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AN SAB REPORT: REVIEW OF DISPROPORTIONATE IMPACT METHODOLOGIES

A REVIEW BY THE INTEGRATED HUMAN EXPOSURE COMMITTEE (IHEC) OF THE SCIENCE ADVISORY BOARD (SAB)

December 8, 1998

EPA-SAB-IHEC-99-007

The Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Subject: Science Advisory Board's Review of the Office of Civil Rights (OCR) Methodologies for Performing Disproportionate Impact Analyses

Dear Ms. Browner:

The Office of Civil Rights (OCR) is charged with responding to complaints filed under Title VI of the Civil Rights Act of 1964 that allege discriminatory effects from the issuance of pollution control permits by states or other governmental bodies that receive financial assistance from EPA. To address such complaints, OCR has collaborated with several other EPA offices on the development of two methodologies for performing disproportionate impact analyses. The first methodology, the Relative Burden Analysis (RBA) [of which there are two versions: the Basic RBA (BRBA) and the Enhanced RBA (ERBA)] was developed by the Office of Research and Development. The second methodology, the Cumulative Outdoor Air Toxics Concentration Exposure Methodology (COATCEM), was developed jointly by the Office of Policy and the Office of Air and Radiation. It was these two methodologies that the Disproportionate Analysis Methodologies Panel of the Integrated Human Exposure Committee (IHEC) of the Science Advisory Board (SAB) reviewed in public session on September 3-4, 1998, addressing 14 questions posed by the Agency in the Charge to the Committee.

The IHEC commends the OCR for its efforts to explore utilization of modeling to estimate chemical-specific impacts on geographic-specific populations at the census block level as a tool to assist in Title VI decisions. The IHEC recognizes that the 180-day requirement for responding to Title VI complaints places significant restraints on the practical ability to use the most scientifically rigorous methods to address the ultimate complex circumstance -- multi-chemical, multi-source, multi-pathway environments -- present in communities. Thus, a truly rigorous risk assessment approach may not be feasible. Emissions data availability limitations, coupled with the simplifying assumptions present in the currently available models, necessarily relegate the model outputs to a limited, secondary role in support of Title VI decisions. The utility of these models is quite different from the comprehensive risk assessments upon which regulatory decisions elsewhere in the EPA are based. The outputs from the Relative Burden Analysis (RBA) should be considered supporting indicators and not primary information upon which to base decisions.

COATCEM methodology is an advancement over the RBA and shows great promise. However, its application to a Title VI analysis has not been fully developed.

Given the important limitations of both methodologies, the Committee provided specific guidance for conducting disproportionate impact analyses at the present time. It recommended that disproportionate impact analyses be conducted in a step-wise manner. The first step should be to examine site-specific data (including both actual measured emissions and TRI reports) to determine whether the air pathway and chronic exposure are appropriate surrogates for community burden calculations and then determine which methodology to select for the initial analysis. It is appropriate for screening purposes to start with simpler methodologies to identify the chemicals or classes of chemicals upon which to focus in subsequent analyses. Hence, a modified form of BRBA which includes a simple distance function might be the first methodology applied. If more detailed analyses are desirable, ERBA could be used to identify burdens based upon air dispersion modeling of chemicals from the facilities. To assess whether the risks associated with the derived burdens are *de minimis*, risk assessments of the chemicals/classes of chemicals that are the drivers for the burden values could then be performed.

The report contains a series of important Findings. In addition to the recommendation to perform disproportionate impact analyses in a step-wise manner, the Committee developed eight other Recommendations to the Agency, as follows:

a) The relevance of relative burden ratio (RBR) determinations is questionable when all populations exhibit either *de minimis* risk or risks demanding action. In the tiered approach suggested, the Agency should consider the sequence in which these analyses are performed (i.e., determining the potential "risk" to all populations before estimating disproportionate impact).

b) The Agency should use the term "toxicity-weighted exposure" instead of "burden." Further, EPA needs to develop a more specific and consistent definition of "toxicity-weighted exposure" for the RBA methodology. The policy decision as to whether the toxicity-weighted exposure is considered adverse should be risk-based. The current RBA burden analyses will not provide useful information to accommodate this decision.

c) COATCEM has significant potential and should be developed further. In calibrating and validating this methodology, the Agency should consider two test cases - one in which mobile and area sources are not considered significant contributors to overall exposure (e.g., rural case) and one in which area and mobile sources are important contributors to overall exposures (e.g., urban case).

d) When evaluating potential risks of emitted chemicals for the purpose of determining whether or not the cumulative risks are *de minimis*, cancer risks and non-cancer health effects should be evaluated separately.

e) Given the large number of uncertainties in both the RBA and COATCEM methodologies, it is important to perform uncertainty and sensitivity analyses of each methodology. In the policy decision process, the power of these methodologies to detect differences in toxicity-weighted exposures should be compared with an a priori identification of the level of difference that is meaningful in a regulatory or legal sense. For example, one could define as significant situations in which the calculated risks are above *de minimis* levels, and the toxicity-weighted exposure ratios are larger than the uncertainty factors in the specific method.

f) An important next step in the validation procedure for both the ERBA and COATCEM methodologies will be to collect ambient monitoring data at sites included in an analysis of disproportionate impacts using these methodologies, in order to compare measured concentrations of chemicals with model-estimated concentrations.

g) Considerations of acute exposure impacts, including irritation and odor, should be included, to the extent that methodologies are available to address such effects.

h) In interacting with the residents of the communities being studied, it is critical to maintain good communications and to convey information on the studies in an understandable and complete manner, making sure that the uses and limitations of the methodologies are adequately addressed. Special care should be taken to explain the difference between "toxicity-weighted exposure" and "risk".

We appreciate the opportunity to review the two methodologies and look forward to your response to the recommendations we have made.

Sincerely,

/signed/
Dr. Joan M. Daisey, Chair
Science Advisory Board

/signed/
Dr. Henry A. Anderson, Chair
Integrated Human Exposure Committee
Science Advisory Board

/signed/
Dr. Thomas E. McKone, Co-Chair
Integrated Human Exposure Committee
Science Advisory Board

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ABSTRACT

The Disproportionate Impact Analysis Methodologies Panel of the USEPA Science Advisory Board (SAB) Integrated Human Exposure Committee (IHEC) met in public session on September 3-4, 1998 to review the Agency's proposed methods for calculating disproportionate impacts of air emissions on surrounding populations of different race, color, or national origin. The Agency is developing these methodologies in connection with Title VI of the Civil Rights Act of 1964 (as amended).

The Panel reviewed two methods: the first was the Relative Burden Analysis (RBA) [in two versions: the Basic RBA (BRBA) and the Enhanced RBA (ERBA)]; the second was the Cumulative Outdoor Air Toxics Concentration Exposure Methodology (COATCEM). The former has been applied on a trial basis to a site in Louisiana; the latter has not yet been applied to a particular site.

The Panel commends the Agency for these initial efforts in trying to determine analytically disproportionate impacts. However, each of the two methods has its limitations in terms of accuracy, uncertainty, data availability, resources, and level of development. The report contains a number of findings, nine specific recommendations, including suggested guidance for moving forward in this important area, and detailed responses to the 14 Charge questions, .

KEYWORDS: Title VI, environmental justice, RBA, COATCEM, disproportionate impact, Shintech

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Science Advisory Board
Integrated Human Exposure Committee
Disproportionate Impact Analysis Methodology Review Panel

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1. EXECUTIVE SUMMARY

The Office of Civil Rights (OCR) is charged with responding to complaints filed under Title VI of the Civil Rights Act of 1964 that allege discriminatory effects from the issuance of pollution control permits by states or other governmental bodies that receive financial assistance from EPA. To address such complaints, OCR has collaborated with several other EPA offices on the development of two methodologies for performing disproportionate impact analyses. The first methodology, entitled the Relative Burden Analysis (RBA), was developed by the Office of Research and Development; the second methodology, entitled the Cumulative Outdoor Air Toxics Concentration Exposure Methodology (COATCEM), was developed jointly by the Office of Policy and the Office of Air and Radiation.

The RBA methodology estimates differential "burdens" to various populations from air emissions from stationary point sources. It consists of two versions, the Basic RBA (BRBA) and the Enhanced RBA (ERBA), and uses as the starting point of the analysis the annualized estimates of emissions reported to the Toxics Release Inventory by specific facilities. It employs the toxicity weights for individual chemicals from the Office of Pollution Prevention and Toxics Risk Screening Environmental Indicators (RSEI) methodology to generate a "pseudo-chemical" for the facilities of concern. The RBA uses the calculated burdens for specific populations to generate rough indications of risk. The RBA has been applied on a trial basis to a site in Louisiana.

The COATCEM methodology is designed to estimate risks from three sources of air emissions; namely, stationary, area and mobile sources. It uses air dispersion modeling to develop exposure concentrations from these sources to populations at specific locations. It includes three measures of differential impacts among populations: cancer risk, non-cancer toxicity hazard ratio, and total benchmark exceedances. COATCEM evaluates hazardous air pollutants with known toxicity values (i.e., cancer slope factors and reference concentrations) individually. To date, COATCEM has not been applied to an actual case.

OCR plans to use these methodologies to generate information on substantial differences in impact between populations from specific facilities, potential harm due to such differential impacts, and an estimate of overall cumulative levels of risks from multiple emitting sources in the areas of concern. Given the significant scientific and technical issues involved in developing such methodologies and the precedent-setting nature of performing these analyses, the OCR requested a review by the EPA Science Advisory Board (SAB) of the RBA and COATCEM methodologies. Consequently, the SAB Integrated Human Exposures Committee (IHEC) conducted a review of the two methodologies on September 3-4, 1998, and addressed the 14 questions posed by the Agency in the charge to the Committee.

The IHEC commends the OCR for its efforts to explore utilization of modeling to estimate chemical-specific impacts to geographic-specific populations. The IHEC recognizes that the 180-day requirement for responding to Title VI complaints places significant restraints on the practical ability to use the most scientifically rigorous methods to address the extremely complex multi-chemical, multi-source environments present in communities. Thus, a risk assessment approach may not be feasible. Within the identified programmatic constraints (time, utilization of existing nationwide data), the OCR has made a strong start, and IHEC encourages OCR to continue its efforts.

The IHEC concluded that each of the methodologies has specific strengths and weaknesses. The RBA methodology is simple, transparent, easy to use and understand, and can be easily updated. It has been utilized in one instance and can be performed in the 180-day time limit for responding to Title VI complaints. The ERBA is an improvement over the BRBA because it uses an air dispersion model to estimate concentrations of the pseudo-chemical at specific distances from the various facilities.

The Committee concluded that the COATCEM methodology has significant potential for future use. It is more comprehensive and more resource intensive than the RBA methodology. It evaluates emissions from point, area and mobile sources, and therefore it should represent a more realistic evaluation of cumulative exposures, particularly in urban areas. It estimates air concentrations for individual chemicals and evaluates separately cumulative cancer risks and non-cancer health effects of the chemicals. Given COATCEM's complexity, it remains to be seen whether it could be utilized within the 180-day limit established for addressing Title VI complaints. Although the most promising of the methodologies reviewed, COATCEM needs further development if it is to be used by OCR.

Importantly, the Committee concluded that the definition of "burden" in both versions of the RBA is not sufficiently precise. It is critical that an understandable and meaningful definition for burden be developed. The term "toxicity-weighted exposure" should be considered as a replacement term for burden, since burden can be confused with concepts of internal dosimetry such as "body burden," and to many people it implies "risk."

The Committee concluded that a fundamental problem in the RBA methodology was an inability to extrapolate from the relative burden ratio (RBR), or toxicity-weighted exposure of one population in a given area divided by the toxicity-weighted exposure of a second population in the same area, to potential harm or risk. The issue of *de minimis* risk cannot be addressed without risk-based analyses. Unless burden is defined to include evaluations of potential risks, the concept of *de minimis* risk based upon the RBR is not meaningful. Hence, as presently defined, the RBR cannot be used to identify *de minimis* risks.

Given the important limitations of both methodologies, the Committee provided specific guidance for conducting disproportionate impact analyses at the present time. It recommended that disproportionate impact analyses be conducted in a step-wise manner. The first step should be to examine site-specific data (including both actual measured emissions and TRI reports) to determine whether the air pathway and chronic exposure are appropriate surrogates for community burden calculations and then determine which methodology to select for the initial analysis. It is appropriate for screening purposes to start with simpler methodologies to identify the chemicals or classes of chemicals upon which to focus in subsequent analyses. Hence, a modified form of BRBA which includes a simple distance function might be the first methodology applied. If more detailed analyses are desirable, ERBA could be used to identify toxicity-weighted exposures based upon air dispersion modeling of chemicals from the facilities. To assess whether the risks associated with the derived burdens are *de minimis*, risk assessments of the chemicals/classes of chemicals that are the drivers for the toxicity-weighted exposure values could then be performed.

The Committee developed eight other recommendations to the Agency, as follows:

a) The relevance of RBR determinations is questionable when all populations exhibit either *de minimis* risk or risks demanding action. In the tiered approach suggested, the Agency should consider the sequence in which these analyses are performed (i.e., determining the potential "risk" to all populations before estimating disproportionate impact).

b) The Agency should use the term "toxicity-weighted exposure" instead of "burden." Further, EPA needs to develop a more specific and consistent definition of "toxicity-weighted exposure" for the RBA methodology. The policy decision as to whether the toxicity-weighted exposure is considered adverse should be risk-based. The current RBA burden analyses will not provide useful information to accommodate this decision.

c) COATCEM has significant potential and should be developed further. In calibrating and validating this methodology, the Agency should consider two test cases: one in which mobile and area sources are not considered significant contributors to overall exposure (e.g., rural case), and one in which area and mobile sources are important contributors to overall exposures (e.g., urban case).

d) When evaluating potential risks of emitted chemicals for the purpose of determining whether or not the cumulative risks are *de minimis*, cancer risks and non-cancer health effects should be evaluated separately.

e) Given the large number of uncertainties in both the RBA and COATCEM methodologies, it is important to perform uncertainty and sensitivity analyses of each methodology. In the policy decision process, the power of these methodologies to detect differences in toxicity-weighted exposures should be compared with an *a priori* identification of the level of difference that is meaningful in a regulatory or legal sense. For example, one could define as significant situations in which the calculated risks are above *de minimis* levels, and the toxicity-weighted exposure ratios are larger than the uncertainty factors in the specific method.

f) An important next step in the validation procedure for both the ERBA and COATCEM methodologies will be to collect ambient monitoring data at sites included in an analysis of disproportionate impacts using these methodologies, in order to compare measured concentrations of chemicals with model estimated concentrations.

g) Considerations of acute exposure impacts, including irritation and odor, should be included, to the extent that methodologies are available to address acute effects.

h) In interacting with the residents of the communities being studied, it is critical to maintain good communications and to convey information on the studies in an understandable and complete manner, making sure that the uses and limitations of the methodologies are adequately addressed. Special care should be taken to explain the difference between "toxicity-weighted exposure" and "risk".

2. INTRODUCTION

2.1 Background

The background for the project was effectively provided in the documentation that provided the Charge to the SAB; specifically, "Questions for the Science Advisory Board on the Title VI Relative Burden Analyses and Cumulative Outdoor Air Toxics Concentrations and Exposure Methodology". That background is quoted as follows:

"Title VI of the Civil Rights Act of 1964 as amended (Title VI) prohibits recipients of Federal financial assistance (such as state environmental departments) from discriminating on the basis of race, color, or national origin in their programs or activities. Title VI requires Federal agencies that provide financial assistance, including the Environmental Protection Agency (EPA), to ensure that recipients of Federal financial assistance do not discriminate on the basis of race, color, or national origin. Discrimination can result from policies and practices that are neutral on their face, but have the effect of discriminating. In addition to prohibiting intentional discrimination, EPA's Title VI regulations (40 C.F.R. Part 7) prohibit facially-neutral policies or practices that result in a disparate adverse impact, unless it is shown that they are justified and that there is no less discriminatory alternative.

"Since 1993, EPA has received an increasing number of Title VI complaints that allege violations of EPA's discriminatory effects regulations from the issuance of pollution control permits by EPA recipients. EPA's Office of Civil Rights (OCR) currently has 15 open investigations, as well as 12 awaiting processing, of complaints which allege discriminatory effects of permitting decisions. On February 5, 1998, EPA released its Interim Guidance for Investigating Title VI Administrative Complaints Challenging Permits (Title VI Interim Guidance) which is an internal guidance document that describes how OCR will process these types of complaints. Generally, Title VI complaints are subject to the following process: 1) initial finding of disparate impact, 2) presentation of rebuttal evidence, 3) identification of legitimate justifications, and 4) identification of less discriminatory alternatives. EPA is currently focused on developing sound methods for establishing the first element of this process - the initial finding of disparate impact. OCR is interested in developing tools that can be used repeatedly with some ease so that ultimately they may be used by recipients and others as a means of identifying potential Title VI disparate impacts in the context of individual permit decisions.

"The investigation and resolution of Title VI complaints regarding potential discriminatory effects of environmental permitting decisions is precedent-setting and may have implications on how recipient agencies implement their environmental permitting programs to ensure no person is discriminated against based on race, color, or national origin. As a result, the issue of how to measure disparate adverse impacts from permitted facilities has had high visibility in the news media, as well as generated interest and debate within the industrial, state/local government, and environmental justice communities.

"A. Context for Assessing Title VI Violations

"EPA's Title VI discriminatory effects regulations are violated if facially-neutral policies or practices result in a disparate adverse impact, unless it is shown that they are justified and that there is no less discriminatory alternative.

"Most of the Title VI administrative complaints filed with OCR under the discriminatory effects standard have involved the issuance of permits for facilities ordinarily considered to be undesirable, including hazardous and municipal waste landfills and incinerators. Some complaints have involved permits for product manufacturing facilities. These activities, requiring environmental pollution control permits, may have both positive impacts (e.g., economic development, necessary services, employment opportunities) and negative impacts (e.g., pollutant emissions and discharges, noise, odors, accidents) upon the surrounding areas and nearby populations. OCR recognizes that positive impacts can and often do result from the operation of such facilities and that such positive impacts can be considered in the justification phase of the Title VI analysis. However, the particular methods and analytic tools discussed herein are solely to measure and analyze specific negative (undesirable) impacts on the surrounding community.

"The Title VI Interim Guidance states that investigations will include an evaluation of permitted facilities 'which together present cumulative burden or which reflect a pattern of disparate impact.' OCR anticipates that many of these Title VI investigations will involve evaluating aggregated, or cumulative, impacts on population subgroups defined by race, color, or national origin. The range of permitted facilities within the scope of these investigations is potentially broad. To determine whether the operation of permitted facilities poses, as an initial matter, a disparate adverse impact based on race, color, or national origin within surrounding populations, OCR needs a method of measuring or estimating the difference in the impact between population subgroups. First, OCR needs to determine whether population subgroups defined by race, color, or national origin are experiencing a substantial difference in impact (i.e., disparity of impact). Second, OCR will determine whether the impact experienced by such population subgroups are at or above a level of concern (as opposed to de minimis) so as to be considered adverse (i.e., the impact is harmful). The determination of whether an identified disparity is substantial and whether the impact is at or above a level of concern are policy issues. However, the methods and tools used to identify the disparity and to measure the impact used in these policy decisions are scientific in nature and should be subjected to peer review.

"B. Approaches to Analyzing Impacts of Permitted Toxic Air Emissions

"In developing the methodologies described below, EPA considered the number and types of facilities potentially involved in these complaints, regulatory time constraints for resolving Title VI administrative complaints (i.e., 180 days), the type of data likely to be made available in such a time frame, as well as resource implications for OCR and recipient agencies. These considerations limit the nature and level of analysis that can be performed and preclude the conduct of detailed risk assessments.

"Impacts from permitted industrial activity tend to be distributed in certain geographic patterns relative to the facilities themselves. Permitted air emissions (stack and fugitive emissions) impact surrounding populations via local wind patterns and inversely with distance from the facility. To determine whether permitted "toxic" air pollution emissions have a disparate adverse impact on population subgroups defined by race, color, or national origin, EPA has developed and applied relative burden analyses [RBA] in an investigation of a Title VI administrative complaint that alleges the Louisiana Department of Environmental Quality's issuance of a Title V permit under the Clean Air Act to Shintech, Inc. for a proposed polyvinyl chloride facility will result in discriminatory effects (i.e., an unjustified disparate adverse impact) on African Americans. The analyses assist EPA in determining the average burden from these combined toxicity-weighted Toxics Release Inventory (TRI) air emissions upon one population subgroup compared to another and to obtain rough estimates of cumulative risk in areas proximate to the permitted facilities.

"In addition, EPA proposes to use, in the Louisiana complaint investigation, the Cumulative Outdoor Air Toxics Concentration and Exposure Methodology (COATCEM). This methodology is similar to the Office of Policy (formerly, Office of Policy, Planning and Evaluation) Cumulative Exposure Project (CEP) methodology that was reviewed by the Science Advisory Board (SAB) in 1996 (SAB, 1996). Like the CEP, the proposed COATCEM approach uses a Gaussian dispersion model to analyze outdoor air concentrations of hazardous air pollutants (HAPs) over large areas from point sources, mobile sources, and area sources in combination. Emissions estimates to be used in the model include data for approximately 115 individual HAPs from the 1996 Louisiana Toxics Emissions Data Inventory (TEDI) and, for mobile sources and area sources, from EPA's National Toxics Inventory. Modeled concentrations for individual HAPs will be compared with health benchmark concentrations for the HAPs to develop several multiple-pollutant metrics. The technical approach for COATCEM will be similar to that for CEP, but will be done on a census block level of resolution, while the CEP was conducted at the census tract level.

"OCR plans to use both methodologies, as appropriate, to generate information about disparity of impacts, potential harm of toxic air emissions from a variety of facilities, and estimates of the overall cumulative background levels of risk from sources in the area of concern. This information will supplement other evidence regarding other impacts gathered during the course of an investigation and will be useful to consider in making the policy-level decisions that must be made in Title VI cases."

2.2 Charge

The Charge to the SAB consisted of 14 specific questions that are detailed in Section 4.0 (Responses to Charge Questions) below. The questions addressed specific aspects of the relative burden analyses (RBA) and Cumulative Outdoor Air Toxics Concentration and Exposure Methodology (COATCEM) methodologies. The intent was to focus the SAB review on particular technical aspects of the methodologies. In preparing this report, the SAB was guided by the Charge questions, which are answered in detail in Section 4.0, but was not limited by the questions. In Section 3.0 (Overall Findings and Recommendations) below, the SAB has offered advice on more general matters beyond the Charge and summarized its review in a set of overall Recommendations.

2.3 SAB Review Process

At the request of the EPA Office of Civil Rights (OCR), the Disproportionate Impact Analysis Methodology Panel of the Integrated Human Exposure Committee (IHEC) of the Science Advisory Board (SAB) met on September 3-4, 1998, to review two methodologies developed to analyze potential disproportionate impacts to populations in specified areas from air emissions from various sources. The Committee evaluated the document on the methodologies, as well as submitted supporting data, and considered written comments submitted by interested parties and oral comments delivered by the public at the meeting.

The Charge and this report are limited to an evaluation of scientific merits of two data modeling methodologies. At the time of the review, the Agency had not yet developed a policy on what model outcomes would constitute substantial differences in impact. A thorough understanding of the science and its limitations should assist the Agency in developing its interpretive policy.

The IHEC draft report was made available to the Agency and the public prior to the October 28-29, 1998 SAB Executive Committee (EC) meeting. The EC reviewed the report for matters of fact, clarity, and completeness in addressing the Charge. Following incorporation of EC comments, the report is being sent to the Administrator.

3. OVERALL FINDINGS AND RECOMMENDATIONS

3.1 Introduction

The IHEC commends the OCR for its efforts to explore utilization of modeling to estimate chemical-specific impacts on geographic-specific populations at the census block level as a tool to assist in Title VI decisions. The IHEC recognizes that the 180-day requirement for responding to Title VI complaints places significant restraints on the practical ability to use the most scientifically rigorous methods to address the ultimate complex circumstances -- multi-chemical, multi-source, multi-pathway environments -- present in communities. Thus, a “rigorous” risk assessment approach may not be feasible. Emissions data availability limitations coupled with the simplifying assumptions present in the currently available models necessarily relegate the model outputs to a limited, secondary role in support of Title VI decisions. The utility of these models is quite different from the comprehensive risk assessments upon which regulatory decisions elsewhere in the EPA are based. The outputs from the Relative Burden Analysis (RBA) should be considered supporting indicators and not primary information upon which to base decisions. COATCEM methodology is an advancement over the RBA and shows great promise. However its application to a Title VI analysis has not been fully developed.

Within the identified programmatic constraints (time, utilization of existing nationwide data), the OCR has made a strong good start, and IHEC encourages OCR to not only continue its efforts to further develop modeling tools applicable to their needs but also to concomitantly carefully define how such model results will contribute to Title VI decisions.

The two methodologies reviewed by the IHEC are the Relative Burden Analysis (RBA), developed by the Office of Research and Development (ORD), and the Cumulative Outdoor Air Toxics Concentration and Exposure Methodology (COATCEM), developed jointly by the Office of Air and Radiation and the Office of Policy. The RBA has contains two versions, the Basic Relative Burden Analysis (BRBA) and the Enhanced Relative Burden Analysis (ERBA). Certain technical flaws have been identified that need to be addressed before either of the proposed methods would be considered viable for immediate use.

To address potential disproportionate impacts among populations, both variations of the RBA methodology estimate the “burden” to specified populations within the vicinity of a group of permitted facilities. In RBA the burden is the measure of intensity. To calculate burden, both BRBA and ERBA convert chemicals known to be emitted from the areas of concern into a pseudo-chemical using relative toxicity weighting factors. In creating the pseudo-chemical, cancer risks and non-cancer toxicities of individual chemicals are combined using a defined conversion factor.

The COATCEM methodology calculates three different metrics of the modeled air toxics to deal with differential impacts among populations; they are cancer risk, non-cancer toxicity hazard ratio, and total benchmark exceedances. COATCEM evaluates hazardous air pollutants with known toxicity values (i.e., cancer slope factors and reference concentrations) individually.

Table 1 summarizes relevant information on the two methodologies, including BRBA and ERBA.

TABLE 1: COMPARISON OF DISPROPORTIONATE IMPACT ANALYSIS METHODOLOGIES

ATTRIBUTE	RBA		COATCEM
	BASIC (BRBA)	ENHANCED (ERBA)	
Medium of Releases	Air	Air	Air
Sources Evaluated	Point Sources	Point Sources	Point, Area and Mobile Sources
Point Sources Evaluated	Stack, Fugitive	Stack, Fugitive	Stack
Source of Emissions Data*	1995 TRI Data; some 1996 TEDI** Data	1995 TRI Data; some 1996 TEDI Data	1996 TEDI Data, supplemented by TRI Data; National Toxics Inventory
Type of Emissions Data	Mainly Estimated/Some Monitored	Mainly Estimated/Some Monitored	Estimated
Exposure Pathways Evaluated	Inhalation	Inhalation	Inhalation
Air Dispersion Modeling	None	ISC-LT	ISC-ST
Ambient Distribution of Emissions from Each Facility	Uniformly Distributed in Circle of Specified Radius with Center at Facility	Function of Air Dispersion Modeling	Function of Air Dispersion Modeling
Nature of Dispersion of Emitted Chemicals	Not Applicable	All assumed to disperse in the same way***	All assumed to disperse in the same way***

ATTRIBUTE	RBA		COATCEM
	BASIC (BRBA)	ENHANCED (ERBA)	
Consideration of Deposition/Re-Emission	No	No	No
Comparison of Calculated Chemical Concentrations with Monitored Concentrations	No	No	Some
Chemicals Evaluated	TRI Chemicals	TRI Chemicals	HAPs, chemicals identified as important in RBA process
Total Number of Chemicals that could be Evaluated	>650	>650	115 (HAPs with toxicity benchmarks)
Approach to Chemical Toxicity	Risk Screening Environmental Indicators toxicity weights of chemicals to develop pseudo-chemical	Risk Screening Environmental Indicators toxicity weights of chemicals to develop pseudo-chemical	Use of cancer and non-cancer toxicity benchmarks for chemicals with sufficient toxicity data
Evaluation of Chronic Effects	Yes	Yes	Yes
Combination of Cancer Risks and Non-Cancer Health Effects	Yes	Yes	No
Evaluation of Acute Health Effects	No	No	No

ATTRIBUTE	RBA		COATCEM
	BASIC (BRBA)	ENHANCED (ERBA)	
Use of GIS	Source Locations, 1990 Census Data	Source Locations, 1990 Census Data	Source Locations, 1990 Census Data
Measure(s) of Disproportionate Impacts to Populations in Given Area	Relative Burden Ratio	Relative Burden Ratio	Modeled concentrations compared to (1) Cancer Benchmark Concentrations (2) Non-Cancer Benchmark Concentrations; Total Number of Benchmark Exceedances
Application of Methodology at Specified Location	Yes	Yes	No
Uncertainty Analysis Done	No	No	No
Sensitivity Analysis Done	No	No	No
Time Frame for Performing Analysis	<180 days	<180 days	May be significantly longer than 180 days

*** Emissions data listed in the table apply only to Louisiana case study. For other sites, different data sets should be used.**
**** TEDI is Louisiana's Toxic Emissions Data Inventory system. In 1996 226 facilities reported to TEDI.**
***** Assumption used for Louisiana case study**

3.2 Findings

3.2.1 Definition of burden

The Committee concluded that the definition of burden in both versions of the RBA is not sufficiently precise. In fact, burden was defined differently in the background document and in the presentation on the RBA methodology at the September 3-4, 1998, IHEC meeting. It is critical that an understandable and meaningful definition for burden be developed. In addition, the term "toxicity-weighted exposure" should be considered as a replacement term for burden, since burden can be confused with concepts of internal dosimetry such as "body burden" or "lung burden" and often is interpreted as a risk estimate.

3.2.2 Projecting *de minimis* risks from relative burden ratios

In the RBA methodology the relative burden ratio (RBR) of two populations in a given area is derived by dividing the average burden of one population in the area (e.g., African Americans) by the average burden of the second population (e.g., non-African Americans). The Committee concluded that there is a fundamental problem in the RBA methodology with extrapolating from the RBR to potential harm or risk. The issue of *de minimis* risk cannot be addressed without risk based analyses. Unless burden is defined to include evaluations of potential risks, the concept of *de minimis* risk based upon the RBR is not meaningful. A possible way to derive risks from burdens would be to determine the set of chemicals which drive the burden values and then perform a risk assessment of that subset of chemicals. Barring that, it is necessary to keep risk and burden separate. Hence, as presently defined, the RBR cannot be used to identify *de minimis* risks.

From a decision policy perspective much remains to be done. It is not clear how the proposed analyses will assist interpretation of a particular RBR. To inform policy, statistical analytic methods will need to be developed to determine whether an RBR of 1.1, 2.0, or 5.0 is significantly different from an RBR of 1.0. Will RBRs only be calculated when risks exceed *de minimis*? What consideration will be given to RBRs which are less than 1.0? Could they be indications of reverse disproportionate impacts? In cases in which calculated risks are available and indicate that risks for all of the populations are below *de minimis* levels, the relevance of the RBRs, regardless of the magnitude of the values, may be questionable and, at worst, misleading to the public.

3.2.3 Strengths and weaknesses of individual methodologies

To be useful in the time frame allowed, these models all begin with comprehensive simplifying assumptions (such as all emissions are additive, health outcomes of concern can be represented by TRI annual average data, all chemicals disperse in a similar manner, etc.) The relevance of these assumptions to a specific geographic location's emission impacts must be carefully evaluated before modeling begins, to assure that the broad uncertainties introduced by the assumptions are manageable. Thus, if the emissions data from the TRI in a locality are flawed, or TRI does not represent the chemicals of concern in a community, use of the models would be inappropriate. Similarly, the model outputs will not be able to address acute, peak effects on a community or quality-of-life issues such as odor and irritation. The Agency will need other tools to address such issues.

a) RBA methodology (BRBA and ERBA forms) - The Committee noted that the BRBA is simple, transparent, easy to use and understand, and can be easily updated. It has been utilized in one instance and can be performed in the 180-day time limit for responding to Title VI complaints.

In its current form the BRBA has a fundamental weakness which significantly limits its utility. It assumes that all emissions from a particular source are distributed uniformly within circles of specified distances (e.g., 2 miles or 4 miles) from that source and that every person living within a given circle is exposed to the same ambient concentration from the source. It does not consider distance from the emitting facility, wind direction and velocity, or stack height. The Committee concluded that, without some modifications, the BRBA is too simplistic and the output not scientifically defensible, even as a first order screening tool. To be of value, the BRBA needs, at a minimum, to include some consideration of dispersion (for example, an inverse distance function).

The ERBA is an improvement over the BRBA because it incorporates an air dispersion model, the Industrial Source Complex - Long Term (ISC-LT) model, to estimate concentrations of the pseudo-chemical at specific distances from the various facilities. Like BRBA, it is easy to use and understand and can be easily updated. It should be able to be utilized within the 180-day limit for responding to Title VI complaints.

Combining all emissions into one pseudo-chemical which is then modeled in the RBA makes the screening process manageable but leads to a number of significant limitations and potential unintended consequences because of the type and magnitude of the differences among chemicals (acute or chronic toxicity, atmospheric reactivity, etc). An approach which would still allow a manageable number of analyses might be to group chemicals into categories, depending upon their chemical/physical properties, and thus generate a set of pseudo-chemicals with similar properties. The role of atmospheric degradation of specific chemicals should be considered.

Combining cancer risk and non-cancer chronic health effects adds uncertainty. Cumulative cancer risks and cumulative non-cancer health effects could be estimated separately and would provide more transparent results. Further, different chemicals have different effects on different organ systems; adding reference concentrations for chemicals which act upon different organ systems can be problematic.

Another limitation of the RBA methodology is that it is designed only to evaluate air emissions from point sources; it does not take into account emissions from area and mobile sources. The ISC-LT model is not predictive in all circumstances, especially in urban environments with tall buildings.

b) COATCEM Methodology - The Committee concluded that the COATCEM methodology has significant potential for future use. It is more comprehensive and more resource intensive than the RBA methodology. It evaluates emissions from point, area and mobile sources, so should represent a more realistic evaluation of cumulative exposures, particularly in urban areas. It estimates air concentrations for individual hazardous air pollutants (HAPs) and evaluates separately cumulative cancer risks and non-cancer health effects of the chemicals.

However, COATCEM has not yet been applied to an actual case. Therefore, no conclusions can be reached as to whether it is an improvement over the RBA. There are presently no outcomes to compare with those of the RBA methodology, nor are there estimated ambient concentrations of emitted chemicals to compare with monitored concentrations of those chemicals.

The models used in COATCEM are relatively large and complex, which makes sensitivity and uncertainty analyses difficult and time-consuming. The quality of the emissions data for area and mobile sources will depend on the data in the 1996 National Toxics Inventory, once that data base has been completed. Given COATCEM's complexity, it remains to be seen whether it could be utilized within the 180-day limit established for addressing Title VI complaints.

Although the most promising of the methodologies reviewed, COATCEM needs further development if it is to be used by OCR. The Agency priority for further development and application of COATCEM is somewhat unclear, since the development to date of the methodology has been overseen by two EPA offices.

3.2.4 Limitations common to both methodologies

Both the RBA and COATCEM methodologies evaluate only exposures through direct contact with ambient air inhalation. Neither takes into account exposures from the drinking water, soil or food chain pathways due to air emissions; exposures from surface water discharges, underground injection or on-site land releases are also not considered.

Although both the ERBA and COATCEM methodologies use air dispersion modeling [ERBA uses the ISC-LT model, while COATCEM uses Industrial Source Complex - Short Term

(ISC-ST)] to estimate air concentrations in the vicinity of facilities with point source air emissions, both use annualized emissions data. They do not take into account short term excursions from steady state levels. As a result there could be acute exposures that may be significantly higher than the calculated steady state levels. Neither ERBA nor COATCEM evaluate deposition transfers to other environmental media of emitted chemicals or subsequent re-emission of these chemicals. In addition, both methodologies assume that all emitted chemicals disperse in the same manner. They do not take into account that some emitted chemicals are stable while others are reactive. In addition, they do not address the fact that certain chemicals are released in the vapor phase, while others are associated with particles.

The RBA and COATCEM methodologies only evaluate risks from chronic exposures. Given that acute, intermittent exposures can be significantly higher than chronic exposures, and are often the source of community complaints about decreased quality of life, failure to consider acute risks is a serious limitation of both methodologies.

Neither of the methodologies consider length of residence of persons within the census blocks or their activity patterns, including time spent indoors versus outdoors. Nor do they consider population mobility such as the percentage of persons employed at other locations.

Both methodologies utilize Toxics Release Inventory (TRI) data on annual air releases reported by specific facilities. These data are useful but have certain limitations, since they are self-reported by facilities and are often based upon estimates rather than upon monitored emissions. Moreover, not all types of facilities are required to report release data to TRI, nor are all chemicals emitted from a facility required to be reported. In addition, specific chemicals at some of the facilities may be used only at certain times during the year, so using average annual emission rates for such chemicals is not appropriate.

3.3 Specific IHEC Recommendations

a) All disproportionate impact analyses should be conducted in a stepwise manner. The first step should be to examine site-specific data (including both actual measured emissions and TRI reports) to determine whether the air pathway and chronic exposure are appropriate surrogates for community burden calculations and then determine which methodology to select for the initial analysis. It is appropriate for screening purposes to start with simpler methodologies to identify the chemicals or classes of chemicals upon which to focus in subsequent analyses. Hence, a modified form of BRBA which includes a simple distance function might be the first methodology applied. If more detailed analyses are desirable, ERBA could be used to identify burdens based upon air dispersion modeling of chemicals from the facilities. To assess whether the risks associated with the derived burdens are *de minimis*, risk assessments of the chemicals/classes of chemicals that are the drivers for the burden values could then be performed.

b) The relevance of RBR determinations is questionable when all populations exhibit either *de minimis* risk or risks demanding action. In the tiered approach suggested, the Agency should consider the sequence in which these analyses, i.e., determining the potential "risk" to all populations before estimating disproportionate impact, are performed.

c) The Agency should use the term "toxicity-weighted exposure" instead of "burden." Further, EPA needs to develop a more specific and consistent definition of "toxicity-weighted exposure" for the RBA methodology. The policy decision as to whether the toxicity-weighted exposure is considered adverse should be risk-based. The current RBA burden analyses will not provide useful information to accommodate this decision.

d) COATCEM has significant potential and should be developed further. In calibrating and validating this methodology, the Agency should consider two test cases - one in which mobile and area sources are not considered significant contributors to overall exposure (e.g., rural case) and one in which area and mobile sources are important contributors to overall exposures (e.g., urban case).

e) When evaluating potential risks of emitted chemicals for the purpose of determining whether or not the cumulative risks are *de minimis*, cancer risks and non-cancer health effects should be evaluated separately.

f) Given the large number of uncertainties in both the RBA and COATCEM methodologies, it is important to perform uncertainty and sensitivity analyses of each methodology. In the policy decision process, the power of these methodologies to detect differences in "toxicity-weighted exposures" should be compared with an a priori identification of the level of difference that is meaningful in a regulatory or legal sense. For example, one could define as significant situations in which the calculated risks are above the *de minimis* levels and the toxicity-weighted exposure ratios are larger than the uncertainty factors in the specific method.

g) An important next step in the validation procedure for both the ERBA and COATCEM methodologies will be to collect ambient monitoring data at sites included in an analysis of disproportionate impacts using these methodologies, in order to compare measured concentrations of chemicals with model estimated concentrations.

h) Considerations of acute exposure impacts, including irritation and odor, should be included, to the extent that methodologies are available to address such effects.

i) In interacting with the residents of the communities being studied, it is critical to maintain good communications and to convey information on the studies in an understandable and complete manner, making sure that the uses and limitations of the methodologies are adequately addressed. Special care should be taken to explain the difference between "toxicity-weighted exposure" and "risk".

4. RESPONSE TO CHARGE QUESTIONS

The IHEC addressed the following 14 specific charge questions.

4.1 Question 1

The Risk Screening Environmental Indicators (RSEI) toxicity weights that Office of Pollution Prevention and Toxics (OPPT) developed have been reviewed and commented upon by the SAB within the past year (EPA-SAB-EEC-98-007). OPPT has addressed the major concerns of the SAB as to having the weights ordered on a continuous scale directly related to their toxicity values rather than in order of magnitude ``bins" and avoiding truncation of the value range. The use of these weights for the specific purpose of doing relative burden analyses in the way outlined in the review document has not been commented upon by the SAB. What are the strengths and weaknesses of this approach, which applies the toxicity weights to a number of chemicals released into the air, for the purpose of developing a burden measure?

4.1.1 Findings and Recommendations

The strengths of using the toxicity weights for individual chemicals from the Risk Screening Environmental Indicators methodology to develop a "pseudo-chemical" in the RBA are the simplicity of the approach and the ability to account for different degrees of toxicity of multiple chemicals in mixtures. This makes the modeling manageable within the 180 day requirement. In addition, data exist to assign toxicity weights to a number of chemicals of concern.

However, the simplicity of the approach is also its greatest weakness. The model assumes that in mixtures of environmental chemicals, the risks from the individual chemicals are additive. This assumption is problematic when considering the universe of chemicals, since it does not take into account possible synergism or antagonism within mixtures. However, it is a commonly used assumption in assessing risks from mixtures because of the extremely limited data base on toxicity of specific mixtures. Moreover, from a practical standpoint it is better than not taking cumulative toxicity into account.

The use of TRI data in the RBA is a limitation since such data are self-reported by facilities and are often based upon estimates rather than upon monitored emissions. Moreover, not all types of facilities are required to report release data to TRI, nor are all chemicals emitted from a facility reported to the TRI data base. In addition, specific chemicals at some of the facilities may be used only at certain times during the year, so using average annual emission rates for such chemicals is not appropriate.

Another option discussed was the use of maximum emissions levels established in the air permits of facilities. However, these data may be even less representative of actual emissions.

It is important to obtain ambient monitoring data to test the validity of the model estimates. Also a validation effort is needed in which several different exposure scenarios are tested. The methodology only considers exposures to air; exposures through other pathways are not evaluated. The approach does not consider the average duration of residence in the census blocks. The toxicity weights are strictly for chronic health effects and do not take into account acute effects, which may well be more significant. Also, ecological effects are not considered.

4.2 Question 2

The Basic Relative Burden Analysis (BRBA) method is relatively simple and may not consider important parameters such as relative proximity, weather, stack height. Please provide comment on the strengths, weaknesses, and utility of the ``basic'' method in estimating the distribution of burden to areas proximate to facilities with air emissions.

4.2.1 Findings and Recommendations

The reviewers agreed that BRBA is simple and easy to use, but concluded that it has a number of weaknesses. A fundamental weakness is that BRBA does not consider distance from the plant or wind direction and velocity, all important variables. Any approach used for assessing differences in exposures to chemicals in air should include an inverse distance function. It also does not consider atmospheric stability. The TRI data are useful but have numerous limitations. At a minimum these limitations must be discussed in the background document. Other sources of emissions data need to be examined. For example, most major corporations have meteorological towers which collect meteorologic data. Some companies measure the concentrations of emitted chemicals at plant boundaries. On a site-specific basis, these data might be obtainable within the 180 day evaluation period.

Given the large number of uncertainties in the emissions levels, it is important to perform an uncertainty analysis. Regardless of the results from the BRBA, it is necessary to do further analyses because BRBA, in its present form, cannot be used to conclude that a particular population group is more affected than another. Thus, the methodology is currently not a useful screening tool.

4.3 Question 3

The Enhanced Relative Burden Analysis (ERBA) method was an extension of the BRBA by using the Industrial Source Complex--Long Term, Version 2 (ISCLT2), a standard air model, to model the toxicity-weighted air emissions from each facility. The toxicity-weighted air emissions are modeled as if they were one “pseudo-chemical,”' although stack and fugitive emissions were treated separately for each facility. This approach has been adopted in order to make more manageable the screening evaluation of potentially hundreds of chemicals and multiple sources. Please provide comment on the utility and limitations of modeling several chemicals simultaneously as one pseudo-chemical with the model. If individual chemical properties would make this modeling method problematic, which classes of air release chemicals are likely to need to be modeled separately? Within the relatively small geographic areas analyzed, will atmospheric degradation play a major factor in the analysis?

4.3.1 Findings and Recommendations

The ERBA is more useful than BRBA because it takes into account air dispersion of the emitted species. However, it does not consider mass or density and treats all chemicals as stable and equally dispersable. A potentially serious limitation is the lack of evaluation of coupled transport in air. Also stack and fugitive emissions need to be considered separately since their effects will occur at different distances from the plant. Fugitive emissions consist mainly of volatile chemicals which may or may not be reactive; they will generally produce more local effects. Emissions from tall stacks will lead to exposures further from the plant. Atmospheric degradation and fallout are also important issues. ERBA specifically excludes evaluation of potential accidental releases, which can significantly increase short-term exposure. It would be beneficial to use a more sophisticated model.

Modeling one pseudo-chemical makes the screening process more manageable. However, the approach has significant limitations. The chemicals should be separated into categories depending upon their chemical/physical properties. For example, persistent compounds should be considered separately from those compounds which are rapidly cleared. The kinetics of the chemical in both the atmosphere and the exposed person should be taken into account. The role of atmospheric degradation of specific chemicals should be considered. Further, different chemicals have different effects on different organ systems. Combining cancer risk and non-cancer health effects is a problem. Overall cancer risks and overall potential for non-cancer health effects should be estimated separately. Another important weakness is the lack of evaluation of acute effects.

4.4 Question 4

In the ERBA method, modeling of the air emissions was truncated at 2, 4, or 6 miles. For example, in the 4-mile run, burden was added to census blocks within 4 miles from each facility, but not beyond that, and correspondingly for the 2- and 6-mile runs. Computationally, the number of census blocks potentially affected increases dramatically with increasing radius from the facility and the burden values drop off as the radius increases. (For example, with 314 facilities in Louisiana, the total number of census block-facility combinations within 6 miles of any facility was over 300,000.) What are the strengths and weaknesses of limiting the modeling to a certain radius from the facility for the purpose of evaluating burden, and specifically, 2, 4, or 6 miles?

4.4.1 Findings and Recommendations

Insufficient information was presented on the ERBA model to conclude whether limiting the modeling to a specific distance, such as 2, 4, or 6 miles, is scientifically appropriate. One needs to know what factors make the most difference. It is well known that most dispersion models are not effective beyond six miles from the source. One also needs to know the dominant chemicals from each site and how far they disperse. A sensitivity analysis is needed to understand the process before technical advice can be given on the appropriate distance at which to truncate the analysis. Moreover, determining the appropriate distance is a policy decision.

4.5 Question 5

Please provide comment on the strengths and weaknesses of the ERBA methods for analyzing the relative burdens from airborne emissions from nearby facilities for one population subgroup versus another in populations proximate to fixed air emissions sources?

4.5.1 Findings and Recommendations

The ERBA method for analyzing the relative burdens is an improvement over the BRBA method and is more scientifically defensible. A number of problems, however, exist with this method. It assumes an equal distribution of the population within each census block, which is often not the case. It also assumes that all the emitted chemicals disperse as if they were one chemical. The chemicals should be divided into groups with similar properties and then modeled. For example, the reactivity of the chemicals and their mode of transport in the atmosphere will affect their dispersion. Furthermore, the toxicity should be computed at the receptors rather than at the source of the emissions. The ERBA method uses standard models with default parameters, but it is used at sites where conditions do not meet the default assumptions. The method should evaluate site-specific conditions rather than model defaults. Sensitivity analyses should be performed using different values for various parameters. Uncertainty analyses should also be conducted.

Whenever the RBR is calculated, the uncertainties should also be discussed. Although the RBR is mathematically acceptable, its value and meaning are questionable. Calculation of a relative burden without consideration of risks to different populations is not likely not produce meaningful answers as to differential health impacts on these populations. Like BRBA, the ERBA method is a screening method. If the ERBA calculations indicate potential differential impacts, further analyses will be needed, which use more data and more realistic assumptions.

4.6 Question 6

The average toxicity weighted concentration, or burden, for each census block has been calculated. Please provide comment on the strengths and weaknesses of additional information which can be derived from the BRBA and ERBA methods, such as ranking census blocks in the state or smaller geographic area by average burden value or comparing the average burden in blocks near one facility to those near another for the purpose of identifying potential problem areas.

4.6.1 Findings and Recommendations

Regarding the average toxicity-weighted exposure, or burden, a mapping of burdens in a given area should be performed, using GIS and different colors in the census blocks, depending upon the calculated burden. Percentiles, rather than average values, should be developed for the census blocks. Based upon the color distribution, one could estimate the most impacted, as well as the least impacted, census blocks.

There are a number of weaknesses in the RBA approach. It is not known how the weighting factors are assigned when aggregating the block burden to obtain the average at one point in the census block. Performing an inter-block comparison should be undertaken only with great caution since burdens at different points could be the same, even though the chemical mixtures could be quite different. Moreover, the criterion for baseline burden has not been developed, so it is not clear how to compare two separate areas, both of which are heavily polluted.

Identifying everything in terms of burden without addressing the potential effects on human health muddies the issues. Toxicity considerations need to be incorporated more fully in the analyses, with at least a consideration of whether there is, or is not, a potential health hazard.

The Agency should use the term "toxicity-weighted exposure" instead of "burden."

4.7 Question 7

What are the strengths and weaknesses of the BRBA methodology for assessing relative impacts on population subgroups?

4.7.1 Findings and Recommendations

Advantages of the BRBA methodology are that the method is relatively easy to perform and to explain, that the models and data that are used can be easily updated, and that sensitivity and uncertainty analyses can be incorporated into model development. It can be performed in the 180-day time limit for responding to Title VI complaints. However, the simplicity of the methodology is also a basic weakness.

In BRBA a circle is drawn and the toxicity-weighted exposure is distributed uniformly to the population within the circle. This yields a set of relationships that are too simplistic. The methodology does not consider meteorology, wind speed and direction, stack height, and deposition/re-emission. A radial distribution function is needed, even for such a basic methodology. Geographic information system (GIS) mapping is a useful tool for managing data but still leaves the need to collect data on populations, such as duration at current residences and activity patterns. Census data should be reviewed for frequency of moving and the percent of employed persons.

The BRBA methodology uses air exposures as the surrogate for exposures from all pathways. This could lead to an underestimate of exposures. There is also no temporal relation for the concentration which is expressed as an annual average; emissions excursions could lead to acute health effects which are not considered. In addition, most people are concerned about their neighborhood, not just about the particular census block in which they live. Questions exist as to the completeness and quality of the TRI data base and the variations from State to State. Using a composite pseudo-chemical does not take into account differences in reactivity of chemicals and in their atmospheric transport.

The Agency should use the term "toxicity-weighted exposure" instead of "burden." Further, EPA needs to develop a more specific and consistent definition of "toxicity-weighted exposure" for the RBA methodology. Without a meaningful definition of "toxicity-weighted exposure" or "burden", it is difficult to evaluate the BRBA method. A real exposure assessment should be performed. Determining "toxicity-weighted exposures" or "burden" in census blocks may not be meaningful, particularly for those blocks in which there is no evidence of health effects or minimal projected risks, or in which there exist risks of significant magnitude to demand action. Ultimately, the important endpoint is potential for health effects. If "toxicity-weighted exposure" is to be estimated, then "toxicity-weighted exposure" values for all census blocks in a State should be calculated, and a relative ranking of census blocks in the State should be developed. Then one can compare the ranking of particular blocks with the percentage of specific populations living in those blocks.

In its present form BRBA is not a useful first-order screening tool. Until such time as an inverse distance function is incorporated into the methodology to account for dispersion, undertaking additional analyses using this methodology is problematic.

4.8 Question 8

What are the strengths and weaknesses of the ERBA methodology assessing relative impacts on population subgroups?

4.8.1 Findings and Recommendations

The main strength of ERBA as compared to BRBA is that distance from the facility is taken into account in developing measures of burden or "toxicity-weighted exposure". A steady state air dispersion model (ISC-LT) is used to calculate air concentrations of the pseudo-chemical at various locations. Wind speed and direction, and stack height are taken into account. As with BRBA, updating of ERBA is an easy task, and uncertainty and sensitivity analyses will be easy to perform.

However, deposition/re-emission is not evaluated. Also one must be clear in presentations to the public on the air dispersion model; otherwise, the function of the model may be overlooked. Aside from including a distance function based upon air dispersion modeling, ERBA suffers from a number of the same problems as does the BRBA version.

4.9 Question 9

Please provide comment on the appropriateness of the review document's interpretation of the Relative Burden Ratio, given the methodology and data used?

4.9.1 Findings and Recommendations

Regarding the interpretation of the relative burden ratio (RBR), the background document does an excellent job of stating the problems. What is missing, however, is how to interpret different relative burden ratios. For example, what is the significance of 1.1 versus 1.0? Is 2.0 significantly different from 1.0? Even if the RBRs are determined to be significantly different in a mathematical sense, the EPA needs to determine the level of difference that is meaningful in a regulatory sense. The RBR is a screening tool; it cannot be used in risk assessment and should only be used with caution.

The definition of "burden" in the background document is different from that given in the presentation to the IHEC. The Committee concluded that "toxicity-weighted exposure" is a better term than "burden" since burden can be confused with concepts such as body burden.

A reality check on the RBA methodology would be to collect from State monitoring stations ambient air concentration data of chemicals considered in ERBA and then compare the concentrations of the chemicals from the monitoring data and the ERBA calculations.

4.10 Question 10

Please provide comment on the strengths and weaknesses of the ERBA method of estimating general risk and hazard numbers from concentration burdens and its utility for screening out *de minimis* burdens.

4.10.1 Findings and Recommendations

ERBA provides a more accurate estimate of concentrations of the pseudo-chemical in air than does BRBA. It is a relatively simple approach, which could be performed within the 180 day time frame of Title VI complaints, and it should be generally understandable by the public.

Like BRBA, however, it does not take into account emissions from area and mobile sources. This is a problem for screening out *de minimis* burdens since ERBA does not take into account cumulative exposures. Thus, it is not a sequential screening tool. In rural locations, area and mobile sources may not be an important issue. But in cities, area and mobile sources are significant contributors to cumulative exposure and must be considered.

Another problem with ERBA is that it does not subdivide the emitted chemicals into subclasses according to how they behave in the environment. Different areas surrounding an emissions source will be impacted more by particular classes of chemicals. One should develop different risk indices for the various classes of chemicals.

For screening purposes only, it is reasonable to lump cancer risks and non-cancer health effects together. However, to make recommendations about *de minimis* risks, cancer risks and non-cancer health effects need to be considered separately. One can add “toxicity-weighted exposures” or “burdens”, but cannot add cancer and non-cancer effects. Also *de minimis* risks may vary by nature of the population in specific areas (e.g., Hispanic families generally have larger families than Anglos in the same area).

There is a fundamental problem with extrapolating from RBR to potential harm or risk. Unless one can derive health risks from burdens or toxicity-weighted exposures, the concept of a *de minimis* risk based upon the RBR is meaningless. To estimate risks, one must evaluate the risks of individual chemicals, or of several classes of similarly acting chemicals. A possible way to derive risks from burdens would be to determine the subset of chemicals which drive the burden values and then perform risk assessments of this subset of chemicals. Barring that, it is necessary to keep risk and burden separate.

It is also important to inform the communities that the ERBA and BRBA methodologies do not address health outcomes, only burdens.

4.11 Question 11

The ambient concentration modeling methodology associated with COATCEM is similar to that used in several previous studies conducted by EPA and reviewed by the SAB (e.g., EPA-SAB-IHEC-96-004; EPA-SAB-EEC-98-007). Are there any assumptions or input data involved in the COATCEM approach which would change the SAB's earlier judgements? Please provide comment on the strengths and weaknesses of the approach for assessing concentrations for the disparate impact analysis given the large number of sources and chemicals considered in the analysis?

4.11.1 Findings and Recommendations

Limited detail has been presented on the COATCEM methodology, so it is difficult to answer whether there is anything that would change the SAB’s earlier judgments on the Cumulative Exposures Project (CEP). However, the SAB had some reservations concerning the reliability of the results from the CEP. It was noted that the CEP needed a strategic plan for the collection of data and calibration and validation of the model. The SAB was also concerned that the description of the modeling process did not detail its capabilities and limitations and that the process did not model the uncertainties. Nor did it contain a sensitivity analysis. Based upon the limited information presented on COATCEM, there is no evidence that COATCEM has yet dealt with these issues.

Regarding the strengths and weaknesses of COATCEM, it is a more comprehensive and more resource intensive approach than the RBA method. It includes evaluation of the contributions of stationary, area and mobile sources. Conceptually, it is moving in the right direction. The level of detail on the 188 HAPs is good. It evaluates cancer risks and non-cancer health effects separately.

However, the method has never been applied, so it is not possible to assess whether it is an improvement over the RBA. The models used are relatively large and complex. This makes performing sensitivity and uncertainty analyses difficult and time-consuming. At present the method only evaluates HAPs, so some important chemicals are not included, which could result in an underestimate of risks. Questions exist as to the availability and reliability of the data on area and mobile sources; when completed, the 1996 National Toxics Inventory may address this issue. In calibrating and validating the method, one should evaluate two test cases - one in which mobile and area sources are not important in terms of exposure, and one in which area and mobile sources are important contributors. Given COATCEM's complexity, it could take more than 180 days to utilize the method in any Title VI case.

It was agreed that there is a trade-off between value added and complexity added in using a validated version of COATCEM. The value added by COATCEM cannot be analyzed at this time because there is no outcome to compare to the outcome of ERBA.

COATCEM has significant potential and should be developed further. The priority within the Agency for further development and application of COATCEM is somewhat unclear, since the development to date of the methodology has been overseen by two EPA offices.

4.12 Question 12

Please provide comment on the strengths and weaknesses of the COATCEM method for: (1) evaluating the relative burdens from airborne emissions from nearby facilities for one group versus another in a population proximate to fixed air emissions sources, and (2) its utility in screening out de minimis burdens.

4.12.1 Findings and Recommendations

The conceptual framework of COATCEM is scientifically defensible for various populations and sub-populations. The method calculates cancer risks and non-cancer health effects separately and estimates the contributions of area and mobile sources to burden as well as those of point sources. It represents a step into the future. A significant advantage is that disproportionate impact measures can be converted into risk indices since COATCEM uses more of a statistical approach than a relative ratio approach. The statistical methods can include effect modifiers and census data covariates. Because COATCEM is a risk-based approach, it has the potential to be used to screen out *de minimis* risks by comparing atmospheric concentrations of chemicals at specific locations to benchmark concentrations. This is an advantage over the RBR approach.

The strengths of COATCEM are dependent, however, on the ability to obtain significant amounts of data. Moreover, like ERBA, it does not take into account atmospheric chemical transformations, deposition, or variations in dispersion modeling around large bodies of water. It does compare monitored and modeled data, but does not make corrections on the basis of the monitored data. It only considers HAPs, but other chemicals can be added. Estimates of whether risks are greater than *de minimis* levels could be improved by grouping chemicals into appropriate chemical classes.

4.13 Question 13

The BRBA, ERBA, and COATCEM approaches described in the review document may be applied to various geographic scales (e.g., national, regional, state, basin, county, place) and collections of sources. Given the inherent uncertainties described in the review document, please comment on how the results of the analysis relate to the resolution of the input data, the varying geographic scales, and numbers of sources being analyzed.

4.13.1 Findings and Recommendations

The uncertainties of BRBA, ERBA and COATCEM are well described in the background document. Because of the relative magnitude of the uncertainties, the Committee questions whether the level of spatial detail used in the disproportionate impact analysis is consistent with the accuracy of the methods. For example, it is not clear why a 50 meter-by-50 meter dense receptor grid is used in ERBA to obtain averaged results within a census block. The use of a centroid concentration by census blocks, as is done in COATCEM, is appropriate if the model used is accurate and has been validated at census-block scales. There are situations in which the use of census blocks can have accuracy problems. For example, if tall buildings are located within the grid, downwash and channeling of the plume will occur. These processes make it difficult to model dispersion at small scales. This is especially an issue in cities.

It is not clear that COATCEM can handle large numbers of chemicals. Like RBA, COATCEM only addresses inhalation exposures.

COATCEM is a variation of the CEP model, which is known to under-predict ambient chemical concentrations. In order to be protective from a public health standpoint, predicted air concentrations should be greater than monitored air concentrations.

COATCEM (and ERBA) can model dispersion of emissions out to 30 miles. Point, area, and mobile emissions sources can all be modeled. It is important that all the input data be collected during the same time periods. If the data are collected at different times, then it is difficult to compare census blocks. It is crucial to use actual data from an area such as the Louisiana Industrial Corridor to validate COATCEM and to compare its outputs with those of ERBA.

The geographic scale should be defined so as to be able to provide information that would be requested by discrete communities (e.g., neighborhood associations).

4.14 Question 14

Overall, what are the other major uncertainties involved in using the BRBA, ERBA, and COATCEM methods to address disparate impact issue? Are there situations where these methods would have to be modified because the models used are not suitable? What research or improvements in the methodologies would be most helpful to focus upon in the next few years?

4.14.1 Findings and Recommendations

There are four categories of uncertainty (variability/ heterogeneity, true uncertainty, model uncertainty, and decision rule uncertainty). Of these, the least important and easiest to deal with is variability and heterogeneity, while the most important and hardest to address is decision rule uncertainty. Examples of decision rule uncertainty in the disproportionate impact methodologies are the definition of relative burden, the location at which to stop evaluating source emissions, and the decision to combine (or not to combine) cancer risks and non-cancer health effects. To improve the process, one should start by decreasing decision rule uncertainties. RBA (both the basic and enhanced versions) have more model uncertainty than does COATCEM, but there are more inputs to COATCEM.

Comparing the outputs of the RBA and COATCEM methods to actual monitoring data will provide key information on the degree of uncertainty associated with the air modeling used in the two methodologies. It is important for the modelers to communicate with the persons who perform the air monitoring. There is a need to improve the emissions inventories; for COATCEM to be validated, it will be important for the 1996 National Toxics Inventory to be completed.

Other areas of significant uncertainty are the absence of an assessment of acute health effects in any of the methodologies and the lack of assessment of exposures other than from the inhalation pathway. All methodologies should evaluate cancer risks and non-cancer health effects separately. More than one pseudo-chemical should be evaluated; toward this end, the chemicals should be categorized into important chemical classes. If, however, only one or two chemicals in a study area are the primary contributors to exposure concentrations, it will not be necessary to model all of the chemicals emitted.

Because of the significant uncertainties in any of the estimates of toxicity-weighted exposure, there is a need for strategies to apply these estimates in the context of the uncertainties. One strategy would be to define as significant only those toxicity-weighted exposure ratios that are larger than the uncertainties in the method used to estimate them. Thus, if the method is only able to make estimates that are good to a factor of 2, a ratio of greater than 2 would be required. If the method is only good to a factor of 10, a ratio of greater than 10 would be required. In practice, this would require that relative "burden" ratios could only be considered significant for situations in which the calculated risks are above *de minimis* levels, and the ratios are larger than the uncertainty factors in the specific method.

Burden should derive from risk considerations, not vice-versa. First the atmospheric concentrations of the emitted chemicals at key locations should be calculated. Then health benchmark values should be used to determine whether estimated risks are below, at, or above *de minimis* levels. It is only at this point that burden should be analyzed. When analyzing burden, it is important to keep in mind that multiple factors contribute to disease states, including lifestyles, genetic polymorphisms, and nutrition.

The community does not care which model is used; they just want to know whether the outcome is defensible and to have it be explained in understandable terms.

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