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AN SAB REPORT: REVIEW OF HYDROGEN FLUORIDE STUDY: REPORT TO CONGRESS

REVIEW OF THE OSWER/CEPPO DRAFT HYDROGEN FLUORIDE STUDY: REPORT TO CONGRESS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

EPA-SAB-EEC-93-004

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

December 9, 1992

Honorable William K. Reilly
Administrator
U.S. Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

Subject: Science Advisory Board report on review of the OSWER/CEPPO draft document "Hydrogen Fluoride Study: Report to Congress"

Dear Mr. Reilly:

The Science Advisory Board (SAB) has completed its review of the Office of Solid Waste and Emergency Response (OSWER), Chemical Emergency Preparedness and Prevention Office (CEPPO) "Hydrogen Fluoride Study: Report to Congress" (May 1992 Draft) and is pleased to submit this report. The attached report stems from a public meeting conducted on July 7 and 8, 1992 by the Hydrogen Fluoride Review Subcommittee (HFRS) of the Environmental Engineering Committee (EEC), supplemented with invited experts from academia, industry and environmental groups. This group reviewed the draft document, received briefings from the Agency's OSWER/CEPPO staff managers and scientists who developed the document, debated technical arguments, and offered advice to the staff on the current draft document.

In contrast to most SAB projects, in this instance we were not asked to review a completed document. Certain essential elements that were missing from the draft document are scheduled to be added later. Specifically, we are alerting you to the fact that the SAB has not reviewed the Findings and Recommendations that will eventually be included in the final version of the Agency's Report to Congress. However, we also would like you to be aware that we did in fact accept this review without the Findings and Recommendations, because of the importance of making sure that the technical issues are properly understood. Without reviewing the full document, it is impossible to establish whether conclusions drawn are supported by the technical details that are presented in the draft document. The Subcommittee strongly recommends that the full report, including

the findings and recommendations, be reviewed when it becomes available in order to ensure scientifically sound interpretation of data.

We commend the Agency's CEPPO staff for collection of a large amount of background information on the properties, hazards, industrial uses, regulations, and accidental releases of hydrogen fluoride in the short time dictated by the Clean Air Act Amendments. We note that the CEPPO staff's approach is basically sound. Despite the limitations listed below, the draft is well-organized and well-written, providing good, though limited, background information about the chemical, its properties, and current practices associated with its production and use. We also note that the CEPPO staff has properly focused their strategy on the uses, properties and hazards associated with the anhydrous form of hydrogen fluoride (HF). Throughout the report, the SAB refers to HF as the anhydrous form, unless otherwise noted.

Consistent with the draft HF report to Congress, the HFRS identified HF production and use to be important to a wide range of stakeholders. For example, HF is used in a wide range of industries including alkylation catalysis in the production of clean fuels, production of fluorocarbons, nuclear applications, aluminum production and production of various chemical derivatives. Increased regulation of HF could potentially have far reaching impacts with extension to other chemicals. Thus, it is important for EPA, the Office of Management and Budget (OMB), the Congress and others to be sensitive to this issue and made aware of the specific nature of those impacts.

In keeping with the tenets of Total Quality Management (TQM), we encourage the Agency to go through a process of "aligning with its customer" for development of this document. If Congress intends for the Agency to conduct an in-depth analysis of the uses of HF in the economy, then considerably more work needs to be done, since the current draft document is incomplete in this area. Further, even if Congress has not explicitly asked for it, we believe that the document should include an assessment of alternatives to HF, since there may be a Congressional sense that the use of HF should be limited or eliminated --without adequately considering the consequences; cf., studies conducted by other groups (e.g., American Petroleum Institute) and agencies (e.g., California, South Coast Air Quality Management District). We believe that the customer (Congress) should be made aware of the progress that has been made in preventing HF-related accidents and in ameliorating the associated harmful effects. In short, the Agency's document should put the hazard issues associated with HF into a larger context. For instance, the Subcommittee raises the point that the hazards of HF appear not to be unique relative to other industrial chemicals, such as chlorine, fuming sulfuric acid, phosgene, and ammonia.

The authors of the draft Report to Congress would do well to study the February 26, 1992 F. Henry Habicht, II memorandum on Risk Characterization and the appended Risk Assessment Council (RAC) Guidance for Risk Assessment. In that document, the Deputy Administrator, and the RAC provide explicit guidance to Agency personnel on how to develop exposure scenarios, both "worst-case" and "best estimate." The current draft document seems uncertain in how to respond to the Congressional request to consider "...a wide range of events, including worst-case accidental releases." The Risk Characterization memorandum and RAC attachment explicitly explains how this can and should be done. The Subcommittee recognizes that the CEPPO staff is currently working to quantitatively address these hazards, as has been recommended in this review.

The draft document utilizes a computer model to estimate exposures associated with releases of HF. We refer the Agency to an earlier report from the SAB, entitled Resolution on Use of Mathematical Models by EPA for Regulatory Assessment and Decision-Making (EPA-SAB-EEC-89-012). That report addresses a number of concerns with the use of models that should also be explicitly considered in this document as a Report to Congress; e.g., input scenarios and model validation.

Finally, we would like to stress that the CEPPO staff should continue to examine the newly-passed (February 24, 1992) Occupational Safety and Health Administration (OSHA) 1910 "Process Safety Management (PSM) Rule" relative to accident prevention for highly hazardous chemicals. The Subcommittee recommends that the CEPPO staff expand its discussion of the PSM standard, and more importantly, address its role in controlling accidental releases of HF. This newly enacted rule establishes performance standards for safety management of hazardous substances, and HF is one of many chemicals covered by this rule.

The SAB has offered a number of broad-ranging and specific recommendations to improve the quality and usefulness of the current draft document. In summary, the draft document is a reasonable work-in-progress. However, limitations identified in the body of this letter need to be addressed prior to the finalization of this report. In this manner the revised report would have increased utility as a Report to Congress, and for this body to make decisions based on sound technical information regarding HF.

We are most pleased to have had the opportunity to be of service in the preparation of this important document and look forward to your response.

Sincerely,

Dr. William Randall Seeker, Chair
Hydrogen Fluoride Review Subcommittee
Environmental Engineering Committee
Science Advisory Board

Mr. Richard Conway, Chair
Environmental Engineering
Committee
Science Advisory Board

Dr. Raymond C. Loehr, Chair
Executive Committee
Science Advisory Board

NOTICE

This report has been written as a part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency; hence, the comments of this report do not necessarily represent the views and policies of the Environmental Protection Agency or of other federal agencies. Any mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

The Hydrogen Fluoride Review Subcommittee (HFRS) of the Environmental Engineering Committee (EEC) of the EPA Science Advisory Board has reviewed the Office of Solid Waste and Emergency Response (OSWER), Chemical Emergency Preparedness and Prevention Office (CEPPO) draft Report to Congress entitled "Hydrogen Fluoride Study: Report to Congress," May 1992 draft and offered a number of recommendations.

The HFRS agrees that Hydrogen Fluoride (HF) production and use is important to a wide range of stakeholders. Increased regulation of HF could potentially have far-reaching impacts if extended with regard to other chemicals. The Subcommittee suggested that a study using life cycle analysis concepts of health, environment and safety could be undertaken concerning both the use of HF and alternatives to the use of HF, noting that Congress should be advised whether alternatives to HF have substantial risk. The Report to Congress should indicate the implications of the findings of this study on the evaluation of hazards associated with other industrial chemicals.

The HFRS recommended that the Agency employ a more rigorous definition of the concepts of hazards, consequences and worst-case scenarios, and that a credible worst-case accidental release scenario be developed. The HFRS made substantial recommendations on the use of dispersion models as they apply to various accident scenarios, and a number of other specific recommendations intended to improve the draft report to Congress.

Key Words: Hydrogen Fluoride, Hydrogen Fluoride Study, Hydrofluoric Acid, Report to Congress

U.S. ENVIRONMENTAL PROTECTION AGENCY
Science Advisory Board
Environmental Engineering Committee
Hydrogen Fluoride Review Subcommittee

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Dr. Jerry Havens, Distinguished Professor, Department of Chemical Engineering, University of Arkansas, Fayetteville, Arkansas

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1. EXECUTIVE SUMMARY

The Science Advisory Board (SAB) has completed its review of the Office of Solid Waste and Emergency Response (OSWER), Chemical Emergency Preparedness and Prevention Office (CEPPO) draft document entitled "Hydrogen Fluoride Study: Report to Congress," May 1992 Draft, (See Appendix A - reference #10). At a public meeting on July 7 and 8, 1992, the Hydrogen Fluoride Review Subcommittee (HFRS), of the Environmental Engineering Committee (EEC), supplemented with experts from academia, industry and environmental groups, reviewed the draft document. The Subcommittee also received briefings from the CEPPO staff managers and scientists who developed the document (See, for instance, Appendix A-reference #9), received public comments (See, for instance, Appendix A-reference #3), debated technical arguments, and offered advice to the OSWER/CEPPO staff on the current draft document.

The Agency study was required pursuant to the Clean Air Act (CAA) Amendments of 1990, Section 301(n)(6) (See Appendix A-reference #8). It should be emphasized that Congress did not specify whether the study should address hydrofluoric acid or anhydrous hydrogen fluoride or both. The Subcommittee concurs with the CEPPO staff's focus on the uses, properties and hazards associated with anhydrous hydrogen fluoride. While the CAA references hydrofluoric acid (HF), the Subcommittee, for the purposes of this report, refers to HF as anhydrous hydrogen fluoride. Our findings and recommendations are aimed at improving the current draft document (hereafter referred to as the draft Report to Congress, the draft document or the HF Study). We commend the CEPPO staff for collection of a large amount of background information on the properties, hazards, industrial uses, regulations, and accidental releases of hydrogen fluoride in the short time dictated by the Clean Air Act Amendments. We found the draft document to be well organized, well written, concise and representative of the special properties, production and uses of hydrogen fluoride. However, it is not clear that the data gathered to date are sufficient to allow EPA to make a reasonable and comprehensive assessment of the potential risks associated with the production, storage or uses of Hydrogen Fluoride (HF) to surrounding communities. We noted that "hazards" are considered intrinsic properties of the potential to do harm from the use of HF whereas "risks" resulting from exposure to hazards are what relate extrinsically to the community. The current draft document lacks the scientific detail requisite for a thorough technical review. Also, some of the data appear to be out of date, due to the long time required to gather the data. For example, the future market assessment for use of HF should be updated in light of acceleration of the adoption of the Montreal protocol for phase-out of chlorofluorocarbons (CFC's) (See Appendix A-references #5 and #13).

Our major findings and recommendations of the HFRS are summarized below:

1) The report did not include any definition of the approach to be used to synthesize the findings and recommendations or to derive the conclusions. Therefore, a clear assessment of the adequacy of the data base could not be made, since the use of the data is not defined. The HFRS recommends that, as a minimum, the final draft report, including the findings and recommendations, and public comment docket, be peer-reviewed with the same rigorous process that the preliminary draft has undergone, including stakeholder reviews [stakeholders include governmental groups, labor, industry, trade associations, public interest groups, professional societies, and state and federal government agencies (See Appendix A, reference #10, page 3]. The SAB could be requested to review the final document if the Agency desires.

2) The HFRS identified HF production and use to be relevant to a wide range of stakeholders. Increased regulation of HF could potentially have far-reaching impacts with extension to other chemicals.

3) The HFRS suggests that "chemical use trees" should be used to inform the reader and foster greater awareness of the families of chemicals which are derived from HF.

4) The HFRS suggests that the Agency should not be so narrow as to only respond directly to Congress's request, but should attempt to anticipate and address the questions which their Report to Congress will generate. The most obvious of such questions is: Is HF so dangerous that its use should singularly be severely restricted, or is it similar to other materials, all of which may require special precautions?

5) It is conceivable that alternatives may be as risky or perhaps more risky than HF. The actual hazards associated with use of substitutes do not appear to have been adequately considered, especially concerning total process implications such as materials transport and handling and component regeneration. A comprehensive study using life cycle analysis concepts of health, environment and safety should be completed on both the use of HF and its alternatives. The evaluation of alternatives should be more completely considered in the report and compared on the basis of all hazards associated with the total process (i.e., life cycle implementation). If the recommended comparative life cycle analysis of alternatives cannot be conducted in a timely manner and consistent with Congressional mandates, then the Report to Congress should recommend this

critical activity as future work. Congress must be aware that the alternatives to HF do exist and they may have substantial risk. The Subcommittee further notes that until the life cycle analysis is performed, the above observation remains a presumption and not an assertion.

6) HF has unique properties and hazards which should be addressed. However, the section on properties and hazards is almost entirely qualitative, apart from the table of basic physical properties and the graphical comparison of guideline exposure levels. The numerous chemical and physical reactions unique to HF, some of which may create dangerous situations, appear to be only summarily described. The draft report did not adequately quantify the importance of these unique properties as they may contribute to accidental releases. The corrosive nature of the chemical and the heat release associated with reactions of HF with various caustic materials have contributed to past releases. Nonetheless, management of HF is not altogether significantly different from a wide range of commonly used industrial chemicals, such as chlorine, fuming sulfuric acid, phosgene or ammonia. For this reason, the approach used in this study could have broader implications for the manner in which hazards associated with other chemicals are evaluated in the future. The report to Congress should clearly state the implications of the findings of this study on the evaluation of hazards associated with other industrial chemicals.

7) The HFRS suggests follow-up visits to sites where chemical safety audits were previously undertaken as one possibility to more completely determine how current practice has changed since the audits.

8) The Subcommittee had substantial concerns regarding the dispersion modeling used in the assessment of worst-case accident scenarios. The detailed nature of the model in relation to the role of the dispersion modeling was not clearly stated in the draft report and, therefore, the HFRS was not able to comment on the adequacy of the modeling for evaluations to be performed. Nonetheless, the HFRS can make several recommendations on the use of these models in the context of regulatory decision-making. The HFRS refers the CEPPO investigators to the SAB Resolution on Use of Mathematical Models by EPA for Regulatory Assessment and Decision-Making (EPA-SAB-EEC-89-012) (See Appendix A - reference #15). This resolution addressed a number of concerns with the use of models that should be considered in this study. These include such concerns as input scenarios and model validation. In the draft report, little or no justification was given pertaining to the selected model inputs. Furthermore, the presented simulations are clearly inadequate to fully explore the consequences of postulated scenarios. A number of specific recommendations pertaining to improving modeling efforts are contained in the body of this report.

9) The definition of hazards, consequences and worst-case scenarios are central to the request from Congress for this study. However, no clear definitions were provided in the draft report, and definitions discussed during the briefing were rather arbitrary. It was not made clear to the HFRS whether the Congressional intent was to evaluate a truly worst-case scenario, even if the scenario had a very low probability of occurrence, or a credible worst case scenario based upon a scientifically defensible probability of occurrence. The HFRS recommends that the Agency (i.e, CEPPO) staff develop a more rigorous definition of these concepts in order to provide Congress with a useful assessment. The rationale for the selection of the "worst-case" HF accidental release scenarios is one of the most important aspects of the assessment of hazards and should be better established and defended. A scientifically defensible, systematic approach to the definition of the credible worst-case accidental release scenario must be developed.

10) The dose response analysis of the worst-case scenario appears to be particularly weak in the draft Report to Congress. The guideline exposure levels such as Immediately Dangerous to Life and Health (IDLH), Emergency Exposure Guideline (EEGL), and Emergency Response Planning Guideline (ERPG) are based upon times of exposure which are typically of 30 and-60 minute durations (See Appendix A-reference #14). It is inappropriate to compare peak concentrations determined from the dispersion analysis without the consideration of exposure time. The HFRS did not evaluate the adequacy of the various guideline exposure levels.

11) Regarding significant releases of HF, no information was available that would suggest such accidents are inevitable, (i.e., lie beyond the prospect of mitigation by human intervention). This suggests that HF major accidental releases can be prevented or mitigated. Prudence dictates a need for increased attention and diligence to workforce training, equipment inspection and improved monitoring, maintenance and mitigation activities. However, the CEPPO staff have made no major effort to evaluate or rank the effectiveness of various prevention and mitigation measures. At a minimum, the Report to Congress should provide all available information regarding opportunities to prevent or mitigate accidental releases, consistent with Congressional intent to prevent pollution. In addition, the standard operating procedures guidance recently proposed by the American Petroleum institute (API) for HF alkylation units (See Appendix A-reference #2) should be evaluated as to its adequacy for accident prevention, and the quantitative reductions in exposure from mitigation approaches like water quench and remote-operated valves should be determined.

12) The HF industry appears to be proactive in research associated with both new uses of HF as well as assessment and mitigation of accidental releases. Much of the current knowledge base concerning fate and transport modeling of HF after accidental releases is attributable largely to existing industry research which is not in the open peer-reviewed literature, as well as the Department of Energy (DOE) programs. The Report to Congress should address how uncertainty in the regulation of HF ought to impact and focus on research and development relative to the chemical and to its alternatives. Case histories and scenarios should be utilized to illustrate the effects on research and development of the current regulatory climate.

13) The issue of vulnerability analysis was not addressed in the draft report. This is one of the major concerns to the Local Emergency Planning Committees (LEPC's) set up under SARA Title III. These groups should be surveyed to determine if any of them have conducted Vulnerability Analyses for HF in their specific communities.

14) We would like to stress that the CEPPO staff should continue to examine the newly-passed (February 24, 1992) Occupational Safety and Health Administration (OSHA) 1910 "Process Safety Management (PSM) Rule" relative to accident prevention for highly hazardous chemicals (See Appendix A, reference #6). The HFRS recommends that the CEPPO staff expand its discussion of the PSM standard, and more importantly, address its role in controlling accidental releases of HF. This newly enacted rule establishes performance standards for safety management of hazardous materials, and HF is one of many chemicals covered by this rule.

A number of other broad-ranging and specific recommendations are made in this SAB report with the aim to improve the quality and usefulness of the current draft document as a Report to Congress. Once the CEPPO staff addresses substantitively the limitations identified in this document, then the revised report would have increased utility as a Report to Congress, and for this body to make decisions based on sound technical information regarding HF.

2. INTRODUCTION

On July 7 and 8, 1992, the Hydrogen Fluoride Review Subcommittee (HFRS) of the Environmental Engineering Committee (EEC) and consultants of the U. S. Environmental Protection Agency's Science Advisory Board reviewed the preliminary draft of the "Hydrogen Fluoride Study: Report to Congress." The EEC's HFRS was supplemented by three invited technical experts representing academic, environmental and industry perspectives. This Report to Congress was mandated by Section 301(n)(6) of the Clean Air Act (CAA) Amendments of 1990 (See Appendix A-reference #80), which required the Agency to complete a study of:

> *"the industrial and commercial applications of hydrofluoric acid (HF) and examine the potential hazards of hydrofluoric acid in industrial and commercial applications to public health and the environment considering a range of events including worst-case accidental releases and shall make recommendations to the Congress for the reduction of such hazards, if appropriate."*

The Agency has correctly distinguished between anhydrous hydrogen fluoride (HF) and hydrofluoric acid. The requirements of the CAA, Section 301(n)(6) Amendments of 1990 did not specify whether the study should focus on the anhydrous form of hydrofluoric acid. The CEPPO staff and the SAB have focused their critique on the properties and uses associated with hazards of anhydrous hydrogen fluoride, which, for the purpose of the SAB report, is referred to as HF. In normal terminology, the term HF refers to hydrofluoric acid, and not anhydrous hydrogen fluoride.

The main text of the draft document presents background information on the properties and hazards of HF, characterization of the HF industry, current regulations and initiatives, HF industry process descriptions, hazards and industry practices for processes involving HF, industry practice to detect and mitigate HF releases, characterization of HF accidents, research efforts and future actions, and community and facility emergency preparedness and planning. This preliminary draft report did not include the executive summary or findings and recommendations of the report, and these sections could therefore not be reviewed by the Subcommittee. This SAB report can only be viewed as a review of the quality of the supporting data per se, and not as a review of whether these data support particular findings as is typical in most SAB reviews. Any reference by the Agency to the SAB review should include this caveat.

Since the CEPPO staff are inviting comment from a number of sectors, including the public and the SAB, and since the time requirement in the Congressional mandate calls for a report by mid-November of 1992, the CEPPO staff have labored to assemble the basic data, and have not had the luxury of the time needed to summarize the findings and recommendations at the time that the SAB conducted its review. Nonetheless, the SAB review should be viewed as technical, and adding value to make sure that the basic building-block data are correct.

A prompt informal review was requested by the EPA. Therefore, the Subcommittee provided individual comments to the Agency and the public at the time of the meeting, but opted to later prepare a consensus report in its usual manner. The charge given to the HFRS was to review the report and to focus on the following questions:

a) Does the technical information related to chemical and process hazards of HF appear to be complete?

b) Is the industry manufacturing, processing and use information properly characterized?

c) Do the industry practices sections appear to be complete and adequately characterized?

d) Does the technical information on accident history and accident scenarios appear to be adequately characterized and complete?

The Subcommittee elected to answer the charge in a general manner, and not focus this report explicitly around the charge, especially since the draft document does not include the critical findings and recommendations. Presentations made by representatives of the EPA's CEPPO summarized the salient features of the HF report and highlighted some of the changes to be made to the HF report as a result of public comment. However, the CEPPO staff provided no indication of the likely content of the executive summary or findings and recommendations. Additionally, several public comments of a technical nature were made at the SAB public hearings; these were considered by the Subcommittee in formulating its report.

3. GENERAL COMMENTS

The CEPPO staff is commended for collection of a large amount of background information on the properties, hazards, industrial uses, regulations, and accidental releases of HF in the short time dictated by the Clean Air Act Amendments. Subject to important reservations noted in remarks that follow, the HFRS found the draft report to be a well organized, well written, concise and generally representative presentation of background information on the special properties of HF and current practices associated with the production and uses of HF. However, it is not clear that the information gathered to date is sufficient to allow the EPA to make a reasonable and comprehensive assessment of the potential risks to surrounding communities associated with the production and uses of HF. In its presentation, the report lacks the scientific detail requisite for a thorough technical review. Also, some of the data appear to be out of date. For example, the future market assessment that was conducted by the Agency for use of HF, should be updated in light of the acceleration of the adoption of the Montreal protocol for phase out of chlorofluorocarbons (CFC's) (See Appendix A-references #5 and #13). Additionally, the draft report should be reviewed for small, but distracting logical errors and that primary sources should be contacted or examined to verify information wherever possible.

As stated earlier, the draft Report to Congress did not include the executive summary or findings and recommendations, nor any definition of the approach to be used to synthesize the findings and recommendations. Therefore, an assessment of the adequacy of the data base could not be determined, since the use of the data in relation to the yet to be inserted executive summary and findings and recommendations section is not clear. At a minimum, the HFRS recommends that the final draft Report to Congress, including the findings, recommendations, and public comment docket, be peer reviewed with the same rigorous process that the preliminary draft has undergone, including stakeholder reviews and, if requested, SAB review. The HFRS recognizes that such a review could not be conducted quickly enough to allow the CEPPO staff time to complete the Report to Congress on the mandated schedule. Nonetheless, the HFRS recommends that the review of the full report be conducted, even if after the Report to Congress has been submitted, since the approach used in evaluating HF is important to the consideration of other hazardous chemicals.

The HFRS recognizes that there is a very real need to foster a thorough and objective analysis and to ensure a more complete presentation of changes in industrial practices and the ability of communities to deal with chemical emergencies. To partially address this need, the HFRS notes that "chemical use

trees" could be a useful visual tool to inform the reader and foster greater awareness of the families of chemicals which are derived from HF. In particular, the importance of this chemical to the evolution, strength, and ultimate competitiveness of affected segments of U.S. industry should be evaluated by the Agency in order to place its role in perspective for the Congress. Likewise, the consequent positive and negative impacts on communities and the concern of the public, as represented by communities and environmental organizations, needs equal attention. If the CEPPO staff cannot place such material in the Report to Congress, then they should recommend to Congress that such activity be conducted by the Agency in the future.

The Agency's response to Congress should not be so narrow as to respond only directly to Congress's request. Rather, the Agency should attempt to anticipate and address questions which their report will generate. The Subcommittee believes, in fact, that this is already explicit in the Congressional charge. The most obvious of these questions is: Is HF so dangerous that HF use should singularly be severely restricted? One aspect of this question should include consideration of the comparative risks presented by alternatives to HF. In one locality, the California South Coast Air Quality Management District (SCAQMD) apparently has determined that the use of HF is unsafe in their specific location and has regulated the phase out of HF use (See Appendix A - reference #7). This phase-out decision could result in significant costs for replacement or retrofit of existing alkylation units to an alternative sulfuric acid (H_2SO_4) alkylation process. It should be noted, however, that the SCAQMD Rule has been suspended by court action in California. It is conceivable that alternatives may be as risky or perhaps more risky than HF.

The actual hazards associated with the use of substitutes do not appear to have been adequately considered, especially concerning total process implications such as materials transport and component regeneration. A comprehensive study using life cycle analysis concepts of health, environment and safety should be completed for both the use of HF and its alternatives. The evaluation of alternatives should be more completely considered in the report and compared on the basis of all hazards associated with the total process (i.e., life cycle implementation). The Office of Research and Development (ORD), Risk Reduction Engineering Laboratory (RREL) in Cincinnati, Ohio has the capability to conduct such an analysis. If the recommended comparative life cycle analysis of alternatives cannot be conducted in a timely manner consistent with Congressional mandates, then this useful activity should be undertaken by the Agency as future work. Congress must be made aware that the alternatives to HF may have substantial risk. Another necessary consideration is the comparison of risks associated with HF and the risks associated with somewhat similar commonly-used

hazardous substances such as chlorine, fuming sulfuric acid, phosgene and ammonia.

HF has unique properties and hazards which should be carefully addressed. However, the section on properties and hazards (Chapter 2) is almost entirely qualitative, apart from the table of basic physical properties and the graphical comparison of guideline exposure levels. The numerous chemical and physical reactions unique to HF, some of which may create dangerous situations, appear to be only summarily described. The draft Report to Congress did not adequately quantify the importance of these properties as they contributed to accidental releases. The corrosive nature of the chemical and the heat release associated with reactions of HF with various caustic materials have clearly contributed to past releases. Nonetheless, management of HF is not altogether significantly different from a wide range of commonly used industrial chemicals, such as fuming sulfuric acid, chlorine, phosgene and ammonia. For this reason, the approach used in this study could clearly have broader implications for the manner in which hazards associated with other chemicals are evaluated in the future. The Subcommittee recommends that the Report to Congress should clearly state implications of the findings of this study on the evaluation of hazards associated with other industrial chemicals.

The Report to Congress should be careful in defining routine industrial practices, since this was not comprehensively characterized in this study for all U.S. facilities. Some of the general statements concerning industrial practices are not substantiated by detailed surveys. Rather, they are anecdotal accounts of an incomplete set of site visits and discussions with industry representatives. Follow-up visits to sites where chemical safety audits were previously undertaken was suggested as one way to more completely determine how current practice has changed at individual facilities since the initial audits. Also, the Subcommittee recommends that a survey of the state of mitigation (industrial and community response and prevention) readiness to such releases be conducted.

4. MODELING

The Subcommittee had substantial concerns regarding the dispersion modeling used in the assessment of worst-case accident scenarios. The detailed nature of the model in relation to the role of dispersion modeling was not clearly stated in the draft report. Therefore, at the time of the review, the HFRS was not able to comment on the adequacy of the modeling effort in relation to the evaluation that was performed. Nonetheless, the HFRS can make several recommendations concerning the use of these models in the context of regulatory

decision-making. The HFRS refers the CEPPO investigators to the SAB Resolution on Use of Mathematical Models by EPA for Regulatory Assessment and Decision-Making (EPA-SAB-EEC-89-012) (See Appendix A -reference #15). This resolution addressed a number of concerns with the use of models that should be considered in regard to this study. These include such concerns as input scenarios and model validation. In addition, the Subcommittee refers the reader to an analysis of the ALOHA model completed by one of our invited technical experts, Dr. Jerry Havens, Distinguished Professor in the Department of Chemical Engineering at the University of Arkansas (See Appendix A - reference #4, as well as Appendix B Letter to Dr. Jack Kooyoomjian from Dr. Jerry Havens, dated November 6, 1992). The EEC notes that this is an individually authored submittal, and not necessarily a consensus position.

In this draft Report to Congress, two computer models were employed to explore the potential consequences of postulated "worst-case" scenarios. Results of simulations are presented in the text for three scenarios. However, based upon the information provided in the draft Report to Congress and its Appendices, it is extremely difficult to assess the appropriateness and limitations of the models in these applications. The mathematical and thermodynamic underpinnings of the models are not described. No citations of refereed journal papers, which would support their application, are provided. The phenomena crucial to understanding HF post-release event behavior are discussed at a basic level that is likely to be informative to a lay audience, but does not provide the underlying material upon which a critical peer review can be conducted. Stated another way, since the underlying principles are not clearly elucidated, this results, at best, in a marginal technical review which lacks significant detail. For instance, it is unclear which phenomena are actually included in the conceptual and mathematical models employed to characterize the propagation of the HF cloud, how critical parameters are estimated, and how cloud movement depends on environmental conditions. Little or no justification or discussion is given pertaining to selected model inputs. Furthermore, the presented simulations are clearly inadequate to fully explore consequences of postulated release scenarios. A sensitivity analysis of simulations for a reasonable range of inputs was apparently not considered. These are serious deficiencies which greatly diminish prospects for successful use of the simulation results for formulation of conclusions regarding the consequences of HF accidents.

The Subcommittee suggested that the dispersion modeling framework used (in particular the HGSystems model) can incorporate the current state-of-the-art understanding of dispersion of HF after release. According to one expert, the industry has conducted significant research and development on dense gas dispersion and adapted models to include special chemical/physical and thermodynamic properties of HF. Near field processes such as aerosol formation,

polymerization (hydrogen bonding), and exothermic hydrolysis are unique features of HF asserted by the Agency staff to be adequately portrayed in the HGSystems model used.

The Subcommittee indicated that the model used in the EPA study has been extensively validated against wind tunnel and idealized field data, which would appear to be typical for other well-validated models. However, the report relies heavily on comparisons of modeling with field tests conducted at a DOE facility in Nevada (test series called "Goldfish") as evidence that HF dispersion behavior is adequately understood with available modeling procedures. The effects of humidity, slope, rough terrain and channel flows have apparently not been experimentally determined in these tests. For instance, the relatively low humidity of the Goldfish tests could affect HF dispersion physics. Therefore, while the physical processes are mathematically portrayed in the models (particularly the HGSystems), the model's ability to accurately simulate these important phenomena have not yet been adequately verified. This limitation should be clearly stated in the Report to Congress. Additionally, the reader is referred to Dr. Jerry Havens' November 6, 1992 analysis of the ALOHA model in Appendix B. (Also listed in Appendix A - reference #4).

The sensitivity of the modeling results to the uncertainty in their treatment of humidity and boundary effects should be examined in order to estimate the uncertainty that this lack of verification brings to conclusions drawn from the modeling. Future efforts should be undertaken to verify results predicted for more realistic conditions. To accomplish this task, more field data will clearly be required. The HFRS was advised that the U.S. Department of Energy (DOE) spill test facilities, which are apparently uniquely suited for this type of testing, are scheduled for shutdown due to lack of operating and maintenance funds. The HFRS expresses concern for the possible future loss of this valuable scientific tool, and encourages the EPA to discuss this situation with DOE.

The HGSystems dense gas dispersion model accounts for many of the critical physical/chemical processes that are considered to be important for HF dispersion. It is a complex tool that requires expertise and familiarity with regard to simulating chemical processes and modeling dispersion and meteorological phenomena for assessment of parameters and applications. It is not clear to the Subcommittee whether the users of the models in this study are experts in the use of this model. If this modeling effort is to be an important and meaningful aspect of the characterization of hazards associated with HF and other hazardous chemicals, then experts should be sought who can appropriately apply the models and interpret the results. In addition, it is not clear that this model is or should be suited for use by the Local Emergency Planning Committees (LEPC's) who

must address facility-specific issues associated with potential HF releases, and who may not be modeling experts. This issue needs to be discussed and clarified in the Report to Congress. The more simplified model, ALOHA, on the other hand, is specifically designed for planning emergency response, and as such, utilizes several simplifications in theory (See Appendix A-reference #1). The impact of these simplifications should be systematically evaluated if this model is to be used for a more comprehensive assessment of HF dispersion.

5. WORST-CASE SCENARIOS

The characterization and study of potential hazards, consequences, and worst-case scenarios are central to the request from Congress for this study. The HFRS noted that "hazards" are considered intrinsic properties of the potential to do harm from the use of HF, whereas "risks" resulting from exposure to hazards are what relate extrinsically to the community. However, no clear underlying definitions of these concepts (potential hazards, consequences and worst-case scenarios) were provided in the draft report. Definitions discussed during the briefing were rather arbitrary and difficult to rigorously employ in the absence of clear definition. It was not made clear to the Subcommittee whether Congressional intent was to evaluate a truly worst-case scenario (even if the scenario had a very low probability) or a credible worst-case scenario based upon a scientifically defensible and/or significant probability of occurrence. The HFRS recommends that the Agency CEPPO staff should develop a more rigorous definition of these concepts in order to provide Congress with a useful assessment. Additionally, the HFRS refers the CEPPO staff to the Deputy Administrator's February 26, 1992 memorandum on Risk Characterization, and the appended Risk Assessment Council (RAC) Guidance for Risk Assessment, which provides explicit guidance to Agency personnel on how to develop exposure scenarios, both "worst-case" and "best estimate." (See Appendix A - reference #11).

The selection and definition of the "worst-case" accidental releases scenarios of HF is one of the most important aspects of the hazards assessment. It is the Subcommittee's opinion that this issue has great uncertainty, is unresolved, and may strongly dictate the outcome of the hazards, risk, and consequences analyses yet to be performed. The Subcommittee has determined and recommends that the identification of credible worst-case scenarios is more important than additional background data gathering, although the currently available background information may not be adequate to apply such models. Apparently, the plausible worst-case accidental release scenarios investigated in the draft Report to Congress were defined by Agency CEPPO staff after discussions with industrial representatives, as well as many other parties. Rationale for the selection of the worst-case scenarios should be further established, refined and presented in the

revised Report to Congress.

One approach suggested by the Subcommittee was the use of dispersion modeling and probabilistic risk assessment procedures to identify and define the release parameters and accident scenarios that most influence dose response to the off-site public. Conducting sensitivity analysis on dense gas dispersion models may provide further understanding of the behavior of the most important parameters. The Subcommittee believes that some important parameters are the HF release rate, event duration, and mitigation systems. The gathering and documenting of accidental release data could be used to identify and statistically define the range of these parameters that have been encountered in actual previous HF releases. By analogy, it may be useful to examine the past releases of other compounds with similar properties in order to "broaden" the accidental release data base framework. If the data base is not sufficient to develop a statistically significant selection of initial model data input, alternative methods of selecting scenarios and data should be explored. Another approach suggested by the Subcommittee was to examine the philosophical approach used in the Agency's Risk Assessment Guidance for Superfund. (See Appendix A - reference #12).

For each scenario, a sensitivity analysis should be conducted in order to clearly understand uncertainties in prediction of impacts associated with assumed release parameters. The water spray mitigation release scenario should be investigated as one of the plausible release scenarios, in order to define the performance of water spray mitigation for hazards control.

The Agency should examine the final selection of worst-case accident scenario(s) with respect to other potential scenarios. For example, the Agency should provide an explanation as to why the screening guidance provided to LEPCs (the "Green Book") is not a credible worst-case for this analysis. Is this due to its oversimplification and unrealistic release scenarios? The Agency should also examine the worst-case scenarios selected for analysis with respect to HF release accidents that have already occurred. Finally, the Agency should examine the assumptions made in the California South Coast Air Quality Management District (SCAQMD) hazards analysis and discuss the differences in selected worst-case release scenarios. Moreover, the Agency should analyze the SCAQMD accident scenarios and dispersion modeling approach and discuss <u>why</u> the methods used may or may not be adequate.

6. DOSE RESPONSE

In the draft Report to Congress, the dose response analysis associated with the worst-case release scenario appears to be particularly weak. The guideline exposure levels, such as Immediately Dangerous to Life and Health (IDLH) and Emergency Response Planning Guideline (ERPG), are based upon times of exposure which are typically of 30-and 60-minute duration. It is inappropriate to utilize and compare peak concentrations determined from the dispersion analysis without consideration of actual exposure-time behavior. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) standards were appropriately not used by the Agency CEPPO staff in this analysis, since they are designed for worker exposure assessment and use an eight-hour time weighted average exposure (See Appendix A-reference #14). The HFRS did not evaluate further the adequacy of the various guideline exposure levels.

7. ACCIDENT PREVENTION

Regarding significant releases of HF, no information was available suggesting that such accidents are inevitable (i.e., lie beyond the prospect of mitigation by human intervention). This suggests that such accidental releases may be made to have a low probability of occurrence. Prudence dictates a need for increased attention and diligence to workforce training, equipment inspection and improved monitoring, maintenance and mitigation activities. The Agency CEPPO staff have made no major effort to evaluate or rank the effectiveness of various prevention and mitigation measures. At a minimum, the Report to Congress should provide all available information regarding opportunities to prevent or mitigate accidental releases, consistent with Congressional intent to prevent pollution. The HFRS would like to stress that the CEPPO staff should continue to examine the newly-passed (February 24, 1992) Occupational Safety and Health Administration (OSHA) 1910 "Process Safety Management (PSM) Rule" relative to accident prevention for highly hazardous chemicals (See Appendix A-reference #6). The HFRS recommends that the CEPPO staff expand its discussion of the PSM standard, and more importantly, address its role in controlling accidental releases of HF. This newly enacted rule establishes performance standards for safety management of hazardous materials, and HF is one of many chemicals covered by this rule.

The use of the recently promulgated OSHA requirements for HF could be used as a framework to define industrial practices that may be adopted in the future. The impact of the adoption of this rule on the prevention of accidents should be evaluated. In addition, the standard operating procedures guidance recently proposed by the American Petroleum Institute (API) for HF alkylation

units should be evaluated as to its adequacy for accident prevention (See Appendix A-reference #2). The mitigation methods defined by the SCAQMD in its rule-making decisions could be evaluated to identify risk-reduction impacts and potential implications of these measures. Finally, the quantitative reductions in exposure from mitigation approaches like water quench and remote-operated valves should be determined.

8. OTHER ISSUES RAISED BY THE HFRS

The HF industry appears to be proactive in research associated with new uses of HF, as well as assessment and mitigation of accidental releases. Much of the current knowledge base concerning fate and transport modeling of HF after accidental releases is attributable largely to existing industry research programs which are not in the open peer-reviewed literature, as well as the DOE programs. The Report to Congress should address how uncertainty in the regulation of HF will impact and focus research and development relative to the chemical and to its alternatives. Case histories and scenarios should be utilized to illustrate how the effects of focused research and development can answer questions raised to deal with the current and future regulatory requirements.

The issue of vulnerability analysis was not addressed in the draft Report to Congress. This is of major concern to the LEPC's set up under SARA Title III. These groups should be surveyed to determine if any of them have conducted Vulnerability Analyses for HF in their specific communities. Clearly, this type of technical information is desirable. These vulnerability analyses could yield some useful information about the vulnerability of local communities to HF release events, and could supply some very useful information that would normally be considered to be confidential by industry.

APPENDIX A - REFERENCES CITED

1) ALOHA-Areal Locations of Hazardous Atmospheres, National Oceanic and Atmospheric Administration, CAMEO TM 3.0 Computer-Aided Management of Emergency Operations, Hazardous Materials Response Branch, Seattle, September, 1991

2) A.P.I., "Safe Operation of Hydrofluoric Acid Alkylation Units," API Recommended Practice 751, First Edition, June 1992

3) Chemical Manufacturers Association Hydrogen Fluoride Panel, Oral Testimony on the EPA Hydrogen Fluoride Study Report, Submitted to the EPA Science Advisory Board by Ms. Carolyn S. Seringer on behalf of Hydrogen Fluoride Panel of the Chemical Manufacturers Association, July 7, 1992

4) Havens, Jerry, Letter to Dr. K. Jack Kooyoomjian, U.S. EPA, Science Advisory Board, entitled "Review of the Draft Hydrogen Fluoride Study – Report to Congress: An Evaluation of the ALOHA Dispersion Model Results," 6 pages, dated November 6, 1992 (See Appendix B for full text of this letter.)

5) Montreal Protocol on Substances that Deplete the Ozone Layer, As Amended in 1990, and as Negotiated Under the Vienna Convention for Protection of the Ozone Layer, Final Act (Nairobi UNEP 1985) [NOTE: There will be subsequent amendments and adjustments to the Protocol.]

6) OSHA Requirements (29CFR1910) (Rule 1910) "Process Safety Management of Highly Hazardous Chemicals, February 24, 1992.

7) South Coast Air Quality Management District (SCAQMD) Hazards Analysis [Los Angeles County, Department of Health Services, Toxics Epidemiology Program, Health Effects Due to Hydrogen Fluoride Inhalation: A Literature Review, 1989. Prepared for the Hydrogen Fluoride Task Force of the SCAQMD]

8) U.S. Congress, Clean Air Act Amendments of 1990, Section 301(n)(6) (Public Law No. 101-549, 104 STAT. 2399), 1990

9) U.S. EPA, Chemical Emergency Preparedness and Prevention Office, "Briefing for the Science Advisory Board's Environmental Engineering Committee on the Hydrogen Fluoride Report to Congress," July 7, 1992

APPENDIX A - REFERENCES CITED: CONTINUED

10) U.S. EPA, Hydrogen Fluoride Study: Draft Report to Congress, Office of Solid Waste and Emergency Response, Washington, D.C., May 1992

11) U.S. EPA, Office of the Administrator, From Mr. F. Henry Habicht II, Deputy Administrator to Assistant Administrators and Regional Administrators, Memo entitled "Guidance on Risk Characterization for Risk Managers and Risk Assessors," February 26, 1992 (6 pages). [See especially the appended 34 page report from the US EPA's Risk Assessment Council, entitled "Guidance for Risk Assessment, November 1991]

12) U.S. EPA, Office of Emergency and Remedial Response, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002 (PB90-1555581), December 1989

13) U.S. EPA, "Protection of Stratospheric Ozone, Proposed Rule," 40CFR Part 82, September 4, 1991

14) U.S. EPA, Science Advisory Board, Environmental Health Committee (EHC), "Superfund Site Health Risk Assessment Guidelines," (Refers to OSHA PEL Standards), EHC Review Draft Number 3, September, 1992

15) U.S. EPA, Science Advisory Board, Resolution on Use of Mathematical Models by EPA for Regulatory Assessment and Decision-Making, Environmental Engineering Committee, EPA-SAB-EEC-89-012, January 13, 1989

APPENDIX B - ALOHA MODEL RUN RESULTS

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November 6, 1992

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RE: Review of the Draft Hydrogen Fluoride Study - Report to Congress: An Evaluation of the ALOHA Dispersion Model Run Results

Dear Dr. Kooyoomjian:

This contains my comments on the OSWER/CEPPO Draft Hydrogen Fluoride Study: Report to Congress, dated May 1992. My general observations of the report, which I provided to you dated September 14, 1992, are unchanged. These comments are directed to those parts of the report involving atmospheric dispersion predictions.

- The draft report correctly identifies the issue of the appropriate surface roughness for use in simulation of releases in an urban environment. This is a general question which should be given high priority for research, since it is a problem which is basic to the understanding of the dispersion of dense gas clouds in the areas where they are most likely to be formed. Since the majority of gases which can constitute a major hazard if accidentally released are denser-than-air, the requirement for information in this area extends to most of the hazardous gases in commerce--hence the top-priority requirement for some resolution of this question. I hope that the SAB's findings in this review process will foster the required research.

- The analysis of the accident scenarios considered consists mainly of the presentation of predictions of the maximum downwind distances to which concentrations of 30 ppm and 50 ppm hydrogen fluoride in air would be experienced.

Two dispersion models are used, HFSYSTEM and ALOHA-5.1.

The HFSYSTEM model is specifically designed for use by persons who are trained in its use. I am familiar with the methods used in the HFSYSTEM model, and there are many similarities between the HFSYSTEM and DEGADIS models. However, without additional information no determination can be made of the accuracy or applicability of the predictions presented.

The ALOHA (Areal Locations of Hazardous Atmospheres) model is a joint development of NOAA and EPA. ALOHA is designed for rapid estimation of downwind hazard extent for emergency response. The DEGADIS model (of which I am a coauthor) is distributed by EPA and the Gas Research Institute, and ALOHA (5.1) incorporates a simplified form of DEGADIS. Since ALOHA is designed for emergency response use, the incorporation of DEGADIS required simplification to allow rapid prediction. The ALOHA directions-for-use distributed by NOAA specifically state that ALOHA-DEGADIS is designed for emergency response application, and that the (parent) DEGADIS model should be used for calculations made for risk assessment purposes where it is frequently required to consider carefully the effects of transient releases and other complicating factors. I have recently completed an evaluation of the ALOHA-DEGADIS model (which has been incorporated in ALOHA) and am therefore in a position to consider this question. I can state the following observations which are important to the consideration of the predictions presented by OSWER/CEPPO in the Draft HF Study-Report to Congress:

- The incorporation of DEGADIS in ALOHA (by NOAA) is generally accurate and acceptable. However, the incorporation of DEGADIS did involve simplifications, and there are effects of these simplifications which bear directly on the predictions presented in the draft report.

- The prediction of HF dispersion for the scenarios presented in the draft report requires model treatment of the complex effects of aerosol formation and the associated thermodynamic effects which can occur in an HF cloud. My initial comparison of NOAA-DEGADIS and DEGADIS indicates that such differences are not likely to be very important in this application, although there are some differences.

- The primary simplifications of DEGADIS in ALOHA relate to the modeling of transient releases. When transient releases are modeled (in ALOHA) the time-varying release rate is approximated by five piecewise "steps" of uniform rate. More importantly, for the calculation of the maximum downwind distance to the concentration of concern, ALOHA presents the distance calculated for the maximum (in the case at hand, the initial) release rate, as if it occurred continuously. The ALOHA directions-for-use specifically state that this simplification (made to decrease run-time) can result in significant overestimation of the downwind extent for transient releases.

The modeling assumptions made for each of the three scenarios are severe and somewhat arbitrary. Specifically:

- Different surface roughnesses are specified for the ALOHA and HGSYSTEM models (3 cm and 1 cm respectively). The comparisons should be made for the same input variables.

- All three scenarios (apparently) assume that all of the HF goes downwind as an aerosol, with no (or negligible) rainout. This assumption would appear to be most questionable for Scenario #3 which describes a leaking tank. Since the formation of aerosol upon release depends critically on the temperature and pressure from which the material is released, this scenario description is incomplete.

- EPA states that "F stability occurs in overcast, pre-dawn, calm hours...". F stability can occur in pre-dawn, calm hours, but it is normally associated with clear skies (which allow for rapid radiation cooling of the surface).

- EPA states that "surface roughness conditions are an estimate of the effect of surface terrain and the presence of high buildings or other man-made structures that will impact the cloud's movement and dispersion ...". One of the main points of contention in dense gas dispersion prediction is the extent to which the effect on dispersion of large "obstacles" (such as buildings) whose height is comparable to the dispersing gas cloud can be represented as surface roughness. This statement fails to acknowledge the importance of this unsolved problem, and it is contradictory to EPA's identification of the surface roughness "issue" in a later section of the report.

I have repeated the simulations with the ALOHA model, using the input data provided in the draft report, of the three HF release scenarios and compared the results with DEGADIS. The input data are summarized below:

Inputs to Aloha (V5.1) Computer Model

	Scenario #1	Scenario #2	Scenario #3
Release Type	3000 lb/min for 1 minute	160 lb/min (continuous)	1800 lb/min (continuous)
Atmospheric Conditions	5.2 mps, D 1.5 mps, F	5.2 mps, D 1.5 mps, F	5.2 mps, D 1.5 mps, F
Surface Roughness	3 cm	3 cm	3 cm
Air Temperature	72 F	72 F	72 F
Relative Humidity	50%	50%	50%
Concentrations of concern	30 ppm/30 min 50 ppm/60 min	30 ppm/30 min 50 ppm/60 min	30 ppm/30 min 50 ppm/60 min

I have verified with ALOHA the ALOHA Model results presented in Exhibits 8-10, 8-12, and 8-13 of the draft report; the results (distances) are summarized below:

ALOHA Model Results

	Distance to IDLH (miles)	Distance to ERPG (miles)
Scenario #1 - Transfer Line Failure		
5.2 m/s, D stability	3.6	2.8
1.5 m/s, F stability	>6	5.5
Scenario #2 - Pump Seal Failure		
5.2 m/s, D stability	0.7	0.6
1.5 m/s, F stability	1.8	1.3
Scenario #3 - Vessel Leak		
5.2 m/s, D stability	2.5	2.0
1.5 m/s, F stability	5.5	4.0

Observations on Scenario #1 - Transfer Hose Failure

The ALOHA footprint assumes release at 3000 lb/min for one hour. This is clearly stated in the ALOHA directions-for-use. Furthermore, the ALOHA model provides for calculation of the concentration and exposure (dose) at a specified downwind distance, and the resulting concentration reflects the transient nature of the release. EPA appears to have simulated the release of 3000 lb as instantaneous. The minimum duration of release for the

ALOHA model is 1 minute. Therefore the release is simulated by ALOHA as 50 lbs/second for 60 seconds, and the footprint (from which the maximum downwind distance to the level of concern is determined) reflects the maximum release rate of 3000 lbs/min. This reported distances of >6 and 5.5 miles for F stability, 1.5 m/s and D stability, 5.2 m/s respectively are gross overpredictions which do not reflect the transient (short-lived) nature of the release. The ALOHA model indicates that there is no significant exposure at either of the presented distances for the 3000 lb release. DEGADIS indicates the maximum downwind distance to be less than 1 mile for both cases. (This result, and my knowledge of the similarity of the DEGADIS and HFSYSTEM models, leads me to view the associated HFSYSTEM predictions with suspicion.)

Observations on Scenario #2 - Pump Seal Failure

The ALOHA footprint prediction assumes 160 lbs/min released for one hour, whereas the actual release that was to be modeled lasted for 20 minutes. The result would be to overpredict the distance, since the along-wind dispersion of the cloud is neglected in the steady state prediction. EPA incorrectly concluded that the ALOHA simulations of Scenarios #1 and #2 indicate that the "release duration seems to play much less of a role (than the release rate)." DEGADIS predictions appear to be in reasonable agreement with the ALOHA predictions for this case.

Observations on Scenario #3 - Vessel Leak

The only difference between the ALOHA simulations of Scenarios #2 and #3 is the 11.25 times greater release rate for Scenario #2. However, since the conditions of pressure and temperature of storage (in the tank) are not specified, it is questionable to model this release as an aerosol plume instead of an evaporating pool. EPA also states that "A pool of HF forms which flashes and aerosolizes into a dense, white cloud that begins to travel downwind". It is unlikely that an aerosol cloud of HF would result from an evaporating pool. The conditions for aerosol formation are generally agreed to involve flashing accompanied by high shear such as occurs during high-velocity discharge from a container. Pool formation and (complete) aerosol cloud formation are contradictory. DEGADIS predictions appear to be in reasonable agreement with the ALOHA predictions for this case.

In summary, important errors have been made in the presentation and analysis of ALOHA predictions in the draft report. The errors are attributed to lack

of understanding and familiarity with the ALOHA model and to failure to observe ALOHA's limitations.

Sincerely,

Jerry Havens
Distinguished Professor

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JH:vh

APPENDIX C - GLOSSARY OF TERMS AND ACRONYMS

ALOHA	AREAL LOCATIONS OF HAZARDOUS ATMOSPHERES (A MODEL DESIGNED SPECIFICALLY FOR PLANNING EMERGENCY RESPONSE)
API	AMERICAN PETROLEUM INSTITUTE
CAA	CLEAN AIR ACT
CEPPO	CHEMICAL EMERGENCY PREPAREDNESS AND PREVENTION OFFICE (CEPPO) (U.S. EPA)
CFC's	CHLOROFLUOROCARBONS
DOE	U.S. DEPARTMENT OF ENERGY
EEC	ENVIRONMENTAL ENGINEERING COMMITTEE (SAB/EPA, ALSO REFERRED TO AS "THE COMMITTEE")
EEGL	EMERGENCY EXPOSURE GUIDELINE
EHC	ENVIRONMENTAL HEALTH COMMITTEE (SAB/EPA)
EPA	U.S. ENVIRONMENTAL PROTECTION AGENCY (U.S. EPA, or "THE AGENCY"
ERPG	EMERGENCY RESPONSE PLANNING GUIDELINE
H_2SO_4	SULFURIC ACID
HF	HYDROFLUORIC ACID (ALSO HYDROGEN FLUORIDE)
HFRS	HYDROGEN FLUORIDE REVIEW SUBCOMMITTEE (EEC/SAB/EPA, ALSO REFERRED TO AS "THE SUBCOMMITTEE")
HG	(REFERS TO HG SYSTEMS MODEL)
IDLH	IMMEDIATELY DANGEROUS TO LIFE AND HEALTH
LEPC's	LOCAL EMERGENCY PLANNING COMMITTEES
OMB	OFFICE OF MANAGEMENT AND BUDGET
OSHA	U.S. OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
OSWER	OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE (U.S. EPA)
PEL	PERMISSIBLE EXPOSURE LIMIT
PSM	PROCESS SAFETY MANAGEMENT STANDARD (PROMULGATED BY OSHA ON FEBRUARY 26, 1992)
RAC	RISK ASSESSMENT COUNCIL (U.S. EPA)
RREL	RISK REDUCTION ENGINEERING LABORATORY, OFFICE OF RESEARCH AND DEVELOPMENT, CINCINNATI, OHIO (U.S. EPA)
SAB	SCIENCE ADVISORY BOARD (EPA)
SARA	SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT
SCAQMD	SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
U.S.	UNITED STATES

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