Epichlorohydrin	3.5	0	0	2.6	7680	8.95	3.8	4	7680	8.95	2.4	1.8	2.5	1	1
140-88-5	Ethyl acrylate*	5	0	0	5	812	6.70	5	5	812	6.70	5	5	2.5	2.5	2.5
75-21-8	Ethylene oxide	2.1	2050	7.63	2.2	55350	10.92	4	5	57400	10.96	0.5	0	2.5	1	1
96-45-7	Ethylene thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
50-00-0	Formaldehyde	2.1	101598	11.53	2.6	531656	13.18	4	3	633254	13.36	2.7	2	2.5	2.5	1
302-01-2	Hydrazine*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
7439-92-1	Lead	0.9	1303	7.17	5	20719	9.94	3.5	4	22022	10.00	3.8	4.3	2.5	2.5	1.39
7440-02-0	Nickel	1.9	12563	9.44	5	16412	9.71	5	3	28975	10.27	2.6	3.1	2.5	2.5	1.3
N495	Nickel Compounds	1.9	4250	8.35	5	9650	9.17	5	3	13900	9.54	2.6	3.1	2.5	2.5	1.3
79-46-9	2-Nitropropane	1.4	0	0	2.4	18250	9.81	3.5	3	18250	9.81	3.9	3.2	2.5	2.5	1
1336-36	Polychlorinated biphenyls	1	0	0	5	250	5.52	3.8	3	250	5.52	4.3	4.8	2.5	2.5	2.5
75-56-9	Propylene Oxide	1.4	382000	12.85	1.5	158791	11.98	4	5	540791	13.20	0.9	0.2	1.25	1	1
100-42-5	Styrene	1.2	750	6.62	1.2	1361539	14.12	3.5	3	1362289	14.12	4	3.9	1.27	2.5	1.45
127-18-4	Tetrachloroethylene	0	250	5.52	0.6	729900	13.50	3.5	4	730150	13.50	3	2.7	2.5	2.5	1.29
62-56-6	Thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
584-84-9	Toluene-2,4-diisocyanate	0	250	5.52	5	2413	7.79	3.5	1	2663	7.89	2.1	1.5	2.5	1	1
91-08-7	Toluene-2,6-diisocyanate	0	250	5.52	5	1258	7.14	3.5	1	1508	7.32	2.1	1.5	2.5	1	1
26471-62-5	Toluenediisocyanate	0	0	0	5	0	0	3.5	1	0	0	2.1	1.5	2.5	1	1
95-53-4	o-Toluidine*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
88-06-2	2,4,6-Trichlorophenol*	5	250	5.52	5	0	0	5	5	250	5.52	5	5	2.5	2.5	2.5
51-79-6	Urethane*	5	0	0	5	2950	7.99	5	5	2950	7.99	5	5	2.5	2.5	2.5
75-01-4	Vinyl chloride	1.7	0	0	4	2203	7.70	5	4	2203	7.70	1.4	0.7	1.13	2.5	1

Table 51 - 1988 Primary Chemical Data With Hazard Values

CAS Number	Chemical	Oral HV	Michigan Water Releases	RWF Water	Inhalation HV	Michigan Air Releases	RWF Air	Carc. HV	Other HV	Michigan Total Releases	RWF Total	Fish HV	Fish NOEL HV	BOD HV	Hydrolysis HV	BCF HV
75-07-0	Acetaldehyde	0.7	0	0	1.6	0	0	3.5	0	0	0	2.4	1.6	1.15	2.5	1
79-06-1	Acrylamide	2.8	800	6.68	2	551	6.31	3.5	4	1351	7.21	1.6	0.9	1.25	2.4	1
107-13-1	Acrylonitrile	3	600	6.40	2.5	29098	10.28	4	3	29698	10.30	3.3	2.7	1.07	1	1
7440-38-2	Arsenic	4.7	0	0	5	127	4.84	5	3	127	4.84	2.5	3	2.5	2.5	1.75
1332-21-4	Asbestos (friable)	0	0	0	0	1250	7.13	5	1	1250	7.13	0	0	2.5	2.5	1
71-43-2	Benzene	0	4533	8.42	0	658656	13.40	5	3	663189	13.40	2.9	2.3	1.27	2.5	1.06
7440-41-7	Beryllium*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
542-88-1	Bis(chloromethyl)ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-99-0	1,3-Butadiene	0.3	0	0	0	34300	10.44	3.5	4	34300	10.44	4	3.3	2.5	2.5	1.01
7440-43-9	Cadmium	2.9	0	0	3	1250	7.13	4	3	1250	7.13	5	5	2.5	2.5	2.25
56-23-5	Carbon Tetrachloride	0.4	30	3.40	0	79100	11.28	3.5	3	79130	11.28	2.3	2.2	2.5	1.63	1.39
67-66-3	Chloroform	1.2	11755	9.37	0.5	320989	12.68	3.5	3	332744	12.72	1.9	1.3	2.5	1.63	1
107-30-2	Chloromethyl methyl ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
XX	Chlorophenols (mixed isomers)	2.1	0	0	4	0	0	3.5	3	0	0	2.9	2.4	1.13	2.5	1.15
7440-47-3	Chromium	2.9	75287	11.23	5	33609	10.42	5	1	108896	11.60	2.5	3	2.5	2.5	1.65
8001-58-9	Creosote*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
25376-45-8	Diaminotoluene	2.1	500	6.21	4	500	6.21	3.5	2	1000	6.91	2.4	1.7	2.5	2.5	1
106-93-4	1,2-Dibromoethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
91-94-1	3,3'-Dichlorobenzidine*	5	2	0.69	5	251	5.53	5	5	253	5.53	5	5	2.5	2.5	2.5
107-06-2	1,2-Dichloroethane	1.3	3500	8.16	1.4	201249	12.21	3.5	4	204749	12.23	1.4	0.8	2.5	1.63	1
75-09-2	Dichloromethane	0.8	273808	12.52	0	8163900	15.92	3.5	1	8437708	15.95	0.8	0.1	2.5	1.83	1
542-75-6	1,3-Dichloropropylene*	5	0	0	5	600	6.40	5	5	600	6.40	5	5	2.5	2.5	2.5
117-81-7	Di-(2-ethylhexyl) pthalate	0	0	0	5	3561	8.18	3.5	4	3561	8.18	4.7	5	1.23	2.43	2.31
77-78-1	Dimethyl sulfate*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-89-8	Epichlorohydrin	3.5	0	0	2.6	1560	7.35	3.8	4	1560	7.35	2.4	1.8	2.5	1	1
140-88-5	Ethyl acrylate*	5	0	0	5	329	5.80	5	5	329	5.80	5	5	2.5	2.5	2.5
75-21-8	Ethylene oxide	2.1	1460	7.29	2.2	57780	10.96	4	5	59240	10.99	0.5	0	2.5	1	1
96-45-7	Ethylene thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
50-00-0	Formaldehyde	2.1	19657	9.89	2.6	938786	13.75	4	3	958443	13.77	2.7	2	2.5	2.5	1
302-01-2	Hydrazine*	5	0	0	5	3	1.10	5	5	3	1.10	5	5	2.5	2.5	2.5
7439-92-1	Lead	0.9	105635	11.57	5	26207	10.17	3.5	4	131842	11.79	3.8	4.3	2.5	2.5	1.39
7440-02-0	Nickel	1.9	10025	9.21	5	15004	9.62	5	3	25029	10.13	2.6	3.1	2.5	2.5	1.3
N495	Nickel Compounds	1.9	4831	8.48	5	12364	9.42	5	3	17195	9.75	2.6	3.1	2.5	2.5	1.3
79-46-9	2-Nitropropnn	1.4	0	0	2.4	13000	9.47	3.5	3	13000	9.47	3.9	3.2	2.5	2.5	1
1336-36	Polychlorinated biphenyls	1	1	0.00	5	0	0	3.8	3	1	0.00	4.3	4.8	2.5	2.5	2.5
75-56-9	Propylene Oxide	1.4	93950	11.45	1.5	144458	11.88	4	5	238408	12.38	0.9	0.2	1.25	1	1
100-42-5	Styrene	1.2	6580	8.79	1.2	1636020	14.31	3.5	3	1642600	14.31	4	3.9	1.27	2.5	1.45
127-18-4	Tetrachloroethylene	0	80	4.38	0.6	710820	13.47	3.5	4	710900	13.47	3	2.7	2.5	2.5	1.29
62-56-6	Thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
584-84-9	Toluene-2,4-diisocyanate	0	250	5.52	5	2907	7.97	3.5	1	3157	8.06	2.1	1.5	2.5	1	1
91-08-7	Toluene-2,6-diisocyanate	0	0	0	5	1792	7.49	3.5	1	1792	7.49	2.1	1.5	2.5	1	1
26471-62-5	Toluenediisocyanate	0	0	0	5	0	0	3.5	1	0	0	2.1	1.5	2.5	1	1
95-53-4	o-Toluidine*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
88-06-2	2,4,6-Trichlorophenol*	5	50	3.91	5	250	5.52	5	5	300	5.70	5	5	2.5	2.5	2.5
51-79-6	Urethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
75-01-4	Vinyl chloride	1.7	0	0	4	800	6.68	5	4	800	6.68	1.4	0.7	1.13	2.5	1

Table 52 - 1989 Primary Chemical Data With Hazard Values

CAS Number	Chemical	Oral HV	Michigan Water Releases	RWF Water	Inhalation HV	Michigan Air Releases	RWF Air	Carc. HV	Other HV	Michigan Total Releases	RWF Total	Fish HV	Fish NOEL HV	BOD HV	Hydrolysis HV	BCF HV
75-07-0	Acetaldehyde	0.7	0	0	1.6	0	0	3.5	0	0	0	2.4	1.6	1.15	2.5	1
79-06-1	Acrylamide	2.8	4005	8.30	2	539	6.29	3.5	4	4544	8.42	1.6	0.9	1.25	2.4	1
107-13-1	Acrylonitrile	3	629	6.44	2.5	53677	10.89	4	3	54306	10.90	3.3	2.7	1.07	1	1
7440-38-2	Arsenic	4.7	0	0	5	0	0	5	3	0	0	2.5	3	2.5	2.5	1.75
1332-21-4	Asbestos (friable)	0	0	0	0	750	6.62	5	1	750	6.62	0	0	2.5	2.5	1
71-43-2	Benzene	0	6643	8.80	0	574900	13.26	5	5	581543	13.27	2.9	2.3	1.27	2.5	1.06
7440-41-7	Beryllium*	5	0	0	5	250	5.52	5	5	250	5.52	5	5	2.5	2.5	2.5
542-88-1	Bis(chloromethyl)ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-99-0	1,3-Butadiene	0.3	0	0	0	15990	9.68	3.5	4	15990	9.68	4	3.3	2.5	2.5	1.01
7440-43-9	Cadmium	2.9	0	0	3	500	6.21	4	3	500	6.21	5	5	2.5	2.5	2.25
56-23-5	Carbon Tetrachloride	0.4	33	3.50	0	71566	11.18	3.5	3	71599	11.18	2.3	2.2	2.5	1.63	1.39
67-66-3	Chloroform	1.2	3547	8.17	0.5	365130	12.81	3.5	3	368677	12.82	1.9	1.3	2.5	1.63	1
107-30-2	Chloromethyl methyl ether*	5	0	0	5	1	0.00	5	5	1	0.00	5	5	2.5	2.5	2.5
XX	Chlorophenols (mixed isomers)	2.1	17	2.83	4	380	5.94	3.5	3	397	5.98	2.9	2.4	1.13	2.5	1.15
7440-47-3	Chromium	2.9	92061	11.43	5	18550	9.83	5	1	110611	11.61	2.5	3	2.5	2.5	1.65
8001-58-9	Creosote*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
25376-45-8	Diaminotoluene	2.1	360	5.89	4	500	6.21	3.5	2	860	6.76	2.4	1.7	2.5	2.5	1
106-93-4	1,2-Dibromoethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
91-94-1	3,3'-Dichlorobenzidine*	5	1	0.00	5	251	5.53	5	5	252	5.53	5	5	2.5	2.5	2.5
107-06-2	1,2-Dichloroethane	1.3	20050	9.91	1.4	139854	11.85	3.5	4	159904	11.98	1.4	0.8	2.5	1.63	1
75-09-2	Dichloromethane	0.8	612640	13.33	0	1575293	16.57	3.5	1	16366933	16.61	0.8	0.1	2.5	1.83	1
542-75-6	1,3-Dichloropropylene*	5	0	0	5	292	5.68	5	5	292	5.68	5	5	2.5	2.5	2.5
117-81-7	Di-(2-ethylhexyl) pthalate	0	0	0	5	65030	11.08	3.5	4	65030	11.08	4.7	5	1.23	2.43	2.31
77-78-1	Dimethyl sulfate*	5	0	0	5	250	5.52	5	5	251	5.53	5	5	2.5	2.5	2.5
106-89-8	Epichlorohydrin	3.5	0	0	2.6	2719	7.91	3.8	4	2719	7.91	2.4	1.8	2.5	1	1
140-88-5	Ethyl acrylate*	5	0	0	5	40	3.69	5	5	40	3.69	5	5	2.5	2.5	2.5
75-21-8	Ethylene oxide	2.1	1000	6.91	2.2	43635	10.68	4	5	44635	10.71	0.5	0	2.5	1	1
96-45-7	Ethylene thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
50-00-0	Formaldehyde	2.1	24114	10.09	2.6	401849	12.90	4	3	425963	12.96	2.7	2	2.5	2.5	1
302-01-2	Hydrazine*	5	0	0	5	500	6.21	5	5	500	6.21	5	5	2.5	2.5	2.5
7439-92-1	Lead	0.9	238072	12.38	5	44608	10.71	3.5	4	282680	12.55	3.8	4.3	2.5	2.5	1.39
7440-02-0	Nickel	1.9	39436	10.58	5	16937	9.74	5	3	56373	10.94	2.6	3.1	2.5	2.5	1.3
N495	Nickel Compounds	1.9	4720	8.46	5	11507	9.35	5	3	16227	9.69	2.6	3.1	2.5	2.5	1.3
79-46-9	2-Nitropropane	1.4	0	0	2.4	10500	9.26	3.5	3	10500	9.26	3.9	3.2	2.5	2.5	1
1336-36	Polychlorinated biphenyls	1	0	0	5	0	0	3.8	3	0	0	4.3	4.8	2.5	2.5	2.5
75-56-9	Propylene Oxide	1.4	75350	11.23	1.5	132796	11.80	4	5	208146	12.25	0.9	0.2	1.25	1	1
100-42-5	Styrene	1.2	578	6.36	1.2	1406354	14.16	3.5	3	1406932	14.16	4	3.9	1.27	2.5	1.45
127-18-4	Tetrachloroethylene	0	386	5.96	0.6	343302	12.75	3.5	4	343688	12.75	3	2.7	2.5	2.5	1.29
62-56-6	Thiourea*	5	0	0	5	500	6.21	5	5	500	6.21	5	5	2.5	2.5	2.5
584-84-9	Toluene-2,4-diisocyanate	0	2950	7.99	5	3882	8.26	3.5	1	6832	8.83	2.1	1.5	2.5	1	1
91-08-7	Toluene-2,6-diisocyanate	0	11150	9.32	5	3287	8.10	3.5	1	14437	9.58	2.1	1.5	2.5	1	1
26471-62-5	Toluenediisocyanate	0	0	0	5	0	0	3.5	1	0	0	2.1	1.5	2.5	1	1
95-53-4	o-Toluidine*	5	250	5.52	5	250	5.52	5	5	500	6.21	5	5	2.5	2.5	2.5
88-06-2	2,4,6-Trichlorophenol*	5	14	2.64	5	113	4.73	5	5	127	4.84	5	5	2.5	2.5	2.5
51-79-6	Urethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
75-01-4	Vinyl chloride	1.7	11	2.40	4	2308	7.74	5	4	2319	7.75	1.4	0.7	1.13	2.5	1

Table 53 - 1990 Primary Chemical Data With Hazard Values

CAS Number	Chemical	Oral HV	Michigan Water Releases	RWF Water	Inhalation HV	Michigan Air Releases	RWF Air	Carc. HV	Other HV	Michigan Total Releases	RWF Total	Fish HV	Fish NOEL HV	BOD HV	Hydrolysis HV	BCF HV
75-07-0	Acetaldehyde	0.7	0	0	1.6	0	0	3.5	0	0	0	2.4	1.6	1.15	2.5	1
79-06-1	Acrylamide	2.8	1752	7.47	2	5122	8.54	3.5	4	6874	8.84	1.6	0.9	1.25	2.4	1
107-13-1	Acrylonitrile	3	406	6.01	2.5	16938	9.74	4	3	17344	9.76	3.3	2.7	1.07	1	1
7440-38-2	Arsenic	4.7	2050	7.63	5	12	2.48	5	3	2062	7.63	2.5	3	2.5	2.5	1.75
1332-21-4	Asbestos (friable)	0	0	0	0	0	0	5	1	0	0	0	0	2.5	2.5	1
71-43-2	Benzene	0	13291	9.49	0	528700	13.18	5	3	541991	13.20	2.9	2.3	1.27	2.5	1.06
7440-41-7	Beryllium*	5	5	1.61	5	255	5.54	5	5	260	5.56	5	5	2.5	2.5	2.5
542-88-1	Bis(chloromethyl)ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-99-0	1,3-Butadiene	0.3	2	0.69	0	30373	10.32	3.5	4	30375	10.32	4	3.3	2.5	2.5	1.01
7440-43-9	Cadmium	2.9	6350	8.76	3	3035	8.02	4	3	9385	9.15	5	5	2.5	2.5	2.25
56-23-5	Carbon Tetrachloride	0.4	31	3.43	0	37584	10.53	3.5	3	37615	10.54	2.3	2.2	2.5	1.63	1.39
67-66-3	Chloroform	1.2	2296	7.74	0.5	296246	12.60	3.5	3	298542	12.61	1.9	1.3	2.5	1.63	1
107-30-2	Chloromethyl methyl ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
XX	Chlorophenols (mixed isomers)	2.1	17	2.83	4	330	5.80	3.5	3	347	5.85	2.9	2.4	1.13	2.5	1.15
7440-47-3	Chromium	2.9	90821	11.42	5	12661	9.45	5	1	103482	11.55	2.5	3	2.5	2.5	1.65
8001-58-9	Creosote*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
25376-45-8	Diaminotoluene	2.1	115	4.74	4	10	2.30	3.5	2	125	4.83	2.4	1.7	2.5	2.5	1
106-93-4	1,2-Dibromoethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
91-94-1	3,3'-Dichlorobenzidine*	5	1	0.00	5	10	2.30	5	5	11	2.40	5	5	2.5	2.5	2.5
107-06-2	1,2-Dichloroethane	1.3	44311	10.70	1.4	98373	11.50	3.5	4	142684	11.87	1.4	0.8	2.5	1.63	1
75-09-2	Dichloromethane	0.8	175261	12.07	0	5349136	15.49	3.5	1	5524397	15.52	0.8	0.1	2.5	1.83	1
542-75-6	1,3-Dichloropropylene*	5	0	0	5	227	5.42	5	5	227	5.42	5	5	2.5	2.5	2.5
117-81-7	Di-2-ethylhexyl phalate	0	0	0	5	382279	12.85	3.5	4	382279	12.85	4.7	5	1.23	2.43	2.31
77-78-1	Dimethyl sulfate*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-89-8	Epichlorohydrin	3.5	5	1.61	2.6	3085	8.03	3.8	4	3090	8.04	2.4	1.8	2.5	1	1
140-88-5	Ethyl acrylate*	5	0	0	5	379	5.94	5	5	379	5.94	5	5	2.5	2.5	2.5
75-21-8	Ethylene oxide	2.1	256	5.55	2.2	43655	10.68	4	5	43911	10.69	0.5	0	2.5	1	1
96-45-7	Ethylene thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
50-00-0	Formaldehyde	2.1	15049	9.62	2.6	483391	13.09	4	3	498440	13.12	2.7	2	2.5	2.5	1
302-01-2	Hydrazine*	5	0	0	5	10	2.30	5	5	10	2.30	5	5	2.5	2.5	2.5
7439-92-1	Lead	0.9	226228	12.33	5	27911	10.24	3.5	4	254139	12.45	3.8	4.3	2.5	2.5	1.39
7440-02-0	Nickel	1.9	10854	9.29	5	14198	9.56	5	3	25052	10.13	2.6	3.1	2.5	2.5	1.3
N495	Nickel Compounds	1.9	5268	8.57	5	8130	9.00	5	3	13398	9.50	2.6	3.1	2.5	2.5	1.3
79-46-9	2-Nitropropane	1.4	0	0	2.4	5	1.61	3.5	3	5	1.61	3.9	3.2	2.5	2.5	1
1336-36	Polychlorinated biphenyls	1	0	0	5	0	0	3.8	3	0	0	4.3	4.8	2.5	2.5	2.5
75-56-9	Propylene Oxide	1.4	66250	11.10	1.5	73921	11.21	4	5	140171	11.85	0.9	0.2	1.25	1	1
100-42-5	Styrene	1.2	345	5.84	1.2	1472907	14.20	3.5	3	1473252	14.20	4	3.9	1.27	2.5	1.45
127-18-4	Tetrachloroethylene	0	80	4.38	0.6	104139	11.55	3.5	4	104219	11.55	3	2.7	2.5	2.5	1.29
62-56-6	Thiourea*	5	0	0	5	510	6.23	5	5	510	6.23	5	5	2.5	2.5	2.5
584-84-9	Toluene-2,4-diisocyanate	0	0	0	5	777	6.66	3.5	1	777	6.66	2.1	1.5	2.5	1	1
91-08-7	Toluene-2,6-diisocyanate	0	0	0	5	13771	9.53	3.5	1	13771	9.53	2.1	1.5	2.5	1	1
26471-62-5	Toluenediisocyanate	0	250	5.52	5	7428	8.91	3.5	1	7678	8.95	2.1	1.5	2.5	1	1
95-53-4	o-Toluidine*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
88-06-2	2,4,6-Trichlorophenol*	5	79	4.37	5	78	4.36	5	5	157	5.06	5	5	2.5	2.5	2.5
51-79-6	Urethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
75-01-4	Vinyl chloride	1.7	24	3.18	4	923	6.83	5	4	947	6.85	1.4	0.7	1.13	2.5	1

Table 54 - 1991 Primary Chemical Data With Hazard Values

CAS Number	Chemical	Oral HV	Michigan Water Releases	RWF Water	Inhalation HV	Michigan Air Releases	RWF Air	Carc. HV	Other HV	Michigan Total Releases	RWF Total	Fish HV	Fish NOEL HV	BOD HV	Hydrolysis HV	BCF HV
75-07-0	Acetaldehyde	0.7	0	0	1.6	111260	11.62	3.5	0	111260	11.62	2.4	1.6	1.15	2.5	1
79-06-1	Acrylamide	2.8	1924	7.56	2	933	6.84	3.5	4	2857	7.96	1.6	0.9	1.25	2.4	1
107-13-1	Acrylonitrile	3	168	5.12	2.5	11508	9.35	4	3	11676	9.37	3.3	2.7	1.07	1	1
7440-38-2	Arsenic	4.7	1455	7.28	5	9	2.20	5	3	1464	7.29	2.5	3	2.5	2.5	1.75
1332-21-4	Asbestos (friable)	0	0	0	0	0	0	5	1	0	0	0	0	2.5	2.5	1
71-43-2	Benzene	0	11890	9.38	0	481307	13.08	5	3	493197	13.11	2.9	2.3	1.27	2.5	1.06
7440-41-7	Beryllium*	5	1000	6.91	5	250	5.52	5	5	1250	7.13	5	5	2.5	2.5	2.5
542-88-1	Bis(chloromethyl)ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-99-0	1,3-Butadiene	0.3	0	0	0	28359	10.25	3.5	4	28359	10.25	4	3.3	2.5	2.5	1.01
7440-43-9	Cadmium	2.9	2700	7.90	3	534	6.28	4	3	3234	8.08	5	5	2.5	2.5	2.25
56-23-5	Carbon Tetrachloride	0.4	10	2.30	0	10575	9.27	3.5	3	10585	9.27	2.3	2.2	2.5	1.63	1.39
67-66-3	Chloroform	1.2	1688	7.43	0.5	190387	12.16	3.5	3	192075	12.17	1.9	1.3	2.5	1.63	1
107-30-2	Chloromethyl methyl ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
XX	Chlorophenols (mixed isomers)	2.1	74	4.30	4	342	5.83	3.5	3	416	6.03	2.9	2.4	1.13	2.5	1.15
7440-47-3	Chromium	2.9	83430	11.33	5	17050	9.74	5	1	100480	11.52	2.5	3	2.5	2.5	1.65
8001-58-9	Creosote*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
25376-45-8	Diaminotoluene	2.1	64	4.16	4	10	2.30	3.5	2	74	4.30	2.4	1.7	2.5	2.5	1
106-93-4	1,2-Dibromoethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
91-94-1	3,3'-Dichlorobenzidine*	5	0	0	5	10	2.30	5	5	10	2.30	5	5	2.5	2.5	2.5
107-06-2	1,2-Dichloroethane	1.3	905	6.81	1.4	37759	10.54	3.5	4	38664	10.56	1.4	0.8	2.5	1.63	1
75-09-2	Dichloromethane	0.8	354893	12.78	0	4596324	15.34	3.5	1	4951217	15.42	0.8	0.1	2.5	1.83	1
542-75-6	1,3-Dichloropropene*	5	0	0	5	224	5.41	5	5	224	5.41	5	5	2.5	2.5	2.5
117-81-7	Di-(2-ethylhexyl) phtalate	0	10	2.30	5	370118	12.82	3.5	4	370128	12.82	4.7	5	1.23	2.43	2.31
77-78-1	Dimethyl sulfate*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
100-89-8	Epichlorohydrin	3.5	251	5.53	2.6	5223	8.56	3.8	4	5473	8.61	2.4	1.8	2.5	1	1
140-88-5	Ethyl acrylate*	5	0	0	5	371	5.92	5	5	371	5.92	5	5	2.5	2.5	2.5
75-21-8	Ethylene oxide	2.1	405	6.00	2.2	19208	9.86	4	5	19613	9.88	0.5	0	2.5	1	1
96-45-7	Ethylene thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
50-00-0	Formaldehyde	2.1	11701	9.37	2.6	395712	12.89	4	3	407413	12.92	2.7	2	2.5	2.5	1
302-01-2	Hydrazine*	5	0	0	5	10	2.30	5	5	10	2.30	5	5	2.5	2.5	2.5
7439-92-1	Lead	0.9	162507	12.00	5	21603	9.98	3.5	4	184110	12.12	3.8	4.3	2.5	2.5	1.39
7440-02-0	Nickel	1.9	22415	10.02	5	14095	9.55	5	3	36510	10.51	2.6	3.1	2.5	2.5	1.3
N495	Nickel Compounds	1.9	2650	7.88	5	6963	8.85	5	3	9613	9.17	2.6	3.1	2.5	2.5	1.3
79-46-9	2-Nitropropane	1.4	0	0	2.4	0	0	3.5	3	0	0	3.9	3.2	2.5	2.5	1
1336-36	Polychlorinated biphenyls	1	0	0	5	0	0	3.8	3	0	0	4.3	4.8	2.5	2.5	2.5
75-56-9	Propylene Oxide	1.4	5050	8.53	1.5	56584	10.94	4	5	61634	11.03	0.9	0.2	1.25	1	1
100-42-5	Styrene	1.2	405	6.00	1.2	1377353	14.14	3.5	3	1377758	14.14	4	3.9	1.27	2.5	1.45
127-18-4	Tetrachloroethylene	0	2	0.69	0.6	154572	11.95	3.5	4	154574	11.95	3	2.7	2.5	2.5	1.29
62-56-6	Thiourea*	5	0	0	5	505	6.22	5	5	505	6.22	5	5	2.5	2.5	2.5
584-84-9	Toluene-2,4-diuocyanate	0	0	0	5	1021	6.93	3.5	1	1021	6.93	2.1	1.5	2.5	1	1
91-08-7	Toluene-2,6-diuocyanate	0	0	0	5	1022	6.93	3.5	1	1022	6.93	2.1	1.5	2.5	1	1
26471-62-5	Toluenediisocyanate	0	5	1.61	5	1485	7.30	3.5	1	1490	7.31	2.1	1.5	2.5	1	1
95-53-4	o-Toluidine*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
88-06-2	2,4,6-Trichlorophenol*	5	2	0.69	5	80	4.38	5	5	82	4.41	5	5	2.5	2.5	2.5
51-79-6	Urethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
75-01-4	Vinyl chloride	1.7	0	0	4	5084	8.53	5	4	5084	8.53	1.4	0.7	1.13	2.5	1

Table 55 - 1992 Primary Chemical Data With Hazard Values

CAS Number	Chemical	Oral HV	Michigan Water Releases	RWF Water	Inhalation HV	Michigan Air Releases	RWF Air	Carc. HV	Other HV	Michigan Total Releases	RWF Total	Fish HV	Fish NOEL HV	BOD HV	Hydrolysis HV	BCF HV
75-07-0	Acetaldehyde	0.7	0	0	1.6	116760	11.67	3.5	0	116760	11.67	2.4	1.6	1.15	2.5	1
79-06-1	Acrylamide	2.8	0	0	2	1034	6.94	3.5	4	1034	6.94	1.6	0.9	1.25	2.4	1
107-13-1	Acrylonitrile	3	243	5.49	2.5	20053	9.91	4	3	20296	9.92	3.3	2.7	1.07	1	1
7440-38-2	Arsenic	4.7	826	6.72	5	12	2.48	5	3	838	6.73	2.5	3	2.5	2.5	1.75
1332-21-4	Asbestos (friable)	0	0	0	0	0	0	5	1	0	0	0	0	2.5	2.5	1
71-43-2	Benzene	0	5729	8.65	0	234372	12.36	5	3	240101	12.39	2.9	2.3	1.27	2.5	1.06
7440-41-7	Beryllium*	5	0	0	5	750	6.62	5	5	750	6.62	5	5	2.5	2.5	2.5
542-88-1	Bis(chloromethyl)ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-99-0	1,3-Butadiene	0.3	73	4.29	0	47709	10.77	3.5	4	47782	10.77	4	3.3	2.5	2.5	1.01
7440-43-9	Cadmium	2.9	1045	6.95	3	347	5.85	4	3	1392	7.24	5	5	2.5	2.5	2.25
56-23-5	Carbon Tetrachloride	0.4	8	2.08	0	8360	9.03	3.5	3	8368	9.03	2.3	2.2	2.5	1.63	1.39
67-66-3	Chloroform	1.2	1299	7.17	0.5	133061	11.80	3.5	3	134360	11.81	1.9	1.3	2.5	1.63	1
107-30-2	Chloromethyl methyl ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
XX	Chlorophenols (mixed isomers)	2.1	19	2.94	4	349	5.86	3.5	3	368	5.91	2.9	2.4	1.13	2.5	1.15
7440-47-3	Chromium	2.9	48076	10.78	5	13546	9.51	5	1	61622	11.03	2.5	3	2.5	2.5	1.65
8001-58-9	Creosote*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
25376-45-8	Diaminotoluene	2.1	52	3.95	4	10	2.30	3.5	2	62	4.13	2.4	1.7	2.5	2.5	1
106-93-4	1,2-Dibromoethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
91-94-1	3,3'-Dichlorobenzidine*	5	0	0	5	10	2.30	5	5	10	2.30	5	5	2.5	2.5	2.5
107-06-2	1,2-Dichloroethane	1.3	945	6.85	1.4	12386	9.42	3.5	4	13331	9.50	1.4	0.8	2.5	1.63	1
75-09-2	Dichloromethane	0.8	193094	12.17	0	2485426	14.73	3.5	1	2678520	14.80	0.8	0.1	2.5	1.83	1
542-75-6	1,3-Dichloropropylene*	5	0	0	5	224	5.41	5	5	224	5.41	5	5	2.5	2.5	2.5
117-81-7	Di-(2-ethylhexyl) pthalate	0	0	0	5	10285	9.24	3.5	4	10285	9.24	4.7	5	1.23	2.43	2.31
77-78-1	Dimethyl sulfate*	5	0	0	5	33	3.50	5	5	33	3.50	5	5	2.5	2.5	2.5
106-89-8	Epichlorohydrin	3.5	0	0	2.6	4931	8.50	3.8	4	4931	8.50	2.4	1.8	2.5	1	1
140-88-5	Ethyl acrylate*	5	0	0	5	145	4.98	5	5	145	4.98	5	5	2.5	2.5	2.5
75-21-8	Ethylene oxide	2.1	255	5.54	2.2	13157	9.48	4	5	13412	9.50	0.5	0	2.5	1	1
96-45-7	Ethylene thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
50-00-0	Formaldehyde	2.1	10949	9.30	2.6	417739	12.94	4	3	428688	12.97	2.7	2	2.5	2.5	1
302-01-2	Hydrazine*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
7439-92-1	Lead	0.9	79229	11.28	5	15451	9.65	3.5	4	94680	11.46	3.8	4.3	2.5	2.5	1.39
7440-02-0	Nickel	1.9	21436	9.97	5	13165	9.49	5	3	34601	10.45	2.6	3.1	2.5	2.5	1.3
N495	Nickel Compounds	1.9	2563	7.85	5	6346	8.76	5	3	8909	9.09	2.6	3.1	2.5	2.5	1.3
79-46-9	2-Nitropropane	1.4	0	0	2.4	32	3.47	3.5	3	32	3.47	3.9	3.2	2.5	2.5	1
1336-36	Polychlorinated biphenyls	1	0	0	5	0	0	3.8	3	0	0	4.3	4.8	2.5	2.5	2.5
75-56-9	Propylene Oxide	1.4	1250	7.13	1.5	49981	10.82	4	5	31981	10.37	0.9	0.2	1.25	1	1
100-42-5	Styrene	1.2	1778	7.48	1.2	1669769	14.33	3.5	3	1671547	14.33	4	3.9	1.27	2.5	1.45
127-18-4	Tetrachloroethylene	0	0	0	0.6	163834	12.01	3.5	4	163834	12.01	3	2.7	2.5	2.5	1.29
62-56-6	Thiourea*	5	0	0	5	505	6.22	5	5	505	6.22	5	5	2.5	2.5	2.5
584-84-9	Toluene-2,4-diisocyanate	0	0	0	5	364	5.90	3.5	1	364	5.90	2.1	1.5	2.5	1	1
91-08-7	Toluene-2,6-diisocyanate	0	0	0	5	301	5.71	3.5	1	301	5.71	2.1	1.5	2.5	1	1
26471-62-5	Toluenediisocyanate	0	250	5.52	5	1501	7.31	3.5	1	1751	7.47	2.1	1.5	2.5	1	1
95-53-4	o-Toluidine*	5	10	2.30	5	10	2.30	5	5	20	3.00	5	5	2.5	2.5	2.5
88-06-2	2,4,6-Trichlorophenol*	5	1	0.00	5	86	4.45	5	5	87	4.47	5	5	2.5	2.5	2.5
51-79-6	Urethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
75-01-4	Vinyl chloride	1.7	0	0	4	7032	8.86	5	4	7032	8.86	1.4	0.7	1.13	2.5	1

Table 56 - 1993 Primary Chemical Data With Hazard Values

CAS Number	Chemical	Oral HV	Michigan Water Releases	RWF Water	Inhalation HV	Michigan Air Releases	RWF Air	Carc. HV	Other HV	Michigan Total Releases	RWF Total	Fish HV	Fish NOEL HV	BOD HV	Hydrolysis HV	BCF HV
75-07-0	Acetaldehyde	0.7	0	0	1.6	102980	11.54	3.5	0	107980	11.54	2.4	1.6	1.15	2.5	1
79-06-1	Acrylamide	2.8	689	6.54	2	1054	6.96	3.5	4	1743	7.46	1.6	0.9	1.25	2.4	1
107-13-1	Acrylonitrile	3	143	4.98	2.5	21633	9.98	4	3	21778	9.99	3.3	2.7	1.07	1	1
7440-38-2	Arsenic	4.7	1420	7.26	5	26	3.26	5	3	1446	7.28	2.5	3	2.5	2.5	1.75
1332-21-4	Asbestos (friable)	0	0	0	0	0	0	5	1	0	0	0	0	2.5	2.5	1
71-43-2	Benzene	0	14735	9.60	0	182152	12.11	5	3	196887	12.19	2.9	2.3	1.27	2.5	1.06
7440-41-7	Beryllium*	5	0	0	5	5	1.61	5	5	5	1.61	5	5	2.5	2.5	2.5
542-88-1	Bis(chloromethyl)ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-99-0	1,3-Butadiene	0.3	0	0	0	10415	9.25	3.5	4	10415	9.25	4	3.3	2.5	2.5	1.01
7440-43-9	Cadmium	2.9	721	6.58	3	328	5.79	4	3	1364	7.17	5	5	2.5	2.5	2.25
56-23-5	Carbon Tetrachloride	0.4	0	0	0	7527	8.93	3.5	3	7527	8.93	2.3	2.2	2.5	1.63	1.39
67-66-3	Chloroform	1.2	1464	7.29	0.5	123607	11.72	3.5	3	125071	11.74	1.9	1.3	2.5	1.63	1
107-30-2	Chloromethyl methyl ether*	5	0	0	5	15	2.71	5	5	15	2.71	5	5	2.5	2.5	2.5
XX	Chlorophenols (mixed isomers)	2.1	20	3.00	4	333	5.81	3.5	3	353	5.87	2.9	2.4	1.13	2.5	1.15
7440-47-3	Chromium	2.9	60456	11.01	5	23230	10.05	5	1	83686	11.33	2.5	3	2.5	2.5	1.65
8001-58-9	Creosote*	5	0	0	5	7519	8.93	5	5	7519	8.93	5	5	2.5	2.5	2.5
25376-45-8	Diaminotoluene	2.1	255	5.54	4	10	2.30	3.5	2	265	5.58	2.4	1.7	2.5	2.5	1
106-93-4	1,2-Dibromoethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
91-94-1	3,3'-Dichlorobenzidine*	5	0	0	5	10	2.30	5	5	10	2.30	5	5	2.5	2.5	2.5
107-06-2	1,2-Dichloroethane	1.3	990	6.90	1.4	24159	10.09	3.5	4	25149	10.13	1.4	0.8	2.5	1.63	1
75-09-2	Dichloromethane	0.8	169862	12.04	0	1963318	14.49	3.5	1	2133180	14.57	0.8	0.1	2.5	1.83	1
542-75-6	1,3-Dichloropropylene*	5	0	0	5	231	5.44	5	5	231	5.44	5	5	2.5	2.5	2.5
117-81-7	Di-(2-ethylhexyl) ethalate	0	250	5.52	5	25124	10.13	3.5	4	25374	10.14	4.7	5	1.23	2.43	2.31
77-78-1	Dimethyl sulfate*	5	0	0	5	33	3.50	5	5	33	3.50	5	5	2.5	2.5	2.5
106-89-8	Epichlorohydrin	3.5	0	0	2.6	2306	7.74	3.8	4	2306	7.74	2.4	1.8	2.5	1	1
140-88-5	Ethyl acrylate*	5	0	0	5	136	4.91	5	5	136	4.91	5	5	2.5	2.5	2.5
75-21-8	Ethylene oxide	2.1	255	5.54	2.2	13105	9.48	4	5	13360	9.50	0.5	0	2.5	1	1
96-45-7	Ethylene thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
50-00-0	Formaldehyde	2.1	12296	9.42	2.6	380590	12.85	4	3	392886	12.88	2.7	2	2.5	2.5	1
302-01-2	Hydrazine*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
7439-92-1	Lead	0.9	133902	11.80	5	15133	9.62	3.5	4	149035	11.91	3.8	4.3	2.5	2.5	1.39
7440-02-0	Nickel	1.9	14825	9.59	5	18228	9.81	5	3	32853	10.40	2.6	3.1	2.5	2.5	1.3
N495	Nickel Compounds	1.9	346	5.85	5	5329	8.58	5	3	5675	8.64	2.6	3.1	2.5	2.5	1.3
79-46-9	2-Nitropropane	1.4	0	0	2.4	0	0	3.5	3	0	0	3.9	3.2	2.5	2.5	1
1336-36	Polychlorinated biphenyls	1	0	0	2	0	0	3.8	3	0	0	4.1	4.8	2.5	2.5	2.5
75-56-9	Propylene Oxide	1.4	500	6.21	1.5	23083	10.05	4	5	23583	10.07	0.9	0.2	1.25	1	1
100-42-5	Styrene	1.2	4480	8.41	1.2	1980224	14.50	3.5	3	1984704	14.50	4	3.9	1.27	2.5	1.45
127-18-4	Tetrachloroethylene	0	2	0.69	0.6	118433	11.68	3.5	4	118435	11.68	3	2.7	2.5	2.5	1.29
62-56-6	Thiourea*	5	0	0	5	510	6.23	5	5	510	6.23	5	5	2.5	2.5	2.5
584-84-9	Toluene-2,4 diisocyanate	0	0	0	5	434	6.07	3.5	1	434	6.07	2.1	1.5	2.5	1	1
91-08-7	Toluene-2,6-diisocyanate	0	0	0	5	317	5.76	3.5	1	317	5.76	2.1	1.5	2.5	1	1
26471-62-5	Toluenediisocyanate	0	250	5.52	5	1411	7.25	3.5	1	1661	7.42	2.1	1.5	2.5	1	1
95-53-4	o-Toluidine*	5	10	2.30	5	10	2.30	5	5	20	3.00	5	5	2.5	2.5	2.5
88-06-2	2,4,6-Trichlorophenol*	5	56	4.03	5	69	4.23	5	5	125	4.83	5	5	2.5	2.5	2.5
51-79-6	Urethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
75-01-4	Vinyl chloride	1.7	0	0	4	6240	8.74	5	4	6240	8.74	1.4	0.7	1.13	2.5	1

Table 57 - 1994 Primary Chemical Data With Hazard Values

CAS Number	Chemical	Oral HV	Michigan Water Releases	RWF Water	Inhalation HV	Michigan Air Releases	RWF Air	Carc. HV	Other HV	Michigan Total Releases	RWF Total	Fish HV	Fish NOEL HV	BOD HV	Hydrolysis HV	BCF HV
75-07-0	Acetaldehyde	0.7	1640	7.40	1.6	158263	11.97	3.5	0	159903	11.98	2.4	1.6	1.15	2.5	1
79-06-1	Acrylamide	2.8	630	6.45	2	1432	7.27	3.5	4	2062	7.63	1.6	0.9	1.25	2.4	1
107-13-1	Acrylonitrile	3	145	4.98	2.5	19516	9.88	4	3	19661	9.89	3.3	2.7	1.07	1	1
7440-38-2	Arsenic	4.7	1220	7.11	5	33	3.50	5	3	1253	7.13	2.5	3	2.5	2.5	1.75
1332-21-4	Asbestos (friable)	0	0	0	0	0	0	5	1	0	0	0	0	2.5	2.5	1
71-43-2	Benzene	0	8730	9.07	0	190372	12.16	5	3	199102	12.20	2.9	2.3	1.27	2.5	1.06
7440-41-7	Beryllium*	5	0	0	5	5	1.61	5	5	5	1.61	5	5	2.5	2.5	2.5
542-88-1	Bis(chloromethyl)ether*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
106-99-0	1,3-Butadiene	0.3	0	0	0	20176	9.91	3.5	4	20176	9.91	4	3.3	2.5	2.5	1.01
7440-43-9	Cadmium	2.9	2514	7.83	3	320	5.77	4	3	2834	7.95	5	5	2.5	2.5	2.25
56-23-5	Carbon Tetrachloride	0.4	5	1.61	0	11458	9.35	3.5	3	11463	9.35	2.3	2.2	2.5	1.63	1.39
67-66-3	Chloroform	1.2	706	6.56	0.5	99173	11.50	3.5	3	99879	11.51	1.9	1.3	2.5	1.63	1
107-30-2	Chloromethyl methyl ether*	5	0	0	5	6	1.79	5	5	6	1.79	5	5	2.5	2.5	2.5
XX	Chlorophenols (mixed isomers)	2.1	20	3.00	4	334	5.81	3.5	3	354	5.87	2.9	2.4	1.13	2.5	1.15
7440-47-3	Chromium	2.9	47311	10.76	5	26406	10.18	5	1	73717	11.21	2.5	3	2.5	2.5	1.65
8001-58-9	Creosote*	5	0	0	5	7818	8.96	5	5	7818	8.96	5	5	2.5	2.5	2.5
25376-45-8	Diaminotoluene	2.1	255	5.54	4	10	2.30	3.5	2	265	5.58	2.4	1.7	2.5	2.5	1
106-93-4	1,2-Dibromoethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
91-94-1	3,3'-Dichlorobenzidine*	5	0	0	5	10	2.30	5	5	10	2.30	5	5	2.5	2.5	2.5
107-06-2	1,2-Dichloroethane	1.3	405	6.00	1.4	25548	10.15	3.5	4	25953	10.16	1.4	0.8	2.5	1.63	1
75-09-2	Dichloromethane	0.8	98601	11.50	0	2276695	14.64	3.5	1	2378296	14.68	0.8	0.1	2.5	1.83	1
542-75-6	1,3-Dichloropropylene*	5	0	0	5	235	5.46	5	5	235	5.46	5	5	2.5	2.5	2.5
117-81-7	Di-(2-ethylhexyl) pthalate	0	0	0	5	31502	10.36	3.5	4	31502	10.36	4.7	5	1.23	2.43	2.31
77-78-1	Dimethyl sulfate*	5	0	0	5	250	5.52	5	5	250	5.52	5	5	2.5	2.5	2.5
106-89-8	Epichlorohydrin	3.5	0	0	2.6	2010	7.61	3.8	4	2010	7.61	2.4	1.8	2.5	1	1
140-88-5	Ethyl acrylate*	5	0	0	5	936	6.84	5	5	936	6.84	5	5	2.5	2.5	2.5
75-21-8	Ethylene oxide	2.1	255	5.54	2.2	12260	9.41	4	5	12515	9.43	0.5	0	2.5	1	1
96-45-7	Ethylene thiourea*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
50-00-0	Formaldehyde	2.1	5549	8.62	2.6	265769	12.49	4	3	271318	12.51	2.7	2	2.5	2.5	1
302-01-2	Hydrazine*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
7439-92-1	Lead	0.9	183344	12.12	5	16509	9.71	3.5	4	199853	12.21	3.8	4.3	2.5	2.5	1.39
7440-02-0	Nickel	1.9	4930	8.50	5	19156	9.86	5	3	24086	10.09	2.6	3.1	2.5	2.5	1.3
N495	Nickel Compounds	1.9	103	4.63	5	11440	9.34	5	3	11543	9.35	2.6	3.1	2.5	2.5	1.3
79-46-9	2-Nitropropane	1.4	0	0	2.4	0	0	3.5	3	0	0	3.9	3.2	2.5	2.5	1
1336-36	Polychlorinated biphenyls	1	0	0	5	0	0	3.8	3	0	0	4.3	4.8	2.5	2.5	2.5
75-56-9	Propylene Oxide	1.4	500	6.21	1.5	27165	10.21	4	5	27665	10.23	0.9	0.2	1.25	1	1
100-42-5	Styrene	1.2	3385	8.13	1.2	1994876	14.51	3.5	3	1998261	14.51	4	3.9	1.27	2.5	1.45
127-18-4	Tetrachloroethylene	0	34	3.53	0.6	122710	11.72	3.5	4	122744	11.72	3	2.7	2.5	2.5	1.29
62-56-6	Thiourea*	5	0	0	5	10	2.30	5	5	10	2.30	5	5	2.5	2.5	2.5
584-84-9	Toluene-2,4-diisocyanate	0	0	0	5	197	5.28	3.5	1	197	5.28	2.1	1.5	2.5	1	1
91-08-7	Toluene-2,6-diisocyanate	0	0	0	5	312	5.74	3.5	1	312	5.74	2.1	1.5	2.5	1	1
26471-62-5	Toluenediisocyanate	0	250	5.52	5	2138	7.67	3.5	1	2388	7.78	2.1	1.5	2.5	1	1
95-53-4	o-Toluidine*	5	10	2.30	5	10	2.30	5	5	20	3.00	5	5	2.5	2.5	2.5
88-06-2	2,4,6-Trichlorophenol*	5	65	4.17	5	199	5.29	5	5	264	5.58	5	5	2.5	2.5	2.5
51-79-6	Urethane*	5	0	0	5	0	0	5	5	0	0	5	5	2.5	2.5	2.5
75-01-4	Vinyl chloride	1.7	0	0	4	6230	8.74	5	4	6230	8.74	1.4	0.7	1.13	2.5	1

Appendix F

Calculated Hazard Values for Specific Carcinogens

Appendix F

Calculated Hazard Values for Specific Carcinogens

Table 58 - 1987 Calculated Hazard Values for Specific Carcinogens

CAS Number	Chemical	WHHE	WEE	EF	THV
75-07-0	Acetaldehyde	0.00	0.00	4.65	0.00
79-06-1	Acrylamide	97.45	42.49	4.65	650.69
107-13-1	Acrylonitrile	119.59	59.58	3.07	550.05
7440-38-2	Arsenic	0.00	0.00	6.75	0.00
1332-21-4	Asbestos (friable)	42.79	0.00	6.00	256.74
71-43-2	Benzene	108.38	39.23	4.83	712.96
7440-41-7	Beryllium	0.00	0.00	7.50	0.00
542-88-1	Bis(chloromethyl)ether	0.00	0.00	7.50	0.00
106-99-0	1,3-Butadiene	82.94	0.00	6.01	498.46
7440-43-9	Cadmium	81.00	71.23	7.25	1103.62
56-23-5	Carbon Tetrachloride	81.12	28.36	5.52	604.28
67-66-3	Chloroform	103.58	40.54	5.13	739.33
107-30-2	Chloromethyl methyl ether	82.82	0.00	7.50	621.16
XX	Chlorophenols (mixed isomers)	0.00	0.00	4.78	0.00
7440-47-3	Chromium	145.08	88.76	6.65	1555.08
8001-58-9	Creosote	0.00	0.00	7.50	0.00
25376-45-8	Diaminotoluene	75.90	38.53	6.00	686.59
106-93-4	1,2-Dibromoethane	0.00	0.00	7.50	0.00
91-94-1	3,3'-Dichlorobenzidine	25.05	10.40	7.50	265.88
107-06-2	1,2-Dichloroethane	124.07	35.30	5.13	817.55
75-09-2	Dichloromethane	83.07	21.81	5.33	559.04
542-75-6	1,3-Dichloropropylene	93.22	0.00	7.50	699.14
117-81-7	Di-(2-ethylhexyl) pthalate	126.35	0.00	5.97	754.31
77-78-1	Dimethyl sulfate	0.00	0.00	7.50	0.00
106-89-8	Epichlorohydrin	93.04	0.00	4.50	418.69
140-88-5	Ethyl acrylate	100.49	0.00	7.50	753.69
75-21-8	Ethylene oxide	138.66	19.83	4.50	713.19
96-45-7	Ethylene thiourea	0.00	0.00	7.50	0.00
50-00-0	Formaldehyde	152.00	78.40	6.00	1382.37
302-01-2	Hydrazine	0.00	0.00	7.50	0.00
7439-92-1	Lead	131.15	64.55	6.39	1250.52
7440-02-0	Nickel	148.66	71.73	6.30	1388.45
N495	Nickel Compounds	138.06	63.50	6.30	1269.83
79-46-9	2-Nitropropane	87.33	0.00	6.00	523.96
1336-36	Polychlorinated biphenyls	65.15	0.00	7.50	488.65
75-56-9	Propylene Oxide	154.76	32.13	3.25	607.42
100-42-5	Styrene	116.70	60.24	5.22	923.66
127-18-4	Tetrachloroethylene	109.36	31.47	6.29	885.82
62-56-6	Thiourea	0.00	0.00	7.50	0.00
584-84-9	Toluene-2,4-diisocyanate	74.44	19.88	4.50	424.41
91-08-7	Toluene-2,6-diisocyanate	68.62	19.88	4.50	398.24
26471-62-5	Toluenediisocyanate	0.00	0.00	4.50	0.00
95-53-4	o-Toluidine	0.00	0.00	7.50	0.00
88-06-2	2,4,6-Trichlorophenol	82.82	82.82	7.50	1242.33
51-79-6	Urethane	119.84	0.00	7.50	898.83
75-01-4	Vinyl chloride	100.07	0.00	4.63	463.32

Appendix F

Calculated Hazard Values for Specific Carcinogens

Table 59 - 1988 Calculated Hazard Values for Specific Carcinogens

CAS Number	Chemical	WHHE	WEE	EF	THV
75-07-0	Acetaldehyde	0.00	0.00	4.65	0.00
79-06-1	Acrylamide	85.40	35.43	4.65	561.87
107-13-1	Acrylonitrile	116.98	57.57	3.07	535.87
7440-38-2	Arsenic	62.97	0.00	6.75	425.08
1332-21-4	Asbestos (friable)	42.79	0.00	6.00	256.71
71-43-2	Benzene	107.24	43.78	4.83	729.42
7440-41-7	Beryllium	0.00	0.00	7.50	0.00
542-88-1	Bis(chloromethyl)ether	0.00	0.00	7.50	0.00
106-99-0	1,3-Butadiene	78.32	0.00	6.01	470.71
7440-43-9	Cadmium	71.31	0.00	7.25	516.99
56-23-5	Carbon Tetrachloride	74.67	16.67	5.52	504.19
67-66-3	Chloroform	100.23	41.24	5.13	725.75
107-30-2	Chloromethyl methyl ether	0.00	0.00	7.50	0.00
XX	Chlorophenols (mixed isomers)	0.00	0.00	4.78	0.00
7440-47-3	Chromium	154.27	94.32	6.65	1653.12
8001-58-9	Creosote	0.00	0.00	7.50	0.00
25376-45-8	Diaminotoluene	75.90	38.53	6.00	686.59
106-93-4	1,2-Dibromoethane	0.00	0.00	7.50	0.00
91-94-1	3,3'-Dichlorobenzidine	86.43	10.40	7.50	726.18
107-06-2	1,2-Dichloroethane	119.43	28.56	5.13	759.18
75-09-2	Dichloromethane	81.78	21.28	5.33	549.35
542-75-6	1,3-Dichloropropylene	95.95	0.00	7.50	719.65
117-81-7	Di-(2-ethylhexyl) pthalate	102.22	0.00	5.97	610.27
77-78-1	Dimethyl sulfate	0.00	0.00	7.50	0.00
106-89-8	Epichlorohydrin	76.47	0.00	4.50	344.09
140-88-5	Ethyl acrylate	86.94	0.00	7.50	652.06
75-21-8	Ethylene oxide	138.33	18.94	4.50	707.72
96-45-7	Ethylene thiourea	0.00	0.00	7.50	0.00
50-00-0	Formaldehyde	152.93	67.23	6.00	1320.93
302-01-2	Hydrazine	16.48	0.00	7.50	123.59
7439-92-1	Lead	149.70	104.11	6.39	1621.84
7440-02-0	Nickel	146.61	70.02	6.30	1364.74
N495	Nickel Compounds	141.25	64.47	6.30	1296.03
79-46-9	2-Nitropropane	84.31	0.00	6.00	505.84
1336-36	Polychlorinated biphenyls	0.00	0.00	7.50	0.00
75-56-9	Propylene Oxide	145.29	28.63	3.25	565.22
100-42-5	Styrene	120.75	80.01	5.22	1047.92
127-18-4	Tetrachloroethylene	109.14	24.98	6.29	843.61
62-56-6	Thiourea	0.00	0.00	7.50	0.00
584-84-9	Toluene-2,4-diisocyanate	76.13	19.88	4.50	432.04
91-08-7	Toluene-2,6-diisocyanate	71.17	0.00	4.50	320.24
26471-62-5	Toluenediisocyanate	0.00	0.00	4.50	0.00
95-53-4	o-Toluidine	0.00	0.00	7.50	0.00
88-06-2	2,4,6-Trichlorophenol	104.21	58.68	7.50	1221.64
51-79-6	Urethane	0.00	0.00	7.50	0.00
75-01-4	Vinyl chloride	86.90	0.00	4.63	402.35

Appendix F

Calculated Hazard Values for Specific Carcinogens

Table 60 - 1989 Calculated Hazard Values for Specific Carcinogens

CAS Number	Chemical	WHHE	WEE	EF	THV
75-07-0	Acetaldehyde	0.00	0.00	4.65	0.00
79-06-1	Acrylamide	98.97	43.97	4.65	664.64
107-13-1	Acrylonitrile	122.88	58.00	3.07	555.28
7440-38-2	Arsenic	0.00	0.00	6.75	0.00
1332-21-4	Asbestos (friable)	39.72	0.00	6.00	238.32
71-43-2	Benzene	106.19	45.77	4.83	733.94
7440-41-7	Beryllium	82.82	0.00	7.50	621.16
542-88-1	Bis(chloromethyl)ether	0.00	0.00	7.50	0.00
106-99-0	1,3-Butadiene	72.60	0.00	6.01	436.31
7440-43-9	Cadmium	62.15	0.00	7.25	450.56
56-23-5	Carbon Tetrachloride	74.06	17.13	5.52	503.39
67-66-3	Chloroform	99.53	35.96	5.13	695.08
107-30-2	Chloromethyl methyl ether	0.00	0.00	7.50	0.00
XX	Chlorophenols (mixed isomers)	68.61	20.97	4.78	428.15
7440-47-3	Chromium	151.97	96.01	6.65	1649.10
8001-58-9	Creosote	0.00	0.00	7.50	0.00
25376-45-8	Diaminotoluene	74.38	36.49	6.00	665.26
106-93-4	1,2-Dibromoethane	0.00	0.00	7.50	0.00
91-94-1	3,3'-Dichlorobenzidine	82.92	0.00	7.50	621.91
107-06-2	1,2-Dichloroethane	119.33	34.67	5.13	790.04
75-09-2	Dichloromethane	85.41	22.65	5.33	575.97
542-75-6	1,3-Dichloropropylene	85.15	0.00	7.50	638.63
117-81-7	Di-(2-ethylhexyl) pthalate	138.53	0.00	5.97	827.04
77-78-1	Dimethyl sulfate	82.86	0.00	7.50	621.46
106-89-8	Epichlorohydrin	82.24	0.00	4.50	370.10
140-88-5	Ethyl acrylate	55.33	0.00	7.50	415.00
75-21-8	Ethylene oxide	134.37	17.96	4.50	685.47
96-45-7	Ethylene thiourea	0.00	0.00	7.50	0.00
50-00-0	Formaldehyde	145.47	68.62	6.00	1284.54
302-01-2	Hydrazine	93.22	0.00	7.50	699.14
7439-92-1	Lead	158.81	111.42	6.39	1726.80
7440-02-0	Nickel	156.31	80.43	6.30	1491.45
N495	Nickel Compounds	140.38	64.29	6.30	1289.45
79-46-9	2-Nitropropane	82.41	0.00	6.00	494.44
1336-36	Polychlorinated biphenyls	0.00	0.00	7.50	0.00
75-56-9	Propylene Oxide	143.63	28.07	3.25	558.04
100-42-5	Styrene	116.64	57.87	5.22	910.95
127-18-4	Tetrachloroethylene	103.25	33.95	6.29	863.00
62-56-6	Thiourea	93.22	0.00	7.50	699.14
584-84-9	Toluene-2,4-diisocyanate	81.05	28.76	4.50	494.17
91-08-7	Toluene-2,6-diisocyanate	83.59	33.55	4.50	527.12
26471-62-5	Toluenediisocyanate	0.00	0.00	4.50	0.00
95-53-4	o-Toluidine	117.36	82.82	7.50	1501.37
88-06-2	2,4,6-Trichlorophenol	85.27	39.59	7.50	936.45
51-79-6	Urethane	0.00	0.00	7.50	0.00
75-01-4	Vinyl chloride	104.79	9.11	4.63	527.38

Appendix F

Calculated Hazard Values for Specific Carcinogens

Table 61 - 1990 Calculated Hazard Values for Specific Carcinogens

CAS Number	Chemical	WHHE	WEE	EF	THV
75-07-0	Acetaldehyde	0.00	0.00	4.65	0.00
79-06-1	Acrylamide	104.26	39.58	4.65	668.87
107-13-1	Acrylonitrile	110.69	54.06	3.07	505.77
7440-38-2	Arsenic	109.32	77.78	6.75	1262.91
1332-21-4	Asbestos (friable)	0.00	0.00	6.00	0.00
71-43-2	Benzene	105.62	49.37	4.83	748.64
7440-41-7	Beryllium	91.36	24.14	7.50	866.26
542-88-1	Bis(chloromethyl)ether	0.00	0.00	7.50	0.00
106-99-0	1,3-Butadiene	77.62	5.27	6.01	498.15
7440-43-9	Cadmium	113.47	112.96	7.25	1641.62
56-23-5	Carbon Tetrachloride	69.85	16.83	5.52	478.47
67-66-3	Chloroform	97.53	34.05	5.13	675.01
107-30-2	Chloromethyl methyl ether	0.00	0.00	7.50	0.00
XX	Chlorophenols (mixed isomers)	67.17	20.97	4.78	421.27
7440-47-3	Chromium	149.62	95.90	6.65	1632.72
8001-58-9	Creosote	0.00	0.00	7.50	0.00
25376-45-8	Diaminotoluene	45.73	29.42	6.00	450.89
106-93-4	1,2-Dibromoethane	0.00	0.00	7.50	0.00
91-94-1	3,3'-Dichlorobenzidine	35.49	0.00	7.50	266.19
107-06-2	1,2-Dichloroethane	119.02	37.45	5.13	802.66
75-09-2	Dichloromethane	79.52	20.53	5.33	533.25
542-75-6	1,3-Dichloropropylene	81.37	0.00	7.50	610.31
117-81-7	Di-(2-ethylhexyl) pthalate	160.67	0.00	5.97	959.22
77-78-1	Dimethyl sulfate	0.00	0.00	7.50	0.00
106-89-8	Epichlorohydrin	89.20	12.39	4.50	457.18
140-88-5	Ethyl acrylate	89.06	0.00	7.50	667.97
75-21-8	Ethylene oxide	131.36	14.42	4.50	655.99
96-45-7	Ethylene thiourea	0.00	0.00	7.50	0.00
50-00-0	Formaldehyde	146.07	65.41	6.00	1268.85
302-01-2	Hydrazine	34.54	0.00	7.50	259.04
7439-92-1	Lead	155.62	110.96	6.39	1703.49
7440-02-0	Nickel	146.49	70.62	6.30	1367.80
N495	Nickel Compounds	137.32	65.13	6.30	1275.43
79-46-9	2-Nitropropane	14.32	0.00	6.00	85.94
1336-36	Polychlorinated biphenyls	0.00	0.00	7.50	0.00
75-56-9	Propylene Oxide	139.01	27.75	3.25	541.99
100-42-5	Styrene	116.37	53.18	5.22	885.06
127-18-4	Tetrachloroethylene	93.59	24.98	6.29	745.78
62-56-6	Thiourea	93.52	0.00	7.50	701.37
584-84-9	Toluene-2,4-diisocyanate	63.23	0.00	4.50	284.52
91-08-7	Toluene-2,6-diisocyanate	90.54	0.00	4.50	407.42
26471-62-5	Toluenediisocyanate	84.82	19.88	4.50	471.15
95-53-4	o-Toluidine	0.00	0.00	7.50	0.00
88-06-2	2,4,6-Trichlorophenol	94.19	65.54	7.50	1198.01
51-79-6	Urethane	0.00	0.00	7.50	0.00
75-01-4	Vinyl chloride	94.39	12.08	4.63	492.95

Appendix F

Calculated Hazard Values for Specific Carcinogens

Table 62 - 1991 Calculated Hazard Values for Specific Carcinogens

CAS Number	Chemical	WHHE	WEE	EF	THV
75-07-0	Acetaldehyde	59.26	0.00	4.65	275.56
79-06-1	Acrylamide	94.53	40.08	4.65	625.94
107-13-1	Acrylonitrile	104.31	46.12	3.07	461.79
7440-38-2	Arsenic	103.53	74.28	6.75	1200.22
1332-21-4	Asbestos (friable)	0.00	0.00	6.00	0.00
71-43-2	Benzene	104.87	48.79	4.83	742.19
7440-41-7	Beryllium	133.46	103.62	7.50	1778.04
542-88-1	Bis(chloromethyl)ether	0.00	0.00	7.50	0.00
106-99-0	1,3-Butadiene	76.90	0.00	6.01	462.14
7440-43-9	Cadmium	98.32	101.92	7.25	1451.79
56-23-5	Carbon Tetrachloride	61.16	11.28	5.52	399.87
67-66-3	Chloroform	94.07	32.70	5.13	650.33
107-30-2	Chloromethyl methyl ether	0.00	0.00	7.50	0.00
XX	Chlorophenols (mixed isomers)	71.58	31.85	4.78	494.38
7440-47-3	Chromium	150.69	95.19	6.65	1635.07
8001-58-9	Creosote	0.00	0.00	7.50	0.00
25376-45-8	Diaminotoluene	41.62	25.79	6.00	404.41
106-93-4	1,2-Dibromoethane	0.00	0.00	7.50	0.00
91-94-1	3,3'-Dichlorobenzidine	34.54	0.00	7.50	259.04
107-06-2	1,2-Dichloroethane	102.82	23.83	5.13	649.73
75-09-2	Dichloromethane	79.59	21.73	5.33	540.02
542-75-6	1,3-Dichloropropylene	81.17	0.00	7.50	608.81
117-81-7	Di-(2-ethylhexyl) pthalate	160.27	22.34	5.97	1090.15
77-78-1	Dimethyl sulfate	0.00	0.00	7.50	0.00
106-89-8	Epichlorohydrin	108.74	42.55	4.50	680.77
140-88-5	Ethyl acrylate	88.74	0.00	7.50	665.57
75-21-8	Ethylene oxide	123.26	15.61	4.50	624.93
96-45-7	Ethylene thiourea	0.00	0.00	7.50	0.00
50-00-0	Formaldehyde	143.60	63.70	6.00	1243.82
302-01-2	Hydrazine	34.54	0.00	7.50	259.04
7439-92-1	Lead	151.63	107.99	6.39	1658.92
7440-02-0	Nickel	150.84	76.13	6.30	1429.95
N495	Nickel Compounds	132.59	59.91	6.30	1212.69
79-46-9	2-Nitropropane	0.00	0.00	6.00	0.00
1336-36	Polychlorinated biphenyls	0.00	0.00	7.50	0.00
75-56-9	Propylene Oxide	127.61	21.32	3.25	484.03
100-42-5	Styrene	116.05	54.64	5.22	890.98
127-18-4	Tetrachloroethylene	96.78	3.95	6.29	633.61
62-56-6	Thiourea	93.37	0.00	7.50	700.26
584-84-9	Toluene-2,4-diisocyanate	65.82	0.00	4.50	296.19
91-08-7	Toluene-2,6-diisocyanate	65.83	0.00	4.50	296.24
26471-62-5	Toluenediisocyanate	69.40	5.79	4.50	338.35
95-53-4	o-Toluidine	0.00	0.00	7.50	0.00
88-06-2	2,4,6-Trichlorophenol	69.44	10.40	7.50	598.80
51-79-6	Urethane	0.00	0.00	7.50	0.00
75-01-4	Vinyl chloride	110.94	0.00	4.63	513.65

Appendix F

Calculated Hazard Values for Specific Carcinogens

Table 63 - 1992 Calculated Hazard Values for Specific Carcinogens

CAS Number	Chemical	WHHE	WEE	EF	THV
75-07-0	Acetaldehyde	59.51	0.00	4.65	276.70
79-06-1	Acrylamide	65.94	0.00	4.65	306.63
107-13-1	Acrylonitrile	110.67	49.44	3.07	491.54
7440-38-2	Arsenic	97.84	68.51	6.75	1122.86
1332-21-4	Asbestos (friable)	0.00	0.00	6.00	0.00
71-43-2	Benzene	99.11	45.00	4.83	696.04
7440-41-7	Beryllium	99.30	0.00	7.50	744.76
542-88-1	Bis(chloromethyl)ether	0.00	0.00	7.50	0.00
106-99-0	1,3-Butadiene	82.10	32.61	6.01	689.36
7440-43-9	Cadmium	88.38	89.68	7.25	1290.90
56-23-5	Carbon Tetrachloride	59.54	10.19	5.52	384.91
67-66-3	Chloroform	91.26	31.55	5.13	629.97
107-30-2	Chloromethyl methyl ether	0.00	0.00	7.50	0.00
XX	Chlorophenols (mixed isomers)	68.01	21.79	4.78	429.22
7440-47-3	Chromium	145.01	90.56	6.65	1566.49
8001-58-9	Creosote	0.00	0.00	7.50	0.00
25376-45-8	Diaminotoluene	40.21	24.50	6.00	388.23
106-93-4	1,2-Dibromoethane	0.00	0.00	7.50	0.00
91-94-1	3,3'-Dichlorobenzidine	34.54	0.00	7.50	259.04
107-06-2	1,2-Dichloroethane	93.33	23.98	5.13	601.82
75-09-2	Dichloromethane	76.34	20.69	5.33	517.17
542-75-6	1,3-Dichloropropylene	81.17	0.00	7.50	608.81
117-81-7	Di-(2-ethylhexyl) pthalate	115.48	0.00	5.97	689.42
77-78-1	Dimethyl sulfate	52.45	0.00	7.50	393.36
106-89-8	Epichlorohydrin	88.43	0.00	4.50	397.95
140-88-5	Ethyl acrylate	74.65	0.00	7.50	559.88
75-21-8	Ethylene oxide	118.04	14.41	4.50	596.00
96-45-7	Ethylene thiourea	0.00	0.00	7.50	0.00
50-00-0	Formaldehyde	143.96	63.25	6.00	1243.25
302-01-2	Hydrazine	0.00	0.00	7.50	0.00
7439-92-1	Lead	144.32	101.52	6.39	1570.90
7440-02-0	Nickel	149.99	75.79	6.30	1422.42
N495	Nickel Compounds	131.45	59.65	6.30	1203.94
79-46-9	2-Nitropropane	30.85	0.00	6.00	185.07
1336-36	Polychlorinated biphenyls	0.00	0.00	7.50	0.00
75-56-9	Propylene Oxide	119.57	17.83	3.25	446.54
100-42-5	Styrene	119.31	68.10	5.22	978.29
127-18-4	Tetrachloroethylene	97.25	0.00	6.29	611.72
62-56-6	Thiourea	93.37	0.00	7.50	700.26
584-84-9	Toluene-2,4-diisocyanate	56.02	0.00	4.50	252.10
91-08-7	Toluene-2,6-diisocyanate	54.22	0.00	4.50	243.98
26471-62-5	Toluenediisocyanate	70.18	19.88	4.50	405.24
95-53-4	o-Toluidine	52.98	34.54	7.50	656.41
88-06-2	2,4,6-Trichlorophenol	66.93	0.00	7.50	501.98
51-79-6	Urethane	0.00	0.00	7.50	0.00
75-01-4	Vinyl chloride	115.16	0.00	4.63	533.18

Appendix F

Calculated Hazard Values for Specific Carcinogens

Table 64 - 1993 Calculated Hazard Values for Specific Carcinogens

CAS Number	Chemical	WHHE	WEE	EF	THV
75-07-0	Acetaldehyde	58.87	0.00	4.65	273.73
79-06-1	Acrylamide	88.19	34.64	4.65	571.17
107-13-1	Acrylonitrile	109.81	44.79	3.07	474.61
7440-38-2	Arsenic	108.62	74.04	6.75	1232.91
1332-21-4	Asbestos (friable)	0.00	0.00	6.00	0.00
71-43-2	Benzene	97.52	49.91	4.83	712.10
7440-41-7	Beryllium	24.14	0.00	7.50	181.06
542-88-1	Bis(chloromethyl)ether	0.00	0.00	7.50	0.00
106-99-0	1,3-Butadiene	69.38	0.00	6.01	416.99
7440-43-9	Cadmium	86.68	84.89	7.25	1243.85
56-23-5	Carbon Tetrachloride	58.02	0.00	5.52	320.27
67-66-3	Chloroform	90.90	32.07	5.13	630.83
107-30-2	Chloromethyl methyl ether	40.62	0.00	7.50	304.66
XX	Chlorophenols (mixed isomers)	67.66	22.17	4.78	429.36
7440-47-3	Chromium	150.20	92.48	6.65	1613.85
8001-58-9	Creosote	133.88	0.00	7.50	1004.08
25376-45-8	Diaminotoluene	51.54	34.36	6.00	515.35
106-93-4	1,2-Dibromoethane	0.00	0.00	7.50	0.00
91-94-1	3,3'-Dichlorobenzidine	34.54	0.00	7.50	259.04
107-06-2	1,2-Dichloroethane	99.09	24.14	5.13	632.18
75-09-2	Dichloromethane	75.21	20.47	5.33	510.01
542-75-6	1,3-Dichloropropylene	81.64	0.00	7.50	612.27
117-81-7	Di-(2-ethylhexyl) pthalate	126.72	53.56	5.97	1076.25
77-78-1	Dimethyl sulfate	52.45	0.00	7.50	393.36
106-89-8	Epichlorohydrin	80.53	0.00	4.50	362.39
140-88-5	Ethyl acrylate	73.69	0.00	7.50	552.67
75-21-8	Ethylene oxide	117.99	14.41	4.50	595.81
96-45-7	Ethylene thiourea	0.00	0.00	7.50	0.00
50-00-0	Formaldehyde	143.35	64.04	6.00	1244.33
302-01-2	Hydrazine	0.00	0.00	7.50	0.00
7439-92-1	Lead	148.09	106.24	6.39	1625.17
7440-02-0	Nickel	150.47	72.89	6.30	1407.18
N495	Nickel Compounds	123.16	44.43	6.30	1055.86
79-46-9	2-Nitropropane	0.00	0.00	6.00	0.00
1336-36	Polychlorinated biphenyls	0.00	0.00	7.50	0.00
75-56-9	Propylene Oxide	114.39	15.54	3.25	422.25
100-42-5	Styrene	121.74	76.51	5.22	1034.87
127-18-4	Tetrachloroethylene	94.63	3.95	6.29	620.04
62-56-6	Thiourea	93.52	0.00	7.50	701.37
584-84-9	Toluene-2,4-diisocyanate	57.69	0.00	4.50	259.62
91-08-7	Toluene-2,6-diisocyanate	54.71	0.00	4.50	246.19
26471-62-5	Toluenediisocyanate	69.63	19.88	4.50	402.78
95-53-4	o-Toluidine	52.98	34.54	7.50	656.41
88-06-2	2,4,6-Trichlorophenol	89.58	60.38	7.50	1124.71
51-79-6	Urethane	0.00	0.00	7.50	0.00
75-01-4	Vinyl chloride	113.60	0.00	4.63	525.98

Appendix F

Calculated Hazard Values for Specific Carcinogens

Table 65 - 1994 Calculated Hazard Values for Specific Carcinogens

CAS Number	Chemical	WHHE	WEE	EF	THV
75-07-0	Acetaldehyde	66.28	34.79	4.65	469.96
79-06-1	Acrylamide	89.82	34.16	4.65	576.51
107-13-1	Acrylonitrile	108.83	44.79	3.07	471.62
7440-38-2	Arsenic	107.95	72.49	6.75	1217.95
1332-21-4	Asbestos (friable)	0.00	0.00	6.00	0.00
71-43-2	Benzene	97.61	47.19	4.83	699.38
7440-41-7	Beryllium	24.14	0.00	7.50	181.06
542-88-1	Bis(chloromethyl)ether	0.00	0.00	7.50	0.00
106-99-0	1,3-Butadiene	74.34	0.00	6.01	446.79
7440-43-9	Cadmium	95.66	101.00	7.25	1425.78
56-23-5	Carbon Tetrachloride	61.40	7.89	5.52	382.45
67-66-3	Chloroform	88.45	28.86	5.13	601.81
107-30-2	Chloromethyl methyl ether	26.88	0.00	7.50	201.57
XX	Chlorophenols (mixed isomers)	67.69	22.17	4.78	429.50
7440-47-3	Chromium	149.37	90.42	6.65	1594.63
8001-58-9	Creosote	134.46	0.00	7.50	1008.47
25376-45-8	Diaminotoluene	51.54	34.36	6.00	515.35
106-93-4	1,2-Dibromoethane	0.00	0.00	7.50	0.00
91-94-1	3,3'-Dichlorobenzidine	34.54	0.00	7.50	259.04
107-06-2	1,2-Dichloroethane	98.24	21.01	5.13	611.79
75-09-2	Dichloromethane	75.27	19.55	5.33	505.37
542-75-6	1,3-Dichloropropylene	81.89	0.00	7.50	614.20
117-81-7	Di-(2-ethylhexyl) pthalate	129.47	0.00	5.97	772.95
77-78-1	Dimethyl sulfate	82.82	0.00	7.50	621.16
106-89-8	Epichlorohydrin	79.10	0.00	4.50	355.96
140-88-5	Ethyl acrylate	102.62	0.00	7.50	769.68
75-21-8	Ethylene oxide	117.26	14.41	4.50	592.50
96-45-7	Ethylene thiourea	0.00	0.00	7.50	0.00
50-00-0	Formaldehyde	138.16	58.63	6.00	1180.70
302-01-2	Hydrazine	0.00	0.00	7.50	0.00
7439-92-1	Lead	151.01	109.07	6.39	1661.90
7440-02-0	Nickel	146.17	64.62	6.30	1328.02
N495	Nickel Compounds	130.36	35.22	6.30	1043.19
79-46-9	2-Nitropropane	0.00	0.00	6.00	0.00
1336-36	Polychlorinated biphenyls	0.00	0.00	7.50	0.00
75-56-9	Propylene Oxide	116.07	15.54	3.25	427.71
100-42-5	Styrene	121.46	73.96	5.22	1020.08
127-18-4	Tetrachloroethylene	94 91	20.10	6.29	723.44
62-56-6	Thiourea	34.54	0.00	7.50	259.04
584-84-9	Toluene-2,4-diisocyanate	50.19	0.00	4.50	225.86
91-08-7	Toluene-2,6-diisocyanate	54.56	0.00	4.50	245.51
26471-62-5	Toluenediisocyanate	73.34	19.88	4.50	419.48
95-53-4	o-Toluidine	52.98	34.54	7.50	656.41
88-06-2	2,4,6-Trichlorophenol	103.10	62.62	7.50	1242.85
51-79-6	Urethane	0.00	0.00	7.50	0.00
75-01-4	Vinyl chloride	113.58	0.00	4.63	525.89