FINAL PROJECT AGREEMENT

IBM XL Project:
Copper Metallization

July 31, 2000

Essex Junction, VT

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I. Introduction to the Agreement

A. Project Signatories

The Project Signatories to this Final Project Agreement (FPA or Agreement) are the International Business Machines Corporation (IBM), Essex Junction Facility, located in Essex Junction Vermont, the U.S. Environmental Protection Agency (EPA), and the Vermont Department of Environmental Conservation (VTDEC). All of those listed are referred to collectively as "Project Signatories;" the regulatory agencies mentioned above are referred to collectively as "the Agencies."

B. Purpose of the XL Program

This FPA states the intentions of the Project Signatories to carry out a pilot project as part of

is an EPA initiative to test the extent to which regulatory flexibility, and other innovative environmental approaches, can be implemented to achieve both superior environmental

(See 60 FR 27282)

C.

This FPA is a joint statement of the Project Signatories' plans and intentions with respect to the IBM Copper Metallization XL Project (IBM XL Project). This FPA outlines the details of how

necessary to implement this project. Specifically, IBM proposes that EPA exempt the copper metallization process rinsewaters and resultant wastewater treatment sludge from consideration

This FPA sets forth the plans of the Project Signatories and represents the firm commitment of each Project Signatory to support the XL process, to implement the necessary regulatory

intended to create legal rights or obligations and is not a contract, a final agency action, or a regulatory action such as a permit or a rule.
Project Signatories for any alleged failure to implement its terms, either to compel implementation or recover damages.

www.epa.gov/projectxl

D. List of Project Contacts

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11. Description of the Project

IBM is proposing that EPA exempt the copper metallization process rinsewaters and resultant wastewater treatment sludge from consideration as an F006 waste through a site-specific rulemaking. Details regarding the proposed exemption and resultant environmental benefits are described below.

IBM Essex Junction, Vermont, is a semiconductor manufacturing facility located in Chittenden County near Burlington, Vermont. The facility property encompasses approximately 735 acres which are divided by the Winooski River and connected by a company-owned bridge. The manufacturing facility is located on approximately 243 acres which lie west of the Winooski River in the Town of Essex and the Village of Essex Junction. The remaining 492 acres are located east of the river in the Town of Williston and contain non-manufacturing buildings.

The facility encompasses 3.6 million square feet of which 627,000 square feet are dedicated to semiconductor manufacturing operations. There are approximately 7,500 IBM employees and 1,500 contractor employees working at the site. The facility manufactures and tests semiconductor memory and logic devices through a complex, multi-step manufacturing process.

IBM has recently developed an innovative copper metallization process to create electrical interconnections between device levels for new semiconductor technologies which replaces the

Aluminum Chemical Vapor Deposition process, a dry process, used in previous generation semiconductor device technologies. EPA currently considers IBM's process a traditional "electroplating" process for purposes of RCRA. Under current regulations promulgated pursuant to the Resource Conservation and Recovery Act (RCRA), sludges or solids created from the treatment of wastewaters which include rinsewaters generated from an electroplating process, carry the F006 listing (40 CFR 261.31). IBM's new process results in the generation of copper plating rinsewaters which are combined with the other process wastewaters generated at the facility and treated in a wastewater treatment unit. This treatment, in turn, generates sludge that is currently managed under RCRA as F006 waste.

IBM maintains that the F006 classification artificially inflates the company's figures for hazardous waste generation, fails to provide any additional environmental protection, and increases paperwork and reporting burdens. The expected volume of rinsewater generated from the copper metallization process of 2,000 - 3,000 gallons per day by 2002 is mixed with an additional 4.1 million gallons per day (expected to be S million gallons per day by the end of 2000) of process wastewaters generated at the facility. Thus, by virtue of commingling the relatively insignificant volume of rinsewater from the copper metallization process with the much greater volume of other wastewaters, all of the sludge generated by the wastewater treatment plant is then treated as F006 hazardous waste.

This commingling, however, has increased IBM's reported non-remediation hazardous waste production by 170% per year, from 2.14 million pounds to 5.78 million pounds (1999 actuals), and waste management costs by $3,500 per year with little or no environmental benefit. A segregated waste treatment system that would prevent the mixing of the copper bearing rinsewater with general influent is currently cost prohibitive. Such a system would require an initial capital investment of $200,000 - $350,000 and have annual operating costs of $25,000 - $50,000.

In addition, it appears that the source documents for the F006 listing focused on much different industrial processes than IBM's copper metallization process, and perhaps most importantly, the chemicals used in IBM's process do not contain any of the contaminants listed in Appendix VII of 40 CFR 261 which are the focus of the original F006 definition. IBM has also conducted analyses of the plating bath and rinsewater that do not show the presence of any materials of concern, including those listed in 40 CFR 261 Appendix VII as the basis for the F006 listing, that would cause the resultant sludge to be considered hazardous (See Appendix A for data). The exemption proposed by IBM as part of this project will not apply, however, to the spent plating bath which will continue to be drummed and disposed of as required by RCRA regulations, and which will not be discharged to the IBM wastewater treatment plant.

Project XL offers the opportunity for the Agency to test its belief that this innovative process should be encouraged as one that is environmentally superior to existing technologies and to consider the appropriate regulatory status of the wastes from this technology before it is adopted by similar manufacturing facilities. Further, this XL project offers EPA the opportunity to test a different approach to re-evaluating whether a specific wastestream is appropriately subject to regulatory controls as a listed waste.

The existing mechanism for removing a waste from a listing on a site-specific basis is through a 'delisting" petition under 40 CFR 260.22. However, the delisting approach is not the most suitable for the situation at the IBM Vermont facility because the scope of the listing itself is at issue. If IBM submitted a delisting petition, EPA would evaluate the hazardous nature of the entire wastewater treatment sludge (which is the wastestream that actually carries the F006 listing) rather than only that portion which is contributed by the copper metallization process. EPA generally prefers a delisting approach in most circumstances; it is, generally, a better approach for determining the hazardous nature of the actual waste material and whether the waste should be removed from the hazardous waste management program. In this instance, however, because the Agency wants to test whether IBM's copper metallization process should be included within the scope of the F006 listing, the Agency believes an evaluation of the "production side" of the sequence of operations that results in the wastewater treatment sludge would be more useful. Specifically, because the wastewater treatment sludge is considered hazardous due to an "upstream" production unit meeting the narrative description of an electroplating operation, the Agency believes it is more appropriate to evaluate the upstream production unit to determine whether the hazardous waste listing on the "downstream" wastewater treatment sludge is warranted. Therefore, the Agency will focus on the key parameters on the production side (in this case, the innovative design and operation of the copper metallization process) to make a determination of the regulatory status of the materials generated on the waste management side (in this case, the wastewater treatment sludge). This XL project therefore represents an opportunity for EPA to explore a different approach to determining whether a waste (in this case, one resulting from an innovative process) should continue to be subject to a hazardous waste listing. In other words, this approach may be considered another "tool" for the Agency to use in "fine tuning" the hazardous waste listings so that the narrative description of a listed waste appropriately delineates between those wastes that pose a risk to human health and the environment from those wastes (which arguably are generated by very similar processes) that do not pose such a risk.

In addition, this innovative metallization process is environmentally superior to the old process it replaces, i.e., the aluminum chemical vapor deposition process. Not only is the metallization process 30 to 40% more energy efficient than the old process and the chips produced are approximately 25% more energy efficient, there are also environmental benefits realized by discontinuing the use of the old process. While the metallization process generates a wastewater stream (and subsequent sludge from the treatment of that wastewater) that was not inherent to the aluminum chemical vapor deposition process, the old vapor deposition process entailed a cleaning step that used perfluorinated compounds (PFCs), which are global warming gases. Thus, by replacing the old process with the metallization process, 10,000 metric tons of carbon equivalent (MTCE) of global warming gases will not be emitted to the air. However, it should be noted that, due to the nature of the materials and components involved in the semiconductor manufacturing process, vapor deposition of aluminum cannot be completely eliminated from the production line, nor can the subsequent cleaning steps. However, the number of cleaning steps requiring the use of PFCs has been significantly reduced. This approach is consistent with other "Design for Environment" and pollution prevention efforts encouraged by EPA whereby regulated entities are encouraged to design their processes for minimal environmental impact by using such methods as product substitution or source reduction. IBM's process has been developed to maximize the efficient use of the copper metal and minimize the release of the materials into the wastewater system while largely eliminating the use of PFC's for chamber cleaning operations necessary in the old aluminum chemical vapor deposition process.

From a public policy standpoint, it would not serve to encourage manufacturers to employ less-hazardous or more environmentally friendly and innovative production processes and ingredients in manufacturing operations if the Agency is unwilling to revisit existing hazardous waste listings to determine if the wastes resulting from such innovative process changes still warrant a hazardous waste listing. This XL project offers EPA the opportunity to consider proactively the appropriate regulatory status of the wastewater treatment sludges generated from an innovative production process before it is widely used and commonplace and may serve as a precedent for other listed wastestreams. Just as it is important to ensure that those wastes that can pose significant risk to human health and the environment are properly controlled and managed, it is also important to not needlessly subject wastes that do not pose such risks to the same type of regulatory oversight.

The successful completion of this XL Project, and the removal of the F006 code on the sludge, will allow IBM to investigate a potential opportunity to recycle the sludge for a beneficial use. IBM may be able to provide the sludge to a cement kiln as feedstock in its process. IBM has begun discussions with a cement kiln about using the wastewater treatment sludge as a feedstock to the cement production process. The sludge characteristics appear to make it amenable for use in the process. However, because the sludge is categorized as a F006 waste, the cement kiln will not consider it for use in its process. Completion of the project would allow IBM to further investigate the environmental benefits associated with such reuse and pursue discussions with the cement kiln regarding potential utilization of the IBM sludge. Reutilization of the sludge has conservatively estimated disposal cost savings of $60,000 per year.

Finally, IBM has asked that EPA recognize the channeling of IBM's cost savings to supplement its additional voluntary effort to reduce greenhouse gas emissions through the introduction of an alternate process chemistry in its chamber cleaning processes to remove silicon dioxide deposits as a significant environmental benefit. This applies to continuing operations where silicon oxide layers are deposited on chips to insulation between chip layers. IBM is investing an additional $2.0 million at its Burlington semiconductor manufacturing facility to significantly cut greenhouse gas emissions from its chamber cleaning process, which accounts for the majority of the facility's overall greenhouse gas emissions. IBM is voluntarily taking this action well ahead of any regulatory requirements. In addition, IBM is also a party to a Memorandum of Understanding negotiated in 1996 between the EPA and 21 other semiconductor manufacturers under which the parties agreed to study pollution prevention and recycling methodologies and propose the most efficient and cost effective manner by which to reduce mass emissions of greenhouse gases, IBM's actions are well ahead of any requirements in the MOU, as well as any actions taken by other semiconductor manufacturers.

In summary, IBM is seeking a site-specific exemption for its copper metallization process that will provide for the declassification of the resultant wastewater treatment sludge from the F006 hazardous waste listing. The conversion to this process results in the minimization of the need to clean chambers using PFC's by reducing the aluminum metal layers to one or two, along with significant energy savings. In addition, IBM has asked that EPA recognize its additional, voluntary effort to reduce greenhouse gas emissions in its remaining silicon dioxide chamber cleaning processes as a significant environmental benefit.

III. How the Project Will Meet the Project XL Acceptance Criteria

A. Environmental Benefits

Several benefits will result directly from the site-specific exemption for the copper metallization process. These benefits include a reduction in the quantity of waste defined as hazardous generated by the IBM Burlington facility; the minimization of the use of PFCs, which are greenhouse gases, used as chamber cleaning compounds in the previous generation aluminum chemical vapor deposition process, and a decrease in the IBM, State of Vermont, and EPA administrative requirements due to the elimination of the need to receive export permission and process United States hazardous waste manifests for the shipment of sludge to the Stablex facility in Quebec, Canada. It will also rationalize the RCRA F006 listing process as it applies to this situation, which will provide for more sensible and accountable regulation a key goal of Project XL.

Perhaps the most notable benefit to this XL project is that it highlights and promotes a new process - copper metallization - which has the potential to impact the electronics industry in profound ways. This new process is approximately 30-40% more energy efficient than the previous one, minimizes PFC usage for chamber cleans by eliminating all but one or two of the aluminum vapor deposition steps as described above, and produces a chip that is approximately 25% more energy efficient than its predecessor. If this process is eventually utilized by other semiconductor facilities, the results of this project may encourage more efficient production methods with corresponding reductions in waste generation per unit output, as well as other benefits associated with energy efficiency such as natural resource conservation, air quality improvements, and decreased impact on climate change.

IBM will also attempt to meet a project goal, defined in Section V.A.2, of further voluntary greenhouse gas reductions from its other chamber cleaning operations which do not use the copper metallization process. EPA also recognizes that IBM's additional efforts to reduce emissions of greenhouse gases from the chamber cleaning processes for removal of silicon dioxide and metal deposits as an environmental benefit associated with this project. IBM has independently developed alternative chamber cleaning processes, one using a reduced flow C_2F_6 (the primary PFC used for chamber cleaning) and the other using dilute Nitrogen Trifluoride (NF_3), to clean silicon dioxide and metal coated tooling chambers. IBM expects that these changes will help reduce the overall global warming gas emissions at the Burlington manufacturing facility by approximately 40% (normalized to production) in the year 2002 when measured against the 1995 base year emissions despite significant, real and projected, increases in manufacturing output between 1995 to 2002. This work is also slated to be done at other IBM semiconductor manufacturing sites through the year 2002.

B. Cost Savings and Paperwork Reduction

Granting an exemption for the copper metallization process and the resulting declassification of the wastewater treatment sludges results in reduced costs and administrative burdens to IBM, EPA and VTDEC. Specifically:

1. IBM expects to see operational savings of $100,000 to $200,000 per year when the conversion to the copper metallization process is complete. The sources of these savings include reduced material costs (e.g., PFCs), and energy savings.

2. IBM currently has an exemption from the VT hazardous waste tax that saves them approximately $225,000.00 per year. Completion of this project would make those savings permanent.

3. The exemption will shorten IBM's annual RCRA report by not requiring information on the wastewater treatment sludges.

4. IBM would not be required to tile an annual "Request for Export of Hazardous Waste" to Canada for its wastewater treatment sludge. Administrative costs associated with the preparation of the application and necessary follow-up to assure that the application is being processed expeditiously would be saved. In addition, EPA will not have to process and track the Request for Export resulting in some manpower savings to EPA.

5. IBM would not be required to prepare United States hazardous waste manifests for each shipment of sludge from the wastewater treatment plant. Administrative costs associated with preparation, tracking and close-out of a RCRA hazardous waste manifest for this sludge would be eliminated. Estimated costs savings here are approximately $3,500/year. Similar savings will be accrued by the State of Vermont.

6. IBM has been reviewing options to send its sludge to a cement kiln to serve as a feedstock to the cement manufacturing process. The sludge has a percentage of active lime which can be used beneficially in the cement manufacturing process. By using the sludge as a cement feedstock, the sludge disposal costs will be reduced by a conservative estimate of approximately $60,000. Use of the sludge as a feedstock to the cement manufacturing process will eliminate the need to send the material for disposal at a secure disposal facility and put it to beneficial use.

While the cement manufacturer is interested in using the IBM sludge in its process, they are unwilling to evaluate the material in detail as long as the sludge carries an F006 listing. Successful completion of this project XL will allow IBM to pursue the beneficial reuse of the sludge material.

C. Stakeholder Involvement and Support

IBM has solicited input on this project from a wide range of stakeholders including local and national environmental groups, neighborhood associations, and industry trade associations. They have been notified of this project by direct mail, telephone, and notification in the local press. IBM continues to pursue additional stakeholders and ongoing information is available from the project contacts listed in Section I.D, as well as EPA's website.

In addition, IBM has conducted a series of meetings with additional stakeholders who have agreed to serve as commenters for this project. They have been briefed on the proposal, and are supportive of the project as described. The State of Vermont also supports the project and is a Project Signatory to this Agreement. Stakeholder meetings were held at the IBM facility on February 17 and March 24, 2000.

IBM will also provide future project information to relevant stakeholders as described in Section V.C, "Project Tracking and Evaluation."

D. Innovation and Pollution Prevention

IBM's process has been developed to maximize the efficient use of the copper metal and minimize the release of the materials into the wastewater system while largely eliminating the use of PFC's for chamber cleaning operations necessary in the old aluminum chemical vapor deposition process. The copper metallization process is also approximately 30 - 40% more energy efficient, and produces a chip that is approximately 25% more energy efficient than its predecessor. IBM's additional efforts at greenhouse gas reductions are expected to achieve a 40% overall reduction in facility greenhouse gas emissions when normalized to production.

E. Transferability

There are a number of chip manufacturing facilities in the US currently implementing or evaluating the copper metallization process, and the implementation of this XL Project might create an incentive for others to use the process. If this were to be the case, the ripple effect of the environmental benefits associated with numerous other semiconductor manufacturers switching to this type of process could be quite significant.

F. Feasibility

IBM has the financial capability, personnel, and senior management commitment necessary to implement the elements of this XL Project.

The Agencies, by signing this FPA, agree to support the project, subject to any public review procedures necessary to implement the legal mechanism for the Project.

G. Shifting of Risk Burden

This project does not result in a transfer of risk. In fact, adoption of the copper metallization process removes some environmental risks by largely eliminating the use and subsequent emissions of PFC's in the process it replaces, thereby removing an estimated 10,000 MTCE of greenhouse gas emissions from IBM's facility. In addition IBM is agreeing to additional voluntary greenhouse gas reductions of 5 1,000 MTCE when adjusted for production, using 1995 as a base year, from its silicon dioxide cleaning chambers as a part of this project. Finally, any risks associated with the process, the treatment of the rinsewaters, and the management of the sludge are minimal.

IV. Requested Flexibility and Implementing Mechanisms

A. Requested Flexibility

IBM has proposed that EPA exempt IBM's wastewater treatment sludge produced from its copper metallization process for semiconductor manufacture from the F006 definition (40 CFR 261.3 1) through a site-specific rulemaking. Through this proposal, IBM seeks to exempt the manufacturing process -- specifically copper metallization -- rather than delisting the wastewater treatment sludge, which would normally occur through EPA's delisting process under 40 CFR 260.22.

The F006 RCRA listing states, "Wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc, and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum" are F006 wastes. The reach of this listing is further defined by the "Development Document for Existing Source Pretreatment Standards for the Electroplating Point Source Category" (August 1979) and documented hotline and compendium determinations.

The copper metallization process discussed in this FPA is very different than the electroplating that was performed twenty years ago, when the regulations were initially conceived. This process does not involve plating baths of thousands of gallons which carry over significant amounts of plating solutions (dragout) into the rinsewaters, resulting in large amounts of toxic metals in the wastewater treatment sludges. In contrast, each tool that IBM uses for the copper metallization process contains one 40 gallon plating bath each and the amount of dragout from the plating bath is nominal. Estimated dragout from the copper plating bath is approximately 3.5 grams of solution per wafer. The specific gravity of the plating solution is 1.001 and as a result the volume of plating solution dragout is approximately 3.5 ml. Each wafer is then rinsed with approximately 0.5 - 0.7 gallons (2,307 ml) of water. Perhaps most importantly, according to tests conducted by IBM, the chemicals used in IBM's process do not contain any of the contaminants, listed in Appendix VII Part 261 (Basis for Listing Hazardous Waste), which were the focus of the original F006 definition. IBM's analysis of the plating bath and rinsewaters from this process are included in Appendix A.

During the five-year life of this XL Project, IBM will submit data as discussed more fully in Section V of this Agreement, that will determine the appropriateness of the site-specific exemption, EPA notes that the adoption of an exemption from the F006 listing in the context of this XL project does not signal EPA's willingness to adopt that exemption as a general matter or as part of other XL projects. It would be inconsistent with the forward-looking nature of these pilot projects to adopt such innovative approaches prematurely on a widespread basis without first determining whether or not they are viable in practice and successful in the particular projects that embody them. Furthermore, as EPA indicated in announcing the XL program, EPA expects to adopt only a limited number of carefully selected projects. These pilot projects are not intended to be a means for piecemeal revision of entire programs. Depending on the results obtained from this project, EPA may or may not be willing to consider adopting this F006 exemption either generally or for other specific facilities.

Should IBM significantly change the process in any way that should cause the sludge to be reclassified as F006 waste by introducing any materials listed as the basis for the F006 listing in 40 CFR 261 Appendix VII, IBM will promptly notify EPA and VTDEC of such a change and the exemption will be removed.

B. Legal Implementing Mechanisms

The legal implementing mechanism for this XL Project will be a site-specific rule which will provide a site-specific exemption of the wastewater treatment sludge produced from IBM's copper metallization process from 40 CFR 261.3 1. The exemption will be listed in 40 CFR 261.4(b) (i.e., "Solid wastes which are not hazardous wastes"). The Agency considered a modification to the F006 listing description in the table in 40 CFR 261,31(a), adding the copper metallization process at the IBM Vermont facility to the list of plating operations that are not intended to be subject to the listing. However, because the exemption will have a number of conditions that the IBM facility must follow to ensure that this XL project is protective of human health and the environment throughout the term of the project and to provide the information and data the Agency will use to consider whether the regulatory exemption should be incorporated into the national program, the Agency prefers placing the exemption language in 40 CFR 261.4(b). Regardless of where EPA chooses to place the exemption language in the regulations (261.3 l(a) or 261,4(b)), the legal effect of the exemption will be the same. EPA expects that should the exemption of the copper metallization process from the F006 listing be incorporated into the national program, EPA would then modify the listing description in 40 CFR 261.31(a).

IBM cannot benefit from this exemption until VTDEC promulgates a conforming state site-specific rule.

V. Discussion of Intentions and Commitments for Implementing the Project

A. IBM's Intentions and Commitments

1. IBM must support their request for an exemption with all necessary and relevant analytical data. See Section V.C.

2. Given the complete conversion of the specified chamber cleaning processes to the low flow C_2F_6 or dilute NF_3 process, IBM Burlington will attempt to meet a project goal for a reduction in its facility global warming gas emissions of 40% by year end 2002, when adjusted for production against a 1995 base year. The methodology by which the extent of the reduction will be demonstrated and documented is included as Appendix B. This methodology is consistent with that identified in the MOU between the Semiconductor Industry and EPA that was previously discussed in this FPA. On the greenhouse gas portion of the project, IBM will target having all of the Novellus and AMAT silicon deposition tools converted to the new low flow C_2F_6 or NF_3 process by the end of CY 2003.[1]

Tool conversions can be gated by tool availability, as qualification of the NF_3 chamber cleaning process can take two to three months during which the chamber cannot be used for production. As a result, IBM has set a project goal for overall greenhouse gas emission reductions through a combination of implementation of the low flow C_2F_6 and NF_3 chamber clean processes on a schedule which tits the demands of the fabricator facility. IBM will provide reports on its emission reductions and chamber conversions as specified in Section V.C. of this FPA.

3. In order to achieve the greenhouse gas emission reductions at the facility, IBM will undertake

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[1] IBM has approached its global warming gas emission reduction efforts in two phases. The first phase involved the optimization of the C_2F_6 chamber clean process, which resulted in emission reductions of 40-50% from the original process. The second phase has been the development of the NF, chamber clean process which achieves emission reductions of 95- 97%. IBM has had excellent success in qualifying tbe NF, chamber clean process for silicon oxide deposition on both the AME and Novellus toolsets. Other processes are proving more difficult due to problems with maintainability of the equipment. In such cases, IBM will work to convert the cleaning process to the low flow C_2F_6 where it has not already been done.

an effort to convert its chamber clean processes to the low flow C_2F_6 and NF, processes where technically and economically feasible. As discussed in (2) above, corresponding greenhouse gas emissions, using 1995 as a base year, are expected to decrease by 40 % by year end 2002 when normalized to an expected 36% increase ip production, and decreased by 17.5 % in absolute terms. 1995 emissions totaled 93,000 MTCE. Accounting for production increases, projected emissions for 2002 without the low flow C_2F_6 or NF_3 process conversion would be 128,000 MTCE, and could be 77,000 MMTCE with the conversions completed.

4. IBM will take periodic samples of the copper plating bath and the copper rinsewater to demonstrate that they do not contain any concentrations of materials that might otherwise cause the rinsewater and resultant sludge to be categorized as hazardous, including those that are listed in 40 CFR 261 Appendix VII as the basis for the F006 listing. Further, IBM will document its progress in reducing greenhouse gas emissions through conversion to the copper metallization process and chamber clean processes discussed above. IBM will provide analytical data on the plating bath and rinsewaters from the copper metallization process and document progress towards their greenhouse gas emission reductions in accordance with paragraph C of this section. In addition, IBM will continue to comply with it existing NPDES permit as it pertains to the copper loading effluent concentrations.

5. IBM will establish a project goal to explore environmentally sound recycling options for the ultimate disposition of the wastewater sludge. Among the potential options that IBM has initially investigated is a contract with a cement kiln for ultimate disposition of the sludge. A sound recycling option will remove the material from the treatment and disposal process as hazardous waste and move it up the waste management matrix to a reuse/recycle situation. This will provide a positive environmental benefit and provide some cost savings to the IBM Essex Junction Facility.

B. EPA's and VTDEC's Intentions and Commitments

1. EPA intends to propose and issue, subject to applicable procedures and review of public comments, a site-specific rule amending 40 CFR 261.4(b) that will exempt the wastewater sludge from IBM's copper metallization process from 40 CFR Part 261.31.

2. The State of Vermont intends to propose and adopt a site-specific rule that would either incorporate the Federal IBM XL rule by reference under Section 7-109 of the Vermont Hazardous Waste Management Regulations, or exempt the wastewater sludge from IBM's copper metallization process through a site-specific exemption, contingent on any Federal standards that are adopted, under Section 7-203 of the Vermont Hazardous Waste Management Regulations.

C. Project Tracking, Reporting and Evaluation

For the copper metallization process, IBM will analyze the plating bath and rinsewaters generated from the copper metallization process. IBM will continue to handle and dispose of the spent plating bath in accordance with existing regulations, and acknowledges that the spent plating bath solutions are not part of this XL Project. As discussed more fully below, IBM will verify that the plating bath and rinsewaters do not contain any concentrations of materials that might otherwise cause the rinsewater and resulting sludge to be categorized as hazardous, including those that are listed in 40 CFR 261 Appendix VII as the basis for the FOO6 listing.

In order for IBM to maintain this exemption, IBM will collect, analyze, and submit data on the plating bath and rinsewaters for the copper metallization project two times per year. IBM expects that there will be a total of between six and ten copper metallization tools operating through the end of the XL project. These results will be submitted to the EPA, VTDEC, and published on EPA's website at www.epa.gov/projectxl for the duration of the project. The submissions will be by January 15 and July 15 of each year. The analysis will be conducted to measure for the presence of volatiles, semi-volatiles and metals using the methods specified in 40 CFR 264 Appendix IX.

In addition, since copper is not listed as a constituent of concern in the basis for the F006 listing, but is a parameter specified in IBM's existing National Pollutant Discharge Elimination System (NPDES) permit, IBM will continue to monitor copper concentrations in its wastewater effluent for conformance with this permit. IBM expects that, under full production, the loadings from the plating and mechanical polishing processes will result in copper effluent concentrations less than 40% of the NPDES permit limit. IBM will seek to keep the copper concentrations below 50% of its permit limit for the duration of the project recognizing that changes in other process steps, treatment performance, and other unforseen circumstances may affect IBM's ability to meet this objective. In all cases, IBM will operate its wastewater treatment systems to maintain compliance with the NPDES permit requirements.

For the global warming gas reductions IBM will track C_2F_6 usage and estimate the reduction in emissions based on the reduction in chemical usage. IBM will use conversion rates of C_2F_6 in the clean steps provided by Sematech to estimate emissions from gas usage. Sematech is a semiconductor manufacturing industry association whose environmental subcommittee researched the environmental fate of certain greenhouse gases used in the semiconductor industry and developed the conversion factors used in this project. IBM has estimated that these estimates will be within plus or minus 10% of the actual performance.

IBM will also use similarly available data for the dilute NF_3, the replacement gas for C_2F_6. IBM will use the measured conversion rate of NF_3 in the cleaning process, the quantity of NF, used in the cleaning process, and the known carbon equivalent potential of the NF, to calculate the global warming impact of the revised process. Details on the specific methodology are provided in Appendix B.

IBM will report the following for the greenhouse gas emission reduction portion of this project:

- Estimated greenhouse gas emissions reported in Metric Tons of Carbon Equivalent (MTCE);
- Estimated greenhouse gas emission reductions in MTCE, both in terms of total mass emitted and mass emitted normalized to production;
- The number of chambers converted to either the low flow C_2F_6 or NF, process during the reporting period, and the number of chambers remaining to be converted to achieve the facility goal for global warming gas emission reductions.

Greenhouse gas emissions will be reported in terms of total mass emitted and mass emitted normalized to production.

These reports are to be issued semi-annually on the 15th of January and July, in conjunction with the plating bath and rinsewater analysis discussed above.

D. Periodic Review by the Project Sigdatories

The Project Signatories will hold periodic performance review conferences to assess their progress in implementing this Project. No later than thirty (30) days following a periodic performance review conference, IBM will provide a summary of the minutes of that conference to all Participating Stakeholders and will also make these minutes available online at www.epa.gov/projectxl. Any additional stakeholder comments will be reported to EPA and VTDEC.

E. Duration

This Agreement will remain in effect for 5 years from the date that the final rulemaking (the later of the EPA or VTDEC rule to be promulgated) becomes effective unless it is terminated earlier or extended by all Project Signatories. If the FPA is extended, the comments and input of stakeholders will be sought and a Federal Register notice will be published. Any Project Signatory may terminate its participation in this Project at any time in accordance with the procedures set forth in Section XI of this FPA.

This exemption, once it is finalized, will apply to all the wastewater treatment sludge resulting from the treatment of the copper metallization rinsewaters at the site, including those sludges that are in the process of being generated, sludges that result from rinsewaters already in the wastewater treatment system, and sludges that have been removed from the wastewater treatment system and are being stored pending off-site transportation. This exemption will remain in effect as long as IBM continues to meet the terms and conditions of the rule.

VI. Legal Basis for the Project

A. Authority to Enter Into the Agreement

By signing this Agreement, EPA, the State of Vermont, and IBM acknowledge and agree that they have the respective authorities, discretion, and resources to enter into this Agreement and to implement all applicable provisions of this Project, as described in this Agreement.

B. Legal Effect of the Agreement

This Agreement states the intentions of the Project Signatories with respect to IBM's XL Project. The Project Signatories have stated their intentions seriously and in good faith, and expect to carry out their stated intentions.

This Agreement in itself does not create or modify legal rights or obligations, is not a contract or a regulatory action, such as a permit or a rule, and is not legally binding or enforceable against any Project Signatory. Rather, it expresses the plans and intentions of the Project Signatories without making those plans and intentions binding requirements. This applies to the provisions of this Agreement that concern procedural as well as substantive matters. Thus, for example, the

Agreement establishes procedures that the Project Signatories intend to follow with respect to dispute resolution and termination (see Sections X and XI). However, while the Project Signatories fully intend to adhere to these procedures, they are not legally obligated to do so.

EPA intends to propose for public comment the site-specific rule amendment needed to implement this Project. The rule, or any other legal mechanism necessary to implement this Project will be effective and enforceable as provided under applicable law.

This Agreement is not a “final agency action” by EPA or VTDEC, because it does not create or modify legal rights or obligations and is not legally enforceable. This Agreement itself is not subject to judicial review or enforcement. Nothing any Project Signatory does or does not do that deviates from a provision of this Agreement, or that is alleged to deviate from a provision of this Agreement, can serve as the sole basis for any claim for damages, compensation or other relief against any Project Signatory.

C. Other Laws or Regulations That May Apply

Except as provided in the legal implementing mechanisms for this Project, the Project Signatories do not intend that this Final Project Agreement will modify any other existing or future laws or regulations.

D. Retention of Rights to Other Legal Remedies

Except as expressly provided in the legal implementing mechanisms described in Section IV, nothing in this Agreement affects or limits IBM’s, EPA’s, or VTDEC’s legal rights. These rights include legal, equitable, civil, criminal or administrative claims or other relief regarding the enforcement of present or future applicable federal and state laws, rules, regulations or permits with respect to the facility.

Although IBM does not intend to challenge agency actions implementing the Project (including any rule amendments or adoptions, permit actions, or other action) that are consistent with this Agreement, IBM reserves any right it may have to appeal or otherwise challenge any EPA or VTDEC action to implement the Project. With regard to the legal implementing mechanisms, nothing in this Agreement is intended to limit IBM’s right of administrative or judicial appeal or review of those legal mechanisms, in accordance with the applicable procedures for such review.

VII. Unavoidable Delay During Project Implementation

“Unavoidable delay” (for purposes of this Agreement) means any event beyond the control of any Project Signatory that causes delays or prevents the implementation of the Project described in this Agreement, despite the Project Signatories’ reasonable efforts to put their intentions into effect. An unavoidable delay can be caused by, for example, chemical supply disruption, process conversion difficulties, a fire, severe weather or acts of war.

When any event occurs that may delay or prevent the implementation of this Project, whether or not it is avoidable, the Project Signatory who knows about it will immediately provide notice to the remaining Project Signatories. Within ten (10) days after that initial notice, the Party should give notice of the event, including appropriate documentation, that includes: 1) the reason for the delay; 2) the anticipated duration; 3) all actions taken to prevent or minimize the delay; and 4) why the delay was considered unavoidable.

If the rest of the Project Signatories agree, that the delay is unavoidable, relevant parts of the Project schedule will be extended to cover the time period lost due to the delay. If they agree, the Project Signatories will also document their agreement in a written amendment to this Agreement. If the Parties do not agree, then they will follow the provisions for Dispute Resolution outlined in Section X, below.

This section applies only to provisions of this Agreement that are not implemented by legal implementing mechanisms. Legal mechanisms, such as permit provisions or rules, will be subject to modification or enforcement as provided under applicable law.

VIII. Amendments or Modifications to the Agreement

This Project is an experiment designed to test new approaches to environmental protection and there is a degree of uncertainty regarding the environmental benefits and costs associated with activities to be undertaken in this Project. Therefore, it may be appropriate to amend this Agreement at some point during its duration.

This Final Project Agreement may be amended by mutual agreement of all of the Project Signatories at any time during the duration of the Project. The parties recognize that amendments to this Agreement may also necessitate modification of legal implementation mechanisms or may require development of new implementation mechanisms. If the Agreement is amended, EPA, VTDEC, and IBM expect to work with stakeholders to identify and pursue any necessary modifications or additions to the implementation mechanisms in accordance with applicable procedures. If the Project Signatories agree to make a substantial amendment to this Agreement, the general public will receive notice of the amendment and be given an opportunity to participate in the process, as appropriate.

In determining whether to amend the Agreement, the Project Signatories will evaluate whether the proposed amendment meets Project XL acceptance criteria and any other relevant considerations agreed on by the Project Signatories. All Project Signatories will meet within ninety (90) days following submission of any proposed amendment (or within a shorter or longer period if all parties agree) to discuss evaluation of the proposed amendment. If all Project Signatories support the proposed amendment, they will, after appropriate stakeholder involvement, amend the Agreement.

IX. Transfer of Project Benefits and Responsibilities to a New Owner

The Project Signatories expect that the implementing mechanisms will allow for a transfer of IBM's benefits and responsibilities under the Project to any future owner or operator upon request of IBM and the new owner or operator, provided that the following conditions are met:

A. IBM will provide written notice of any such proposed transfer to the EPA and VTDEC at least ninety (90) days before the effective date of the transfer. The notice is expected to include identification of the proposed new owner or operator, a description of its financial and technical capability to assume the obligations associated with the Project, and a statement of the new owner or operator's intention to take over the responsibilities in the XL Project of the existing owner or operator.

B. Within forty-rive (45) days of receipt of the written notice, the Project Signatories expect that EPA and VTDEC, in consultation with stakeholders, will determine whether: 1) the new owner or operator has demonstrated adequate capability to meet EPA's requirements for carrying out the XL Project; 2) is willing to take over the responsibilities in the XL Project of the existing owner or operator; and 3) is otherwise an appropriate Project XL partner. Other relevant factors, including the new owner or operator's record of compliance with Federal, State and local environmental requirements, may be considered as well.

It will be necessary to modify the Agreement to reflect the new owner and it may also be necessary for EPA and VTDEC to amend appropriate rules, permits, or other legal implementing mechanisms (subject to applicable public notice and comment) to transfer the legal rights and obligations of IBM under this Project to the proposed new owner or operator.

X. Dispute Resolution

Any dispute which arises under or with respect to this Agreement will be subject to informal negotiations between the Project Signatories. The period of informal negotiations will not exceed twenty (20) calendar days from the time the dispute is first documented, unless that period is extended by a written agreement of the parties to the dispute. The dispute will be considered documented when one party sends a written Notice of Dispute to the other parties,

If the parties cannot resolve a dispute through informal negotiations, the parties may invoke non-binding mediation by describing the dispute with a proposal for resolution in a letter to the Regional Administrator for EPA Region 1. Prior to the issuance of an opinion, the Regional Administrator may request an additional informal mediation hearing. The Regional Administrator will serve as the non-binding mediator. If so requested, the Regional Administrator will issue a written opinion that will be non-binding and does not constitute a final EPA action. If this effort is not successful, the parties still have the option to terminate or withdraw from the Agreement, as set forth in Section XI below.

XI. Withdrawal From or Termination of the Agreement

A. Expectations

Although this Agreement is not legally binding and any Project Signatory may withdraw from the Agreement at any time, it is the desire of the Project Signatories that it should remain in effect through the expected duration of 5 years, and be implemented as fully as possible and it is not their intent to terminate or withdraw from the FPA unless there is a compelling reason to do so.

The Project Signatories agree that appropriate points to seek withdrawal from the FPA include but are not limited to:

1. Substantial failure by any Project Signatory to: (a) comply with the provisions of the

implementing mechanisms for this Project; or (b) act in accordance with the provisions of this Agreement;

2. Substantial failure of any Project Signatory to disclose material facts during development of the Agreement;

3. Substantial failure of the XL Project to provide superior environmental performance consistent with the provisions of this Agreement;

4. Enactment or promulgation of any environmental, health or safety law or regulation after execution of the Agreement, which renders the Project legally, technically or economically impracticable; and/or

5. Decision by EPA or VTDEC to reject the transfer of the Project to a new owner or operator of the facility.

EPA and VTDEC do not intend to withdraw from the Agreement unless actions by IBM constitute a substantial failure to act consistently with intentions expressed in this Agreement and its implementing mechanisms.

IBM will be given notice and a reasonable opportunity to remedy any "substantial failure" before EPA's or VTDEC's withdrawal. If there is a disagreement between the Project Signatories over whether a "substantial failure" exists, the Project Signatories will use the dispute resolution mechanism set forth in Section X of this Agreement. EPA and VTDEC retain their discretion to use existing enforcement authorities, including withdrawal or termination of this Project, as appropriate. IBM retains any existing rights or abilities to defend itself against any enforcement actions, in accordance with applicable procedures.

B. Procedures

The Project Signatories agree that the following procedures will be used to withdraw from or terminate the Project before expiration of the Project term. They also agree that the implementing mechanism(s) will provide for withdrawal or termination consistent with these procedures.

1. Any Project Signatory that wants to terminate or withdraw from the Project is expected to provide written notice to the other Project Signatories at least sixty (60) days before the withdrawal or termination.

2. If requested by any Project Signatory during the sixty (60) day period noted above, the dispute resolution proceedings described in Section X of this Agreement may be initiated to resolve any dispute relating to the intended withdrawal or termination. If, following any dispute resolution or informal discussion, a Project Signatory still desires to withdraw or terminate from this agreement, that Project Signatory will provide written notice of final withdrawal or termination to the other Project Signatories.

3. If any agency withdraws or terminates its participation in the Agreement, the remaining agency will consult with IBM to determine whether the Agreement should be continued in a modified form, consistent with applicable federal or State law, or whether it should

be terminated.

4. The procedures described in this Section apply only to the decision to withdraw or terminate participation in this Agreement. Procedures to be used in modifying or rescinding any legal implementing mechanisms will be governed by the terms of those legal mechanisms and applicable law. It may be necessary to invoke the implementing mechanism's provisions that end authorization for the Project (called "sunset provisions") in the event of withdrawal or termination.

XII. Compliance After the Project is Over

A. Continuation of Implementing Rule if Project is Successful

Upon completion of the project term, and if the project results indicate that it was a success, as determined by EPA and VTDEC, the implementing rule will remain in effect as long IBM continues to meet its terms and conditions. EPA and VTDEC will intend to allow IBM to continue operating under the site-specific rule. However, the Administrator may promulgate a rule to withdraw the exemption at any time in the future, after the initial 5 year period of the project, if the terms and conditions of the rule are not met or if the exemption becomes inconsistent with future statutory or regulatory requirements. EPA agrees that it will promulgate such a rule only after consultation with IBM and VTDEC or after any of the Project Signatories invoke the Dispute Resolution provisions set forth in Section X. If after such consultation, EPA still decides to withdraw the exemption, IBM agrees that it will not contest this action by EPA.

B. Orderly Return to Compliance

In the event that the project has not been successful, and where IBM has undertaken efforts in good faith, EPA and VTDEC may decide not to extend the term of the Agreement. In such case, the Project Signatories must prepare for a return to compliance with the previously applicable regulations. The Project Signatories intend that there be an orderly return to compliance upon completion, withdrawal from, or termination of the Project, as follows:

1. Orderly Return to Compliance with Otherwise Applicable Regulations, if the Project Term is Completed

If, after an evaluation, the Project is terminated because EPA and VTDEC in consultation with IBM have determined that the project has not been successful, IBM will return to compliance with all applicable requirements by the end of the Project term, unless the Project is extended through amendment or modification in accordance with Section VIII of this Agreement. IBM is expected to anticipate and plan for all activities to return to compliance sufficiently in advance of the end of the Project term. IBM may request a meeting with EPA and VTDEC to discuss the timing and nature of any actions that IBM will be required to take. The Project Signatories should meet within thirty days of receipt of IBM's written request for such a discussion. At and following such a meeting, the Project Signatories should discuss with reason and in good faith, which of the requirements deferred under this Project will apply after termination of the Project.

2. Orderly Return to Compliance with Otherwise Applicable Regulations in the Event of Early Withdrawal or Termination

In the event of a withdrawal or termination not based on the end of the Project term and where IBM has made efforts in good faith, the Project Signatories will determine an interim compliance period to provide sufficient time for IBM to return to compliance with any regulations deferred under the Project. The interim compliance period will extend from the date on which EPA, VTDEC or IBM provides written notice of final withdrawal or termination of the Project, in accordance with Section XI of this Agreement. By the end of the interim compliance period, IBM will comply with the applicable deferred standards set forth in 40 CFR 261.31 and Section 7-210 of the Vermont Hazardous Waste Management Regulations. During the interim compliance period, EPA and VTDEC may issue an order, permit, or other legally enforceable mechanism establishing a schedule for IBM to return to compliance with otherwise applicable regulations as soon as practicable. IBM intends to be in compliance with all applicable Federal, State, and local requirements as soon as is practicable, as will be set forth in the new schedule.

XIII. Effective Date

This FPA is effective on the date it is dated and signed by EPA's Regional Administrator for Region 1.

Mindy Lubber, Regional Administrator, US EPA, Region 1	Date Signed
Ira Leighton, Acting Deputy Regional Administrator, US EPA, Region 1	Date Signed
Canute Dalmasse, Commissioner, Vermont Department of Environmental Conservation	Date Signed
H. J. Geipel Senior Location Executive International Business Machines Corporation	Date Signed

APPENDIX A
Plating Bath and Rinsewater Analysis

Plating Bath Analytical Data

IBM VT XL Project FPA May 2000

IBM Hudson Valley Environmental Laboratory
1580 Route 52, B/300, 2/4A1
Hopewell Junction, NY 12533

NYSDOH ELAP # 10426

ANALYTICAL RESULTS

Client : Patrick Hewlett **Phone** : (802) 7694627 **Fax :** (662) 769-4139

Lab ID : 0002045 **COC** : 3714 **Sample Date :** 3/14/00
Client Sample ID : FW0128-1 **Received Date :** 3/21/00
Sample Type : LIQUID **Report Date :** 3/28/00

Test	Method	MDL	Result	Units	Analysis Date	Analyst
Mercury	SW846 7470a	0.0020	< 0.0020	mg/L	3/24/00	Wiseman
Aluminum	SW846 6010	1.00	1.61	mg/L	3/24/00	Peaton
Antimony	SW846 6010	0.200	< 0.200	mg/L	3/24/00	Peaton
Arsenic	SW846 6010	0.200	0.620	mg/L	3/24/00	Peaton
Barium	SW846 6010	0.600	< 0.600	mg/L	3/24/00	Peaton
Beryllium	SW846 6010	0.0100	< 0.0100	mg/L	3/24/00	Peaton
Boron	SW846 6010	0.600	1.000	mg/L	3/24/00	Peaton
Calcium	SW846 6010	1.00	5.08	mg/L	3/24/00	Peaton
Cadmium	SW846 6010	0.0200	< 0.0200	mg/L	3/24/00	Peaton
Chromium	SW846 6010	0.0600	< 0.0600	mg/L	3/24/00	Peaton
Copper	SW.546 6010	4.000	1610	mg/L	3/24/00	Peaton
Iron	SW846 6010	0.400	2.590	mg/L	3/24/00	Peaton
Lead	SW.346 6010	0.100	2.266	mg/L	3/24/00	Peaton
Magnesium	SW846 6010	1.00	CI.00	mg/L	3/24/00	Peaton
Manganese	SW6466010	0.100	< 0.100	mg/L	3/24/00	Peaton
Molybdenum	SW846 6010	0.100	< 0.100	mg/L	3/24/00	Peaton
Nickel	SW846 6010	0.100	SO.100	mg/L	3/24/00	Peaton
Selenium	SW648 6010	0.206	< 0.200	mg/L	3/24/00	Peaton
Silver	SW646 6010	0.0600	0.5300	mg/L	3/24/00	Peaton
Thallium	SW846 6010	0.200	< 0.200	mg/L	3/24/00	Peaton
Vanadium	SW846 6010	0.0400	< 0.0400	mg/L	3/24/00	Peaton
Zinc	SW846 4010	0.300	10.3	mg/L	3/24/00	Peaton

Comments : Review of sample spectrum indicates that apparent zinc concentration is due to copper interference. Ag and Sb data is estimated.

IBM Corporation
Dept 728, Bldg 966-2
Essex Junction, VT 05452

Attn: P. Hewlett

COC: 3714

Blank ID: X9604

Date:	03/22/00
Matrix:	Water
Batch:	
Received:	03/21/00
Lab ID:	0002045
File ID:	X9606
Dilution:	200

Custmr ID:	FW0128-1
Sample ID:	BV000314419
Collected:	03/14/00 1100
Analyzed:	03/22/00 1241

volatile **Organic Compounds** by **Method 8260**
concentrations in ug/L

cone.	Q	Compound	Conc.	Q	Compound
2000.0	U	Acetone	200.0	U	Ethyl Benzene
200.0	U	Benzene	200.0	U	Freon 123A
ZOO.0	U	Bromodichloromethane	200.0	U	Freon TF
200.0	U	Bromoform	1000.0	U	2-Hexanone
2000.0	U	Bromomethane	4000.0	U	Isopropyl Alcohol
1000.0	v	2-Butanone	200.0	U	Methylene Chloride
2000.0	U	n-Butyl Acetate	200.0	U	Styrene
200.0	U	Carbon Disulfide	200.0	U	Tetrachloroethene
200.0	U	Carbon Tetrachloride	200.0	U	1,1,1,2-Tetrachloroethane
200.0	U	Chlorobenzene	200.0	U	1,1,2,2-Tetrachloroethane
200.0	U	Chloroethane	2000.0	v	Tetrahydrofuran
200.0	U	Chloroform	200.0	U	Toluene
200.0	U	Chloromethane	200.0	U	1,1,1-Trichloroethane
200.0	U	Dibromochloromethane	200.0	U	1,1,2-Trichloroethane
200.0	u	Dichlorodifluoromethane	200.0	U	Trichloroethene
200.0	U	1,2-Dichlorobenzene	200.0	U	Trichlorofluoromethane
200.0	U	1,3-Dichlorobenzene	2000.0	U	4-Methyl-2-Pentanone
200.0	U	1,4-Dichlorobenzene	1000.0	U	Vinyl Acetate
200.0	U	1,1-Dichloroethane	100.0	U	Vinyl Chloride
200.0	U	1,2-Dichloroethane	200.0	U	m,p-Xylenes
200.0	U	1,1-Dichloroethene	200.0	U	o-Xylenes
200.0	U	cis-1,2-Dichloroethene			
200.0	U	trans-1,2-Dichloroethene			
200.0	U	1,2-Dichloropropane			
200.0	U	cis-1,3-Dichloropropene			
200.0	U	trans-1,3-Dichloropropene			

Summary of Surrogate Recoveries

Rec (%)	Compound
103.3	1,4-Dichlorobutane
94.7	4-Bromofluorobenzene
10D.l	1,2-Dichlorobenzene-d4

SEMIVOLATILE ORGANICS DATA SHEET page 1 of 3

Name:	P. HEWLETT	Report date:	03/24/00
Client Sample ID:	FW0128-1	Project ID:	
Lab Sample ID:	0002045	Matrix:	WATER
Date/Time Sampled:	03/14/00 1100	Dilution Factor:	1
Date/Time Received:	03/21/00 1120	Date/Time Analyzed:	03/23/00 1211
Date Extracted:	03/21/00		
Location:	IBM BURLINGTON	Method:	8270
File No.:	V18024	Batch No.:	18022
Lab No.:	BV000314421	Samplers Initials:	KE
Blank File No.:	V18009	COC:	3714

CAS No.	COMPOUND	CRL ug/L	Result	Q
83-32-9	Acenaphthene	10.0		U
208-96-8	Acenaphthylene	10.0		U
120-12-7	Anthracene	10.0		U
56-55-3	Benzo(a)anthracene	10.0		U
50-32-E	Benzo(a)pyrene	10.0		U
205-99-2	Benzo(b)fluoranthene	10.0		U
191-24-2	Benzo(g,h,i)perylene	10.0		U
207-08-9	Benzo(k)fluoranthene	10.0		U
100-51-S	Benzyl Alcohol	20.0	5.13	J
111-91-1	bis(2-Chloroethoxy)methane	10.0		U
111-44-4	bis(2-Chloroethyl)ether	10.0		U
108-60-L	bis(2-Chloroisopropyl)ether	10.0		U
117-81-7	bis(2-Ethylhexyl)phthalate	10.0		U
101-55-3	4-Bromophenyl-phenyl ether	10.0		U
85-68-7	Butylbenzylphthalate	10.0		U
95-57-e	2-Chlorophenol	10.0		U
91-58-7	2-Chloronaphthalene	10.0		U
106-47-S	4-Chloroaniline	20.0		U
59-50-7	4-Chloro-3-methylphenol	20.0		U
7005-72-3	4-Chlorophenyl-phenyl ether	10.0		U
218-01-9	Chrysene	10.0		U
53-70-3	Dibenzo(a,h)anthracene	10.0		U
132-64-9	Dibenzofuran	10.0		U
84-74-2	Di-n-butylphthalate	10.0		U
95-50-l	1,2-Dichlorobenzene	10.0		U
541-73-l	1,3-Dichlorobenzene	10.0		U
106-46-7	1,4-Dichlorobenzene	10.0		U
91-94-l	3,3'-Dichlorobenzidine	20.0		U
120-83-Z	2,4-Dichlorophenol	10.0		U
84-66-Z	Diethylphthalate	10.0		U
105-67-S	2,4-Dimethylphenol	10.0		U
131-11-3	Dimethylphthalate	10.0		U

5

SEMIVOLATILE ORGANICS DATA SHEET page 2 of 3

Name:	P. HEWLETT	Report date:	03/24/00
Client Sample ID;	FW0128-1	roject ID:	
Lab Sample ID:	0002045	Matrix:	WATER
Pile No.:	V18024		

CAS No.	COMPOUND	CRL ug/L	Result	Q
117-94-o	Di-n-octylphthalate	10.0		U
534-52-l	4,6-Dinitro-2-methylphenol	50.0		U
51-28-S	2,4-Dinitrophenol	50.0		U
121-14-Z	2,4-Dinitrotoluene	10.0		U
606-20-z	2,6-Dinitrotoluene	10.0		U
206-44-O	Fluoranthene	10.0		U
86-73-7	Fluorene	10.0		U
110-74-l	Hexachlorobenzene	10.0		U
87-68-3	Hexachlorobutadiene	10.0		U
77-47-4	Hexachlorocyclopentadiene	10.0		U
67-72-1	Hexachloroethane	10.0		U
193-39-S	Indeno(1,2,3-cd)pyrene	10.0		U
78-59-1	Isophorone	10.0		U
91-57-6	2-Methylnaphthalene	10.0		U
95-48-7	2-Methylphenol	10.0		U
106-44-S	4-Methylphenol •	10.0		U
91-20-3	Naphthalene	10.0		U
W-74-4	2-Nitroaniline	60.0		U
99-09-2	3-Nitroaniline	50.0		U
100-01-6	4-Nitroaniline	20.0		U
98-95-3	Nitrobenzene	10.0		U
88-75-5	2-Nitrophenol	10.0		U
100-02-7	4-Nitrophenol	10.0		U
86-30-S	N-Nitrosodiphenylamine	10.0		U
621-64-7	N-Nitroso-di-n-propylamine	10.0		U
87-86-S	Pentachlorophenol	50.0		U
85-01-U	Phenanthrene	10.0		U
108-95-Z	Phenol	10.0		U
129-00-0	Pyrene	10.0		U
120-92-l	1,2,4-Trichlorobenzene	10.0		U
95-95-4	2,4,5-Trichlorophenol	50.0		U
88-06-2	2,4,6-Trichlorophenol	10.0		U

• coelutes with 3-Methylphenol

SEMIVOLATILE ORGANICS DATA SHEET **page 3 of** 3

Name:	P. **HEWLETT**	Report **date:**	**03/24/00**
Client **Sample ID:**	**FW0128-1**	**Project ID:**	
Lab **Sample** ID:	**0002045**	**Matrix:**	**WATER**
File No.:	**V18024**		

CAS No.	**COMPOUND**	**CRL** ug/L	**Result**	**Q**

SURROGATE RECOVERIES %

2-Fluorophenol	61.7
Phenol-d5	**49.9**
Nitrobenzene-d5	'11.6
2-Fluorobiphenyl	**75.8**
2,4,6-Tribromophenol	69.9
Terphenyl-d14	93.6

Q = Data Qualifiers:

U = **Compound analyzed** for but not **detected**

B = **Analyte is** found **in** the **associated** blank

Conc = If **"U" is present**, **the compound was analyzed** for **but** not **detected** (no **signal)**. The **value** to **the left** of **the "U"** **is the** contract detection limit for **that compound. If** **"U"** is not **present**, the **value** to **the left** is **the** actual found in the **sample** in **ug/L.**

If **"J" is** present, **the compound** ram **detected** at greater **than the method detection limit** and **less than** ths **contract** detection **limit.**

Comments:

IBM Hudson Valley Environmental Laboratory
1580 Route 52, B/300, Z/4A1
Hopewell Junction, NY 12533

NYSDOH ELAP # 10426

ANALYTICAL RESULTS

Client : Patrick Hewlett **Phone :** (802) 769-4527 **Fax :** (802) 769-4139

Lab ID : 0007.046
COC : 3714
Sample Date : 3/14/00
Client Sample ID : FW0126-2
Received Date : 3/21/00
Sample Type : LIQUID
Report Date : 3/28/00

Test	Method	MDL	Result	Units	Analysis Date	Analyst
Mercury	SW846 7470a	0.0020	< 0.0020	mg/L	3/24/00	Wiseman
Aluminum	SW846 6010	1.00	1.39	mg/L	3/24/00	Peaton
Antimony	SW846 6010	0.200	< 0.200	mg/L	3/24/00	Peaton
Arsenic	SW846 6010	0.200	0.460	mg/L	3/24/00	Peaton
Barium	SW846 6010	0.600	< 0.600	mg/L	3/24/00	Peaton
Beryllium	SW846 6010	0.0100	< 0.0100	mg/L	3/24/00	Peaton
Boron	SW846 6010	0.600	0.730	mg/L	3/24/00	Peaton
Calcium	SW846 6010	1.00	8.77	mg/L	3/24/00	Peaton
Cadmium	SW846 6010	0.0200	< 0.0200	mg/L	3/24/00	Peaton
Chromium	SW846 6010	0.0600	0.0700	mg/L	3/24/00	Peaton
Copper	SW846 6010	4.000	7840	mg/L	3/24/00	Peaton
Iron	SW846 6010	0.400	1.020	mg/L	3/24/00	Peaton
Lead	SW846 6010	0.100	3.710	mg/L	3/24/00	Peaton
Magnesium	SW846 6010	1.00	cl.00	mg/L	3/24/00	Peaton
Manganese	SW846 6010	0.100	< 0.100	mg/L	3/24/00	Peaton
Molybdenum	SW846 6010	0.100	0.110	mg/L	3/24/00	Peaton
Nickel	SW846 6010	0.100	< 0.100	mg/L	3/24/00	Peaton
Selenium	SW846 6010	0.200	< 0.200	mg/L	3/24/00	Peaton
Silver	SW846 6010	0.0600	0.4700	mg/L	3/24/00	Peaton
Thallium	SW846 6010	0.200	< 0.200	mg/L	3/24/00	Peaton
Vanadium	SW846 6010	0.0400	< 0.0400	mg/L	3/24/00	Peaton
Zinc	SW846 6010	0.300	10.5	mg/L	3/24/00	Peaton

Comments : Review of sample spectrum indicates that apparent zinc concentration is due to copper interference. Ag and Sb data is estimated.

I B M **Corporation**
Dept 728, **Bldg** 966-2
Essex Junction, VT 05452

Attn: P. Hewlett

COC: 3714

Blank ID: X9604

Date: 03/22/00
Matrix: Water
Batch:
Received: 03/21/00

Custmr m: FW0128-2
Sample m: BV000314420
Collected: 03/14/00 1115
Analyzed: 03/22/00 1318

Lab ID: 0002046
File ID: X9607
Dilution: 200

Volatile **Organic Compounds** by **Method** 8260
concentrations in ug/L

Conc.	Q	Compound
2000.0	U	Acetone
200.0	u	Benzene
200.0	v	Bromodichloromethane
200.0	U	Bromoform
2000.0	U	Bromomethane
1000.0	U	2-Butanone
2000.0	v	n-Butyl Acetate
200.0	U	Carbon Disulfide
200.0	U	Carbon Tetrachloride
200.0	U	Chlorobenzene
200.0	U	Chloroethane
200.0	U	Chloroform
200.0	U	Chloromethane
200.0	U	Dibromochloromethane
200.0	v	Dichlorodifluoromethane
200.0	U	1,2-Dichlorobenzene
200.0	v	1,3-Dichlorobenzene
200.0	v	1,4-Dichlorobenzene
200.0	U	1,1-Dichloroethane
200.0	U	1,2-Dichloroethane
200.0	v	1,1-Dichloroethene
100.0	U	cis-1,2-Dichloroethene
200.0	v	trans-1,2-Dichloroethene
200.0	U	1,2-Dichloropropane
200.0	v	cis-1,3-Dichloropropene
200.0	U	trans-1,3-Dichloropropene
200.0	U	Ethyl Benzene
200.0	U	Freon 123A
200.0	U	Freon TF
1000.0	U	2-Hexanone
4000.0	U	Isopropyl Alcohol
200.0	U	Methylene Chloride
200.0	U	Styrene
200.0	v	Tetrachloroethene
200.0	U	1,1,1,2-Tetrachloroethane
200.0	v	1,1,2,2-Tetrachloroethane
2000.0	U	Tetrahydrofuran
200.0	U	Toluene
200.0	v	1,1,1-Trichloroethane
200.0	U	1,1,2-Trichloroethane
200.0	U	Trichloroethene
200.0	U	Trichlorofluoromethane
2000.0	v	4-Methyl-2-Pentanone
1000.0	U	Vinyl Acetate
100.0	U	vinyl Chloride
200.0	v	m,p-Xylenes
200.0	U	o-Xylenes

Summary of surrogate **Recoveries**

Rec (%)	Compound
103.1	1,4-Dichlorobutane
82.1	4-Bromofluorobenzene
104.9	1,2-Dichlorobenzene-d4

SEMIVOLATILE ORGANIC9 DATA **SHEET** **page** 1 of 3

Name:	P. HEWLETT	**Report date:**	03/24/00
Client Sample ID:	FW0128-2	**Project ID:**	
Lab Sample ID:	0002046	**Matrix:**	WATER
Date/Time Sampled:	03/14/00 1115	Dilution **Factor:**	1
ate/Time Received:	03/21/00 1120	**Date/Time Analyzed:**	03/23/00 1326
Date Extracted:	03/21/00		
Location:	IBM BURLINGTON	Method:	8270
File No.:	V18025	**Batch** No.:	I.8022
Lab No.:	BV000314422	**Samplers Initials:**	KE
Blank File No.:	V18009	**COC:**	3714

CAS NO.	COMPOUND	CRL ug/L	Result	Q
83-32-9	Acenaphthene	10.0		U
208-96-E	Acenaphthylene	10.0		U
120-12-7	Anthracene	10.0		U
56-55-3	Benzo(a)anthracene	10.0		U
50-32-E	Benzo(a)pyrene	10.0		U
205-99-2	Benzo(b)fluoranthene	10.0		U
191-24-z	Benzo(g,h,i)perylene	10.0		U
207-08-9	Benzo(k)fluoranthene	10.0		U
100-51-6	Benzyl Alcohol	20.0	6.57	J
111-91-l	bis(2-Chloroethoxy)methane	10.0		U
111-44-4	bis(2-Chloroethyl)ether	10.0		V
106-60-l	bis(2-Chloroisopropyl)ether	10.0		v
117-81-7	bis(2-Ethylhexyl)phthalate	10.0		U
101-55-3	4-Bromophenyl-phenyl ether	10.0		U
85-68-7	Butylbenzylphthalate	10.0		U
95-57-B	2-Chlorophenol	10.0		U
91-58-7	2-Chloronaphthalene	10.0		U
106-47-8	4-Chloroaniline	20.0		U
59-50-7	4-Chloro-3-methylphenol	20.0		U
7005-72-3	4-Chlorophenyl-phenyl ether	10.0		U
218-01-9	Chrysene	10.0		U
53-70-3	Dibenzo(a,h)anthracene	10.0		U
132-64-9	Dibenzofuran	10.0		U
84-74-2	Di-n-butylphthalate	10.0		U
95-50-l	1,2-Dichlorobenzene	10.0		U
541-73-1	1,3-Dichlorobenzene	10.0		U
106-46-7	1,4-Dichlorobenzene	10.0		U
91-94-1	3,3'-Dichlorobenzidine	20.0		V
120-83-2	2,4-Dichlorophenol	10.0		U
84-66-2	Diethylphthalate	10.0		U
105-67-9	2,4-Dimethylphenol	10.0		U
131-11-3	Dimethylphthalate	10.0		U

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SEMIVOLATILE ORGANICS DATA **SHEET**

page 2 of 3

Name: P. **HEWLETT**
Client Sample ID: **FW0128-2**
Lab **Sample** ID: **0002046**
File No.: **V18025**

Report date: **03/24/00**
:oject ID:
Matrix: **WATER**

CAS No.	**COMPOUND**	**CRL ug/L**	**Result**	**Q**
117-04-o	Di-n-octylphthalate	10.0		U
534-52-l	4,6-Dinitro-2-methylphenol	50.0		U
51-28-5	2,4-Dinitrophenol	60.0		U
121-14-Z	2,4-Dinitrotoluene	10.0		V
606-20-2	2,6-Dinitrotoluene	10.0		V
206-44-o	Fluoranthene	10.0		V
86-73-7	Fluorene	10.0		V
118-74-l	Hexachlorobenzene	10.0		U
Q-l-68-3	Haxachlorobutadiene	10.0		W
77-47-4	Hexachlorocyclopentadiene	10.0		V
67-72-l	Hexachloroethane	10.0		U
103-39-s	Indeno(1,2,3-cd)pyrene	10.0		U
78-59-1	Isophorone	10.0		V
91-57-6	2-Methylnaphthalene	10.0		U
95-48-7	2-Methylphenol	10.0		U
106-44-5	4-Methylphenol *	10.0		U
91-20-3	Naphthalene	10.0		W
88-74-4	2-Nitroaniline	50.0		U
99-09-2	3-Nitroaniline	50.0		U
100-01-6	4-Nitroaniline	20.0		V
98-95-3	Nitrobenzene	10.0		U
88-75-5	2-Nitrophenol	10.0		U
100-02-7	4-Nitrophenol	50.0		U
86-30-6	N-Nitrosodiphenylamine	10.0		U
621-64-7	N-Nitroso-di-n-propylamine	10.0		U
87-86-5	Pentachlorophenol	SO.0		U
85-01-Q	Phenanthrene	10.0		U
108-95-2	Phenol	10.0		U
120-00-0	Pyrene	10.0		U
120-82-l	1,2,4-Trichlorobenzene	10.0		W
95-95-4	2,4,5-Trichlorophenol	50.0		W
88-06-Z	2,4,6-Trichlorophenol	10.0		V

* coelutes with 3-Methylphenol

SEMIVOLATILE ORGANICS DATA SHEET **page 3 of 3**

Name: P. **HEWLETT**
Client **Sample** ID: **FW0128-2**
Lab **Sample** ID: 0002046
File No.: **V18025**

Report date: 03/24/00
Project ID:
Matrix: **WATER**

CAS NO.	**COMPOUND**	**CRL** ug/L	**Result**	**Q**

SURROGATE RECOVERIES	%
2-Fluorophenol	57.8
Phenol-d5	45.0
Nitrobenzene-d5	63.8
2-Fluorobiphenyl	78.1
2,4,6-Tribromophenol	83.8
Terphenyl-d14	84.3

Q = Data Qualifiers:
U = **Compound** ● uAyned for but not **detected**
B = **Analyte is** found in **the associated** blank
Conc = If "U" is present, the **compound was analyzed for** but not **detected** (no signal). **The value** to **the left** of **the** "U" is the contract detection **limit** for **that compound**. If "U" is not **present**, the **value** to the **left** is **the actual** found in **the sample** In ug/L.

If "J" is **present**, the **compound was** detected at greater than the **method detection** limit and lams than the contract detection limit.

Comments:

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ANALYTICAL NARRATIVE page 1 of 2

CLIENT: IBM Burlington

COC NO: 3714

SAMPLES: 0002045 - **0002046**

METHOD: **8270**

The above referenced sample was analyzed on March 23, 2000 in the following analytical batches? v18022.

The following quality control met method criteria for each analytical batch:

- DFTPP Key Ion Abundance
- Initial Calibration
- Continuing Calibration
- Extraction Blanks
- Matrix Spike/Matrix Spike Duplicate (per 20 samples)
- Laboratory Fortified Blank

Surrogates and internal standards met method criteria for each aamplo:

Surrogates	Internal Standards
Nitrobenzene-d5	1,4-Dichlorobenzene-d4
2-Fluorobiphenyl	Acenaphthene-d10
Terphenyl-d14	Chrysene-d12
2-Fluorophenol	Naphthalene-d8
2,4,6-Tribromophenol	Phenanthrene-d10
Phenol-d5	Perylene-d12

Compounds that were detected but not included on the final report are listed below:

Sample ID	Target Compound	MDL	CDL	(ppb) Result	Q
	NONE				

Sample ID	Tentatively Identified	RT	Result	Q
FW0128-1	Benzaldehyde	9.81	5.6	J
	Triathylene glycol	18.21	6.5	J
	Benzene,[(2-methoxyethoxy)methyl]	20.03	156.3	J
	Dodecanoic acid	27.32	12.6	J
	1,4,7,10,13,16-Hexaoxacyclooctade	40.25	5.6	J
	Heneicosane	45.48	4.7	J
	Octadecane	47.05	5.4	J
	Heptacosane	48.55	27.7	J
	Docosane	30.01	16.1	J

ANALYTICAL **NARRATIVE**

CLIENT? IBM Burlington

COC NO: 3714

Sample ID	Tentatively Identified	RT	Result	Q
FW0128-2	Benzaldehyde	9.81	6.9	J
	Benzene,[(ethoxymethoxy)methyl]	20.09	284.8	J
	Dodecanoic acid	27.38	21.3	J
	Octadec-9-enoic acid	39.39	4.1	J
	Nonadecane	48.56	10.2	J

Q.C. coordinator: T. Lund

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Rinsewater Analytical Data

ANALYTICAL RESULTS
FOR

International Business Machines (IBM)
1000 River Road - Bldg.974
Essex Junction, VT 05452

Name of Collector : IBM Essex

ASSIGNED TRANS-ENVIRO #	CUSTOMER ID	SAMPLE MATRIX	SITE, DATE & TIMEOPCOLLECTION
990625-17-A	124A	Liquid	6/22/99 11:40

Laboratory Information : Sample was refrigerated upon receipt and analyzed as received.

Released by:
TRANS-ENVIRO ANALYTICAL SERVICES, INC.

Signed by M Hp on behalf of:
Mark Kalmeyer
Lab Manager

Husein Sitabkhan
President/Lab Director

Date : 07/16/99

Date Received : 06/22/99
Date Analyzed : 07/01/99

Analysis For : IBM Essex

TRANS-ENVIRO # : 990625-17-A

Customer I.D. : 124A

VOLATILE ORGANICS - APPENDIX IX

PARAMETER	μg/L	RESULTS μg/L
Acetone	1000	BDL
Acetonitrile	200	BDL
Acrolein	1000	BDL
Acrylonitrile	500	BDL
Benzene	50	BDL
Bromodichloromethane	50	BDL
Bromoform	50	BDL
Bromomethane	100	BDL
Carbon disulfide	50	BDL
Carbon tetrachloride	50	BDL
Chlorobenzene	50	BDL
Chloroethane	100	BDL
Chlorodibromomethane	50	BDL
Chloroform	50	BDL
Chloromethane	100	BDL
Chloroprene	100	BDL
3-Chloro-1-propene (allyl chloride)	50	BDL
1,2-Dibromo-3-chloropropane	100	BDL
Dibromomethane	50	BDL
trans-1,4-Dichloro-2-butene	50	BDL
Dichlorodifluoromethane	200	BDL
1,2 Dibromoethane	50	BDL
1,1-Dichloroethane	50	BDL
1,2-Dichloroethane	50	BDL
cis-1,2-Dichloroethylene	50	BDL
trans-1,2-Dichloroethylene	50	BDL
1,1-Dichloroethylene	50	BDL
Dichloromethane (Methylene chloride)	50	BDL
1,2-Dichloropropane	50	BDL
cis-1,3-Dichloropropene	50	BDL
trans-1,3-Dichloropropene	50	BDL

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8260)

Date : 07/16/99

Date Received : 06/22/99
Date Analyzed : 07/01/99

Analysis For : IBM Essex

TRANS-ENVIRO # : 990625-17-A

Customer I.D. : 124A

VOLATILE ORGANICS - APPENDIX IX

PARAMETER	DL µg/L	RESULTS µg/L
1,4-Dioxane	12000	BDL
Ethyl benzene	50	BDL
Ethyl methacrylate	50	BDL
2-Hexanone	50	BDL
Iodomethane	ioo	BDL
Isobutyl alcohol	5000	BDL
Methacrylonitrile	200	BDL
Methyl ethyl ketone	500	7,670
Methyl methacrylate	50	BDL
4-Methyl-2-pentanone	500	BDL
Styrene	50	BDL
Propionitrile	200	BDL
1,1,1,2-Tetrachloroethane	50	BDL
1,1,2,2-Tetrachloroethane	50	BDL
Tetrachloroethylene	50	BDL
Toluene	50	BDL
1,1,1-Trichloroethane	50	BDL
1,1,2-Trichloroethane	50	BDL
Trichloroethylene	50	BDL
Trichlorofluoromethane	50	BDL
1,2,3-Trichloropropane	50	BDL
Vinyl acetate	500	BDL
Vinyl chloride	100	BDL
Xylene (total)	150	BDL

SURROGATE	% RECOVERY	ACCEPTABLE LIMITS
Dibromofluoromethane	88	86-118 %
Toluene-d8	91	88-110 %
Bromofluorobenzene	95	86-115 %

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8260)

Date : 07/16/99

Date Received : 06/22/99
Date Extracted: 07/02/99
Date Analyzed : 07/07/99

Analysis For : IBM Essex

TRANS-ENVIRO # : 990625-17-A

Customer I.D. : 124A

BASE/NEUTRAL ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL µg/L	RESULTS µg/L
Acenaphthene	20	BDL
Acenaphthylene	20	BDL
Acetophenone	20	BDL
2-Acetylaminofluorene	20	BDL
4-Aminobiphenyl	20	BDL
Aniline	20	BDL
Anthracene	20	BDL
Aramite	20	BDL
Benzo[a]anthracene	20	BDL
Benzo[b]fluoranthene	20	BDL
Benzo[k]fluoranthene	20	BDL
Benzo[g,h,i]perylene	20	BDL
Benzo[a]pyrene	20	BDL
Benzyl alcohol	40	BDL
Bis(2-chloroethoxy)methane	20	BDL
Bis(2-chloroethyl)ether	20	BDL
Bis(2-chloroisopropyl)ether	20	BDL
Bis(2-ethylhexyl)phthalate	20	BDL
4-Bromophenyl phenyl ether	20	BDL
Butyl benzyl phthalate	20	BDL
4-Chloroaniline	40	BDL
4-Chlorobenzilate	20	BDL
2-Chloronaphthalene	20	BDL
4-Chlorophenyl phenyl ether	20	BDL
Chrysene	20	BDL
Diallate	20	BDL
Dibenz[a,h]anthracene	20	BDL
Dibenzofuran	20	BDL
Di-n-butyl phthalate	20	BDL
1,2-Dichlorobenzene	20	BDL
1,3-Dichlorobenzene	20	BDL
1,4-Dichlorobenzene	20	BDL

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

Date : 07/16/99

Date Received : 06/22/99
Date Extracted: 07/02/99
Date Analyzed : 07/07/99

Analysis For : IBM Essex

TRANS-ENVIRO # : 990625-17-A

Customer I.D. : 124A

BASE/NEUTRAL ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL µg/L	RESULTS µg/L
3,3'-Dichlorobenzidine	40	BDL
Diethyl phthalate	20	BDL
Dimethoate	20	BDL
p-(Dimethylamino)azobenzene	20	BDL
7,12-Dimethylbenz[a] anthracene	20	BDL
3,3'-Dimethylbenzidine	20	BDL
Dimethyl phthalate	20	BDL
1,3-Dinitrobenzene	20	BDL
2,4-Dinitrotoluene	20	BDL
2,6-Dinitrotoluene	20	BDL
Di-n-octyl phthalate	20	BDL
Diphenylamine	20	BDL
Disulfoton	20	BDL
Ethyl methanesulfonate	20	BDL
Famphur	20	BDL
Fluoranthene	20	BDL
Fluorene	20	BDL
Hexachlorobenzene	20	BDL
Hexachlorobutadiene	20	BDL
Hexachlorocyclopentadiene	100	BDL

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

Date : 07/16/99

Date Received : 06/22/99
Date Extracted: 07/02/99
Date Analyzed : 07/07/99

Analysis For : IBM Essex

TRANS-ENVIRO # : 990625-17-A

Customer I.D. : 124A

BASE/NEUTRAL ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL μg/L	RESULTS μg/L
Hexachloroethane	20	BDL
Hexachloropropene	20	BDL
Indeno(1,2,3-cd)pyrene	20	BDL
Isophorone	20	BDL
Isosafrole (total)	20	BDL
Methapyrilene	20	BDL
3-Methylcholanthrene	20	BDL
Methyl methanesulfonate	20	BDL
2-Methylnaphthalene	20	BDL
Naphthalene	20	BDL
1,4-Naphthoquinone	20	BDL
1-Naphthylamine	20	BDL
2-Naphthylamine	20	BDL
2-Nitroaniline	100	BDL
3-Nitroaniline	100	BDL
4-Nitroaniline	100	BDL
Nitrobenzene	20	BDL
4-Nitroquinoline l-oxide	20	BDL
N-Nitrosodi-n-butylamine	20	BDL
N-Nitrosodiethylamine	20	BDL
N-Nitrosodiphenylamine	20	BDL
N-Nitrosodimethylamine (as diphenylamine)	20	BDL
N-Nitrosodipropylamine	20	BDL
N-Nitrosomethylethylamine	20	BDL
N-Nitrosomorpholine	20	BDL
N-Nitrosopiperidine	20	BDL

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

Date : 07/16/99

Date Received : 06/22/99
Date Extracted: 07/02/99
Date Analyzed : 07/07/99

Analysis For : IBM Essex

TRANS-ENVIRO # : 990625-17-A

Customer I.D. : 124A

BASE/NEUTRAL ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL μg/L	RESULTS μg/L
N-Nitrosopyrrolidine	20	BDL
5-Nitro-o-toluidine	20	BDL
Pentachlorobenzene	20	BDL
Pentachloroethane	20	BDL
Pentachloronitrobenzene	20	BDL
Phenacetin	20	BDL
Phenanthrene	20	BDL
Phorate	20	BDL
2-Picoline	20	BDL
Pronamide	20	BDL
Pyrene	20	BDL
Pyridine	20	BDL
Safrole (total)	20	BDL
1,2,4,5-Tetrachlorobenzene	20	BDL
Tetraethyl dithiopyrophosphate	20	BDL
o-Toluidine	20	BDL
1,2,4-Trichlorobenzene	20	BDL
o,o,o-Triethyl phosphorothioate	20	BDL
1,3,5-Trinitrobenzene	20	BDL

'SURROGATE	% RECOVERY	ACCEPTABLE LIMITS
Nitrobenzene-d5	63	35-114 %
2-Fluorobiphenyl	122	43-116 %
Terphenyl-d14	72	33-141 %

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

Date : 07/16/99

Date Received : 06/22/99
Date Extracted: 07/02/99
Date Analyzed : 07/07/99

Analysis For : IBM Essex

TRANS-ENVIRO # : 990625-17-A

Customer I.D. : 124A

ACID ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL µg/L	RESULTS µg/L
4-Chloro-3-methylphenol	40	BDL
2-Chlorophenol	20	BDL
2-Methylphenol	20	BDL
3 & 4-Methylphenol	40	BDL
2,4-Dichlorophenol	20	BDL
2,6-Dichlorophenol	20	BDL
2,4-Dimethylphenol	20	BDL
4,6-Dinitro-2-methylphenol	100	BDL
2,4-Dinitrophenol	100	BDL
Dinoseb	20	BDL
Hexachlorophene	100	BDL
Methyl parathion	20	BDL
2-Nitrophenol	20	BDL
4-Nitrophenol	100	BDL
Parathion	20	BDL
Pentachlorophenol	100	BDL
Phenol	20	BDL
2,3,4,6-Tetrachlorophenol	20	BDL
Thionazine	40	BDL
2,4,5-Trichlorophenol	20	BDL
2,4,6-Trichlorophenol	20	BDL

SURROGATE	% RECOVERY	ACCEPTABLE LIMITS
2-Fluorophenol	59	25-100 %
Phenol-d6	34	11- 94 %
2,4,6-Tribromophenol	85	16-123 %

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

Date : 07/16/99

Date Received : 06/22/99
Date Extracted: 07/02/99
Date Analyzed : 07/01/99

Analysis For : IBM Essex

TRANS-ENVIRO # : 990625-17-A

Customer I.D. : 124A

LIST OF TEN MOST PROMINENT PEAKS

COMPOUND	CAS NUMBER	RESULTS µg/L*
Furan, tetrahydro	109-99-g	405
Undecane	1120-21-4	306
diethyl(3-methyl-2-thienyl)methyle	104085-29-2	207
2-methyl-4-OXO-2-vinyl-2,3,4,5,6,7,	91969-81-Z	188
1-(2'-hydroxy-5'methyl phenyl)-1-	103582-37-7	185
Phenol, 4-nitro	100-02-7	153
Benzoic acid,3,5-dimethyl -methyl	25081-39-4	153
2-methyl-3-phenyl-4-nitroindole	97437-50-E	140
Ethyl trans-2-cis-4-decadienoate	7328-34-9	139
cyclopentene 1-isopropyl-2, 3-dimer	7712-73-4	137

* All values are estimates.

(In decreasing order of concentration)

DL = Detection Limit
BDL = Below Detection Limit

Method: EPA SW 846(8260)

Date : 07/16/99

Date Received : 06/22/99
Date Analyzed : 06/29-07/02/99

Analysis For : IBM Essex

TRANS-ENVIRO # : 990625-17-A

Customer I.D. : 124A

METALS - APPENDIX IX

ELEMENT	mg/L	RESULTS mg/L
Aluminum	0.45	BDL
Antimony	0.264	BDL
Arsenic	0.336	BDL
Barium	0.015	BDL
Beryllium	0.006	BDL
Cadmium	0.027	BDL
Calcium	0.004	BDL
Chromium	0.026	BDL
Cobalt	0.034	BDL
Copper	0.011	32.2
Iron	0.036	BDL
Lead	0.136	BDL
Magnesium	0.011	BDL
Manganese	0.003	BDL
Mercury	0.0002	BDL
Nickel	0.120	BDL
Potassium	0.05	0.21
Selenium	0.397	BDL
Silver	0.009	BDL
Sodium	0.05	0.116
Thallium	0.740	BDL
Tin	0.440	BDL
Vanadium	0.015	BDL
Zinc	0.030	0.043

DL = Detection Limit
BDL = Below Detection Limit

Method : Mercury - EPA SW 846(7470)
Potassium - EPA SW 846(7610)
Sodium - EPA SW 846(7770)
Other Metals - EPA SW 846(6010)

QUALITY CONTROL REPORT

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VOLATILE ORGANICS - APPENDIX IX

PARAMETER	DL µg/L	RESULTS µg/L
Acetone	100	BDL
Acetonitrile	20	BDL
Acrolein	100	BDL
Acrylonitrile	50	BDL
Benzene	5	BDL
Bromodichloromethane	5	BDL
Bromoform	5	BDL
Bromomethane	10	BDL
Carbon disulfide	5	BDL
Carbon tetrachloride	5	BDL
Chlorobenzene	5	BDL
Chloroethane	10	BDL
Chlorodibromomethane	5	BDL
Chloroform	5	BDL
Chloromethane	10	BDL
Chloroprene	10	BDL
3-Chloro-1-propene (allyl chloride)	5	BDL
1,2-Dibromo-3-chloropropane	10	BDL
Dibromomethane	5	BDL
trans-1,4-Dichloro-2-butene	5	BDL
Dichlorodifluoromethane	20	BDL
1,2 Dibromoethane	5	BDL
l,l-Dichloroethane	5	BDL
1,2-Dichloroethane	5	BDL
cis-1,2-Dichloroethylene	5	BDL
trans-1,2-Dichloroethylene	5	BDL
1,1-Dichloroethylene	5	BDL
Dichloromethane (Methylene chloride)	5	BDL
1,2-Dichloropropane	5	BDL
cis-1,3-Dichloropropene	5	BDL
trans-1,3-Dichloropropene	5	BDL

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8260)

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VOLATILE ORGANICS - APPENDIX IX

PARAMETER	DL µg/L	RESULTS µg/L
1,4-Dioxane	1200	BDL
Ethyl benzene	5	BDL
Ethyl methacrylate	5	BDL
2-Hexanone	5	BDL
Iodomethane	10	BDL
Isobutyl alcohol	500	BDL
Methacrylonitrile	20	BDL
Methyl ethyl ketone	50	BDL
Methyl methacrylate	5	BDL
4-Methyl-2-pentanone	50	BDL
Styrene	5	BDL
Propionitrile	20	BDL
1,1,1,2-Tetrachloroethane	5	BDL
1,1,2,2-Tetrachloroethane	5	BDL
Tetrachloroethylene	5	BDL
Toluene	5	BDL
1,1,1-Trichloroethane	5	BDL
1,1,2-Trichloroethane	5	BDL
Trichloroethylene	5	BDL
Trichlorofluoromethane	5	BDL
1,2,3-Trichloropropane	5	BDL
Vinyl acetate	50	BDL
Vinyl chloride	10	BDL
Xylene (total)	15	BDL

SURROGATE	% RECOVERY	ACCEPTABLE LIMITS
Dibromofluoromethane	89	86-118 %
Toluene-d8	94	88-110 %
Bromofluorobenzene	93	86-115 %

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8260)

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BASE/NEUTRAL ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL μg/L	RESULTS μg/L
Acenaphthene	10	BDL
Acenaphthylene	10	BDL
Acetophenone	10	BDL
2-Acetylaminofluorene	10	BDL
4-Aminobiphenyl	10	BDL
Aniline	10	BDL
Anthracene	10	BDL
Aramite	10	BDL
Benzo [a] anthracene	10	BDL
Benzo[b]fluoranthene	10	BDL
Benzo[k]fluoranthene	10	BDL
Benzo[g,h,i]perylene	10	BDL
Benzo[a]pyrene	10	BDL
Benzyl alcohol	20	BDL
Bis(2-chloroethoxy)methane	10	BDL
Bis(2-chloroethyl)ether	10	BDL
Bis(2-chloroisopropyl)ether	10	BDL
Bis(2-ethylhexyl)phthalate	10	BDL
4-Bromophenyl phenyl ether	10	BDL
Butyl benzyl phthalate	10	BDL
4-Chloroaniline	20	BDL
4-Chlorobenzilate	10	BDL
2-Chloronaphthalene	10	BDL
4-Chlorophenyl phenyl ether	10	BDL
Chrysene	10	BDL
Diallate	10	BDL
Dibenz[a,h]anthracene	10	BDL
Dibenzofuran	10	BDL
Di-n-butyl phthalate	10	BDL
1,2-Dichlorobenzene	10	BDL
1,3-Dichlorobenzene	10	BDL
1,4-Dichlorobenzene	10	BDL

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

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BASE/NEUTRAL ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL µq/L	RESULTS µq/L
3,3'-Dichlorobenzidine	20	BDL
Diethyl phthalate	10	BDL
Dimethoate	10	BDL
p-(Dimethylamino)azobenzene	10	BDL
7,12-Dimethylbenz[a] anthracene	10	BDL
3,3'-Dimethylbenzidine	10	BDL
Dimethyl phthalate	10	BDL
1,3-Dinitrobenzene	10	BDL
2,4-Dinitrotoluene	10	BDL
2,6-Dinitrotoluene	10	BDL
Di-n-octyl phthalate	10	BDL
Diphenylamine	10	BDL
Disulfoton	10	BDL
Ethyl methanesulfonate	10	BDL
Famphur	10	BDL
Fluoranthene	10	BDL
Fluorene	10	BDL
Hexachlorobenzene	10	BDL
Hexachldrobutadiene	10	BDL
Hexachlorocyclopentadiene	50	BDL

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

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BASE/NEUTRAL ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL/L	RESULTS µg/L
Hexachloroethane	10	BDL
Hexachloropropene	10	BDL
Indeno(1,2,3-cd)pyrene	10	BDL
Isophorone	10	BDL
Isosafrole (total)	10	BDL
Methapyrilene	10	BDL
3-Methylcholanthrene	10	BDL
Methyl methanesulfonate	10	BDL
2-Methylnaphthalene	10	BDL
Naphthalene	10	BDL
1,4-Naphthoquinone	10	BDL
1-Naphthylamine	10	BDL
2-Naphthylamine	10	BDL
2-Nitroaniline	50	BDL
3-Nitroaniline	50	BDL
4-Nitroaniline	50	BDL
Nitrobenzene	10	BDL
4-Nitroquinoline l-oxide	10	BDL
N-Nitrosodi-n-butylamine	10	BDL
N-Nitrosodiethylamine	10	BDL
N-Nitrosodiphenylamine	10	BDL
N-Nitrosodimethylamine (as diphenylamine)	10	BDL
N-Nitrosodipropylamine	10	BDL
N-Nitrosomethylethylamine	10	BDL
N-Nitrosomorpholine	10	BDL
N-Nitrosopiperidine	10	BDL

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

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BASE/NEUTRAL ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL ug/L	RESULTS us/L
N-Nitrosopyrrolidine	10	BDL
5-Nitro-o-toluidine	10	BDL
Pentachlorobenzene	10	BDL
Pentachloroethane	10	BDL
Pentachloronitrobenzene	10	BDL
Phenacetin	10	BDL
Phenanthrene	10	BDL
Phorate	10	BDL
2-Picoline	10	BDL
Pronamide	10	BDL
Pyrene	10	BDL
Pyridine	10	BDL
Safrole (total)	10	BDL
1,2,4,5-Tetrachlorobenzene	10	BDL
Tetraethyl dithiopyrophosphate	10	BDL
o-Toluidine	10	BDL
1,2,4-Trichlorobenzene	10	BDL
o,o,o-Triethyl phosphorothioate	10	BDL
1,3,5-Trinitrobenzene	10	BDL

SURROGATE	% RECOVERY	ACCEPTABLE LIMITS
Nitrobenzene-d5	53	35-114 %
2-Fluorobiphenyl	96	43-116 %
Terphenyl-d14	53	33-141 %

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

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ACID ORGANIC COMPOUNDS - APPENDIX IX

PARAMETER	DL us/L	RESULTS μg/L
4-Chloro-3-methylphenol	20	BDL
2-Chlorophenol	10	BDL
2-Methylphenol	10	BDL
3 & 4-Methylphenol	20	BDL
2,4-Dichlorophenol	10	BDL
2,6-Dichlorophenol	10	BDL
2,4-Dimethylphenol	10	BDL
4,6-Dinitro-2-methylphenol	50	BDL
2,4-Dinitrophenol	50	BDL
Dinoseb	10	BDL
Hexachlorophene	50	BDL
Methyl parathion	10	BDL
2-Nitrophenol	10	BDL
4-Nitrophenol	50	BDL
Parathion	10	BDL
Pentachlorophenol	50	BDL
Phenol	10	BDL
2,3,4,6-Tetrachlorophenol	10	BDL
Thionazine	20	BDL
2,4,5-Trichlorophenol	10	BDL
2,4,6-Trichlorophenol	10	BDL

SURROGATE	% RECOVERY	ACCEPTABLE LIMITS
2-Fluorophenol	49	25-100 %
Phenol-d6	27	11- 94 %
2,4,6-Tribromophenol	72	16-123 %

DL = Detection Limit
BDL = Below Detection Limit

Method : EPA SW 846(8270)

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METALS - APPENDIX IX

ELEMENT	DL mg/L	RESULTS mg/L
Aluminum	0.45	BDL
Antimony	0.264	BDL
Arsenic	0.336	BDL
Barium	0.015	BDL
Beryllium	0.006	BDL
Cadmium	0.027	BDL
Calcium	0.004	BDL
Chromium	0.026	BDL
Cobalt	0.034	BDL
Copper	0.011	BDL
Iron	0.036	BDL
Lead	0.136	BDL
Magnesium	0.011	BDL
Manganese	0.003	BDL
Mercury	0.0002	BDL
Nickel	0.120	BDL
Potassium	0.05	BDL
Selenium	0.397	BDL
Silver	0.009	BDL
Sodium	0.05	BDL
Thallium	0.740	BDL
Tin	0.440	BDL
Vanadium	0.015	BDL
Zinc	0.030	BDL

DL = Detection Limit
BDL = Below Detection Limit

Method : Mercury - EPA SW 846(7470)
Potassium - EPA SW 846(7610)
Sodium - EPA SW 846(7770)
Other Metals - EPA SW 846(6010)

APPENDIX B
Greenhouse Gas Reduction Methodology for Chamber Cleaning Process Conversions

IBM, Burlington reserves the right to revise the emissions estimates as global warming potentials (GWPs) change and as more accurate emission factors are developed.

I. INTRODUCTION

The methodology used for estimating emissions in this report is consistent with the approach taken by IBM for reporting PFC emissions pursuant to a 1996 Memorandum of Understanding between USEPA and IBM's Microelectronics Division on voluntary PFC emissions reduction.

II. PFC USAGE DETERMINATION

PFC gas usage at IBM Burlington is determined on a facility-wide basis. The location chemical tracking system is used for determining PFC use This system contains information regarding quantities of PFCs delivered to using departments. Residual gas left in the returned cylinder(heel) is measured.

For any PFC, the annual facility-wide usage, $Q_{(annual\ usage)}$, can be expressed as follows:

$$Q_{(annual\ usage)} = \Sigma\, Q_{(delivered)} - Q_{(heel)} \qquad (1)$$

III. SOURCES OF EMISSION FACTORS AND HOW FACTORS WERE USED

1. Sources of Emission Factors

Various emission factors were obtained from the following sources:

A. Sematech (Technology Transfer # 96073156A-ENG, pp. 8 - 10);
B. DuPONT (PFC Characterization: GC-MS, Global Warming PTAB meeting, May, 1996);
C. LAM (LAM Research Corporation letter dated September 26, 1996);
D. AME (AME letter transmitted via facsimile on September 10, 1996);
E. Novellus (Novellus Systems, Inc. letter dated May, 1996); and
F. IBM's own test data (note this will be updated later this year).

For IBM's own test data, the following is a discussion on what and how the data was obtained, as well as the quality control process:

-- Set-up and Sampling Process:

PFC emissions measurements were taken during PECVD cleans in an AME5000 deposition chamber.

Extractive Fourier Transform Infra Red (FTIR) spectroscopy was used to monitor perfluorocompounds emissions in-situ during cleaning of an AME5000 PECVD chamber based on C_2F_6 chemistry. The recipes used are those currently used in manufacturing. Emissions from C_2F_6 feed-gas sampled from a port in the exhaust were identified and quantitatively analyzed by extractive FTIR for C_2F_6, CF, & C_3F_8.

The tests were conducted at IBM's Burlington facility by a team of participants consisting of the personnel from a PFC gas supplier and IBM engineers.

-- Results:

Typically the PECVD cleans consist of an inner (high pressure) and outer (low pressure) clean in order to clean both the inter-electrode region and the chamber walls. These two parts of the clean operate in different pressure ranges and often are characterized by different feed-gas utilization and emissions profiles. Four C_2F_6-based recipes were tested. In each case, the utilization of the etch gas as well as its conversion to other PFCs is reported.

-- Utilization:

The utilization of the etch gas refers to the percentage of each etch gas which reacts during the plasma clean to form other products. The utilization was determined by measuring the etch gas concentration with the radio frequency (RF) power on and off:

$$\%\ \text{Utilization of } C_2F_6 = [C_2F_6\ (\text{RF off}) - C_2F_6\ (\text{RF on})]\ / C_2F_6\ (\text{RF off}) \qquad (2)$$

-- Experimental:

a. FTIR instrument: MIDAC g5000, MCT detector, ZnSe Optics.

b. Sampling line is made of Teflon, about 12 feet long. Samples were continuously extracted with a vacuum pump at 1 .0 liter per minute for all source sampling, matrix spiking and instrument calibration checks. Flows were set with pre-calibrated mass flow controllers. Calibration gas cylinders were used for instrument calibration checks and matrix spiking. Flows were verified with Dry-Cal flow meter.

c. Sample spectra generated by co-addition of four scans from 5000-600 cm-l at 0.5 cm-l resolution. Typical minimum detection limit for the 1 cm cell used are:

CF_4 (5 ppmv), C_2F_6 (50 ppmv), C_3F_8 (20 ppmv), COF_2 (250 ppmv),
SIF_4 (50 ppmv), and SF, (7 ppmv).

d. Single beam FTIR spectrum was taken every 10 seconds.

-- Qualitv Control:

a. Instrument calibration check was performed using certified gas standards of ethylene, SF,, CF_4, C_2F_6 and C_3F_8.

b. Matrix spike check was performed to demonstrate quantitative recovery and measurement of a given spike gas in the matrix of exhaust gases. Certified gas standards of CF,, C_2F_6 and C_3F_8 were spliced into the sampling port. The percentage recovery of the spike gas was usually within 0.1%.

c. Data analysis was performed by using quantitative spectral subtraction with an automated spectral subtraction software based on a least squares algorithm. About 5% of data quantification was verified by manual subtraction. All PFCs were quantified using the gas supplier's quantitative library spectrum and a minimum four point calibration curve generated at the supplier's facility following EPA guideline for extractive FTIR.

-- Quantitative Error Assessment:

Errors in FTIR results were estimated at +/- 10%.

-- Limitations:

F_2 and HF were not quantified. (F_2, a homonuclear diatomic, is not detectable by IR absorption, and quantitative assessment of HF was not attempted.) However, fluorine mass balance was usually within 10%.

2. How Were Emission Factor Used

Table 1 below lists the available emission factors for each PFC gas. Letters “A” through “F” correspond to sources of emission factors provided under item 1 above:

Table

PFC (Application)	Sources of Emission Factors
C_2F_6 (clean)	**A, B, C, D, E, F**
C_2F_6 (etch)	**D, F**
CF_4	**A, C, D**
NF, (etch)	**A, C, F**
NF, (clean)	**A, C, D**
CHF,	**A, C, D**
SF_6	**A, C, D**

Note: our company did not use C_3F_8

The arithmetic mean of emission factors for each gas was used in estimating that gas’ emissions.

IV. PFC EMISSIONS DISCUSSION --

While the absolute PFC emissions increased by 0.024 in million metric ton of carbon equivalent (MMTCE) between 1995 and 1999, on a normalized (production) basis, PFC emissions increased only 0.007 MMTCE since the base year of 1995. We have seen significant reductions in the last year of .018MMTCE with the increased us of lower emitting process recipes.

V. EXAMPLE PFC EMISSION CALCULATION

Given:

PFC gas:	NF3
Application:	Clean
Annual usage:	1,484 kilograms
Mean emission factor:	0.39 or 39% of the NF_3 used was emitted as NF_3
GWP:	8000

Calculation:

MMTCE for NF_3	$[Q_{NF3} x(GWP_{100})_{NF3} x(12/44)]/10^9$ $[1484x0.39x8000x(12/44)]/10^9 = 0.0013$
MMTCE for all PFCs	Sum of (MMTCE),