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Characterization of Organic Air Emissions from the Certification and Segregation Building and Air Support Weather Shield II at the Radioactive Waste Management Complex

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ACRONYMS

AAC	acceptable ambient concentration
AACC	acceptable ambient concentrations for carcinogen
AEI	air emissions inventory
AREAL	Atmospheric Research and Exposure Assessment Laboratories
ASWS II or ASB II	Air Support Weather Shield II
C&S	Certified and Segregated
cfm	cubic feet per minute
CFR	Code of Federal Regulations
DEQ	Division of Environmental Quality
DOE-HQ	U. S. Department of Energy Head Quarters
DOE-ID	U. S. Department of Energy Idaho Field Office
DVF	Drum Vent Facility
EDF	engineering design file
EL	(screening) emissions levels
EPA	U. S. Environmental Protection Agency
ERT	Environmental Response Team (EPA)
GC	gas chromatography
IDHW	Idaho Department of Health and Welfare
INEL	Idaho National Engineering Laboratory
MS	mass spectroscopy
NIOSH	National Institute of Occupational Safety and Health
OEL	occupational exposure limit
OP-FTIR	Open-Path Fourier Transform Infrared Spectroscopy

OSHA	Occupational Safety and Health Administration
OVMs	organic vapor monitor
PEL	permissible exposure limit
ppb	parts per billion
ppm	parts per million
ppmw	parts per million by weight
PTC	permit to construct
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RWMC	Radioactive Waste Management Complex
SWEPP	Stored Waste Examination Pilot Plant
TAP	toxic air pollutant
TRACT	toxics reasonably available control technology
TRU	transuranic
TSA	Transuranic Storage Area
TSD	treatment, storage and disposal
TWA	time-weighted average
VOC	Volatile Organic Compound
WMF	Waste Management Facility

Characterization of Organic Air Emissions From the Certification and Segregation Building and Air Support Weather Shield II at the Radioactive Waste Management Complex

1. INTRODUCTION

During the latter part of Fiscal Year (FY-92), a task was initiated to characterize the organic air emissions from the Certification and Segregation (C&S) Building [Waste Management Facility (WMF) 612] and the Air Support Weather Shield II (ASWS II or ASB II) (WMF 711) at the Radioactive Waste Management Complex (RWMC). The purpose of this task, titled the RWMC Organic Air Emissions Evaluation Task, was to identify and quantify the volatile organic compounds (VOCs) present in the ambient air in these two facilities and to estimate the organic air emissions. The VOCs were identified and quantified by implementing a dual method approach using two dissimilar analytical methodologies, Open-Path Fourier Transform Infrared Spectroscopy (OP-FTIR) and SUMMA canister sampling, following the U. S. Environmental Protection Agency (EPA) analytical method TO-14. The data gathered was used in conjunction with the building's ventilation rate to calculate an estimated organic air emissions rate. This report presents the data gathered during the performance of this task and relates the data to the relevant regulatory requirements.

2. REGULATORY REQUIREMENTS

Various state and federal regulations address the characterization of the VOCs and the resultant ambient air emissions that may originate from facilities involved in industrial production and/or waste management activities. A variety of these regulatory drivers have been directly associated in developing the scope and the performance of the RWMC Organic Air Emissions Evaluation Task. The three main regulatory drivers associated with this task are outlined below.

2.1 Resource Conservation and Recovery Act

The primary driver of this task has been the EPA Resource Conservation and Recovery Act's (RCRA's) proposed rule titled "Hazardous Waste Treatment, Storage and Disposal Facilities; Organic Air Emission Standards for Tanks, Surface Impoundments, and Containers; Proposed Rule" published on July 22, 1991, in the Federal Register (56 FR 33489-33580), and hereafter referred to as the Phase II proposed rule.

The objective of the Phase II proposed rule is to reduce organic air emissions from specific RCRA-regulated units. This proposed rule addresses organic air emissions from RCRA-regulated treatment, storage, and disposal (TSD) units, which have been identified as tank systems, surface impoundments, or container storage units. The Phase II proposed rule applies to those waste streams with volatile organic concentrations equal to or greater than 500 parts per million by weight (ppmw) as determined by the EPA-approved methodologies specified. This proposed rule also identifies specific emissions control devices for container storage units through the use of tight covers for those containers addressed in the standard. Both the C&S and the ASB II are identified as RCRA-regulated, interim status container storage units on the Idaho National Engineering Laboratory (INEL) RCRA Part A permit application and will therefore be subject to these standards upon promulgation.

2.2 State of Idaho Toxic Air Pollutant Limits

In September 1989, a permit to construct (PTC) application addressing the estimated emissions from the proposed Type I and Type II waste storage modules to be constructed at the RWMC was prepared and submitted to the State of Idaho Department of Health and Welfare (IDHW), Division of Environmental Quality (DEQ). In December of that same year, the DEQ issued a PTC for these facilities. The potential for organic air emissions from these two facilities was not addressed in the PTC application nor the PTC.

In 1991, an INEL Air Emissions Inventory (AEI) was prepared and submitted to the DEQ. Later that year, the DEQ requested additional AEI information from the Department of Energy-Idaho Field Office (DOE-ID) regarding the emissions from the various facilities located at the RWMC. The information requested for the RWMC facilities was gathered and submitted to the DEQ in a technical memo in 1992. Organic air emissions from the Drum Vent Facility (DVF) was addressed in this technical memo in the form of an engineering design file (EDF) prepared by EG&G Idaho, Inc. for the DOE-ID (Reference 1). Currently, the DVF does not have a PTC and as such all operations campaigns have been approved by the DEQ on a case by case basis.

During February of 1993, the DEQ provided, for public review and comment, the final draft version of the Proposed Rules for the Control of Toxic Air Pollution in Idaho. These proposed rules were

derived from the Toxic Air Pollutant (TAP) policy, which is driven by the regulation identified in IDAPA 16.01.01011,01 titled "Toxic Substances". This section of the proposed rule addressing Toxic Substances states that "Any contaminant which is by its nature toxic to human or animal life or vegetation, but which is not specifically controlled elsewhere in this chapter, shall not be emitted in: (i) Amounts which will cause, or significantly contribute to causing, ambient air concentrations to exceed acceptable ambient concentrations listed in the toxic air pollutant carcinogenic standards, toxic air pollutant non-carcinogenic standards, or toxic air pollutant interim limits; or (ii) Emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation." The information presented in this section of the proposed standards is very broad and allows the DEQ to propose stringent ambient air emissions standards if the decision is made to do so.

In the final draft version of the Proposed Rules for the Control of Toxic Air Pollution in Idaho, the DEQ has established TAP Carcinogenic Standards addressing Screening Emissions Levels (EL) and Acceptable Ambient Concentrations for Carcinogens (AACC) (annual) for over 80 compounds including carbon tetrachloride, chloroform, and methylene chloride. The DEQ has also proposed TAP Non-Carcinogenic Standards based on Occupational Exposure Limits (OEL), EL, and Acceptable Ambient Concentrations (AAC) (annual) for numerous compounds including acetone, 1,1,1-trichloroethane, trichloroethene and 1,1,2-trichloro-1,2,2-trifluoroethane (more commonly known as Freon-113). Many of these proposed concentration and emissions limits are extremely low which will make compliance with this TAP policy exceedingly difficult. Currently, the DEQ is enforcing the proposed TAP policy concentration and emissions limits even though they have not yet been promulgated into a final rule. Additionally, all potential emissions of the compounds identified in this proposed rule must be addressed in any future PTC applications.

It is highly unlikely that the TAP policy concentration and emissions limits will change significantly before promulgation of the final TAP rule. All PTC application(s) or modification(s) submitted to the DEQ in the future will be required to address these proposed standards for the control of TAP. Accurate organic air emissions monitoring data will be extremely helpful in addressing compliance with the proposed TAP policy limits.

2.3 Occupational Safety and Health Administration

The Occupational Safety and Health Administration (OSHA) has published personal exposure limits in the form of 29 Code of Federal Regulations (CFR) 1910.1000 that establishes chemical concentrations to which nearly all workers may be repeatedly exposed, day after day, without suffering adverse health effects. In addition, 29 CFR 1910.120 was promulgated to ensure the health and safety of personnel at hazardous waste site operations and TSD units regulated by RCRA under 40 CFR Parts 264 and 265. Both the C&S and ASB II are RCRA-regulated interim status TSD units. Both of the aforementioned standards require extensive knowledge of the types and concentrations of chemical to which personnel are or may be exposed.

2.3.1 U. S. Department of Energy Orders and EG&G Company Procedures

In addition to the OSHA standards which establish personal exposure limits for workers and ensures the health and safety of personnel, DOE has established DOE Order 5480.10 titled "Contractor Industrial Hygiene Program", which among other things addresses the control of occupational

exposures to chemical carcinogens for all DOE operations. In an effort to comply with this DOE order, EG&G Idaho, Inc. established Company Procedure 11.6, titled "Carcinogen Control." The purpose of this procedure is to provide instructions, based upon the requirements of DOE Order 5480.10, for controlling occupational exposures to chemical carcinogens at all EG&G Idaho operations and work places. This procedure contains provisions designed to prevent personnel exposures to carcinogens and to provide a wide margin of safety in the varied situations in which both DOE specified carcinogens and other potential carcinogens are used.

This procedure also specifies the requirements for: the identification and evaluation of carcinogenic chemicals and materials; the careful controlling of the levels of personnel exposure to carcinogens in order to keep these exposure levels as low as reasonably achievable; and minimizing the exposures to carcinogens in general. Three of the suspect human carcinogens identified in the waste containers stored at the Transuranic Storage Area (TSA) portion of RWMC are carbon tetrachloride, chloroform and methylene chloride.

Performing ambient air monitoring to identify and quantify the VOCs present in the C&S Building and ASB II would facilitate compliance with the OSHA standards as well as the related DOE Orders and EG&G Idaho policies and procedures.

3. RWMC ORGANIC AIR EMISSIONS SOURCES

The primary mission of the RWMC is to safely dispose of INEL-generated low-level waste and to temporarily store mixed transuranic (TRU) waste. As TRU waste containers are retrieved from temporary storage they are first processed through the DVF followed by an aspiration period of at least 8 weeks. These containers are then processed through the Stored Waste Examination Pilot Plant (SWEPP) facility for nondestructive examination and then they are transferred to the C&S Building or ASB II for storage.

The DVF remotely vents TRU waste drums by insertion of a carbon composite filter assembly into the drum lid. Studies have been conducted that indicate TRU waste containers have the potential to contain flammable/explosive concentrations of hydrogen. Hydrogen is generated in TRU waste drums through such mechanisms as radiolysis, thermal degradation, bacteriological decomposition, chemical corrosion, and alpha decay (Reference 2). Venting of TRU waste drums is considered necessary to mitigate the explosion potential due to the potentially high concentrations of hydrogen that may exist inside the drums. The carbon composite filter assembly is designed to allow aspiration of internally generated gases, such as hydrogen, oxygen, and carbon dioxide, while containing radioactive particulates inside the drum. Some TRU waste containers were originally assembled with a semi-permeable lid gasket which was designed to allow internally generated gases to diffuse out of the drum and allow for pressure equalization. Gas permeation rates of semi-permeable lid gaskets are less than the carbon composite filter assemblies and as such do not meet the current shipping requirements. Therefore, all drums previously fitted with the semi-permeable lid gasket are required to have the carbon composite filter assemble installed prior to shipping.

All TRU waste containers have previously been assigned content codes based on process knowledge, employee interviews and waste form descriptions (Reference 3). RWMC EDF-421 (Reference 4) describes various content codes and the hazardous chemical constituents that may be present. Studies have been conducted that indicate that some content codes may have relatively high headspace gas concentrations of VOCs (Reference 5). These VOCs can be released from the TRU waste drums during the drum venting and aspiration processes and during storage in the C&S Building and ASB II. It is anticipated that the most significant release of VOCs would occur in the C&S Building and ASB II due to the large number of drums stored there. The VOC concentrations in the C&S Building and ASB II would depend on a number of variables, including number of drums of a specific content code vented, length of time since the drums had been vented, the number of drums with carbon composite filters[1], headspace gas concentration, quantity of liquid organic material present, temperature, ambient pressure, number of layers of confinement, and matrix affects.

The C&S Building is an approximately 150 x 600-ft structure consisting of a nonflammable fiberglass fabric weather shield supported by internal air pressure. The building height at the center is approximately 59 ft. An internal steel support structure installed beneath the fabric envelope provides a safety support to prevent the fabric from collapsing should the building's air pressure system fail. Two airlocks are located on the west side of the C&S Building. Each of the airlocks has a dual function: to allow entry into the C&S Building and to provide temporary covered storage for trailers

1. At present, it is unclear to what degree the semi-permeable lid gaskets prevent VOCs from escaping.

carrying waste containers or container surge storage. Electrically-operated overhead sectional doors at each entry portal are interlocked to prevent depressurization of the building and/or pressurization of the SWEPP. The C&S Building air inflation package is comprised of two blowers, each with a rated capacity of 12,220 cubic feet per minute (cfm). The blowers maintain the building pressure at approximately 1.5 inches of water above atmospheric pressure. Under normal operating conditions, one blower operates continually until the building pressure drops to 1.3 inches of water, then the second blower is activated until the building pressure reaches approximately 1.6 inches of water. A 7,500,000 British thermal unit (BTU) input propane fired furnace, a blower with a rated capacity of 65,367 cfm, and a fabric duct along the top center of the fabric shell provide heat in the winter time to remove snow and ice.

The paved floor of the C&S Building, comprising nearly 2.25 acres, is divided into 8 x 8-ft grids labeled A through Q (excluding I and O) and 1 through 78 (Figure 1). Each grid can contain 16 drums or two boxes on each layer, and containers within the grid may be stacked up to five layers high. Each layer of drums is separated by fire-resistant plywood. Currently, there are approximately 7,485 TRU waste drums stored in the C&S Building that have been fitted with the carbon composite filter. Appendix A describes the grid location, content code, and approximate number of drums fitted with the carbon composite filter in the C&S Building. The remainder of drums stored in the C&S Building have previously been fitted with a semi-permeable lid gasket. The majority of drums fitted with a carbon composite filter were vented between 1986 and 1989. An additional 177 drums were fitted with a carbon composite filter in the spring/summer of 1992 (not included in the previous total).

The ASB II is a 150 x 150-ft structure consisting of an inflated, nonflammable fiberglass fabric weather shield similar to the C&S Building; however, there is no steel skeletal support structure. The building height at center is slightly higher than that of the C&S Building. One airlock is located on the north side of ASB II to allow materials to be moved into or removed from the facility without loss of air pressure. Electrical fans provide air for building inflation, and propane heaters provide heated air to remove snow and ice from the fiberglass fabric weather shield. The air inflation package for the ASB II operates similar to that of the C&S Building air inflation package.

The paved floor of the ASB II is divided into 8 x 8-ft grids labeled B through G and M through S (excluding O) and numbered 29 through 31, 33 through 35, and 37 through 42 (Figure 2). Each grid can contain 16 drums or two boxes on each layer, and containers within the grid may be stacked up to five layers high. Each layer of drums is separated by fire-resistant plywood. Currently, there are approximately 3,198 TRU waste drums stored in the ASB II that have been fitted with the carbon composite filter. Appendix B describes the grid location, content code, and approximate number of drums fitted with the carbon composite filter in the ASB II. Approximately 50% of the TRU waste drums stored in the ASB II are either fitted with the carbon composite filter or the semi-permeable lid gasket. The majority of drums fitted with a carbon composite filter were vented between 1986 and 1989.

A comprehensive evaluation of the VOCs emanating from the drums stored in the C&S Building and ASB II has not previously been conducted. However, previously conducted investigatory studies have indicated that significant concentrations of VOCs could exist in the C&S Building and ASB II. In July 1991, air samples were collected in the C&S Building and ASB II using organic vapor monitors (OVMs) manufactured by the 3M Company. Ten OVMs were placed at various levels above the waste stacks in various locations throughout the C&S Building (7 OVMs) and ASB II (3 OVMs). Two additional OVMs served as field blanks. The OVMs were left in place for 10 days,

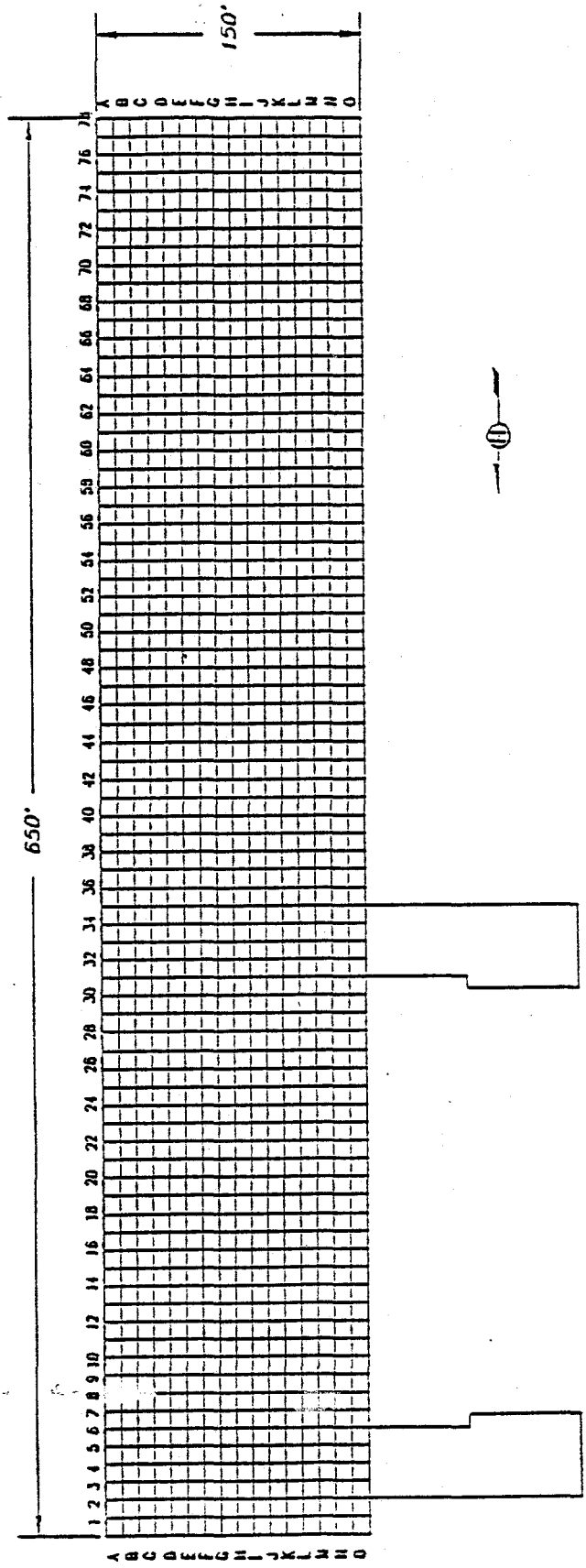

Figure 1. C&S Building grid layout.

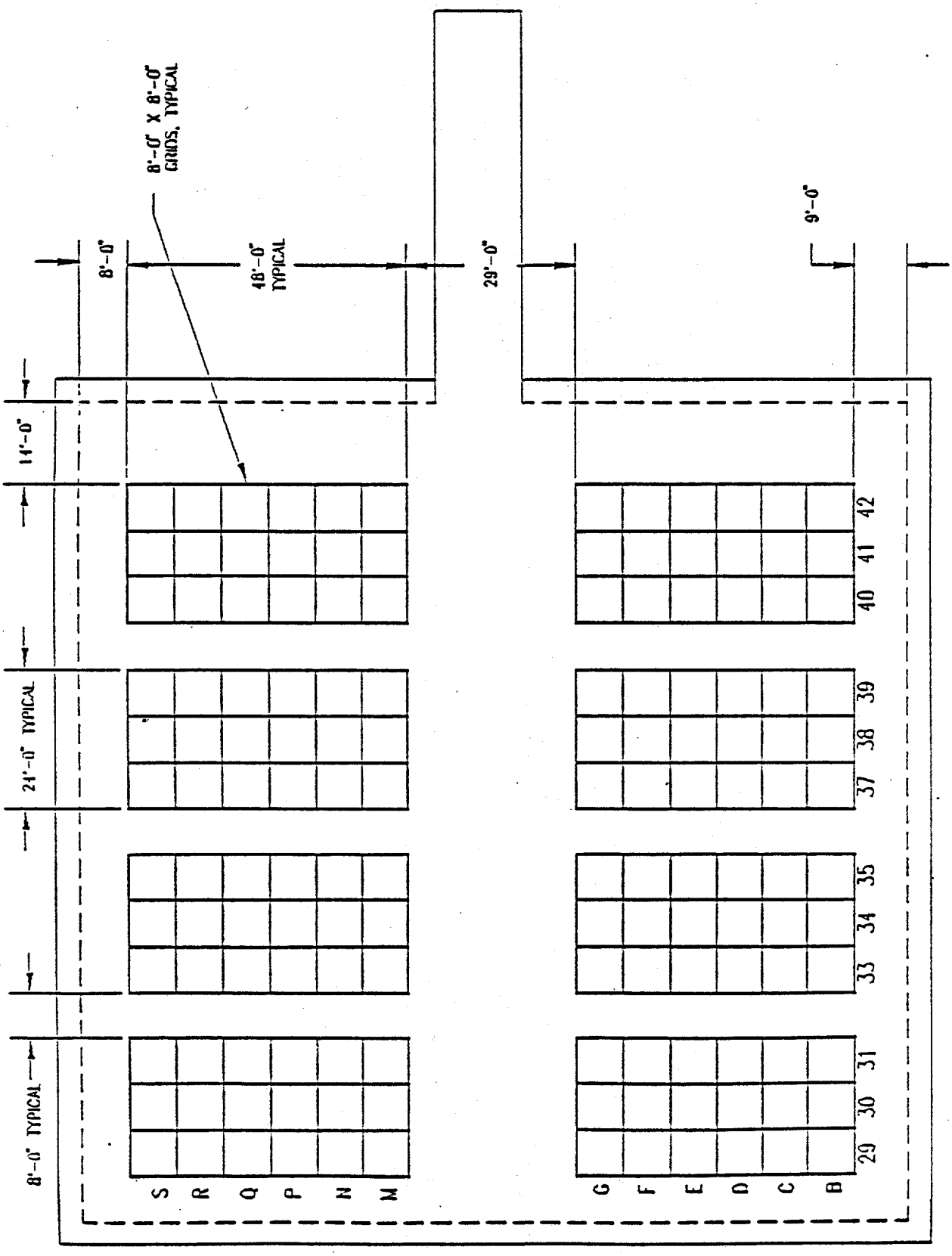

Figure 2. ASB II grid layout.

accumulating VOCs. Analytical results detected hexane, carbon tetrachloride, trichloroethene, 1,1,1-trichloroethane, chloroform, and toluene. Total VOCs averaged approximately 2 parts per million (ppm). Carbon tetrachloride/1,1,1-trichloroethane averaged approximately 90% of the total VOCs present. Carbon tetrachloride co-eluted with 1,1,1-trichloroethane, and as such the individual concentrations of each constituent was not determined.

During the summer of 1991, an OP-FTIR system was demonstrated in the C&S Building. Carbon tetrachloride, dichloromethane, 1,1,1-trichloroethane, 1,1,2 trichloro 1,2,2 trifluoroethane, propane, and ammonia were measured by the OP-FTIR in the C&S Building (Reference 6). Table 1 lists a range of VOCs detected during this demonstration.

Personal sampling using National Institute of Occupational Safety and Health (NIOSH) methodologies have also confirmed the presence of VOCs. Personnel working in either the C&S Building or ASB II have been sampled, their time-weighted average (TWA) exposures calculated, and the results documented. All personal samples taken to date have been below applicable health based regulatory limits (e.g., permissible exposure limits, threshold limit values, recommended exposure limits).

Numerous methods are available for identifying and quantifying VOCs; however, currently there is no regulatory referenced method for measuring VOCs in ambient air (Reference 7). The EPA has published the "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air" (Reference 8), which describes a generalized protocol for the collection and analysis of specific hazardous air pollutants. EPA Method TO-1 (Tenax Tube Sampling) and Method TO-14 (Summa Canister Sampling) are specifically designed for the collection of VOCs. Method TO-14, which allows for the collection of a larger variety of VOCs than does TO-1, can be used for some semivolatile organic compounds and is widely used to characterize toxic organic compounds. In general, TO-14 sampling involves collection of ambient air samples over a prescribed period of time in a passivated stainless steel canister. Samples are then analyzed by gas chromatography (GC) and mass spectroscopy (MS).

Over the last several years, an optical remote sensing technique using OP-FTIR has been used with increasing frequency to conduct environmental measurements of airborne toxic pollutants, particularly VOCs (References 7 and 9 through 14). The OP-FTIR is essentially an open-path infrared spectral

Table 1. Range of VOCs concentrations detected in the C&S Building using the OP-FTIR.

Compound	Concentration (ppb)
Ammonia	79 - 104
Carbon tetrachloride	215 - 449
Dichloromethane	MDL[a] - 760
Propane	1020 - 1193
1,1,2-trichloro 1,2,2-trifluoroethane	80 - 146
1,1,1-trichloroethane	145 - 345

a. MDL - method detection limit.

analyzer. The OP-FTIR makes measurements of spatially integrated infrared absorption using transmitter/receiver optics at one end of the path and a retroreflector at the other end. In an *active* OP-FTIR system, an infrared absorption spectrum is obtained by performing a Fourier transform on the wave form,resulting from an infrared probe passing through an interferometer and the atmosphere containing the absorbing chemicals. Quantitative results are obtained from the size of the absorption bands that result from the chemicals being measured.

Numerous research papers written by recognized authorities in the field of air emissions monitoring have been published in notable professional journals discussing the use of OP-FTIR. In addition, a number of EPA publications are currently being developed to address the use of OP-FTIR for a variety of air emissions monitoring scenarios. Dr. William J. McClenny, Supervisory Physicist for the EPA at the Atmospheric Research and Exposure Assessment Laboratories (AREAL), is currently preparing a guidance document for the general use of OP-FTIR sensors for the measurement of air quality. Thomas H. Prichett, Senior Chemist for the EPA Environmental Response Team (ERT), is currently revising an operating procedure for the use of OP-FTIR for air quality measurements at Superfund sites. This document, titled "Field Standard Operating Procedure for the Use of Open-Path FTIR Spectroscopy at Hazardous Waste Sites," has been used as a reference method for collecting data in the support of ERT assessments in the past. The data collected using this reference method has been deemed acceptable as valid data for Superfund air quality monitoring purposes. Jody L. Hudson, EPA Region VII, has recently written a paper that explains that in the case of collecting measurements of air toxics in ambient air for which there is no reference method available, one does not need EPA's approval of the method used for measurements of this type. Under these circumstances, the data can be validated by employing the appropriate quality assurance/quality control (QA/QC) procedures established for that methodology. Information extracted from these and other publications and from direct communications with EPA personnel indicates that the development of an EPA-approved method for monitoring ambient air emissions with OP-FTIR is forthcoming.

OP-FTIR offers numerous advantages over traditional point source SUMMA canister sampling methodologies (References 15 and 16), such as a) no sampling of air is required so that concerns about sample integrity are not relevant as they are with point source sampling techniques; b) numerous gases can be measured simultaneously; c) concentration data can be obtained in the matter of minutes instead of days or weeks in the case of point source sampling; d) concentration data is expressed as the path-average concentration, thus eliminating bias due to sampling in "hot spots"; e) the cost per sample is much less than point source sampling; f) relatively large areas can be sampled with a minimal amount of time, cost, and effort; and g) sampling can be done remotely, thus eliminating the need to enter potential hazardous areas.

As previously mentioned, OP-FTIR has the advantage over SUMMA canister sampling in that the OP-FTIR produces a concentration average over the length of the path from source to detector for a given compound, whereas the SUMMA canister method produces a concentration for only those points sampled. Numerous studies have been conducted that indicate that OP-FTIR and SUMMA canister results compare favorably when SUMMA canister samples are collected adjacent to the OP-FTIR beam or when a SUMMA canister is transported along the OP-FTIR beam (References 17 through 27). These studies support the use of OP-FTIR in conjunction with SUMMA canister sampling when characterizing organic air emissions.

Studies were conducted in the C&S Building and ASB II in the late summer/early fall of 1992 to provide a more comprehensive evaluation of the VOCs present and their relative concentrations, to

determine the nature and extent of organic air emissions from these air support buildings, and to evaluate the feasibility of using OP-FTIR in conjunction with SUMMA canister sampling for future organic air emission measurements. The VOCs in the C&S Building and ASB II were identified and quantified using both SUMMA canister sampling and OP-FTIR technology. The VOC concentration data was then used in conjunction with the air support building ventilation rate to estimate the organic air emissions. SUMMA canister sampling data was compared to OP-FTIR data collected at the same time and location to assess how well the two methods compared under the conditions present in the air support buildings.

4. METHODS

4.1 SUMMA Canister Sampling

SUMMA canister sampling was conducted in accordance with the EPA Compendium of Methods For the Determination of Toxic Organic Compounds in Ambient Air, Method TO-14, "Determination of Volatile Organic Compounds in Ambient Air Using SUMMA Polished Canister Sampling and Gas Chromatography Analysis." After sample collection, the SUMMA canisters were sent to Southwest Research Institute, San Antonio, Texas and analyzed by GC/MS per ERD-SOW-114 (Reference 28).

Air samples were collected in 6-liter SUMMA canisters (Scientific Instrumentation Specialists or equivalent), which were certified cleaned, evacuated, and ready for sample collection by Southwest Research Institute. The SUMMA canisters were equipped with stainless steel pressure gauges capable of being processed at 110°C and with 1% full scale accuracy. Pressure gauges were used as for gross indicator of canister pressure. The canisters were equipped with Veriflo stainless steel sampling valves set at 25 mL/minute. Air samples were collected over a five-hour time period, and the canisters were packaged and transported via overnight air carrier to Southwest Research Institute for analysis. Building temperature and atmospheric pressure readings were recorded before and after sample collection.

Sampling locations from each building were statistically derived using a Latin square design (Reference 29). Each building was stratified vertically into three strata. The first two strata were at heights below 15 ft; the height of the stack of drums based on the assumption that the majority of contaminants of interest would reside in this region. The first stratum was set from 0 to 7.5 ft, the second stratum from 7.5 to 15 ft, and the third stratum was set from 15 ft to the top of the building. The horizontal plane of each building was divided into nine sections defined by evenly dividing the x and y axes into three regions, thus providing 27 sections of each building that could be sampled. The Latin square design ensures that each of the regions in one dimension are sampled in each of the three regions of the other two dimensions. The physical placement of the SUMMA canister within the selected sample section were randomly placed.

SUMMA canister samples were collected in the C&S Building or ASB II on three different occasions. On August 24 and 25, 1992, fourteen air samples were collected in the C&S Building. Two QC samples were also included in this sample group. The sample collection sites and height from the floor to the canister are listed in Table 2.

Table 2. Grid locations and SUMMA canister sample heights for Data Set 1.

Grid Location	Height (ft)	Grid Location	Height (ft)
J-65	39	C-63	2.5
F-37	4	N-38	29
A-46	11.5	G-25	8.5
B-4	21	P-2	5.75
Q-73	9	F-10	3
C-15	4	D-20	1
K-55	1	K-71	4

On September 1, 1992, eleven air samples were collected from ASB II. Nine samples were collected according to the Latin square design, plus one replicate sample and a trip blank. Samples were collected at the locations and heights listed in Table 3.

Table 3. Grid locations and SUMMA canister sample heights for Data Set 2.

Grid Location	Height (ft)	Grid Location	Height (ft)
N-29	12	I-32	1 (plus replicate)
D-31	12	G-38	15
B-37	3	S-38	9
R-43	1	G-42	9
C-42	15		

On September 9, 1992, ten samples were collected in ASB II. Nine samples were collected according to the Latin square design, plus one replicate sample. Samples were collected at the following locations and heights listed in Table 4.

Table 4. Grid locations and SUMMA canister sample heights for Data Set 3.

Grid Location	Height (ft)	Grid Location	Height (ft)
B-40	1 (plus replicate)	M-37	1
Q-29	1	G-41	9
S-38	9	E-31	12
M-30	15	A-34	12
N-41	12		

4.2 Open-Path Fourier Transform Infrared Spectroscopy Monitoring

OP-FTIR monitoring was performed using an MDA Scientific OP-FTIR (model: System, FTIR-RS; Rev.: P). The OP-FTIR was operated per the MDA Scientific, OP-FTIR Operators Manual and training provided by Dr. Robert Kagann of MDA Scientific.. Additionally, personnel involved in operating the OP-FTIR attended a training session entitled "The Basics of Remote Sensing for Atmospheric Pollutants" (instructors: Thomas Prichett, EPA Environmental Response Team; Dr. Orman Simpson, MDA Scientific Research and Development Division; and Timothy Minnich, Blasland, Bouch and Lee [BB&L]). Additional training and project oversight was provided by Dr. Robert Kricks, BB&L, who assisted in authoring the EPA's Preliminary Draft Field Standard Operating Procedure for the use of OP-FTIR Spectroscopy at Hazardous Waste Sites.

The MDA Scientific OP-FTIR was used in a unistatic configuration with a single 12-inch Cassegrain telescope, which was used simultaneously to transmit the infrared beam and receive the infrared beam on its return after being reflected by a retroreflector array (Figure 3). Three monitoring corridors were established adjacent to the waste stacks in each of the air support buildings (Figure 4 and 4a). On any given day, the OP-FTIR was set up at the north end of the corridor and the retroreflector on the south end of the corridor. The infrared beam was transmitted between the OP-FTIR and the retroreflector at a beam center height of 5 ft. For the purpose of this study, each corridor was

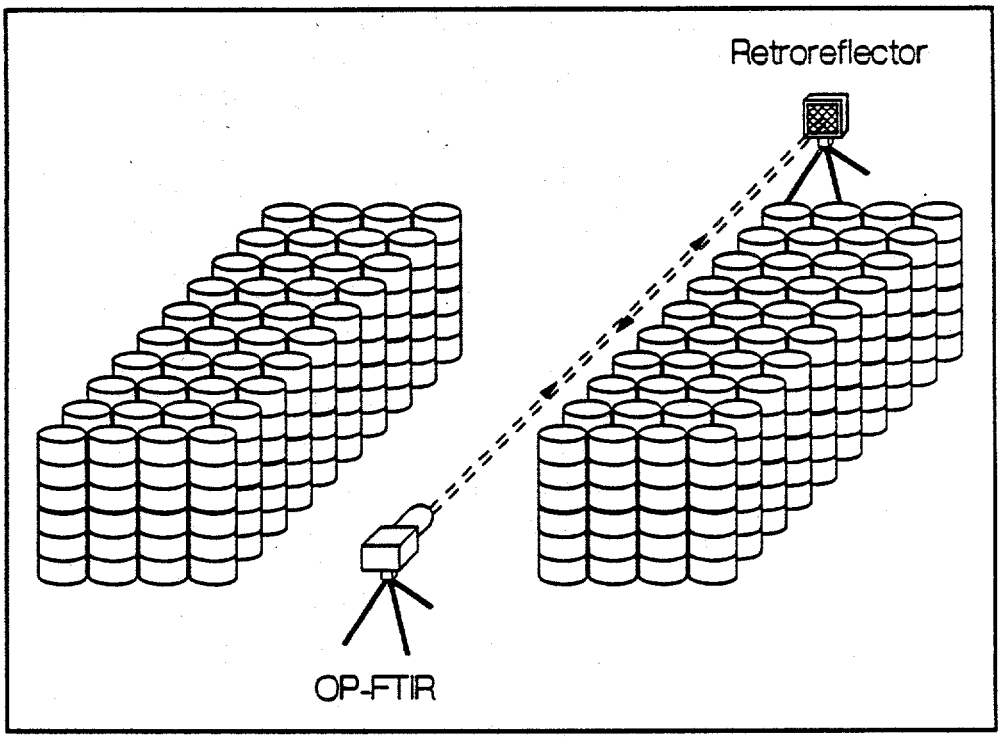

Figure 3 Schematic of OP-FTIR monitoring VOCs between stacked barrels. Dashed lines (with arrows) represent the IR beam probing the ambient air between the barrels.

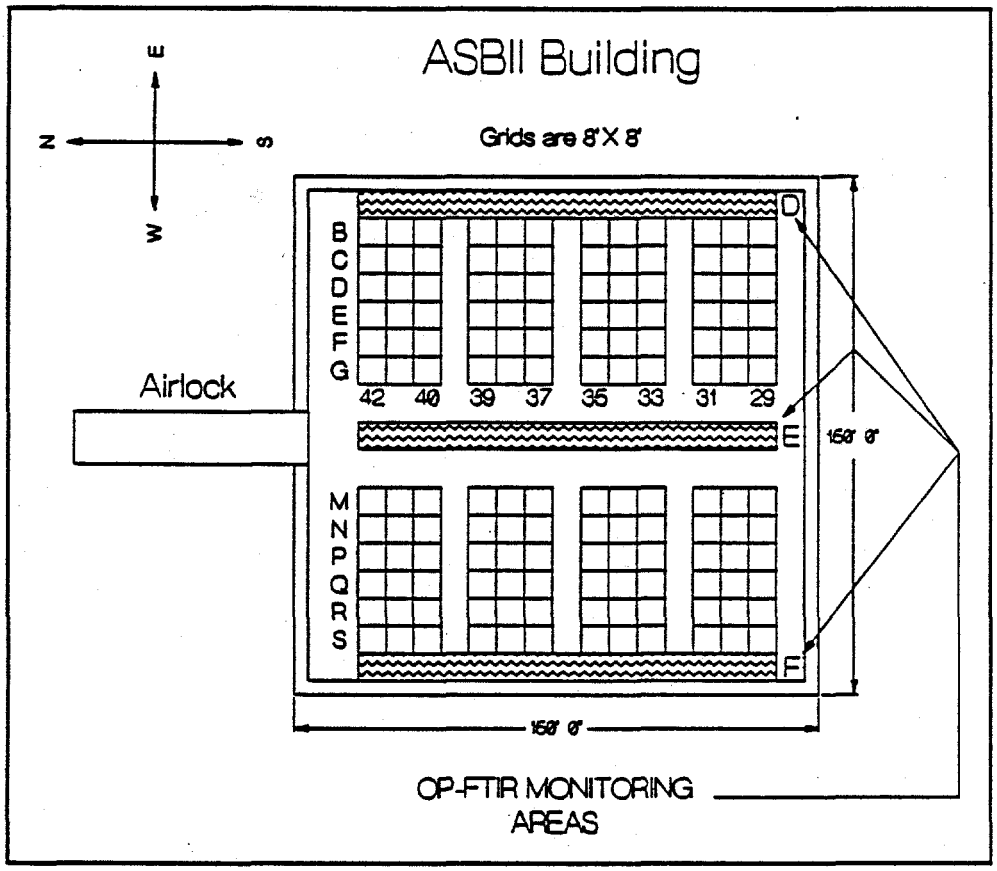

Figure 4. ASB II monitoring corridors are labeled D, E, and F for east, center, and west, respectively.

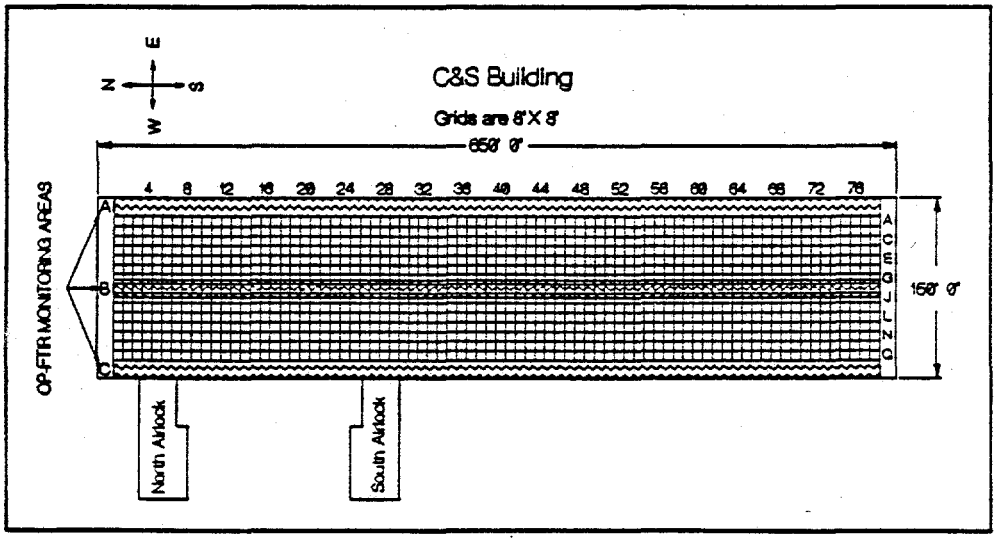

Figure 4a. C&S monitoring corridors are labeled A, B, and C for east, center, and west, respectively.

monitored on at least one occasion and for as long a period of time as possible given the facility operating requirements. The OP-FTIR data was collected by co-adding 64 scans such that concentration data was recorded approximately every 5 minutes throughout the entire period monitored. Additional details regarding OP-FTIR data collection and analysis can be found in Appendix C.

4.2.1 OP-FTIR Quality Assurance Procedure

The OP-FTIR QA procedure used followed the initial draft of the protocol document created by the ERT of the EPA[2]. This procedure consists of making a field measurement under identical (or at least very similar) conditions to those that existed when the measurements, which are being validated, were made. While the field measurement is being made, a precisely known amount of the target chemical is introduced into the infrared beam. The determined concentration of the target chemical should increase by the amount introduced to the beam by the QA procedure. Changes in the field conditions (humidity, temperature, and transient atmospheric interference) require periodic repetition of the QA procedure. The degree of similarity of the conditions for the QA measurement to the validated field measurements and frequency of the QA measurements is dictated by the requirements of the program and the ultimate purpose of the measurement results.

The QA measurement was performed by flowing a National Institute of Standards and Technology tracable certified gas mixture through the 15-cm internal spectroscopic gas cell. This cell was always in the path of the infrared beam so that the only difference between a QA measurement and the field measurement was the presence of the certified QA gas mixture. Figure 5 shows a schematic of the QA measurement setup. Two flow-through tubes were attached to the gas cell, one on each end of the cell. The gas cylinder regulator was then connected to one of the two flow-through tubes. The out-flow flow-through tube was connected to a tube submerged in low vapor pressure diffusion pump oil in a flask, to prevent back-streaming of the atmosphere to the cell. The flask was then contained in a sealed plastic bag so that the gas mixture was captured, preventing the perturbation of the concentrations of the gases in the air support buildings. After the QA measurement was made, the cell was flushed out by flowing dry nitrogen through the cell.

During the entire QA procedure, the OP-FTIR measured chemical vapors on a continuous basis and determined the concentration-pathlength product, CL. The procedure consisted of the following three steps:

1. **Before the Gas Mixture Flow.** At this time there was only clean nitrogen in the cell, a series of measurements were made to establish a baseline. The OP-FTIR was functioning in its normal measurement mode, making measurements of the chemical vapors that were present in the external beam.

2. **During the Gas Mixture Flow Through the Cell.** As the gas mixture, which had a certified volume ratio of one or more of the target chemical species being measured, flowed through the gas cell, the measured concentration of the species present in the

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2. This draft protocol is being used by ERT as a criterion for accepting OP-FTIR field data as valid at Superfund sites. A revision of this draft, which is presently being prepared, will evolve in a guidance document for using OP-FTIR at Superfund sites.

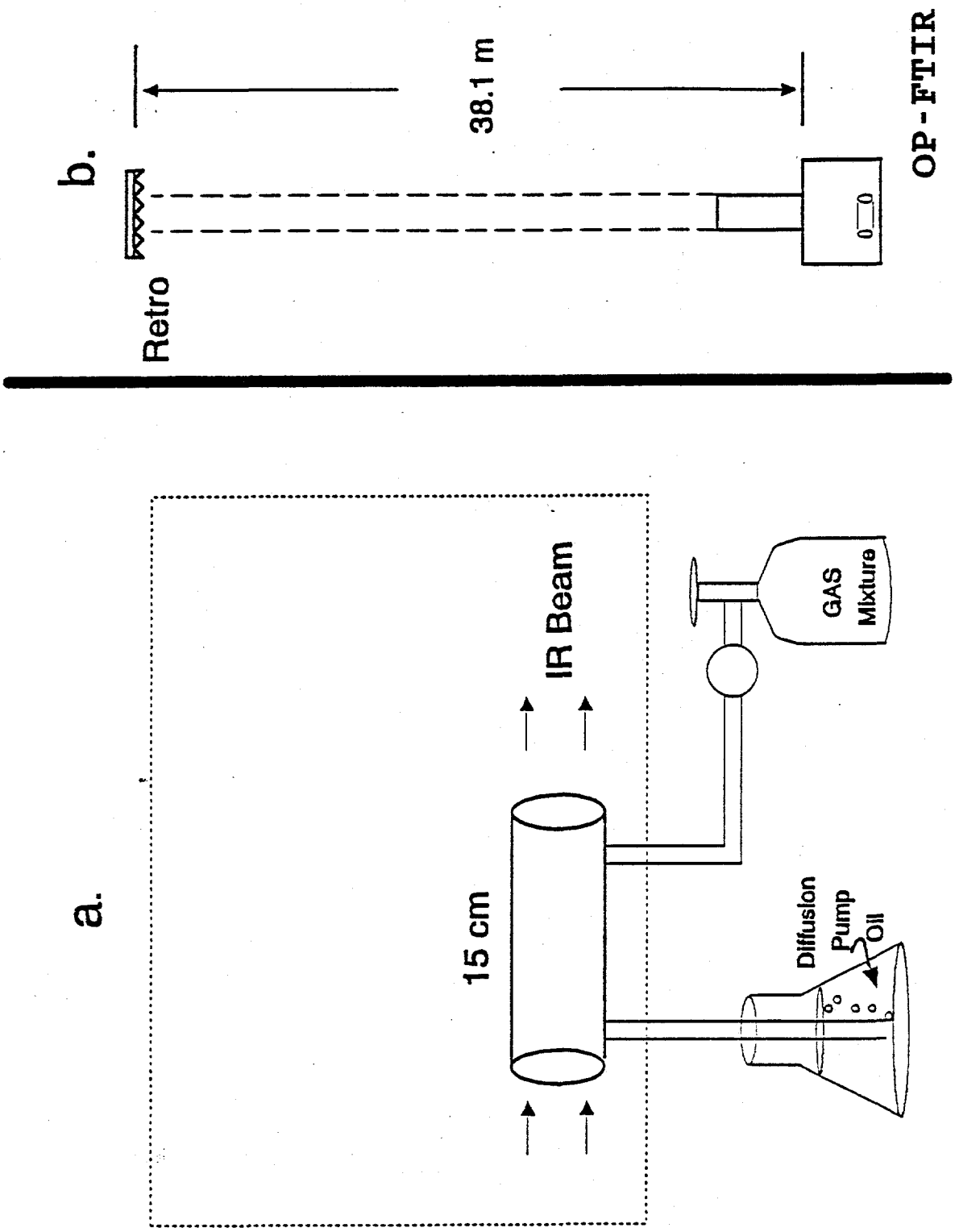

Figure 5. Schematic of the QA measurement configuration. a. Details the gas mixture flow-through procedure. b. Depicts the OP-FTIR external beam configuration.

QA mixture increased until equilibrium was established between losses of the chemical vapor to adsorption on the cell walls and desorption of the chemical from the walls. During this period, the measured concentration-pathlength products was the sum of CL due to absorption by the vapors in the external beam and the absorption by the vapors in the gas mixture in the cell.

3. **After the Gas Mixture Flow is Stopped.** After the flow of the gas mixture through the gas cell ended, the measured CL decreased until all the vapors were completely purged out of the cell with clean nitrogen and most of the adsorbed material was also removed.

4.3 Organic Air Emissions Estimates

Organic air emission estimates from the C&S Building and ASB II were calculated based on the following assumptions:

- The volume of air exiting the air support buildings equals the volume of air entering the buildings.
- The concentration of VOCs exiting the air support buildings is equal to the measured concentration of VOCs inside the buildings.

4.3.1 Volumetric Flow

The volume of air entering the air support buildings, the volumetric flow, was calculated using Equation (1) where Q equals the volumetric flow, A equals the area of the inflation package air discharge plenum and V equals the average air velocity across the face of the discharge plenum.

$$Q = V \times A \qquad (1)$$

All velocity measurements were made with a TSI, Inc., Model 8350 VelociCalc hot wire anemometer and were in accordance with EG&G Idaho, Inc., Company Procedure Manual Volume III, Section 11.11. Velocity measurements were made with one of the two air inflation fans operating as if typical under normal operating conditions. Fifty-four and 64 velocity measurements were made approximately equal distance from each other across the face of the discharge plenum in the C&S Building and ASB II, respectively. Velocity measurements were averaged and reported in cubic feet per hour.

4.3.2 Volatile Organic Compound Concentration Conversion

The concentration of VOCs in the air support buildings was determined using both TO-14 and OP-FTIR. Concentration data from these two methods were reported in ppm. Equation (2) was used to convert ppm (volume/volume relationship) to milligrams per cubic meter (mg/m^3; mass/volume relationship).

$$\frac{MG}{M^3} = \frac{(PPM)\ (P_2)\ (298)\ (MW)}{(24.45)\ (29.92)\ (T_2)} \qquad (2)$$

where mg/m^3 is milligrams/cubic meter; PPM is parts per million; P_2 is barometric pressure at time of sampling expressed in inches of mercury; MW is gram molecular weight of the VOC; 24.45 is molar volume of a gas in liters at 29.92 inches of mercury and 298° Kelvin (K; 273 + 25° Celsius {C}); and T_2 is temperature at time of sampling expressed in degrees Kelvin (273 + °C).

Milligrams per cubic meter concentration data was converted to pounds per cubic foot for the purpose of calculating organic air emissions rates from the air support buildings.

4.3.3 Calculated Organic Air Emissions

The mass of VOCs released per unit time or the organic air emissions rate was determined using data results from Equation (1) and (2) such that Equation (1) defines the volume of air discharged from the C&S Building or ASB II expressed in cubic feet per hour and Equation (2) defines the concentration of VOCs expressed in pounds per cubic feet contained in that volume of air or;

$$\frac{\text{pounds of VOC}}{\text{cubic feet}} \times \frac{\text{cubic feet}}{\text{hour}} = \frac{\text{pounds of VOC}}{\text{hour}} \qquad (3)$$

4.3.4 SUMMA Walk/OP-FTIR Comparison

The purpose of the quality assurance procedure, described in Section 4.2.1, was to acquire confidence in the quality of the OP-FTIR data. Another method of achieving confidence in the OP-FTIR data is to compare the data with that obtained simultaneously from SUMMA canisters. This comparison was made by transporting a SUMMA canister (SUMMA walk) adjacent to the beam of the OP-FTIR thus obtaining path-averaged VOC concentration measurements for both methods simultaneously. Two such comparisons were made on September 9, 1992. The first canister (SUMMA walk 1) was walked for 17 minutes while the OP-FTIR made seven sets of measurements. The second canister (SUMMA walk 2) was walked for 18 minutes while the OP-FTIR made eight sets of measurements. Care was taken to open the valve of the canister simultaneously with the start of the first OP-FTIR data run and to close the valve precisely at the end of the last OP-FTIR data run. Each of the OP-FTIR measurements were time-averaged for 2.5 minutes. In each case, a SUMMA canister/OP-FTIR sample was collected along a 120-ft path located along the west side of ASB II (west of row "S") at an approximate height of 4 ft. The sampling valve of the SUMMA canister was completely open to a flow of >800 ml/minute. After six roundtrip passes (1440 ft), the canister was filled and the valve shut. SUMMA canister samples were than sent to the Southwest Research Institute for analysis.

5. RESULTS

5.1 SUMMA Canisters Results

Appendix D presents "corrected" data results for SUMMA canister samples collected on August 24 and 25 in the C&S Building (first data set) and September 1 in ASB II (second data set). Preliminary data analysis from Data Set 1 and 2 indicated that the analytical laboratory was not processing the samples in accordance with the requirements of ERD-SOW-114. The initial pressure of the canisters was not recorded before the samples were diluted. Instead, canister pressures were assumed to be 0 psi. The laboratory acknowledged their omission and implemented procedures to ensure that subsequent samples were analyzed in accordance with ERD-SOW-114. Samples collected on September 9 (third data set) were processed in accordance with ERD-SOW-114, and the results can be found in Appendix E.

Data Sets 1 and 2 were "corrected" by using the initial pressure readings of the samples from the third data set (September 9) as outlined in the letter from Chee-Kai Tan, Southwest Research Institute to Joan Connolly dated December 15, 1992. Because data sets one and two were "corrected", an element of uncertainty remains about the relative accuracy of these sets. However, the QC sample included in the first sample set had results closer to the true concentrations after the data was corrected thus supporting the methodology used to correct data sets one and two. While data from data sets one and two may not represent the "true" concentration, it does provide good qualitative data and provides a good estimate of the "true" concentration.

Data sets one and two did not receive internal EG&G Idaho Inc. data validation due to the aforementioned laboratory error(s). Data set three was validated in accordance with the EG&G Idaho Inc. Sample Management Office's Standard Operating Procedures and ERD-SOW-114 and as such, is believed to provide accurate concentration data.

Tables 5 and 6 presents the average and maximum VOC concentration for samples collected in the C&S Building and ASB II, respectively. Table 7 provides data relative to the building temperature and barometric pressure readings before and after SUMMA canister sample collection. Only those VOCs that were detected in greater than or equal to 50% of the samples, regardless of date or sampling location, are reported. Appendices D and E provide additional information for those VOCs not reported in Tables 5 and 6. The reported average concentration is equal to the average contaminant concentration detected in all of the SUMMA canister (e.g., zero values were included), while the maximum concentration is equal to the maximum contaminant concentration detected in any one SUMMA canister. All samples were collected over a 5-hour sample collection period between approximately 9:00 a.m. to 2:00 p.m..

In general, individual VOC concentrations varied from day to day and to a lesser degree from SUMMA canister sampling location to SUMMA canister sampling location. Data analysis indicates a trend regarding vertical stratification of contaminants. Carbon tetrachloride concentrations show a vertical preference below the 15-ft level (below the top of the drum stacks). This appears to be true for each sampling round and building. A general trend of the horizontal distribution of contaminants is evidenced by the fact that somewhat higher carbon tetrachloride concentrations appear in the southern portions of the air support buildings. In all likelihood, this trend is a result of the influx of

Table 5. Summa canister data from C&S Building (Data Set 1).

Compound/ CAS Number	08/24/92 Average Concentration (ppm)	08/24/92 Maximum Concentration (ppm)	08/25/92 Average Concentration (ppm)	08/25/92 Maximum Concentration (ppm)
Toluene 108-88-3	3.10E-02	9.90E-02	1.30E-02	2.60E-02
Carbon tetrachloride 56-23-5	1.43E-01	2.20E-01	1.48E-01	2.50E-01
Acetone 67-64-1	9.00E-02	1.20E-01	0.00E+00	0.00E+00
Chloroform 67-66-3	2.00E-03	8.00E-03	2.00E-03	7.00E-03
1,1,1-trichloroethane 71-55-6	6.80E-02	1.20E-01	8.40E-02	1.40E-01
Propane 74-98-6	4.49E-01	7.70E-01	6.22E-01	9.00E-01
Methylene chloride 75-09-2	8.30E-02	1.60E-01	1.36E-01	2.10E-01
1,1-dichloroethene 75-35-4	5.80E-02	9.90E-02	3.10E-02	6.50E-02
Dichlorodifluoromethane 75-71-8	2.00E-03	1.30E-02	2.00E-03	1.10E-02
C2Cl3F3 (Freon 113) 76-13-1	5.80E-02	9.90E-02	4.40E-02	7.40E-02
Trichloroethene 79-01-6	1.90E-02	4.00E-02	2.20E-02	3.80E-02

Table 6. SUMMA canister data from ASB II (Data Sets 2 and 3).

Compound/ CAS Number	Data Set 2 09/01/92 Average Concentration (ppm)	Data Set 2 09/01/92 Maximum Concentration (ppm)	Data Set 3 09/09/92 Average Concentration (ppm)	Data Set 3 09/09/92 Maximum Concentration (ppm)
Carbon tetrachloride 56-23-5	2.49E-01	3.20E-01	4.02E-01	4.50E-01
Acetone 67-64-1	1.30E-02	5.10E-02	2.00E-01	1.20E+00
Chloroform 67-66-3	9.00E-03	1.30E-02	5.00E-03	1.10E-02
1,1,1-trichloroethane 71-55-6	1.94E-01	3.10E-01	2.83E-01	3.80E-01
Propane 74-98-6	1.10E-02	1.10E-01	0.00E+00	0.00E+00
Methylene chloride 75-09-2	5.00E-03	5.00E-02	2.50E-02	2.50E-01
1,1-dichloroethene 75-35-4	9.60E-02	1.20E-01	5.40E-02	1.10E-01
Dichlorodifluoromethane 75-71-8	1.40E-02	2.30E-02	4.00E-03	1.60E-02
C2Cl3F3 (Freon 113) 76-13-1	1.45E-01	1.90E-01	1.20E-01	1.80E-01
Trichloroethene 79-01-6	2.00E-03	1.00E-02	3.00E-03	1.10E-02

Table 7. Building temperature and barometeric pressure readings collected during SUMMA canister sampling.

Date	Temperature (°C)		Barometric Pressure (inches of mercury)	
	Before	After	Before	After
8/24/92	9	16	25.2	25.2
8/25/92	8	16	25.2	25.2
9/01/92	12	25	25.1	25.1
9/09/92	14	20	25.2	25.2
Averages	11	19	25.2	25.2

fresh, noncontaminated air from the air inflation plenum located at the northeast corner of both buildings, which would be expected to provide some contaminant dilution.

5.2 OP-FTIR Results

Tables 8 through 13 present the average and maximum VOC concentration for samples collected in the C&S Building and the ASB II with the OP-FTIR on various dates. The average concentration is equal to the average contaminant concentration detected along the entire OP-FTIR beam pathlength (e.g., across the length of the entire air support building) averaged over the entire period monitored. The maximum concentration is equal to the maximum contaminant concentration detected along the entire OP-FTIR beam pathlength at any 5 minute interval. Tables 8 through 13 present concentration data for carbon tetrachloride, 111-trichloroethane, and Freon 113. Additional VOCs were detected by the OP-FTIR but the data was not analyzed due to budget and time constraints. However, cursory data analysis indicates that the concentrations of carbon tetrachloride, 1,1,1-trichloroethane, and Freon 113 far exceed any of the other VOCs detected.

OP-FTIR data was collected on 12 different days in the C&S Building and on 7 different days in the ASB II. On a majority of the days (15 of 19 days), data were collected over a minimum period of time of 19 hours or greater. Daily average concentrations of carbon tetrachloride ranged from 0.863 ppm on 8/19/92 to 0.221 ppm on 9/15/92 and 0.731 ppm on 9/10/92 to 0.224 ppm on 8/31/92 in the C&S Building and ASB II, respectively. Daily average concentrations of Freon 113 ranged from 0.289 ppm on 8/19/92 to 0.033 ppm on 9/17/92 and 0.322 ppm on 9/10/92 to 0.052 ppm on 9/13/92 in the C&S Building and ASB II, respectively. Daily average concentrations of 1,1,1-trichloroethane ranged from 0.621 ppm on 8/18/92 to 0.168 ppm on 9/15/92 and 0.612 ppm on 9/10/92 to 0.196 ppm on 8/31/92 in the C&S Building and ASB II, respectively.

Table 8. C&S OP-FTIR carbon tetrachloride data.

Start Date/Time	End Date/Time	Average Concentration (ppm)	Maximum Concentration Date/Time	Maximum Concentration (ppm)
8/12/92 @ 12:13	8/13/92 @ 15:02	4.97E-01	8/12/92 @ 16:18	9.01E-01
8/17/92 @ 12:04	8/18/92 @ 14:21	6.36E-01	8/18/92 @ 10:34	9.52E-01
8/18/92 @ 16:38	8/19/92 @ 13:28	7.37E-01	8/18/92 @ 19:58	9.42E-01
8/19/92 @ 15:13	8/20/92 @ 13:52	8.63E-01	8/20/92 @ 10:39	1.02E+00
8/24/92 @ 11:06	8/25/92 @ 09:16	2.77E-01	8/24/92 @ 21:41	3.77E-01
8/25/92 @ 10:54	8/26/92 @ 07:41	4.83E-01	8/26/92 @ 02:28	6.57E-01
8/26/92 @ 09:05	8/27/92 @ 08:06	6.34E-01	8/26/92 @ 19:41	8.41E-01
9/14/92 @ 09:00	9/15/92 @ 09:44	2.89E-01	9/14/92 @ 16:02	4.72E-01
9/15/92 @ 11:09	9/16/92 @ 13:45	2.21E-01	9/15/92 @ 17:47	3.83E-01
9/16/92 @ 14:43	9/17/92 @ 09:55	2.94E-01	9/16/92 @ 15:39	5.47E-01
9/17/92 @ 10:09	9/17/92 @ 14:25	2.73E-01	9/17/92 @ 14:25	3.97E-01
9/21/92 @ 07:43	9/22/92 @ 09:22	3.87E-01	9/21/92 @ 19:07	9.12E-01

Table 9. C&S OP-FTIR Freon 113 Data.

Start Date/Time	End Date/Time	Average Concentration (ppm)	Maximum Concentration Date/Time	Maximum Concentration (ppm)
8/12/92 @ 12:13	8/13/92 @ 15:02	1.27E-01	8/12/92 @ 16:18	2.51E-01
8/17/92 @ 12:04	8/18/92 @ 14:21	2.22E-01	8/18/92 @ 10:34	3.51E-01
8/18/92 @ 16:38	8/19/92 @ 13:28	2.20E-01	8/18/92 @ 19:53	2.94E-01
8/19/92 @ 15:13	8/20/92 @ 13:52	2.89E-01	8/20/92 @ 10:39	3.41E-01
8/24/92 @ 11:06	8/25/92 @ 09:16	6.70E-02	8/24/92 @ 21:41	1.09E-01
8/25/92 @ 10:54	8/26/92 @ 07:41	1.53E-01	8/26/92 @ 02:28	2.13E-01
8/26/92 @ 09:05	8/27/92 @ 08:06	1.92E-01	8/26/92 @ 19:46	2.65E-01
9/14/92 @ 09:00	9/15/92 @ 09:44	8.70E-02	9/14/92 @ 15:17	1.48E-01
9/15/92 @ 11:09	9/16/92 @ 13:45	4.30E-02	9/15/92 @ 17:47	1.21E-01
9/16/92 @ 14:43	9/17/92 @ 09:55	6.80E-02	9/16/92 @ 15:39	1.57E-01
9/17/92 @ 10:09	9/17/92 @ 14:25	3.30E-02	9/17/92 @ 14:25	1.04E-01
9/21/92 @ 07:43	9/22/92 @ 09:22	9.20E-02	9/21/92 @ 19:07	3.11E-01

Table 10. C&S OP-FTIR 1,1,1-trichloroethane data.

Start Date/Time	End Date/Time	Average Concentration (ppm)	Maximum Concentration Date/Time	Maximum Concentration (ppm)
8/12/92 @ 12:13	8/13/92 @ 15:02	4.03E-01	8/12/92 @ 16:18	7.73E-01
8/17/92 @ 12:04	8/18/92 @ 14:21	5.63E-01	8/18/92 @ 10:34	8.60E-01
8/18/92 @ 16:38	8/19/92 @ 13:28	6.21E-01	8/18/92 @ 19:53	8.26E-01
8/19/92 @ 15:13	8/20/92 @ 13:52	3.11E-01	8/20/92 @ 10:39	8.88E-01
8/24/92 @ 11:06	8/25/92 @ 09:16	2.00E-01	8/24/92 @ 21:36	2.84E-01
8/25/92 @ 10:54	8/26/92 @ 07:41	3.80E-01	8/26/92 @ 02:28	5.16E-01
8/26/92 @ 09:05	8/27/92 @ 08:06	4.91E-01	8/26/92 @ 19:46	6.85E-01
9/14/92 @ 09:00	9/15/92 @ 09:44	2.52E-01	9/14/92 @ 15:17	4.25E-01
9/15/92 @ 11:09	9/16/92 @ 13:45	1.68E-01	9/15/92 @ 17:47	3.22E-01
9/16/92 @ 14:43	9/17/92 @ 09:55	2.12E-01	9/16/92 @ 15:39	4.07E-01
9/17/92 @ 10:09	9/17/92 @ 14:25	1.86E-01	9/17/92 @ 14:25	2.67E-01
9/21/92 @ 07:43	9/22/92 @ 09:22	2.86E-01	9/21/92 @ 19:07	7.57E-01

Table 11. ASB II OP-FTIR carbon tetrachloride data.

Start Date/Time	End Date/Time	Average Concentration (ppm)	Maximum Concentration Date/Time	Maximum Concentration (ppm)
8/31/92 @ 10:26	9/01/92 @ 08:14	2.24E-01	8/31/92 @ 13:17	4.59E-01
9/01/92 @ 09:26	9/01/92 @ 23:55	5.55E-01	9/01/92 @ 14:53	1.20E+00
9/02/92 @ 00:00	9/02/92 @ 23:58	5.89E-01	9/02/92 @ 14:56	1.34E+00
9/03/92 @ 00:02	9/03/92 @ 14:10	4.81E-01	9/03/92 @ 13:52	1.32E+00
9/07/92 @ 09:53	9/08/92 @ 09:28	4.39E-01	9/07/92 @ 14:58	8.37E-01
9/08/92 @ 10:51	9/09/92 @ 09:11	3.88E-01	9/08/92 @ 16:09	8.92E-01
9/10/92 @ 10:05	9/10/92 @ 15:24	7.31E-01	9/10/92 @ 14:47	1.31E+00

Table 12. ASB II OP-FTIR Freon 113 data.

Start Date/Time	End Date/Time	Average Concentration (ppm)	Maximum Concentration Date/Time	Maximum Concentration (ppm)
8/31/92 @ 10:26	9/01/92 @ 08:14	5.20E-02	8/31/92 @ 16:17	2.10E-01
9/01/92 @ 09:26	9/01/92 @ 23:55	2.30E-01	9/01/92 @ 14:43	5.12E-01
9/02/92 @ 00:00	9/02/92 @ 23:58	2.33E-01	9/02/92 @ 14:56	5.59E-01
9/03/92 @ 00:02	9/03/92 @ 14:10	1.51E-01	9/03/92 @ 13:52	5.46E-01
9/07/92 @ 09:53	9/08/92 @ 09:28	1.90E-01	9/07/92 @ 15:45	3.70E-01
9/08/92 @ 10:51	9/09/92 @ 09:11	1.58E-01	9/08/92 @ 15:41	3.83E-01
9/10/92 @ 10:05	9/10/92 @ 15:24	3.22E-01	9/10/92 @ 14:47	5.51E-01

Table 13. ASB II OP-FTIR 1,1,1-trichloroethane data.

Start Date/Time	End Date/Time	Average Concentration (ppm)	Maximum Concentration Date/Time	Maximum Concentration (ppm)
8/31/92 @ 10:26	9/01/92 @ 08:14	1.96E-01	8/31/92 @ 16:22	4.07E-01
9/01/92 @ 09:26	9/01/92 @ 23:55	4.78E-01	9/01/92 @ 14:53	1.06E+00
9/02/92 @ 00:00	9/02/92 @ 23:58	5.34E-01	9/02/92 @ 15:01	1.16E+00
9/03/92 @ 00:02	9/03/92 @ 14:10	3.31E-01	9/03/92 @ 14:04	1.08E+00
9/07/92 @ 09:53	9/08/92 @ 09:28	3.96E-01	9/07/92 @ 15:45	7.65E-01
9/08/92 @ 10:51	9/09/92 @ 09:11	3.62E-01	9/08/92 @ 15:39	7.61E-01
9/10/92 @ 10:05	9/10/92 @ 15:24	6.12E-01	9/10/92 @ 14:52	1.10E+00

In general, the maximum concentration of carbon tetrachloride, Freon 113, and 1,1,1-trichloroethane was detected at approximately the same time of day on any one given day. However, the time of day that the maximum occurred varied from day to day, especially in the C&S Building. The maximum VOC concentration usually occurred between approximately 10:30 a.m. to 9:30 p.m. and 1:00 p.m. to 4:00 p.m. in the C&S Building and the ASB II, respectively

OP-FTIR data analysis indicates that the VOC concentrations in the air support buildings vary significantly with time. In all likelihood, this variation is due to temperature and to a lesser degree pressure changes (e.g., as temperature increases and pressure decreases, concentration increases). Graphic representation of this variation can be seen in Figure 6 and Appendix F.

5.2.1 OP-FTIR Quality Assurance Results

Figure 7 shows a plot of the OP-FTIR measurements versus time, during a QA measurement sequence made on carbon tetrachloride in ASB II. The one-way pathlength for the external measurement was 38.1 meters. The error bars are the 99% tolerance limits (three times the standard deviation) of the concentration pathlength product determined from the Classical Least-Squares fitting routine. These QA measurements plotted versus time produce a curve that has the appearance of a square wave. This can be seen in Figure 7. The time is presented in these plots as decimal hours, with 10.00 corresponding to 10 a.m. The three steps of the OP-FTIR QA procedure (Section 4.2.1) are seen in the shape of the plot. The concentration of the chemicals in the QA mixture in the cell was determined by taking the difference between the "plateau" region of the square-wave curve and the baseline portion and dividing by the cell pathlength to obtain the concentration in ppm. This is straightforward when the baseline does not vary (i.e., when the concentration of the gases in the

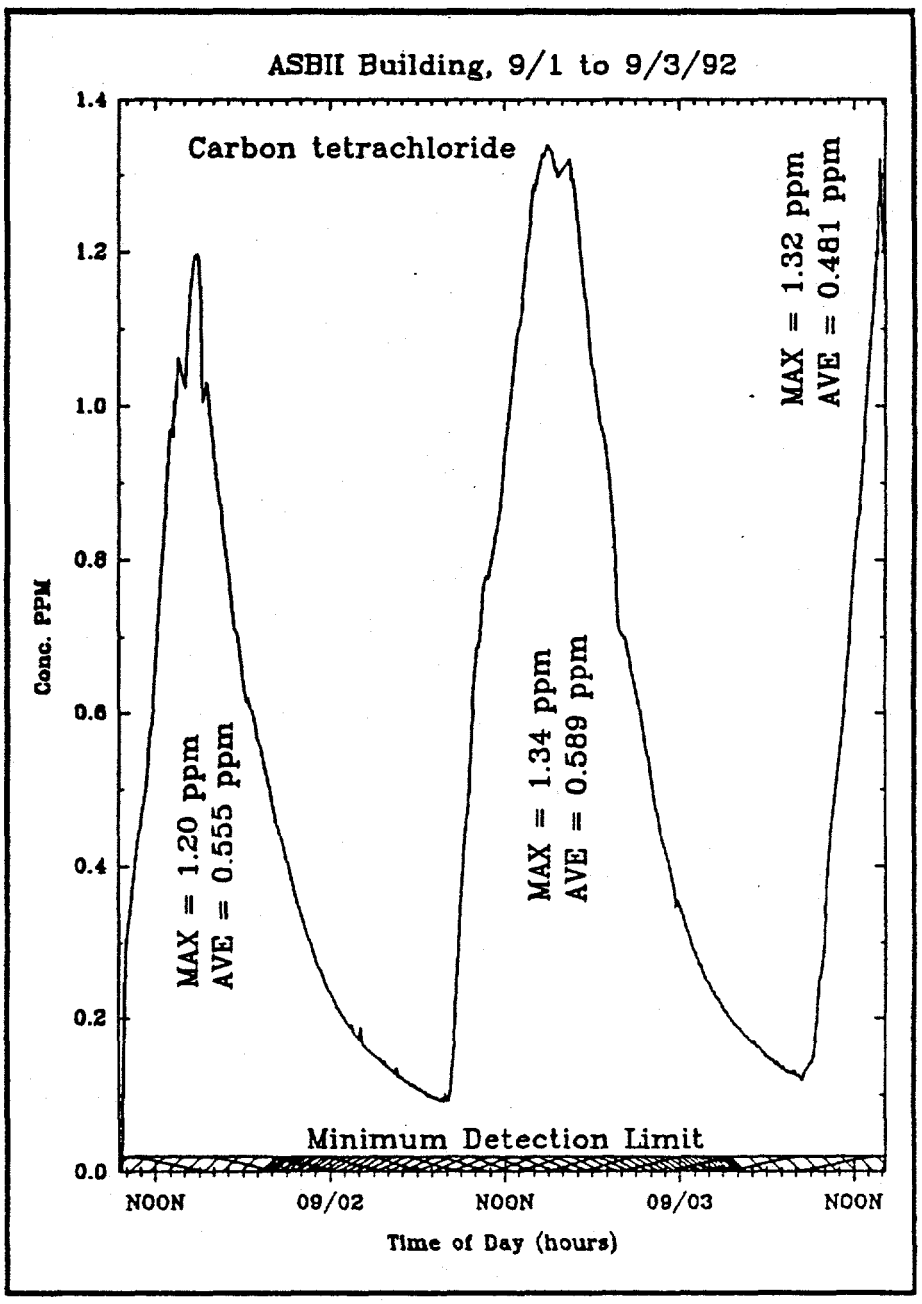

Figure 6. Graph of CCl_4. Center corridor was monitored September 1st @ 09:26 am to 1:54 pm, while the west corridor was monitored September 1st @ 2:00 pm to September 3rd @ 2:10 pm. Maximum conc. occurred @ 2:53 pm, 2:56 pm, and 1:52 pm, respectively.

external beam are not changing over the duration of the QA procedure). The example in Figure 7 was deliberately chosen to illustrate how variations in the baseline were handled. Roughly seven data points were chosen from the plot in each of the two baseline regions corresponding to Step 1 (before the flow) and Step 3 (after the flow stopped and the material was completely flushed out). A curve fit was performed to the total of ~14 data points. In the case, depicted in Figure 7, the baseline data points were fitted to a third order polynomial. The result was CL = -3226.61040 + 902.02742 t - 84.18398 t^2 + 2.64761 t^3, where t is the time in decimal hours, and the units for CL is ppm meter (ppm-m). The baseline was then calculated at the time of gas flow. This calculated baseline was then subtracted from the CL measurements in the equilibrium portion of the plateau. In Figure 7, this region lies between 10.77 and 11.03 hours. The total value for CL was 132 ppm m in this period, and the calculated baseline for this period was ~30ppm m. Thus, the measured CL in the cell was 102 ppm m corresponding to a concentration of 673 ppm. The certified value for carbon tetrachloride in the gas mixture was 630.2 ppm.

Additional OP-FTIR QA measurements were made for carbon tetrachloride, 1,1,1-trichloroethane, and Freon 113 from September 2 to September 17 in the air support buildings. A comparison of the certified values of the three species in their respective mixtures to the OP-FTIR QA measurements are given in Table 14.

The deviations in 12 QA measurements of carbon tetrachloride (using three different gas mixtures) ranged from (-)11.7 to (+)11.8%. Six QA measurements were performed for 1,1,1 trichloroethane and the deviations ranged from (-)7.5 to (-)12.4 percent. For the one measurement made of Freon 113, the deviation was 3.2%.

The QA measurements provided in Table 14 illustrate the systematic error in the field measurements. In a program where many measurements are made using different background spectra, the error due to the baseline would be expected to change. If a consistent discrepancy appears in the QA concentration determinations, the likely source is the reported concentration of the gas in the reference spectrum or possibly a baseline error in the reference spectrum. A new reference spectrum can be measured and all data can be reanalyzed.

The variation in the deviations of the carbon tetrachloride QA measurements are mostly due to two error sources. One is baseline error in the absorbance spectrum. The Classical Least Squares algorithm corrects for linear baseline error. However, if a curved feature was present in the baseline over the spectral region being analyzed, a systematic error of 10% could result. The other source of variation is error in the baseline in the QA time plot, as represented in Figure 7.

The deviations in the 1,1,1-trichloroethane determination indicate a systematic discrepancy between the certified concentration value and the OP-FTIR determination. The mean deviation of the six measurements is 9.85 percent. This could very well reflect a ~10% error in the concentration used in the reference spectrum of 1,1,1-trichloroethane.

The single measurement on Freon 113 is statistically insufficient to come to any general conclusion about systematic error, other than that the agreement in this single measurement (3.2%) is excellent.

The quality of the concentration data is clearly indicated by the fact that the largest discrepancy between the certified values and the OP-FTIR measurement is (-)12.4% and eight of the nineteen determinations had agreement to within 5%. It would be conservative to estimate that the overall

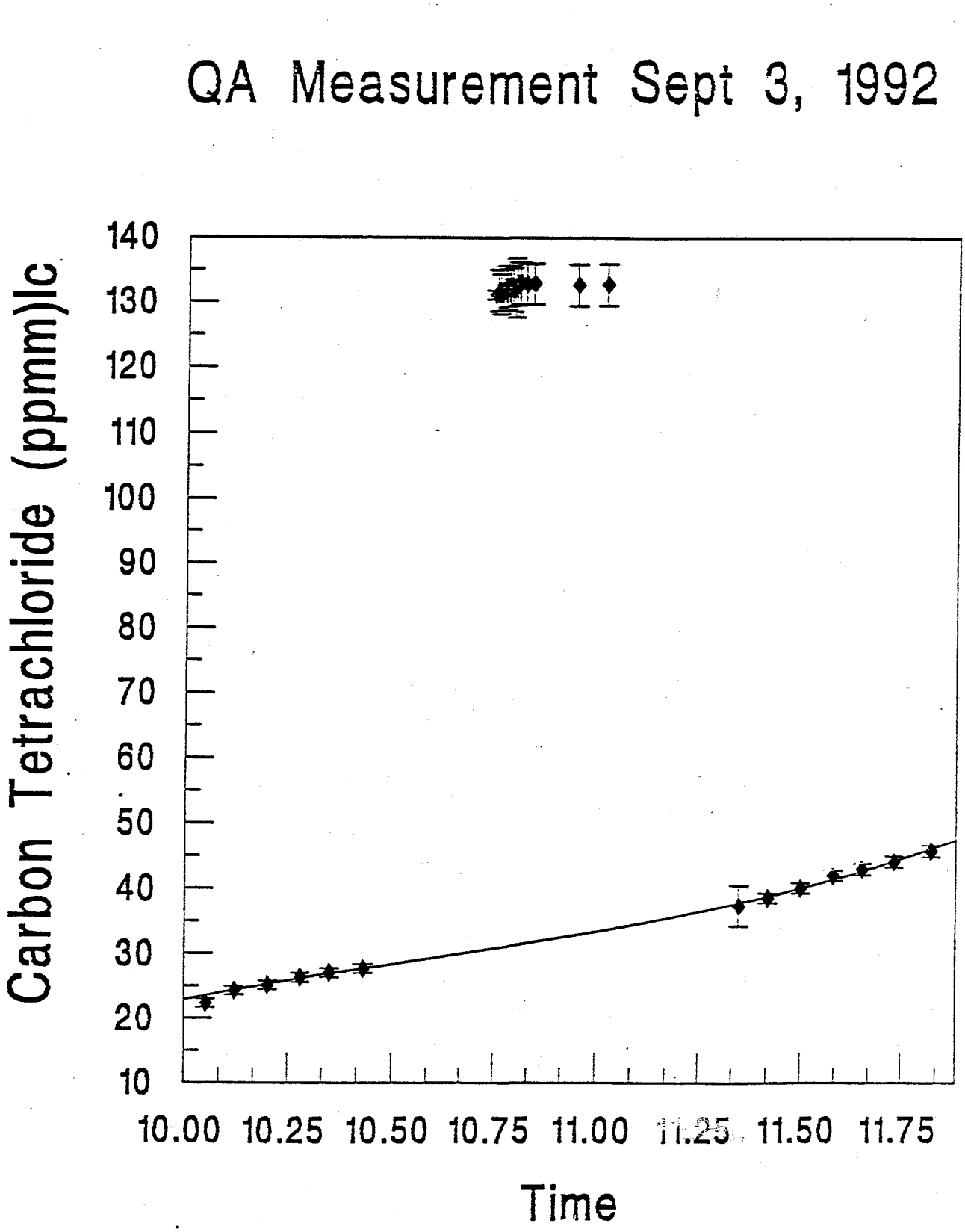

Figure 7. Plot of time versus measured concentration-pathlength product from a OP-FTIR QA measurement made in ASB II.

Table 14. Results of the OP-FTIR QA measurements.

Compound	Date of QA Measurement	QA Assay (ppm) l.c.	FTIR Meas. (ppm) l.c.	Deviation (ppm) l.c.	% Deviation
Carbon tetrachloride	Sept 8	326.9	341.9	15.0	4.6
	Sept 9	326.9	321.0	-5.9	-1.8
	Sept 2	630.2	704.8	74.6	11.8
	Sept 3	630.2	673.6	43.4	6.9
	Sept 8	630.2	654.0	23.8	3.8
	Sept 9	630.2	657.4	27.2	4.3
	Sept 14	630.2	608.9	-21.3	-3.4
	Sept 16	630.2	556.3	-73.9	-11.7
	Sept 17	630.2	569.8	-61.4	-9.7
	Sept 8	936.6	988.7	52.1	5.6
	Sept 9	936.6	937.8	1.2	0.1
	Sept 10	936.6	893.3	-43.3	-4.6
111-trichloroethane	Sept 2	849.3	764.3	-85.0	-10.0
	Sept 8	849.3	785.4	-63.9	-7.5
	Sept 10	849.3	771.8	77.5	-9.1
	Sept 14	849.3	752.4	-96.9	-11.4
	Sept 16	849.3	775.0	-74.3	-8.7
	Sept 17	849.3	744.4	-104.9	-12.4
Freon 113	Sept 2	1012	1044.8	33	3.2

error for the determinations of these three chemical species is no worse than 13%. Overall, the results from the QA procedure indicate that the OP-FTIR was functioning properly and that the OP-FTIR data collected should compare favorably with the "true" concentrations of carbon tetrachloride, 1,1,1-trichloroethane, and Freon 113 in the air support buildings.

5.3 Organic Air Emissions Results

5.3.1 Volumetric Flow Results

The calculated volumetric flow for the C&S Building and ASB II is 6.18 E+05 and 4.18 E+05 ft^3/hour, respectively. Appendix G provides the individual velocity measurements and associated volumetric flow calculations.

5.3.2 Calculated Organic Air Emissions Results

Organic air emissions were calculated using Equation (2) and (3) described in the Sections 4.3.2 and 4.3.3. The barometric pressure value at time of sampling (P_2) was approximated using published values for barometric pressure corrections for specific elevations (24.89 inches of mercury at 5,000 feet elevation) (Reference 30). The temperature value at the time of sampling (T_2) was approximated based on the average building temperature at the beginning of SUMMA canister sampling and at the end of SUMMA canister sampling averaged over all days sampled (15°C or 288°K). These approximated values are representative of the values measured at the time of sampling.

Estimated organic air emissions from the C&S Building and ASB II are reported in Tables 15 and 16, respectively, based on SUMMA canister sampling concentration data found in Tables 5 and 6. SUMMA canister average organic air emissions estimates are based on average SUMMA canister VOC concentration data, whereas SUMMA canister maximum organic air emissions estimates are based on the maximum SUMMA canister VOC concentration detected in any one SUMMA canister.

Estimated organic air emissions from the C&S Building and ASB II are reported in Tables 17 and 18, respectively, based on OP-FTIR concentration data found in Tables 8 through 13. OP-FTIR average organic air emissions estimates are based on daily average OP-FTIR VOC concentration data, whereas OP-FTIR maximum organic air emissions estimates are based on the maximum OP-FTIR concentration data collected over a 5-minute period.

5.4 SUMMA Walk/OP-FTIR Comparison Results

Table 19 shows the comparison of VOC concentrations measured by the SUMMA canister walk and the OP-FTIR. The OP-FTIR values in the table are averages of the 7 and 8 runs measured for SUMMA Walks 1 and 2, respectively.

The percent differences reported in the last column in Table 19 are the differences of the OP-FTIR results relative to the TO-14 SUMMA walk results, that is,

$$\text{Relative Difference} = [C(\text{TO-14}) - C(\text{OP-FTIR})]/C(\text{TO-14})$$

and is calculated by comparing the OP-FTIR to the SUMMA walk measurements. This does not imply that the TO-14 results are more "correct" than the OP-FTIR results. In fact, more confidence should be placed in the OP-FTIR measurements since the OP-FTIR measurements have been validated by the QA procedure described in Section 5.2.1, and the largest systematic error in that procedure was 12%. The SUMMA walk results are lower than the OP-FTIR determinations in all of the measurements. The lower values may be explained by VOC adsorption to the SUMMA canister wall, sample preparation, and analytical instrument errors.

In a study conducted by the EPA AREAL on Method TO-14, the measurement accuracy for analysis performed in six different laboratories ranged from 50 to 206% (Reference 31). In the case of 1,1,1-trichloroethane, the measurement accuracies ranged from 101 to 206%. Carbon tetrachloride was not a part of the study. Table 20 shows a comparison of the relative values of the TO-14 results for the SUMMA walk measurements and OP-FTIR determinations to the range of accuracies determined in the EPA study.

Table 15. C&S Building estimated organic air emissions based on SUMMA canister sampling data.

Compound/ CAS Number	08/24/92 Average Emissions (lbs/hr)	08/24/92 Maximum Emissions (lbs/hr)	08/25/92 Average Emissions (lbs/hr)	08/25/92 Maximum Emissions (lbs/hr)
Toluene 108-88-3	3.88E-03	1.24E-02	1.63E-03	3.25E-03
Carbon tetrachloride 56-23-5	2.99E-02	4.60E-02	3.09E-02	5.22E-02
Acetone 67-64-1	7.10E-03	9.47E-03	0.00E+00	0.00E+00
Chloroform 67-66-3	3.24E-04	1.30E-03	3.24E-04	1.14E-03
1,1,1-trichloroethane 71-55-6	1.23E-02	2.17E-02	1.52E-02	2.54E-02
Propane 74-98-6	2.69E-02	4.61E-02	3.72E-02	5.39E-02
Methylene chloride 75-09-2	9.57E-03	1.85E-02	1.57E-02	2.42E-02
1,1-dichloroethene 75-35-4	7.64E-03	1.30E-02	4.08E-03	8.56E-03
Dichlorodifluoromethane 75-71-8	3.28E-04	2.13E-03	3.28E-04	1.81E-03
C2Cl3F3 (Freon 113) 76-13-1	1.48E-02	2.52E-02	1.12E-02	1.88E-02
Trichloroethene 79-01-6	3.39E-03	7.14E-03	3.93E-03	6.78E-03

Table 16. ASB II estimated organic air emissions based on SUMMA canister sampling data.

Compound/ CAS Number	Data Set 2 09/01/92 Average Emissions (lbs/hr)	Data Set 2 09/01/92 Maximum Emissions (lbs/hr)	Data Set 3 09/09/92 Average Emissions (lbs/hr)	Data Set 3 09/09/92 Maximum Emissions (lbs/hr)
Carbon tetrachloride 56-23-5	3.52E-02	4.52E-02	5.68E-02	6.36E-02
Acetone 67-64-1	6.94E-04	2.72E-03	1.07E-02	6.40E-02
Chloroform 67-66-3	9.87E-04	1.43E-03	5.48E-04	1.21E-03
1,1,1-trichloroethane 71-55-6	2.38E-02	3.80E-02	3.47E-02	4.66E-02
Propane 74-98-6	4.46E-04	4.46E-03	0.00E+00	0.00E+00
Methylene chloride 75-09-2	3.90E-04	3.90E-03	1.95E-03	1.95E-02
1,1-dichloroethene 75-35-4	8.55E-03	1.07E-02	4.81E-03	9.80E-03
Dichlorodifluoromethane 75-71-8	1.56E-03	2.55E-03	4.44E-04	1.78E-03
C2Cl3F3 (Freon 113) 76-13-1	2.50E-02	3.27E-02	2.07E-02	3.10E-02
Trichloroethene 79-01-6	2.41E-04	1.21E-03	3.62E-04	1.33E-03

Table 17. C&S Building estimated organic air emissions based on OP-FTIR monitoring data.

	Compound/ CAS Number					
	Carbon tetrachloride 56-23-5		C2Cl3F3 (Freon 113) 76-13-1		1,1,1-trichloroethane 71-55-6	
Date	Maximum Emissions (lbs/hr)	Average Emissions (lbs/hr)	Maximum Emissions (lbs/hr)	Average Emissions (lbs/hr)	Maximum Emissions (lbs/hr)	Average Emissions (lbs/hr)
8/13/92	1.88E-01	1.04E-01	6.39E-02	3.23E-02	1.40E-01	7.30E-02
8/18/92	1.99E-01	1.33E-01	8.93E-02	5.65E-02	1.56E-01	1.02E-01
8/19/92	1.97E-01	1.54E-01	7.48E-02	5.60E-02	1.50E-01	1.13E-01
8/20/92	2.13E-01	1.80E-01	8.68E-02	7.36E-02	1.61E-01	1.38E-01
8/25/92	7.88E-02	5.79E-02	2.77E-02	1.71E-02	5.15E-02	3.62E-02
8/26/92	1.37E-01	1.01E-01	5.42E-02	3.89E-02	9.35E-02	6.89E-02
8/27/92	1.76E-01	1.32E-01	6.74E-02	4.89E-02	1.24E-01	8.90E-02
9/15/92	9.86E-02	6.04E-02	3.77E-02	2.21E-02	7.70E-02	4.57E-02
9/16/92	8.11E-02	4.62E-02	3.08E-02	1.09E-02	5.83E-02	3.04E-02
9/17/92						
Mid-night	1.14E-01	6.14E-02	4.00E-02	1.73E-02	7.37E-02	3.84E-02
Noon	8.29E-02	5.70E-02	2.65E-02	8.40E-03	4.84E-02	3.37E-02
9/22/92	1.91E-01	8.09E-02	7.92E-02	2.34E-02	1.37E-01	5.18E-02

Table 18. ASB II estimated organic air emissions based on OP-FTIR monitoring data.

	Compound/ CAS Number					
	Carbon tetrachloride 56-23-5		C2Cl3F3 (Freon 113) 76-13-1		1,1,1-trichloroethane 71-55-6	
Date	Maximum Emissions (lbs/hr)	Average Emissions (lbs/hr)	Maximum Emissions (lbs/hr)	Average Emissions (lbs/hr)	Maximum Emissions (lbs/hr)	Average Emissions (lbs/hr)
9/1/92	6.49E-02	3.17E-02	3.61E-02	8.95E-03	4.99E-02	2.40E-02
9/2/92	1.70E-01	7.84E-02	8.81E-02	3.96E-02	1.30E-01	5.86E-02
9/3/92	1.89E-01	8.32E-02	9.62E-02	4.01E-02	1.42E-01	6.54E-02
9/4/92	1.87E-01	6.80E-02	9.40E-02	2.60E-02	1.32E-01	4.06E-02
9/8/92	1.18E-01	6.20E-02	6.37E-02	3.27E-02	9.38E-02	4.85E-02
9/9/92	1.26E-01	5.48E-02	6.59E-02	2.72E-02	9.33E-02	4.44E-02
9/10/92	1.85E-01	1.03E-01	9.49E-02	5.54E-02	1.35E-01	7.50E-02

Table 19. SUMMA Walk/OP-FTIR data comparison.

Data Set	Chemical	SUMMA Walk (ppb)	OP-FTIR (ppb)	Relative Difference (%)
Walk 1 (17 minutes)	Carbon tetrachloride	460	618	34
	1,1,1-trichloroethane	390	532	36
	Freon 113	150	318	112
Walk 2 (18 minutes)	Carbon tetrachloride	490	643	31
	1,1,1-trichloroethane	400	547	37
	Freon 113	160	331	107

Table 20. Comparison of percent accuracies for Method TO-14 and SUMMA Walk and OP-FTIR values.

Chemical	EPA Study (TO-14) Low Number Accur. (%)	EPA Study (TO-14) High Number Accur. (%)	SUMMA Walk 1 C(TO-14)/ C(OP-FTIR) (%)	SUMMA Walk 2 C(TO-14)/ C(OP-FTIR) (%)
Carbon tetrachloride	N.M.	N.M.	74	76
1,1,1-trichloroethane	72	120	73	73
Freon 113	101	206	45	48

Note: The accuracies in the EPA study are defined as relative to the correct value.

The discrepancy in the SUMMA walk values and the OP-FTIR values clearly fall within the range of the measurement error of the TO-14 method. In light of these results and in consideration that the OP-FTIR QA measurements indicate the measurement accuracy of the OP-FTIR is in the range of 12%, the differences in Table 19 are very reasonable.

6. DISCUSSION

For the purposes of this report, it was assumed that the organic air emissions rate from the air support buildings was equal to the product of the VOC concentration inside the air support structures and the air support building ventilation rate. This methodology is valid if the measured VOC concentrations represent the true concentration inside the buildings. Determining the "true" concentration inside the buildings is complicated by the fact that each drum stored inside the buildings could be considered a point source, with each point source having its own unique source term and release rate. Furthermore, release rates from the drums appear to vary significantly with such factors as temperature and atmospheric pressure.

When using SUMMA canister sampling, the true concentration on any given day can only be obtained by sampling in a statistically valid number of locations for as long of a period of time as possible. The sampling locations must be chosen such that samples are not collected in areas of high or low air flow patterns, which may bias the concentration data. Given the fact that the C&S Building and ASB II do not have any designed air outlets and the air is discharged from the buildings through numerous cracks and leaks in and around the fabric covering it, it is expected that there are no major air flow patterns. Smoke tests have previously been conducted in the C&S Building and ASB II to evaluate air flow patterns (Reference 32). Smoke tests in the C&S Building show that the majority of air exiting the C&S Building inflation package discharge plenum travels up the ceiling of the C&S Building, down the west side of the building, and along the floor in the general direction of the air inflation package discharge plenum. Other than this, there does not appear to be any major air flow patterns in the C&S Building or ASB II.

Tracer gas studies are also used to determine air flow patterns and have the advantage over smoke tests in that it provides a quantitative method for determining air flow patterns. In general, tracer gas studies involve the release of a nontoxic gas at a prescribed location with subsequent air sample collection at multiple locations. The air samples are then analyzed to determine the relative concentration of the gas at each sampling location, thus giving an indication of the air flow patterns and air mixing. While no formal tracer gas studies were conducted inside the C&S Building or ASB II, an informal tracer gas study was conducted inside the C&S Building in the fact that small propane leaks are known to occur just outside the air inflation package air intake plenum. Propane is picked up from these small leaks and discharged into the C&S Building. Results from SUMMA canister sampling inside the C&S Building indicates that propane was detected in 100% of the samples at similar concentrations (average is 523 ppb and standard deviation is 216 ppb). These data reaffirm that there is no major air flow pattern in the C&S Building and indicate that the air inside the building mixes relatively well over time. Since the C&S Building and ASB II are similar in design, it is assumed that the same is true of the ASB II. The aforementioned information supports the assumption that the summa canister sampling strategy used in this study provides a good estimate of the true VOC concentration in the air support buildings.

In the present study, the comparison between SUMMA canister sampling results and OP-FTIR monitoring (Table 19) demonstrates a good correlation between the two methods for carbon tetrachloride, 1,1,1-trichloroethane, and Freon 113. Similar types of results for other VOCs have previously been reported by other investigators (References 17 through 27). OP-FTIR measurements have the advantage over SUMMA canister sampling in that the VOC concentration along the entire OP-FTIR path length (e.g., across the entire C&S Building or ASB II) is measured, the

concentrations are integrated and reported as the path average concentration, and as such, may provide a better estimate of the "true" VOC concentration inside the air support buildings.

It can be argued that since all of the OP-FTIR measurements were made at a beam center height of 5- feet, the path average concentration does not represent the true concentration for the air support buildings but rather represents the true average concentration at the 5-foot level. However, SUMMA canister sampling results indicate that the VOC concentration is relatively constant as a function of height and, therefore, supports the assumption that the OP-FTIR data collected at 5 feet provides a relatively good estimate of the true concentrations for the entire air support building.

Figure 6 and Appendix F indicate that the VOC concentrations in the air support buildings vary significantly with time. This variation is likely due to temperature and pressure changes inside the air support buildings. Tables 15 through 18 provide an estimate of average organic air emissions from the C&S Building and ASB II based on the average VOC concentration detected in the air support buildings using SUMMA canister sampling or OP-FTIR monitoring. In the case of SUMMA canister sampling, the reported average organic air emissions is indicative of the VOC concentration averaged over the 5-hour sample collection period (approximately between 9:00 a.m. and 2:00 p.m.), whereas the OP-FTIR monitoring reported average organic air emissions generally represents the VOC concentration averaged over approximately a 24-hour period. Tables 15 through 18 indicates that the maximum VOC concentration occurs sometime after 2:00 p.m. If this trend holds true, the SUMMA canister sampling average VOC concentration does not represent the true VOC concentration for the day but rather for the 5-hour period sampled. Given the OP-FTIR monitoring was generally conducted for the entire day, the OP-FTIR VOC concentration may be a better overall indicator of the true VOC concentration for the day.

Given the variability of VOC concentrations in the air support buildings, the most accurate method for determining organic air emissions would be to monitor/sample VOC concentrations over numerous 24-hour periods at various times of the year representing various temperature and pressure ranges. It is anticipated that the worstcase organic air emissions from the air support buildings would occur during the hottest months of the year especially under low atmospheric pressure conditions. Organic air emissions would likely be the lowest during the coldest months of the year under high atmospheric pressure conditions. Continued use of the OP-FTIR system coupled with periodic confirmatory summa canister sampling seems to offer the most cost effective, efficient mechanism to achieve a comprehensive evaluation of organic air emissions from the air support buildings over extended periods of time. However, if the data is to be used for compliance purposes, this approach should be approved by the appropriate regulatory agency before it is implemented.

7. CONCLUSION

The VOC concentrations in the air support buildings would depend on a number of variables, including number of drums of a specific content code vented, length of time since the drums had been vented, the number of drums with carbon composite filters, headspace gas concentration, quantity of liquid organic material present, temperature, ambient pressure, number of layers of confinement, and matrix affects. The majority of the drums currently stored in the air support buildings have been vented (carbon composite filter installed) between 1986 to 1989 and as such the VOC concentrations are expected to be significantly less now then they were 4-7 years ago. As more drums are fitted with the carbon composite filters, especially drums of content codes with high concentrations of VOCs or with significant quantities of liquid organic material, the VOC concentrations in the air support building would be expected to increase. VOC concentrations would be expected to increase under high temperature conditions and/or low atmospheric pressure conditions. If the drums presently stored in the air support buildings are relocated to new storage units such as the Type II storage modules, VOC concentrations would vary with changes in temperature, atmospheric pressure, ventilation rates and with number and content code type stored in the buildings.

The following sections relate the current state of knowledge relative to the nature and extent of organic air emissions from the air support buildings to specific regulatory requirements. Potential problems and suggested recommendations are presented whenever possible.

RCRA

As indicated in the Section 2.1, in July 1991, the EPA proposed organic air emission standards for RCRA TSD facilities. Extensive comments on this proposed rule were submitted to the EPA by EG&G Idaho directly and through the Department of Energy Headquarters (DOE-HQ) via the DOE-ID. These comments addressed the potential compliance problems that would arise at RCRA-regulated mixed waste storage units, such as those located at the RWMC, if the proposed rule was promulgated as proposed. Many of the problems that would be encountered would be the lack of detailed waste characterization/waste analysis information and the lack of facilities to sample and analyze the wastes due to the radiological exposure concerns. Additional concerns arise due to the internal requirement that all waste drums must eventually be vented, thus preventing the ability to provide a tight cover to control emissions from the storage device, which is the recommended control technology for containers. A request for an alternative compliance standard that would establish a VOC emissions rate was also included in the comments package. During conversations with EPA personnel working on the development of the Phase II regulations during the comment period, it was indicated that the option of an alternative VOC emissions based standard had been addressed in the proposed rule and was not selected due to excessive compliance costs and complicated strategies for compliance verification. EPA indicated that further analysis of this option would not be pursued and an alternative VOC-emissions-based compliance standard would probably not be included in the final rule. Additional comments from the EPA personnel indicated that the Phase II proposed rule would probably be promulgated as proposed with only a few minor changes from the standard originally proposed. If the proposed rule is promulgated as proposed, compliance with it will be extremely difficult for the RWMC mixed waste container storage units. Negotiations with the DEQ and/or with EPA Region X may be required to establish a policy that can be adhered to by DOE facilities, such as the RWMC, to provide adequate control of organic air emissions from RCRA-regulated mixed waste

units. The Phase II proposed rule is scheduled to be finalized sometime in the final quarter of calendar year 1993.

TAP

As indicated in the Section 2.1, in February 1993, the State of Idaho DEQ proposed rules for the control of toxic air pollution in Idaho. These proposed rules, called the TAP Policy, establish very low emissions rate criteria for industrial and waste management facilities located in the State of Idaho. These standards establish a screening level that is based on the average maximum hourly emission rate. If this screening level is exceeded, refined modeling must be performed to identify the level of exposure to the nearest ambient air receptor to TAPs. Screening modeling has been performed for portions of the RWMC, and the screening model indicates that the TAP limits will be exceeded. Refined modeling is currently underway for the DVF, the Type I and Type II Storage Modules. If this refined modeling indicates that the established TAP limit will be exceeded, then the installation of the toxics reasonably available control technology would be required or a risk assessment must be performed in order to demonstrate that the health risks to the nearest ambient air receptor is acceptable. No permitsto construct for new construction or modifications to existing facilities will be granted unless this criteria has been met. The data presented in this report will be useful as a comparison to the calculated emissions models currently required by the DEQ and will also support modeling data if negotiations with DEQ are required.

OSHA

To date, all personal monitoring conducted inside the air support buildings indicates that personnel are not exposed to VOCs above the applicable health based regulatory limits. Area sampling conducted for the purposes of this study also indicate that personnel working in the air support buildings are unlikely to be exposed above the applicable regulatory limits. However, the potential for personal overexposure may exist if personnel were to work in the air support buildings for long periods of time and in an area of unusually high VOC concentrations. Given this and the variability of VOC concentrations observed in the present study, full shift personal sampling should continue to be conducted in the air support buildings, especially under high atmospheric temperature conditions and when personnel are working extended periods of time. Additionally, personal exposure results should be viewed with caution due to the fact that the calculated TWA assumes that the combined chemical effect of the VOCs are additive in nature and that there is no synergistic effects. This may or may not be true under conditions of prolonged exposure to multiple chemicals, and as such personal exposure should be limited to the extent possible.

Personal exposure to chemical carcinogens, such as carbon tetrachloride, chloroform, and methylene chloride can be minimized by limiting the number and the amount of times personnel are allowed to work in the air support buildings. This would be especially important in the case of carbon tetrachloride, for which concentrations as high as 0.863 and 0.731 ppm have been detected in the C&S Building and ASB II. OSHA has admitted that even at the TWA PEL of 2 ppm, the risk of material health impairment remains significant (Reference 33).

If additional drums are fitted with the carbon composite filters or if any other variables that affect VOC concentrations change significantly, appropriate precautions such as additional characterization efforts, personal protective equipment, engineering controls, and administrative controls limiting

personnel access should be implemented until such time that the health and safety of personnel can be assured.

8. REFERENCES

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APPENDIX A

APPENDIX A

The Stored Waste Examination Pilot Plant (SWEPP) Track Database was used to estimate the number of drums that have been fitted with a carbon composite filter and are stored in the ASB II. The assumptions used for this estimate was that all Rocky Flats Plant (RFP) drums have been fitted with a carbon composite filter and all RFP drums were stored in the following grid locations: B37-B42, C37-C42, D38-D42, E33-E35, E37-E42, F33-F35, F47-F42, G33-G35, G37-G42.

The Stored Waste Examination Pilot Plant (SWEPP) Track Database and Transuranic Waste Database were merged to estimate the number of drums that have been fitted with a carbon composite filter and are stored in the C&S Building. The parameters used for this estimate was that only those drums with a generator site equal to the RFP was selected and only those drums with a package date before 6/1/83 (containers with package dates after 6/1/83 have semi-permeable lid gaskets installed) were selected.

The number of drums in the C&S and ASB II fitted with a carbon composite filter presented in this appendix are based on the above assumptions/parameters and may not reflect the absolute number.

NUMBER OF VENTED DRUMS IN THE C&S BUILDING WITH CONTAINER TYPES OF "A" OR "001" BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
N/A	3	2
	300	1
	376	1
	442	1
A1	1	20
	3	6
	4	1
	7	5
	336	1
	339	1
	374	3
	376	1
A14	1	6
	2	1
	7	1
	300	1
	337	1
	376	3
	442	1
	480	1
A15	1	1
	3	3
	7	6
	292	1
	300	4
	336	1
	376	2
	440	1
	480	2
A19	300	1
	442	1
A2	1	12
	4	1
	7	19
	300	2
	320	1
	330	1
	376	4
	440	4
	480	1
	481	1
A20	1	1
	3	1
	300	2
	337	2
	442	6
	480	1
A3	1	19

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
A3	2	1
	3	7
	4	2
	292	2
	300	3
	320	1
	330	3
	337	1
	339	1
	374	5
	432	1
	480	1
	481	1
A4	480	31
	481	2
A5	371	11
	411	1
	414	1
	480	1
A6	4	2
	330	8
	335	2
	336	5
	337	11
	338	7
A7	338	5
	339	7
A8	432	12
A9	302	1
	409	1
B1	1	15
	2	1
	3	9
	7	15
	292	1
	300	3
	320	1
	376	2
	440	2
	442	3
	480	2
	481	1
B14	1	2
	3	2
	4	1
	292	1
	300	3
	337	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
B14	374	1
	480	1
B15	1	2
	7	3
	300	2
	480	1
	481	1
B17	1	2
	3	4
B19	1	5
	3	1
	376	1
B2	1	7
	2	2
	3	8
	4	4
	7	6
	300	8
	330	1
	339	2
	376	2
	440	1
	480	4
B20	339	1
	374	1
B3	1	22
	3	4
	7	15
	300	2
	374	1
	376	9
	422	1
	442	1
	481	1
B6	442	1
C1	1	14
	2	1
	3	3
	7	39
	292	3
	300	5
	339	1
	372	1
	374	1
	376	8
	440	1
	480	3
C14	1	5

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
C14	4	2
	7	1
	292	1
	300	2
	320	1
	374	1
	440	1
	442	2
	480	3
C15	1	7
	2	1
	3	2
	300	5
	330	1
	336	3
	337	1
	374	1
	376	1
	442	2
	480	4
C16	1	3
	3	6
	7	1
C17	1	9
	3	3
	376	1
C19	1	9
	3	6
	7	3
	300	4
	339	1
	374	1
	376	6
	480	2
C2	1	6
	3	5
	4	3
	7	19
	292	1
	300	5
	330	2
	336	1
	337	9
	339	7
	374	1
	376	2
	440	3
	480	5

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
C20	1	3
	3	2
	7	6
	300	1
	337	1
	376	1
	442	1
	480	2
C3	1	28
	3	2
	4	2
	7	21
	292	1
	300	9
	336	1
	339	2
	376	7
	440	1
	481	2
DVS	1	3
	337	1
	376	1
D1	1	9
	3	7
	7	36
	292	1
	300	2
	337	7
	339	2
	376	1
	432	1
	440	1
	480	4
D13	1	3
	7	2
	292	1
	300	8
	301	1
	372	1
	376	4
	440	1
	442	1
D14	1	2
	7	3
	300	10
	376	4
	440	1
	442	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
D14	480	1
D15	1	2
	7	1
	300	9
	374	1
	440	1
	480	1
	481	1
D16	1	7
	3	4
	7	1
	300	2
D17	1	2
	2	1
	3	9
	337	1
D18	3	3
D19	1	5
	3	5
	4	1
	7	9
	300	1
	376	4
D2	1	8
	3	3
	7	31
	292	1
	300	5
	330	1
	337	6
	339	3
	376	3
	422	2
	440	3
	480	6
	481	1
D20	1	2
	3	6
	4	2
	7	4
	300	1
	376	2
	480	1
D29	1	1
	3	15
	336	1
	374	7
	376	2

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
D29	440	2
	442	4
	480	3
D3	1	14
	3	5
	7	24
	292	1
	300	3
	336	1
	337	3
	339	1
	372	1
	374	1
	376	5
	440	5
	480	6
D30	1	2
	3	25
	374	3
	376	2
	442	3
	480	3
E1	1	27
	3	1
	4	2
	7	24
	300	7
	374	1
	376	6
	440	1
	480	1
E13	1	7
	2	1
	300	19
	328	1
	330	1
	376	5
	442	2
E14	1	7
	7	2
	292	2
	300	11
	335	1
	376	10
	440	1
E15	1	7
	7	4
	292	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
E15	300	6
	376	9
	440	2
	442	2
E16	1	23
	2	4
	3	10
	7	1
	376	1
	442	1
	480	2
E17	1	30
	2	2
	3	22
	7	10
	292	2
	300	1
	339	2
	376	2
	480	4
	481	1
E19	3	3
E2	1	2
	3	12
	7	36
	292	5
	300	4
	328	1
	339	1
	372	2
	376	3
	432	2
	440	4
E20	1	8
	3	4
	4	1
	7	2
	376	1
	480	1
E23	1	18
	3	22
	4	4
	7	3
	300	15
	320	1
	374	7
	376	11
	440	5

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
E23	442	2
	480	5
	481	2
E24	1	6
	3	6
	300	2
	374	1
	480	3
E25	1	18
	2	1
	3	15
	7	6
	292	2
	300	13
	320	1
	374	1
	376	12
	391	1
	440	2
	442	3
	480	4
E26	1	15
	2	1
	3	20
	7	5
	292	1
	300	8
	320	1
	336	1
	371	2
	372	1
	374	1
	376	9
	440	1
	442	4
	480	7
	481	1
E27	1	5
	3	14
	7	2
	300	6
	320	2
	336	1
	374	1
	376	4
	440	2
	442	2
	480	3

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
E29	1	1
E3	1	9
	3	12
	7	36
	292	4
	300	3
	328	1
	372	3
	375	1
	376	3
	440	1
	480	1
	481	1
E58	1	1
F1	1	16
	3	13
	4	3
	7	8
	292	5
	300	2
	330	2
	337	2
	339	2
	374	10
	376	2
	425	1
	442	3
	480	6
F10	7	1
F11	320	1
	432	1
	440	7
	441	1
	442	10
F12	1	1
	4	1
	292	1
F13	1	6
	7	4
	300	11
	376	3
	440	1
F14	1	5
	7	4
	292	2
	300	26
	328	1
	337	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
F14	376	15
	440	3
	480	1
F15	1	7
	7	7
	292	4
	300	26
	328	1
	376	14
	442	1
	480	4
F16	1	26
	2	1
	3	11
	7	5
	300	1
	336	1
	376	1
	442	2
	480	1
F17	1	8
	3	16
	7	2
	376	1
F2	1	15
	3	12
	4	1
	7	21
	292	4
	300	8
	330	2
	337	3
	372	1
	374	3
	376	3
	440	1
	480	1
F20	1	2
	3	5
	4	2
	292	1
	336	1
	372	1
F21	300	1
F22	1	8
	3	11
	4	1
	292	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
F22	300	6
	336	5
	337	4
	374	1
	376	1
	480	1
F23	1	18
	3	14
	300	7
	336	3
	374	1
	376	5
	440	3
	442	2
	480	4
	481	1
F24	1	10
	3	21
	4	1
	7	11
	292	4
	300	5
	320	2
	371	1
	374	1
	376	11
	432	1
	440	3
	442	2
	480	5
F25	1	4
	3	11
	320	1
	376	2
	442	1
	480	2
F26	1	4
	2	2
	3	6
	4	1
	7	1
	300	2
	337	1
	374	1
	376	1
	440	1
F3	1	24
	2	2

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
F3	3	9
	4	1
	7	18
	292	2
	300	5
	320	1
	336	1
	372	1
	374	4
	376	2
	480	5
G1	1	1
G14	1	9
	7	7
	292	2
	300	22
	337	1
	376	17
	422	1
	440	2
	442	3
	480	3
G15	1	9
	3	2
	7	7
	300	18
	328	1
	337	1
	376	18
	440	6
	442	1
	480	3
G16	1	3
G20	1	1
	3	1
	7	3
G21	1	2
	3	3
	374	1
	480	1
	481	1
G22	1	4
	3	7
	300	1
	320	1
	336	1
	374	1
	376	2

NUMBER OF VENTED DRUMS IN THE C&S BUILDING WITH CONTAINER TYPES OF "A" OR "001" BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
G22	480	3
G23	1	8
	2	1
	3	18
	300	7
	374	2
	376	3
	440	1
	442	2
	480	3
G24	1	14
	2	1
	3	8
	7	4
	292	3
	300	6
	330	1
	337	2
	374	4
	376	3
	442	3
	480	1
G25	1	6
	7	1
G27	1	4
	2	1
	337	1
HB	1	6
	2	2
	3	3
	4	3
	292	1
	300	1
	328	1
	330	1
	335	1
	336	2
	337	2
	371	3
	440	1
	480	1
K65	2	2
	3	5
	4	1
	330	25
	336	26
	337	9
	441	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
K65	480	5
	900	1
	960	2
K66	2	3
	3	8
	4	2
	320	1
	330	11
	335	2
	336	31
	337	7
	338	1
	371	1
	374	3
	480	4
	481	1
	900	2
	950	1
K67	2	2
	3	8
	4	2
	330	11
	336	28
	337	13
	371	1
	374	3
	421	1
	441	1
	480	3
	490	1
	900	1
	950	1
	960	1
K68	1	9
	3	6
	300	1
	376	1
	442	1
K69	3	3
L2	4	1
	336	1
L25	1	28
	3	1
	4	2
	7	4
	337	1
	371	2
	440	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
L25	480	2
L26	1	7
	3	1
	7	1
	292	1
L27	1	4
	3	1
	7	2
	337	1
L33	1	6
	7	1
	292	1
L34	1	16
	2	1
	7	3
	292	1
L35	1	22
L42	300	1
L53	1	18
	2	3
	4	2
	339	1
	440	3
	442	1
	480	2
L54	1	23
	2	4
	4	1
	330	3
	336	3
	337	3
	338	1
	371	2
	432	1
L55	1	21
	2	2
	4	3
	7	1
	336	5
	337	1
	371	1
	480	2
L56	1	15
	2	3
	330	4
	336	5
	337	5
	338	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
L56	371	3
	432	1
	440	3
	442	1
	480	2
L57	1	4
	7	1
	292	2
	330	1
	339	2
	480	2
L58	1	5
	3	1
	7	3
	337	1
	339	1
L59	1	6
	7	1
	336	1
	440	2
	442	1
L60	1	1
L65	3	6
	4	3
	320	1
	330	20
	336	25
	337	5
	338	1
	371	1
	374	3
	441	1
	480	2
	950	1
	960	3
L66	2	3
	3	8
	4	1
	330	11
	336	32
	337	9
	338	1
	374	5
	480	4
	900	1
	960	2
L67	1	1
	2	3

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
L67	3	3
	4	3
	330	17
	335	1
	336	22
	337	13
	371	1
	374	2
	480	5
	481	1
	900	1
	960	2
L68	1	7
	2	27
	3	12
	330	1
	336	2
	337	1
	339	1
	376	2
	441	1
	480	1
L69	1	22
	2	10
	3	12
	300	1
	330	2
	336	2
	374	1
	376	2
L70	1	25
	2	14
	3	11
	241	1
	336	2
	374	1
	376	1
	442	2
	960	1
L71	1	23
	2	3
M2	1	5
	2	5
	3	4
	300	2
	330	3
	336	8
	337	4

NUMBER OF VENTED DRUMS IN THE C&S BUILDING WITH CONTAINER TYPES OF "A" OR "001" BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
M2	338	1
	371	1
	374	2
	480	1
	960	1
M25	1	21
	4	5
	7	7
	337	1
	339	1
	440	1
	442	2
	480	3
M26	1	2
	4	1
	7	1
	442	1
	480	1
M27	1	6
	3	1
	7	2
	432	1
	440	1
	480	1
M32	1	11
	2	2
	292	1
M33	1	11
	3	1
	414	1
M34	1	24
	4	3
	7	8
	292	2
	414	1
M35	1	33
	4	1
	7	4
	409	1
M40	1	1
M41	1	10
M42	1	5
	3	1
M43	1	11
M44	1	25
	7	1
	320	1
M53	1	36

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
M53	2	4
	4	3
	330	1
	336	6
	337	5
	371	2
	432	2
	440	6
	480	1
	900	1
	970	1
M54	1	31
	2	3
	330	5
	336	10
	337	1
	371	2
	432	3
	440	1
	480	1
	970	1
M55	1	37
	2	3
	4	3
	330	5
	336	8
	337	1
	371	2
	432	2
	480	5
	970	1
M56	1	35
	2	2
	4	3
	330	3
	336	4
	337	1
	371	1
	432	4
	480	4
	970	1
M57	1	32
	4	2
	7	2
	320	1
	337	2
	339	2
	432	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
M57	440	2
	442	5
	480	5
M58	1	23
	2	1
	4	1
	7	3
	320	3
	336	1
	337	4
	339	1
	440	2
	442	2
	480	7
M60	336	1
M61	1	1
	3	23
	7	1
	320	1
	330	1
	336	7
	374	5
	376	2
	440	1
	442	1
	480	6
M62	3	29
	336	1
	337	1
	374	5
	376	1
	440	2
	442	2
	480	7
M65	2	3
	3	6
	330	15
	335	2
	336	23
	337	9
	338	1
	360	1
	371	1
	374	5
	442	1
	480	2
	900	2
	960	8

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
M66	2	4
	3	8
	4	4
	320	1
	330	16
	336	22
	337	7
	338	1
	374	2
	480	2
	481	1
	960	5
M67	2	1
	3	9
	4	2
	330	22
	335	2
	336	26
	337	6
	374	2
	480	4
	900	2
	960	4
M68	1	5
	2	17
	3	13
	336	4
M69	1	4
	2	17
	3	14
	330	2
	336	1
M70	1	1
	2	4
	3	6
	4	1
M71	1	5
	2	2
M75	1	1
	292	3
	300	15
	320	1
	338	1
	371	2
	374	1
	376	5
M76	292	1
	300	9

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
M76	320	2
	338	1
	371	1
	376	12
N2	1	4
	2	3
	3	3
	4	1
	292	1
	300	1
	330	5
	336	5
	337	3
	371	4
	440	1
	480	1
	900	1
	960	1
N25	1	21
	4	1
	7	9
	320	3
	371	1
	440	2
	480	2
	481	1
N26	1	2
	442	1
N27	1	6
	4	2
	442	1
	480	1
N32	1	25
	2	2
	4	1
	7	5
	292	3
N33	1	27
	7	4
	292	3
	414	1
N34	1	2
N35	1	1
N37	1	3
	7	3
	320	6
	330	1
	370	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
N37	440	1
	442	6
	480	14
	481	1
N38	1	2
	4	1
	320	5
	440	8
	442	7
	480	14
N39	1	3
	7	1
	320	3
	337	1
	440	8
	442	12
	480	11
N40	1	8
	7	5
N41	1	3
	7	3
N42	1	7
	7	4
N44	1	1
	7	1
N49	1	11
N50	1	26
	7	1
	292	1
N53	1	13
	2	1
	330	2
	337	1
	432	1
N54	1	10
	4	3
	320	1
	330	1
	336	2
	337	1
	371	2
N55	1	13
	2	1
	330	2
	337	2
	338	1
	440	1
N56	1	8

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
N56	2	2
	4	2
	336	2
	480	1
N57	1	20
	4	2
	7	5
	292	1
	320	3
	336	1
	337	1
	371	2
	440	3
	480	9
N58	1	31
	2	1
	7	1
	320	2
	330	1
	337	1
	371	2
	440	1
	442	2
	480	6
	481	1
N61	3	38
	292	1
	336	3
	374	4
	376	1
	440	2
	442	3
	480	11
	481	2
N62	3	48
	336	1
	374	4
	376	1
	440	2
	442	4
	480	7
N63	3	18
	374	10
	376	1
	440	1
	442	7
	480	5
N64	3	38

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
N64	335	1
	374	13
	376	2
	432	1
	440	2
	442	8
	480	7
N65	2	1
	3	5
	4	3
	330	16
	336	30
	337	12
	338	1
	339	1
	374	1
	440	1
	464	1
	480	6
	900	1
	960	1
N66	1	1
	2	1
	3	6
	4	1
	330	15
	336	32
	337	4
	338	1
	371	1
	374	2
	442	1
	464	1
	480	7
	481	1
	960	4
N67	2	1
	3	11
	4	2
	302	1
	330	5
	336	32
	337	12
	371	1
	374	3
	480	2
	900	2
	960	4

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
N71	1	11
	2	9
N72	1	24
	2	11
N73	4	3
	300	10
	330	1
	335	1
	336	1
	338	1
	371	1
	374	1
	376	12
	442	1
N74	300	2
	330	1
	335	1
	336	1
	371	1
	376	1
	425	1
	490	1
N78	300	9
	376	1
	440	5
	442	2
P18	1	2
P19	1	26
	2	5
P2	1	7
	2	1
	3	4
	4	3
	320	1
	328	1
	330	5
	336	6
	337	4
	338	1
	371	1
	374	1
	376	5
	440	1
	442	1
	480	1
	960	2
	970	1
P25	0	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
P25	1	25
	3	2
	4	2
	7	6
	292	1
	440	2
	480	4
P26	1	4
	4	1
	7	1
	480	1
P27	1	6
	7	2
	337	1
	371	1
	480	1
P3	480	2
P32	1	3
	2	2
P34	1	7
	7	1
	292	1
	337	1
P35	1	11
	292	2
P37	1	12
	2	1
	4	1
	7	3
	300	1
	320	2
	336	2
	337	2
	371	3
	440	9
	442	16
	480	11
	481	1
P38	1	18
	4	1
	7	3
	320	11
	339	1
	371	1
	440	13
	442	13
	480	8
P39	1	18

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
P39	4	3
	7	2
	320	10
	337	1
	339	1
	371	1
	440	7
	442	12
	480	17
	481	2
P4	440	1
	442	4
	480	6
P53	1	3
	4	1
P56	442	1
P57	1	3
	480	1
P58	1	3
	330	1
P59	320	1
	442	2
P61	1	1
	3	39
	336	1
	374	3
	376	4
	440	1
	442	10
	480	11
P62	3	39
	320	1
	374	5
	376	1
	440	2
	442	4
	480	10
P63	2	2
	3	2
	330	5
	336	20
	337	4
	374	6
	376	3
	440	2
	442	6
	480	8
	900	3

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
P63	960	4
P64	2	3
	3	2
	302	1
	330	19
	336	32
	337	11
	338	1
	480	4
	900	1
	960	1
P65	2	2
	3	7
	330	7
	336	15
	337	2
	374	4
	480	3
	950	1
	960	1
P66	2	2
	3	3
	330	6
	336	10
	337	5
	338	1
	490	1
	960	1
P78	300	21
	301	1
	330	8
	336	10
	337	10
	440	6
Q34	1	6
	4	1
	7	2
	292	1
Q35	1	2
	7	4
Q37	1	9
	4	1
	7	2
	336	1
	337	8
	339	1
	432	1
	442	2

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
Q37	480	2
Q38	1	8
	4	2
	7	2
	336	2
	337	5
	339	1
Q39	1	6
	4	1
	7	2
	320	2
	330	1
	337	3
	339	1
	432	1
	440	1
Q57	1	11
	2	3
	330	3
	337	1
	371	1
	432	1
	440	1
Q58	1	45
	2	4
	330	5
	336	6
	337	2
	371	1
	440	2
	480	2
Q59	1	15
	4	1
	7	4
	292	1
	320	1
	442	1
	480	2
Q61	1	2
	3	40
	336	1
	374	2
	376	2
	442	5
	480	4
Q62	1	1
	3	40
	4	1

NUMBER OF VENTED DRUMS IN THE C&S BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
BY GRID LOCATION AND CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
Q62	320	1
	374	2
	376	2
	442	4
	480	2
	481	1
Q63	1	1
	2	1
	3	5
	4	2
	330	10
	336	21
	337	13
	371	2
	374	4
	480	5
	900	5
	960	2
Q64	2	3
	3	2
	330	8
	336	27
	337	12
	371	3
	374	4
	480	3
	900	1
	960	3
Q77	300	1
	336	1
	337	1
	480	9
Q78	300	9
	301	1
	330	8
	336	5
	337	6
	440	3
	900	1
		7,485

APPENDIX B

APPENDIX B

The Stored Waste Examination Pilot Plant (SWEPP) Track Database was used to estimate the number of drums that have been fitted with a carbon composite filter and are stored in the ASB II. The assumptions used for this estimate was that all Rocky Flats Plant (RFP) drums have been fitted with a carbon composite filter and all RFP drums were stored in the following grid locations: B37-B42, C37-C42, D38-D42, E33-E35, E37-E42, F33-F35, F47-F42, G33-G35, G37-G42.

The Stored Waste Examination Pilot Plant (SWEPP) Track Database and Transuranic Waste Database were merged to estimate the number of drums that have been fitted with a carbon composite filter and are stored in the C&S Building. The parameters used for this estimate was that only those drums with a generator site equal to the RFP was selected and only those drums with a package date before 6/1/83 (containers with package dates after 6/1/83 have semi-permeable lid gaskets installed) were selected.

The number of drums in the C&S and ASB II fitted with a carbon composite filter presented in this appendix are based on the above assumptions/parameters and may not reflect the absolute number.

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
B37	1	19
	3	11
	7	3
	300	3
	320	1
	336	1
	376	5
	391	1
	440	1
	442	13
	480	11
	481	3
B38	1	20
	3	9
	300	10
	336	1
	339	1
	376	2
	440	1
	442	21
	480	3
	481	4
B39	1	21
	3	6
	7	2
	300	2
	374	1
	376	5
	440	1
	442	20
	480	11
	481	3
B40	1	25
	3	14
	4	8
	300	1
	330	3
	337	1
	374	1
	376	6
	440	2
	442	3
	480	4
	481	1
B41	1	14
	2	3

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
B41	3	22
	4	4
	292	2
	300	2
	320	2
	330	1
	337	1
	374	2
	376	3
	393	1
	442	6
	480	6
	481	1
B42	1	16
	2	1
	3	15
	292	1
	300	4
	320	3
	330	4
	336	2
	337	3
	374	2
	376	4
	425	2
	440	4
	442	2
	480	8
	481	1
C37	1	25
	3	19
	4	4
	336	1
	337	3
	374	1
	376	6
	440	4
	442	5
	480	2
	481	1
C38	1	20
	3	20
	4	5
	300	1
	337	2
	339	3

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
C38	374	1
	376	5
	440	2
	442	4
	480	10
	481	1
C39	1	15
	3	26
	4	4
	7	1
	300	2
	330	1
	337	2
	339	2
	374	1
	376	6
	440	3
	442	10
	480	3
	481	1
C40	1	22
	3	11
	4	4
	7	1
	292	1
	300	3
	320	1
	330	1
	336	3
	337	3
	374	5
	376	4
	425	2
	440	4
	442	7
	480	5
	481	1
C41	1	21
	3	15
	4	1
	300	4
	320	2
	330	3
	336	1
	337	7
	374	4

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
C41	376	2
	425	1
	440	2
	442	5
	480	11
C42	1	25
	3	15
	4	2
	7	1
	300	5
	320	1
	330	1
	337	3
	339	1
	374	6
	376	5
	440	1
	442	4
	480	7
D37	1	20
	3	14
	4	2
	7	2
	292	1
	330	2
	337	1
	339	2
	376	4
	440	1
	442	6
	480	3
	481	1
D38	1	23
	3	13
	292	1
	300	2
	320	1
	330	1
	337	5
	339	1
	376	1
	440	3
	442	3
	480	8
	481	2
D39	1	22

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
D39	3	21
	4	1
	300	2
	330	1
	337	2
	339	1
	376	3
	440	1
	441	1
	442	7
	480	2
D40	1	14
	2	1
	3	22
	4	4
	300	2
	320	3
	330	1
	337	2
	339	1
	374	2
	376	1
	440	4
	442	13
	480	3
	481	1
D41	1	17
	2	1
	3	24
	292	1
	300	5
	320	5
	330	1
	336	2
	337	1
	374	2
	376	4
	440	1
	442	8
	480	6
D42	1	20
	3	11
	4	4
	300	4
	320	1
	330	5

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
D42	336	4
	337	3
	374	2
	376	4
	425	1
	440	4
	442	7
	480	9
	481	1
E33	1	15
	3	9
	4	3
	7	13
	292	2
	300	3
	330	1
	336	3
	337	6
	440	1
	442	4
	481	1
E34	1	12
	3	8
	4	1
	7	10
	292	4
	300	3
	320	1
	330	1
	337	7
	339	2
	376	2
	412	1
	440	2
	442	4
	480	3
	481	3
E35	1	10
	3	10
	7	6
	300	4
	336	1
	337	2
	339	2
	376	4
	442	8

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
E35	480	10
	481	6
E37	1	12
	3	21
	300	2
	320	3
	339	2
	376	1
	442	4
	480	4
	481	1
E38	1	14
	3	15
	4	1
	7	1
	300	2
	330	1
	337	2
	339	3
	376	1
	442	6
	480	5
	481	3
E39	1	20
	2	1
	3	18
	4	1
	7	1
	320	1
	330	1
	337	4
	339	2
	376	2
	440	1
	442	4
	480	5
	481	2
E40	1	27
	3	19
	7	1
	292	2
	300	7
	374	2
	376	6
	440	6
	442	7

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
E40	480	3
E41	1	20
	3	27
	300	8
	330	1
	374	2
	376	7
	442	4
	480	8
E42	1	23
	3	14
	4	4
	300	9
	328	1
	330	1
	374	1
	376	4
	440	4
	442	5
	480	11
F33	1	24
	3	9
	320	1
	330	1
	336	1
	337	4
	339	2
	374	1
	442	6
	480	4
	481	2
F34	1	34
	3	4
	7	1
	292	2
	320	2
	336	1
	337	9
	339	1
	374	1
	376	2
	440	3
	442	5
	480	4
F35	1	45
	3	5

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
F35	4	1
	7	2
	292	1
	330	2
	336	2
	337	1
	339	3
	374	1
	376	2
	393	1
	440	1
	442	1
	480	4
	481	3
F37	1	12
	2	2
	3	18
	7	2
	300	6
	330	1
	336	3
	337	8
	339	2
	374	2
	376	1
	440	3
	442	8
	480	9
	481	2
F38	1	6
	3	15
	7	4
	292	2
	300	7
	320	3
	330	1
	337	8
	339	2
	376	1
	440	4
	442	11
	480	11
	481	4
F39	1	17
	3	26
	4	1

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
F39	292	1
	300	6
	320	1
	330	1
	336	1
	337	1
	339	2
	370	1
	374	1
	376	1
	440	3
	442	5
	480	8
	481	1
F40	1	19
	3	10
	7	2
	292	2
	300	7
	374	2
	376	4
	440	5
	442	13
	480	14
	481	1
F41	1	9
	3	11
	7	3
	292	1
	300	7
	320	1
	374	1
	376	6
	416	1
	440	4
	442	18
	480	18
F42	1	17
	3	13
	4	1
	292	1
	300	9
	339	2
	374	2
	376	3
	440	3

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
F42	442	4
	480	23
	481	1
G33	1	28
	3	11
	7	1
	336	1
	337	1
	339	3
	370	1
	393	1
	440	2
	442	14
	480	8
G34	1	17
	3	7
	4	2
	300	1
	330	1
	337	8
	339	4
	440	4
	442	7
	480	8
	481	1
G35	1	11
	3	7
	4	4
	337	5
	376	2
	440	2
	442	4
	480	8
G37	1	9
	3	25
	4	1
	7	7
	300	2
	330	1
	337	9
	339	2
	374	2
	376	3
	440	1
	442	4
	480	5

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
G37	481	4
G38	1	6
	3	12
	7	16
	300	6
	330	3
	336	3
	337	13
	339	1
	376	3
	440	1
	442	4
	480	4
	481	2
G39	1	8
	3	14
	4	3
	7	8
	292	1
	300	4
	330	3
	336	2
	337	5
	339	5
	376	6
	440	5
	442	3
	480	6
	481	2
G40	1	33
	2	2
	3	16
	4	1
	300	4
	320	2
	339	1
	374	4
	376	2
	440	2
	442	4
	480	6
G41	1	18
	2	1
	3	22
	300	7
	339	1

NUMBER OF VENTED DRUMS IN THE ASB2 BUILDING
WITH CONTAINER TYPES OF "A" OR "001"
IN GRIDS B37-42, C37-42, D37-42, E33-35, E37-42,
F33-35, F37-42, G33-35 AND G37-42
BY CONTENT CODE

GRID LOCATION	CONTENT CODE	NUMBER OF VENTED DRUMS
G41	374	5
	376	1
	392	1
	425	1
	440	3
	442	4
	480	14
	481	2
G42	1	18
	3	20
	4	2
	292	1
	300	5
	320	2
	330	1
	339	1
	374	3
	376	5
	440	3
	442	8
	480	11
		3,198

APPENDIX C

APPENDIX C

OP-FTIR REMOTE SENSOR

A recent review[1] describes the use of optical remote sensors, including OP-FTIR, to measure toxic gases. The OP-FTIR is essentially an open-path infrared spectral analyzer (referred to as Fourier transform infrared spectroscopy remote sensor or FTIR-RS by some authors). In an *active* OP-FTIR system, an infrared absorption spectrum is obtained by performing a Fourier transform on the wave form resulting from an infrared probe passing through a Michelson interferometer and the atmosphere containing the absorbing chemicals. Quantitative results are obtained from the size of the absorption bands due to the chemicals being measured. A Fourier transform spectrometer is used instead of a conventional slit/grating spectrometer, because the Fourier transform spectrometer if far more efficient optically than the conventional spectrometer. This is particularly important for long path applications where the light signal is relatively weak.

An MDA Scientific FTIR-RS (model: System, FTIR-RS; Rev.: P) was used in the present program in a unistatic configuration with a single 12 inch Cassegrain telescope which is used simultaneously as a transmitter of the infrared probe beam and as a receiver of the probe beam on its return, after being reflected by a 35 X 35 cm corner-cube retroreflector array. This configuration with the probe beam passing through the measured portion of the atmosphere twice, doubles the instrument sensitivity, in respect to infrared absorption by the measured chemicals. The Michelson interferometer is of a wishbone corner-cube design, the alignment of which is extremely stable to temperature variations. No interferometer alignment adjustments are ever necessary in normal operation. In the Fourier transform, triangle apodization was used, and the resultant infrared spectra (16 co-added scans) was collected a resolution of 1 cm^{-1}. The sensor uses a resistively heated glowbar for an infrared source and a mercury cadmium telluride (MCT) detector, maintained at cryogenic temperatures with a Stirling engine cooler.

ANALYTICAL METHOD

The OP-FTIR was used to make integrated-path concentration determinations of the chemical constituents in the ambient air volume. The initial spectroscopic data were single beam spectra, **I**. I_o (background spectrum) were collected with the retroreflector positioned 15 cm from the end of the telescope (referred to as "zero path"). It was not possible to collect an I_o upwind due to logistical constraints. According to Beer's law, the concentration-path length product, **C L**, of an absorbing specie is proportional to the absorbance, **A**, which is defined as

$$A(\nu) = -\log\frac{I(\nu)}{I_o(\nu)} \qquad (1)$$

where all three quantities here are spectra and are written as functions of ν, the optical frequency in wave number (cm^{-1}) units. $I_o(\nu)$ is the background spectrum taken under identical conditions to $I(\nu)$, with the exception that the absorbing chemicals are minimized by the short path length. Beer's law is written as

$$A(\nu) = \epsilon(\nu) CL \qquad (2)$$

where the proportionality constant, $\epsilon(\nu)$ is the absorption coefficient of the specie. The absorption coefficient is essentially a spectral shape function and is unique for each molecule, resulting in the unique "fingerprint" shape of the chemical absorption spectrum used in making qualitative identifications. The quantitative determination is made by measuring the absorbance, $A(\nu)$, and determining the concentration-path length product, $C L$, of the absorbing specie.

The concentration-path length products of the absorbing species were calculated using the multicomponent classical least-squares technique (CLS) developed by Haaland and Easterling.[2] This technique involves performing a least-squares fit of the field spectra to reference spectra (of the absorbing species) using Beer's law,

$$A_s(\nu) = a + b(\nu) + \sum_r \gamma_r A_r(\nu) + e(\nu) \qquad (3)$$

where $A_s(\nu)$ is the total absorbance of the measured atmospheric spectrum, at frequency ν, $A_r(\nu)$ is the absorbance of the r^{th} reference spectrum and γ_r is the ratio of the concentration-path length product for the r^{th} specie in the field, to the concentration-path length product for the reference spectrum of the r^{th} specie. The first two terms, on the right side of the equation, perform a linear correction for baseline error. The ranges of frequencies, ν, for the analysis are limited to regions where the target compound actually absorb the radiation. For each region, the sum in the third term is over all species that absorb in that particular region. The final term is the error or residual. The reference spectra are measurements of high purity NIST certified gases, diluted in nitrogen.

OP-FTIR MEASUREMENTS

The OP-FTIR, with its compact unistatic retroreflector array design, is amenable to easy and fast setup and break-down (i.e., < 30 min.). This allowed us to repeatedly relocate and setup the measurement throughout a given facility, within a reasonable short period of time (i.e. < 30 min.), to acquire information on the spatial distribution of the chemical vapors. Background spectra, I_o, were obtained in each facility by "zero path" measurements. The retroreflector was placed directly in front of the transmitter/receiver telescope, 15 centimeters beyond the telescope tube.

REFERENCES

1. W. B. Grant, R. H. Kagann, and W. A. McClenny, "Optical Remote Measurement of Toxic Gases". *J Air Waste Manage. Assoc.* 42, 18 - 30 (1992).

2. D. M. Haaland and R. G. Easterling, "Application of New Least-Squares Methods for the Quantitative Infrared Analysis of Multicomponent Samples," Applied Spectroscopy **36**, 665 - 673, (1982).

APPENDIX D

SUMMARY - SUMMA CANISTER DATA SET #1 (SDG OAE00901CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE00901CG	02656	8/24/93	09:12-14:16	C&S	B-4	21'	76-13-1	C2Cl3F3 (Freon 113)	54
							75-35-4	1,1-Dichloroethene	39
							67-64-1	Acetone	120 B
							75-09-2	Methylene chloride	83
							71-55-6	1,1,1-Trichloroethane	72
							56-23-5	Carbon tetrachloride	140
							79-01-6	Trichloroethene	20
							108-88-3	Toluene	20
							74-98-6	Propane	490 J
OAE01001CG	02835	8/24/93	09:16-14:18	C&S	P-2	5'9"	76-13-1	C2Cl3F3 (Freon 113)	70
							75-35-4	1,1-Dichloroethene	71
							67-64-1	Acetone	120 B
							75-09-2	Methylene chloride	120
							71-55-6	1,1,1-Trichloroethane	61
							56-23-5	Carbon tetrachloride	220
							79-01-6	Trichloroethene	40
							108-88-3	Toluene	21
							74-98-6	Propane	570 J
							75-05-8	Acetonitrile	210 J
OAE01101CG	02838	8/24/93	09:08-14:10	C&S	G-25	8-1/2'	76-13-1	C2Cl3F3 (Freon 113)	99
							75-35-4	1,1-Dichloroethene	92
							67-64-1	Acetone	32 B
							75-09-2	Methylene chloride	90
							67-66-3	Chloroform	8.2
							71-55-6	1,1,1-Trichloroethane	97
							56-23-5	Carbon tetrachloride	200 (DL)
							79-01-6	Trichloroethene	25
							108-88-3	Toluene	9.3
							74-98-6	Propane	770 J

SUMMARY - SUMMA CANISTER DATA SET #1 (SDG OAE00901CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE01201CG	01711	8/24/93	08:55-14:06	C&S	F-37	4'	75-71-8	Dichlorodifluoromethane	13
							76-13-1	C2Cl3F3 (Freon 113)	16
							75-35-4	1,1-Dichloroethene	22
							67-64-1	Acetone	120 B
							75-09-2	Methylene chloride	34
							71-55-6	1,1,1-Trichloroethane	20
							56-23-5	Carbon tetrachloride	29
							71-43-2	Benzene	95
							108-88-3	Toluene	99
								M/P-Xylene	36
							95-47-6	O-Xylene	12
							100-42-5	Styrene	14
							74-98-6	Propane	170 J
							75-28-5	Propane, 2-Methyl-	220 J
							78-78-4	Butane, 2-Methyl-	3100 J
							109-66-0	Pentane	2300 J
								Cyclopropane, 1,2-Dimethyl-	140 J
							107-83-5	Pentane, 2-Methyl-	470 J
							96-14-0	Pentane, 3-Methyl-	170 J
							110-54-3	Hexane	130 J
							565-59-3	Pentane, 2,3-Dimethyl-	170 J
								C8H18	140 J
OAE01301CG	02943	8/24/93	09:03-14:13	C&S	A-46	11-1/2'	76-13-1	C2Cl3F3 (Freon 113)	62
							75-35-4	1,1-Dichloroethene	52
							67-64-1	Acetone	46 B
							75-09-2	Methylene chloride	85
							71-55-6	1,1,1-Trichloroethane	82
							56-23-5	Carbon tetrachloride	170
							79-01-6	Trichloroethene	19
							108-88-3	Toluene	9
							74-98-6	Propane	460 J

SUMMARY - SUMMA CANISTER DATA SET #1 (SDG OAE00901CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE01401CG	01666	8/24/93	08:58-14:08	C&S	N-38	29'	76-13-1	C2Cl3F3 (Freon 113)	62
							75-35-4	1,1-Dichloroethene	85
							67-64-1	Acetone	62 B
							75-09-2	Methylene chloride	91
							71-55-6	1,1,1-Trichloroethane	68
							56-23-5	Carbon tetrachloride	180
							71-43-2	Benzene	18
							79-01-6	Trichloroethene	20
							108-88-3	Toluene	18
							74-98-6	Propane	410 J
							75-28-5	Propane, 2-Methyl-	49 J
							78-78-4	Butane, 2-Methyl-	850 J
							109-66-0	Pentane	610 J
							107-83-5	Pentane, 2-Methyl-	100 J
							96-14-0	Pentane, 3-Methyl-	31 J
OAE01501CG	02549	8/24/93	08:52-14:00	C&S	C-63	2-1/2'	76-13-1	C2Cl3F3 (Freon 113)	92
							75-35-4	1,1-Dichloroethene	99
							67-64-1	Acetone	100 B
							75-09-2	Methylene chloride	160
							67-66-3	Chloroform	7
							71-55-6	1,1,1-Trichloroethane	120
							56-23-5	Carbon tetrachloride	180 (DL)
							79-01-6	Trichloroethene	30
							108-88-3	Toluene	11
							74-98-6	Propane	540 J

SUMMARY - SUMMA CANISTER DATA SET #1 (SDG OAE00901CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE01601CG	02824	8/24/93	08:50-14:04	C&S	J-65	39'	76-13-1	C2Cl3F3 (Freon 113)	12
							67-64-1	Acetone	120 B
							71-55-6	1,1,1-Trichloroethane	23
							56-23-5	Carbon tetrachloride	21
							71-43-2	Benzene	58
							108-88-3	Toluene	58
								M/P Xylene	13
							100-42-5	Styrene	28
							74-98-6	Propane	180 J
							75-28-5	Propane, 2-Methyl-	160 J
							78-78-4	Butane, 2-Methyl-	3900 J
							109-66-0	Pentane	2700 J
								2-Pentene or Isomer	88 J
							107-83-5	Pentane, 2-Methyl-	340 J
							96-14-0	Pentane, 3-Methyl-	120 J
							110-54-3	Hexane	90 J
							565-59-3	Pentane, 2,3-Dimethyl-	110 J
								C8H18	92 J
OAE01701CG	02464	8/25/92	08:35-14:09	C&S	Q-73	9'	76-13-1	C2Cl3F3 (Freon 113)	74
							75-35-4	1,1-Dichloroethene	12
							75-09-2	Methylene chloride	180
							71-55-6	1,1,1-Trichloroethane	140
							56-23-5	Carbon tetrachloride	150 (DL)
							79-01-6	Trichloroethene	37
							108-88-3	Toluene	10
							74-98-6	Propane	900 J
								Unknown Hydrocarbon	170 J

SUMMARY - SUMMA CANISTER DATA SET #1 (SDG OAE00901CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE01701CG (DUP)	02464	8/25/92	08:35-14:09	C&S	Q-73	9'	76-13-1	C2Cl3F3 (Freon 113)	49
							75-35-4	1,1-Dichloroethene	61
							67-64-1	Acetone	64 J
							75-09-2	Methylene chloride	150
							71-55-6	1,1,1-Trichloroethane	64
							56-23-5	Carbon tetrachloride	170
							79-01-6	Trichloroethene	28
							74-98-6	Propane	660 J
OAE01801CG	02842	8/25/92	08:48-14:19	C&S	F-10	3'	76-13-1	C2Cl3F3 (Freon 113)	39
							75-09-2	Methylene chloride	56
							71-55-6	1,1,1-Trichloroethane	110
							56-23-5	Carbon tetrachloride	160
							79-01-6	Trichloroethene	15
							108-88-3	Toluene	8.2
							74-98-6	Propane	740 J
OAE01901CG	02599	8/25/92	08:50-14:18	C&S	C-15	4'	76-13-1	C2Cl3F3 (Freon 113)	27
							75-35-4	1,1-Dichloroethene	35
							75-09-2	Methylene chloride	110
							71-55-6	1,1,1-Trichloroethane	37
							56-23-5	Carbon tetrachloride	80
							79-01-6	Trichloroethene	11
							108-88-3	Toluene	11
							74-98-6	Propane	390 J
							78-78-4	Butane, 2-Methyl-	110 J

SUMMARY - SUMMA CANISTER DATA SET #1 (SDG OAE00901CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE02001CG	02658	8/25/92	08:55-14:17	C&S	D-20	1'	75-71-8	Dichlorodifluoromethane	11
							76-13-1	C2Cl3F3 (Freon 113)	45
							75-35-4	1,1-Dichloroethene	65
							75-09-2	Methylene chloride	120
							78-93-3	2-Butanone	19 J
							67-66-3	Chloroform	5.7 J
							71-55-6	1,1,1-Trichloroethane	66
							56-23-5	Carbon tetrachloride	130
							71-43-2	Benzene	9.6
							79-01-6	Trichloroethene	15
							108-88-3	Toluene	26
							74-98-6	Propane	410 J
							78-78-4	Butane, 2-Methyl-	980 J
							109-66-0	Pentane	260 J
							96-14-0	Pentane, 3-Methyl-	29 J
OAE02101CG	02550	8/25/92	08:59-14:15	C&S	K-55	1'	76-13-1	C2Cl3F3 (Freon 113)	33
							75-35-4	1,1-Dichloroethene	30
							75-09-2	Methylene chloride	210
							71-55-6	1,1,1-Trichloroethane	75
							56-23-5	Carbon tetrachloride	120
							79-01-6	Trichloroethene	18
							108-88-3	Toluene	13
							74-98-6	Propane	520 J
							78-78-4	Butane, 2-Methyl-	41 J

SUMMARY - SUMMA CANISTER DATA SET #1 (SDG OAE00901CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE02201CG	02600	8/25/92	09:02-14:13	C&S	K-71	4'	76-13-1	C2Cl3F3 (Freon 113)	43
							75-35-4	1,1-Dichloroethene	41
							75-09-2	Methylene chloride	140
							67-66-3	Chloroform	6.5
							71-55-6	1,1,1-Trichloroethane	75
							56-23-5	Carbon tetrachloride	250 (DL)
							79-01-6	Trichloroethene	38
							108-88-3	Toluene	11
							74-98-6	Propane	770 J
OAE02301CG (Blind QC)		8/25/92	NA	NA	NA	NA	76-13-1	C2Cl3F3 (Freon 113)	710 (DL)
							75-35-4	1,1-Dichloroethene	1400 (DL)
							75-09-2	Methylene chloride	1500
							156-59-4	1,2-Dichloroethene (cis)	1300
							75-35-4	1,1-Dichloroethane	950
							67-66-3	Chloroform	1400
							107-06-6	1,2-Dichloroethane	940
							71-55-6	1,1,1-Trichloroethane	1000
							56-23-5	Carbon tetrachloride	1100
							71-43-2	Benzene	1200
							79-01-6	Trichloroethene	1100
							108-88-3	Toluene	1100
							127-18-4	Tetrachloroethene	1000
								M/P-Xylene	1300
							95-47-6	O-Xylene	1000
							108-90-7	Chlorobenzene	850
							100-41-4	Ethylbenzene	790
							75-25-2	Bromoform	1300 (DL)
							108-67-8	1,3,5-Trimethylbenzene	450
							79-34-5	1,1,2,2-Tetrachloroethane	1200 (DL)
							95-63-6	1,2,4-Trimethylbenzene	450
							60-29-7	Diethyl ether	620 J
							110-82-7	Cyclohexane	2200 J

SUMMARY - SUMMA CANISTER DATA SET #1 (SDG OAE00901CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE02401CG		8/25/92	NA	NA	NA	NA	76-13-1	C2Cl3F3 (Freon 11)	2.3
(TB)							108-88-3	Toluene	3

B Indicates that the analyte was detected in the blank as well as in the sample.
J Indicates that the analyte concentration is an estimated value.
DL Indicates a compound concentration from a diluted sample of the original sample. The compound was detected above the instrument calibration range in the original sample, so the sample was diluted at the laboratory and analyzed again.
DUP Laboratory duplicate sample.
NA Not applicable.
QC Quality control sample.
TB Trip blank submitted to the laboratory by EG&G Idaho.

Temperature and Barometric Pressure Readings for SUMMA Canister Data Set #1

According to sampling logbook records, the temperature (T) and barometric pressure (BP) readings on the sampling dates are as follows for the samples indicated:

For OAE00901CG-OAE01601CG, at 8:30, outside T = 5 degrees C (41 degrees F); BP = 25.157 in. of Hg. Inside the C&S building (no time recorded), T = 9 degrees C (48 degrees F) and BP = 25.16 in. of Hg. End-of-the-day measurements were not recorded.

For OAE01701CG-OAE02201CG, at 8:10, outside T = 2 degrees C (36 degrees F); BP = 25.427 in. of Hg. Inside the C&S building (no time recorded) T = 8 degrees C (46 degrees F) and BP = 25.2 in. of Hg. At the end of the sampling day, at 14:25 inside the C&S building, T = 16 degrees C (61 degrees F) and BP = 25.2 in. of Hg.

SUMMA CANISTER DATA SET #1 (SDG OAE00901CG) MATRIX SUMMARY*

		Concentration in ppb (v/v) listed by Sample ID**																			
Cas No.	Compound	009	010	011	012	013	014	015	016	017	018	019	020	021	022	SUM	N	%	A1	A2	Max	SD
100-42-5	Styrene	0	0	0	14	0	0	0	28	0	0	0	0	0	0	42	2	14.3%	21.0	3.0	28.0	8.11
107-83-5	Pentane, 2-Methyl	0	0	0	470	0	100	0	340	0	0	0	0	0	0	910	3	21.4%	303.3	65.0	470.0	148.67
108-88-3	Toluene	20	21	9.3	99	9	18	11	58	10	8.2	11	26	13	11	324.5	14	100.0%	23.2	23.2	99.0	25.35
109-66-0	Pentane	0	0	0	2300	0	610	0	2700	0	0	0	260	0	0	5870	4	28.6%	1467.5	419.3	2700.0	901.22
110-54-3	Hexane	0	0	0	130	0	0	0	90	0	0	0	0	0	0	220	2	14.3%	110.0	15.7	130.0	40.71
56-23-5	Carbon tetrachloride	140	220	200	29	170	180	180	21	150	160	80	130	120	250	2030	14	100.0%	145.0	145.0	250.0	66.18
565-59-3	Pentane, 2,3-Dimethyl-	0	0	0	170	0	0	0	110	0	0	0	0	0	0	280	2	14.3%	140.0	20.0	170.0	52.18
67-64-1	Acetone	120	120	32	120	46	62	100	120	0	0	0	0	0	0	720	8	57.1%	90.0	51.4	120.0	53.75
67-66-3	Chloroform	0	0	8.2	0	0	0	7	0	0	0	0	5.7	0	6.5	27.4	4	28.6%	6.9	2.0	8.2	3.25
71-43-2	Benzene	0	0	0	95	0	18	0	58	0	0	0	9.6	0	0	180.6	4	28.6%	45.2	12.9	95.0	28.39
71-55-6	1,1,1-Trichloroethane	72	61	97	20	82	68	120	23	140	110	37	66	75	75	1046	14	100.0%	74.7	74.7	140.0	34.55
74-98-6	Propane	490	570	770	170	460	410	540	180	900	740	390	410	520	770	7320	14	100.0%	522.9	522.9	900.0	215.60
75-05-8	Acetonitrile	0	210	0	0	0	0	0	0	0	0	0	0	0	0	210	1	7.1%	210.0	15.0	210.0	56.12
75-09-2	Methylene chloride	83	120	90	34	85	91	160	0	180	56	110	120	210	140	1479	13	92.9%	113.8	105.6	210.0	56.26
75-28-5	Propane, 2-Methyl-	0	0	0	220	0	49	0	160	0	0	0	0	0	0	429	3	21.4%	143.0	30.6	220.0	69.76
75-35-4	1,1-Dichloroethene	39	71	92	22	52	85	99	0	12	0	35	65	30	41	643	12	85.7%	53.6	45.9	99.0	32.68
75-71-8	Dichlorodifluoromethane	0	0	0	13	0	0	0	0	0	0	0	11	0	0	24	2	14.3%	12.0	1.7	13.0	4.38
76-13-1	C2Cl3F3 (Freon 113)	54	70	99	16	62	62	92	12	74	39	27	45	33	43	728	14	100.0%	52.0	52.0	99.0	26.31
78-78-4	Butane, 2-Methyl-	0	0	0	3100	0	850	0	3900	0	0	110	980	41	0	8981	6	42.9%	1496.8	641.5	3900.0	1263.55
78-93-3	2-Butanone	0	0	0	0	0	0	0	0	0	0	0	19	0	0	19	1	7.1%	19.0	1.4	19.0	5.08
79-01-6	Trichloroethene	20	40	25	0	19	20	30	0	37	15	11	15	18	38	288	12	85.7%	24.0	20.6	40.0	12.62
95-47-6	O-Xylene	0	0	0	12	0	0	0	0	0	0	0	0	0	0	12	1	7.1%	12.0	0.9	12.0	3.21
96-14-0	Pentane, 3-Methyl-	0	0	0	170	0	31	0	120	0	0	0	29	0	0	350	4	28.6%	87.5	25.0	170.0	52.88
None	2-Pentene or Isomer	0	0	0	0	0	0	0	88	0	0	0	0	0	0	88	1	7.1%	88.0	6.3	88.0	23.52
None	Cyclopropane, 1,2-Dimethyl-	0	0	0	140	0	0	0	0	0	0	0	0	0	0	140	1	7.1%	140.0	10.0	140.0	37.42
None	M/P-Xylene	0	0	0	36	0	0	0	13	0	0	0	0	0	0	49	2	14.3%	24.5	3.5	36.0	9.97
None	Unknown HC	0	0	0	0	0	0	0	0	170	0	0	0	0	0	170	1	7.1%	170.0	12.1	170.0	45.43
None	C8H18	0	0	0	140	0	0	0	92	0	0	0	0	0	0	232	2	14.3%	116.0	16.6	140.0	43.16

* QC samples and trip blanks are given on the attached table and not included with this summary matrix.

** Samples are identified by three digits from each original sample number (ex.: OAE00901CG is listed as 009).

SUMMA CANISTER DATA SET #1 (SDG OAE00901CG) MATRIX SUMMARY*

SUM	Summation of the detected concentrations from the 14 samples.
N	The number of samples in which the compound was detected.
%	The percentage of the 14 samples in which the compound was detected.
A1	The average concentration among the samples in which the compound was detected (zero values not included in the average).
A2	The average concentration of the compound in all 14 samples.
Max	The maximum concentration detected among the 14 samples.
SD	The standard deviation of the 14 samples (a sample of a population).

ATTACHMENT TO DATA SET #1 (SDG OAE00901CG) MATRIX SUMMARY

QUALITY CONTROL SAMPLES AND TRIP BLANKS

Cas No.	Compound	Conc. In ppb (v/v) 023(QC)	024(TB)
100-41-4	Ethylbenzene	790	0
107-06-6	1,2-Dichloroethane	940	0
108-67-8	1,3,5-Trimethylbenzene	450	0
108-88-3	Toluene	1100	3
108-90-7	Chlorobenzene	850	0
110-82-7	Cyclohexane	2200	0
127-18-4	Tetrachloroethene	1000	0
156-59-4	1,2-Dichloroethene (cis)	1300	0
56-23-5	Carbon tetrachloride	1100	0
60-29-7	Diethyl ether	620	0
67-66-3	Chloroform	1400	0
71-43-2	Benzene	1200	0
71-55-6	1,1,1-Trichloroethane	1000	0
75-09-2	Methylene chloride	1500	0
75-25-2	Bromoform	1300	0
75-35-4	1,1-Dichloroethene	1400	0
75-35-4	1,1-Dichloroethane	950	0
76-13-1	C2Cl3F3 (Freon 113)	710	2.3
79-01-6	Trichloroethene	1100	0
79-34-5	1,1,2,2-Tetrachloroethane	1200	0
95-47-6	O-Xylene	1000	0
95-63-6	1,2,4-Trimethylbenzene	450	0
	M/P-Xylene	1300	0

QC Blind quality control sample submitted to the laboratory by EG&G Idaho.
TB Trip blank submitted to the laboratory by EG&G Idaho.

SUMMARY - SUMMA CANISTER DATA SET #2 (SDG OAE02501CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE02501CG	11909	9/1/92	08:32-13:48	ASB-II	N-29	12'	75-71-8	Dichlorodifluoromethane	11
							76-13-1	C2Cl3F3 (Freon 113)	110
							75-35-4	1,1-Dichloroethene	85
							67-64-1	Acetone	51
							71-55-6	1,1,1-Trichloroethane	140
							56-23-5	Carbon tetrachloride	230
OAE02601CG	12101	9/1/92	08:37-13:40	ASB-II	I-32	1'	75-71-8	Dichlorodifluoromethane	17
							76-13-1	C2Cl3F3 (Freon 113)	150
							75-35-4	1,1-Dichloroethene	100
							67-64-1	Acetone	29
							67-66-3	Chloroform	11
							71-55-6	1,1,1-Trichloroethane	100 (DL)
							56-23-5	Carbon tetrachloride	200 (DL)
							79-01-6	Trichloroethene	10
							74-98-6	Propane	110 J
OAE02701CG (Replicate)	12104	9/1/92	08:37-13:40	ASB-II	I-32	1'	75-71-8	Dichlorodifluoromethane	16
							76-13-1	C2Cl3F3 (Freon 113)	130
							75-35-4	1,1-Dichloroethene	77
							67-66-3	Chloroform	8.4
							71-55-6	1,1,1-Trichloroethane	200
							56-23-5	Carbon tetrachloride	180 (DL)
							79-01-6	Trichloroethene	7.7
OAE02801CG	12097	9/1/92	08:40-13:45	ASB-II	D-31	12'	76-13-1	C2Cl3F3 (Freon 113)	140
							75-35-4	1,1-Dichloroethene	89
							67-66-3	Chloroform	10
							71-55-6	1,1,1-Trichloroethane	230
							56-23-5	Carbon tetrachloride	270

SUMMARY - SUMMA CANISTER DATA SET #2 (SDG OAE02501CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE02901CG	11911	9/1/92	08:44-13:53	ASB-II	G-38	15'	75-71-8	Dichlorodifluoromethane	15
							76-13-1	C2Cl3F3 (Freon 113)	150
							75-35-4	1,1-Dichloroethene	120
							67-66-3	Chloroform	11
							71-55-6	1,1,1-Trichloroethane	180
							56-23-5	Carbon tetrachloride	300
OAE03001CG	12103	9/1/92	08:47-13:55	ASB-II	B-37	3'	75-71-8	Dichlorodifluoromethane	12
							76-13-1	C2Cl3F3 (Freon 113)	190
							75-35-4	1,1-Dichloroethene	86
							75-09-2	Methylene chloride	50
							67-66-3	Chloroform	13
							71-55-6	1,1,1-Trichloroethane	310
							56-23-5	Carbon tetrachloride	200 (DL)
OAE03101CG	11912	9/1/92	08:51-14:00	ASB-II	S-38	9'	75-71-8	Dichlorodifluoromethane	13
							76-13-1	C2Cl3F3 (Freon 113)	110
							75-35-4	1,1-Dichloroethene	76
							67-64-1	Acetone	48
							71-55-6	1,1,1-Trichloroethane	120
							56-23-5	Carbon tetrachloride	200
OAE03201CG	12102	9/1/92	08:55-14:05	ASB-II	R-43	1'	75-71-8	Dichlorodifluoromethane	23
							76-13-1	C2Cl3F3 (Freon 113)	140
							75-35-4	1,1-Dichloroethene	110
							67-66-3	Chloroform	10
							71-55-6	1,1,1-Trichloroethane	180
							56-23-5	Carbon tetrachloride	290

SUMMARY - SUMMA CANISTER DATA SET #2 (SDG OAE02501CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE03301CG	12099	9/1/92	08:59-14:01	ASB-II	G-42	9'	75-71-8	Dichlorodifluoromethane	17
							76-13-1	C2Cl3F3 (Freon 113)	190
							75-35-4	1,1-Dichloroethene	120
							67-66-3	Chloroform	13
							71-55-6	1,1,1-Trichloroethane	290
							56-23-5	Carbon tetrachloride	320 (DL)
OAE03401CG	12098	9/1/92	09:01-14:04	ASB-II	C-42	15'	75-71-8	Dichlorodifluoromethane	14
							76-13-1	C2Cl3F3 (Freon 113)	140
							75-35-4	1,1-Dichloroethene	100
							67-66-3	Chloroform	10
							71-55-6	1,1,1-Trichloroethane	190
							56-23-5	Carbon tetrachloride	300
OAE03501CG (SUMMA Walk)	11908	9/1/92	13:20-13:27	ASB-II	Center Aisle	4'	75-71-8	Dichlorodifluoromethane	30
							76-13-1	C2Cl3F3 (Freon 113)	270 (DL)
							75-35-4	1,1-Dichloroethene	230
							75-09-2	Methylene chloride	50
							67-66-3	Chloroform	24
							71-55-6	1,1,1-Trichloroethane	490 (DL)
							56-23-5	Carbon tetrachloride	620 (DL)
							79-01-6	Trichloroethene	26

SUMMARY - SUMMA CANISTER DATA SET #2 (SDG OAE02501CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE03601CG (TB)		9/1/92	NA	NA	NA	NA		Benzene, (1-methylethyl) - or isomer	7.3 J

DL Indicates a compound concentration from a diluted sample of the original sample. The compound was detected above the instrument calibration range in the original sample, so the sample was diluted at the laboratory and analyzed again.

TB Trip blank submitted to the laboratory by EG&G Idaho.

NA Not applicable.

J Indicates that the analyte concentration is an estimated value.

Temperature and Barometric Pressure Readings for SUMMA Canister Data Set #2

According to sampling logbook records, the temperature (T) and barometric pressure (BP) readings on the sampling date are as follows for the samples indicated:

For OAE02401CG-OAE03501CG, outside the ASB-II building (no time recorded), T = 8 degrees C (46 degrees F); BP = 25.110 in. of Hg. Inside the building at 8:17, T = 12 degrees C (54 degrees F) and BP = 25.11 in. of Hg. At 14:07, inside the building, T = 25 degrees C (76 [sic] degrees F), and BP = 25.1 in. of Hg.

SUMMA CANISTER DATA SET #2 (SDG OAE02501CG) MATRIX SUMMARY

Cas No.	Compound	Concentration in ppb (v/v) listed by Sample Number*																	
		025	026	027	028	029	030	031	032	033	034	035	036**	SUM	N	%	A1	A2	Max	SD
56-23-5	Carbon tetrachloride	230	200	180	270	300	200	200	290	320	300	620	0	3110	11	100%	282.7	282.7	620.0	122.40
67-64-1	Acetone	51	29	0	0	0	0	48	0	0	0	0	0	128	3	27%	42.7	11.6	51.0	20.63
67-66-3	Chloroform	0	11	8.4	10	11	13	0	10	13	10	24	0	110	9	82%	12.3	10.0	24.0	6.47
71-55-6	1,1,1-Trichloroethane	140	100	200	230	180	310	120	180	290	190	490	0	2430	11	100%	220.9	220.9	490.0	110.13
74-98-6	Propane	0	110	0	0	0	0	0	0	0	0	0	0	110	1	9%	110.0	10.0	110.0	33.17
75-09-2	Methylene chloride	0	0	0	0	0	50	0	0	0	0	50	0	100	2	18%	50.0	9.1	50.0	20.23
75-35-4	1,1-Dichloroethene	85	100	77	89	120	86	76	110	120	100	230	0	1193	11	100%	108.5	108.5	230.0	43.20
75-71-8	Dichlorodifluoromethane	11	17	16	0	15	12	13	23	17	14	30	0	168	10	91%	16.8	15.3	30.0	7.43
76-13-1	C2Cl3F3 (Freon 113)	110	150	130	140	150	190	110	140	190	140	270	0	1720	11	100%	156.4	156.4	270.0	45.89
79-01-6	Trichloroethene	0	10	7.7	0	0	0	0	0	0	0	26	0	43.7	3	27%	0.0	4.0	26.0	8.13
	Benzene (1-methylethyl)	0	0	0	0	0	0	0	0	0	0	0	7.3							

* Samples are identified by three digits from each original sample number (ex.: OAE02501CG is listed as 025). Additionally, sample number 035 was collected by walking with the SUMMA canister.

** Sample 036 is a trip blank submitted to the laboratory by EG&G Idaho and is not included in any calculations.

SUM Summation of the detected concentrations from the 11 samples.

N The number of samples in which the compound was detected.

% The percentage of the 11 samples in which the compound was detected.

A1 The average concentration among the samples in which the compound was detected (zero values not included in the average).

A2 The average concentration of the compound in all 11 samples.

Max The maximum concentration detected among the 11 samples.

SD The standard deviation of the 11 samples (a sample of a population).

APPENDIX E

SUMMARY - SUMMA CANISTER DATA SET #3 (SDG OAE03701CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE03701CG	02813	9/9/92	09:03-14:10	ASB-II	B-40	1'	74-83-9	Bromomethane	57
							76-13-1	C2Cl3F3 (Freon 113)	100
							75-35-4	1,1-Dichloroethene	52
							67-64-1	Acetone	78
							67-66-3	Chloroform	9
							71-55-6	1,1,1-Trichloroethane	260
							56-23-5	Carbon tetrachloride	420 (DL)
OAE03801CG	02938	9/9/92	09:03-14:10	ASB-II	B-40	1'	76-13-1	C2Cl3F3 (Freon 113)	110
							75-35-4	1,1-Dichloroethene	49
							67-64-1	Acetone	83
							67-66-3	Chloroform	9.2
							71-55-6	1,1,1-Trichloroethane	260
							56-23-5	Carbon tetrachloride	450 (DL)
OAE03901CG	02828	9/9/92	09:06-14:14	ASB-II	M-37	1'	75-71-8	Dichlorodifluoromethane	16
							76-13-1	C2Cl3F3 (Freon 113)	130
							75-35-4	1,1-Dichloroethene	79
							67-64-1	Acetone	86
							67-66-3	Chloroform	11
							71-55-6	1,1,1-Trichloroethane	280
							56-23-5	Carbon tetrachloride	420 (DL)
							79-01-6	Trichloroethene	11
OAE04001CG	01722	9/9/92	09:10-14:18	ASB-II	Q-29	1'	75-71-8	Dichlorodifluoromethane	16
							76-13-1	C2Cl3F3 (Freon 113)	110
							75-35-4	1,1-Dichloroethene	110
							67-66-3	Chloroform	10
							71-55-6	1,1,1-Trichloroethane	190
							56-23-5	Carbon tetrachloride	440 (DL)
							79-01-6	Trichloroethene	11

SUMMARY - SUMMA CANISTER DATA SET #3 (SDG OAE03701CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE04101CG	02942	9/9/92	09:17-14:30	ASB-II	S-38	9'	75-71-8	Dichlorodifluoromethane	12
							76-13-1	C2Cl3F3 (Freon 113)	110
							75-35-4	1,1-Dichloroethene	81
							67-64-1	Acetone	44
							67-66-3	Chloroform	9.6
							71-55-6	1,1,1-Trichloroethane	200
							56-23-5	Carbon tetrachloride	400 (DL)
							79-01-6	Trichloroethene	9.4
OAE04201CG	02723	9/9/92	09:21-14:21	ASB-II	E-31	12'	76-13-1	C2Cl3F3 (Freon 113)	96
							67-64-1	Acetone	180
							71-55-6	1,1,1-Trichloroethane	380
							56-23-5	Carbon tetrachloride	360
OAE04301CG	02830	9/9/92	09:25-14:19	ASB-II	M-30	15'	76-13-1	C2Cl3F3 (Freon 113)	110
							75-35-4	1,1-Dichloroethene	31
							67-64-1	Acetone	250
							75-09-2	Methylene chloride	250
							71-55-6	1,1,1-Trichloroethane	270
							56-23-5	Carbon tetrachloride	340
OAE04401CG	02827	9/9/92	09:29-14:28	ASB-II	A-34	12'	76-13-1	C2Cl3F3 (Freon 113)	120
							75-35-4	1,1-Dichloroethene	55
							67-64-1	Acetone	77
							71-55-6	1,1,1-Trichloroethane	290
							56-23-5	Carbon tetrachloride	390

SUMMARY - SUMMA CANISTER DATA SET #3 (SDG OAE03701CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
OAE04501CG (SUMMA Walk)	02821	9/9/92	13:36-13:53	ASB-II	West Wall	4'	74-83-9	Bromomethane	36 J
							76-13-1	C2Cl3F3 (Freon 113)	150
							75-35-4	1,1-Dichloroethene	82
							67-64-1	Acetone	430
							67-66-3	Chloroform	12
							71-55-6	1,1,1-Trichloroethane	390 (DL)
							56-23-5	Carbon tetrachloride	460 (DL)
							79-01-6	Trichloroethene	15
OAE04601CG	02720	9/9/92	09:34-14:25	ASB-II	N-41	12'	76-13-1	C2Cl3F3 (Freon 113)	130
							75-35-4	1,1-Dichloroethene	36
							67-64-1	Acetone	1200
							71-55-6	1,1,1-Trichloroethane	360
							56-23-5	Carbon tetrachloride	410
OAE04701CG (SUMMA Walk)	01663	9/9/92	13:56-14:14	ASB-II	West Wall	4'	76-13-1	C2Cl3F3 (Freon 113)	160
							67-64-1	Acetone	3600
							71-55-6	1,1,1-Trichloroethane	400
							56-23-5	Carbon tetrachloride	490
OAE05101CG (TB)	02816	9/9/92	NA	NA	NA	NA	75-35-4	1,1-Dichloroethene	1.4
							67-64-1	Acetone	64
							71-55-6	1,1,1-Trichloroethane	2.7
OAE05201CG	02831	9/9/92	09:17-14:30	ASB-II	G-41	9'	76-13-1	C2Cl3F3 (Freon 113)	180
							75-35-4	1,1-Dichloroethene	42
							71-55-6	1,1,1-Trichloroethane	340
							56-23-5	Carbon tetrachloride	390 (DL)

SUMMARY - SUMMA CANISTER DATA SET #3 (SDG QAE03701CG)

Sample ID	Canister No.	Date Collected	Time Collected	Bldg.	Grid	Height	Cas No.	Compound	Conc. (ppb v/v)
LCS							75-35-4	1,1-Dichloroethene	39 (DL)
							67-64-1	Acetone	27
							71-43-2	Benzene	44
							79-01-6	Trichloroethene	22
							108-88-3	Toluene	33
							108-90-7	Chlorobenzene	27
LCSD							75-35-4	1,1-Dichloroethene	39 E
							67-64-1	Acetone	32
							71-43-2	Benzene	46 E
							79-01-6	Trichloroethene	24
							108-88-3	Toluene	36
							108-90-7	Chlorobenzene	31 E

DL Indicates a compound concentration from a diluted sample of the original sample. The compound was detected above the instrument calibration range in the original sample, so the sample was diluted at the laboratory and analyzed again.

J Indicates that the analyte concentration is an estimated value.

TB Trip blank submitted to the laboratory by EG&G Idaho.

NA Not applicable.

LCS Laboratory control standard.

LCSD Duplicate run of the laboratory control standard.

E Identifies a concentration exceeding the calibration range. The sample was not diluted or reanalyzed.

SUMMARY - SUMMA CANISTER DATA SET #3 (SDG OAE03701CG)

Temperature and Barometric Pressure Readings for SUMMA Canister Data Set #3

The temperature (T) and barometric pressure (BP) recorded for all twelve samples identified in Summa Canister Data Set #3 that were taken at the ASB-II on 9/9/92 were the same.

At 8:10 on the morning of 9/9/92 outside of the ASB-II building, the T = 8 degrees C (45 degrees F) and the BP = 25.174 in. of Hg according to the NOAA station at the RWMC.

At 9:00, the start of the sampling day, inside the ASB-II building, the T = 14 degrees C (55 degrees F) and the BP = 25.16 in. of Hg according to the measurements made by the sampling team.

At 13:20, the end of the sampling day, inside the ASB-II building, the T = 20 degrees C (64 degrees F) and the BP = 25.18 in. of Hg according to the measurements made by the sampling team.

SUMMA CANISTER DATA SET #3 (SDG OAE03701CG) MATRIX SUMMARY

Cas No.	Compound	Concentration in ppb (v/v) listed by Sample Number*																				
		037	038	039	040	041	042	043	044	045	046	047	052	051 (TB)	LCS	LCSD	SUM	N	%	A1	A2	Max	SD
56-23-5	Carbon tetrachloride	420	450	420	440	400	360	340	390	460	410	490	390	0	0	0	4970	12	100%	414.2	414.2	490	42.31
67-64-1	Acetone	78	83	86	0	44	180	250	77	430	1200	3600	0	64	27	32	6028	10	83%	602.8	502.3	3600	1030.44
67-66-3	Chloroform	9	9.2	11	10	9.6	0	0	0	12	0	0	0	0	0	0	60.8	6	50%	10.1	5.1	12	5.35
71-55-6	1,1,1-Trichloroethane	260	260	280	190	200	380	270	290	390	360	400	340	2.7	0	0	3620	12	100%	301.7	301.7	400	71.58
74-83-9	Bromomethane	57	0	0	0	0	0	0	0	36	0	0	0	0	0	0	93	2	17%	46.5	7.8	57	18.65
75-09-2	Methylene chloride	0	0	0	0	0	0	250	0	0	0	0	0	0	0	0	250	1	8%	250.0	20.8	250	72.17
75-35-4	1,1-Dichloroethene	52	49	79	110	81	0	31	55	82	36	0	42	1.4	39	39	617	10	83%	61.7	51.4	110	33.10
75-71-8	Dichlorodifluoromethane	0	0	16	16	12	0	0	0	0	0	0	0	0	0	0	44	3	25%	14.7	3.7	16	6.71
76-13-1	C2Cl3F3 (Freon 113)	100	110	130	110	110	96	110	120	150	130	160	180	0	0	0	1506	12	100%	125.5	125.5	180	25.78
79-01-6	Trichloroethene	0	0	11	11	9.4	0	0	0	15	0	0	0	0	22	24	46.4	4	33%	11.6	3.9	15	5.85
71-43-2	Benzene	0	0	0	0	0	0	0	0	0	0	0	0	0	44	46							
108-88-3	Toluene	0	0	0	0	0	0	0	0	0	0	0	0	0	33	36							
108-90-7	Chlorobenzene	0	0	0	0	0	0	0	0	0	0	0	0	0	27	31							

* Samples are identified by three digits from each original sample number (ex.: OAE02501CG is listed as 025).

LCS Laboratory control standard. Concentrations from this sample are not included in the matrix summary calculations.
LCSD Laboratory control standard duplicate. Concentrations from this sample are not included in the matrix summary calculations.
TB Trip blank submitted to laboratory by EG&G Idaho. This sample is not included in the matrix summary calculations.

SUM Summation of the detected concentrations from the 12 samples.
N The number of samples in which the compound was detected.
% The percentage of the 12 samples in which the compound was detected.
A1 The average concentration among the samples in which the compound was detected (zero values not included in the average).
A2 The average concentration of the compound in all 12 samples.
Max The maximum concentration detected among the 12 samples.
SD The standard deviation of the 12 samples (a sample of a population).

APPENDIX F

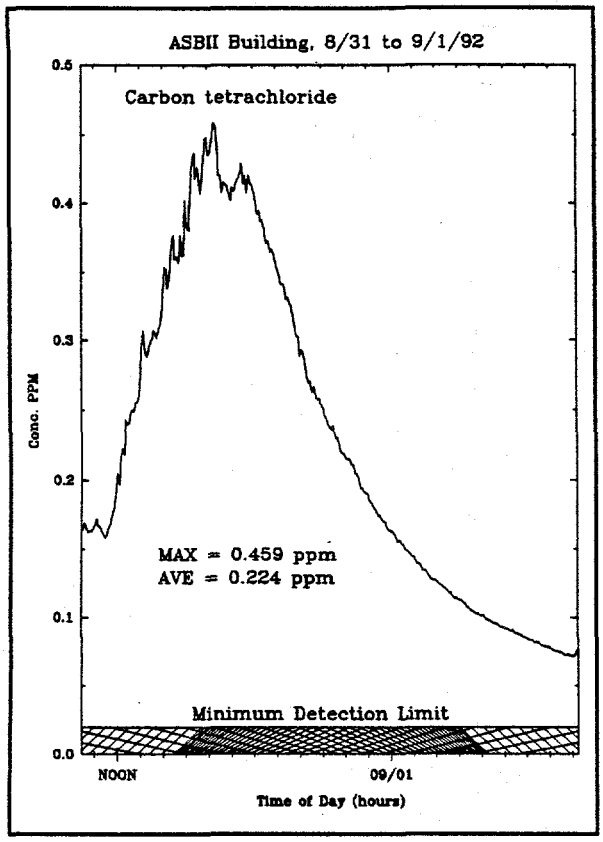


Figure 1 Graph of CCl_4 from Aug. 31st @ 10:26 am to Sept. 1st @ 8:14 am in the east corridor. Max. conc. occurred on Aug. 31st @ 4:17 pm.

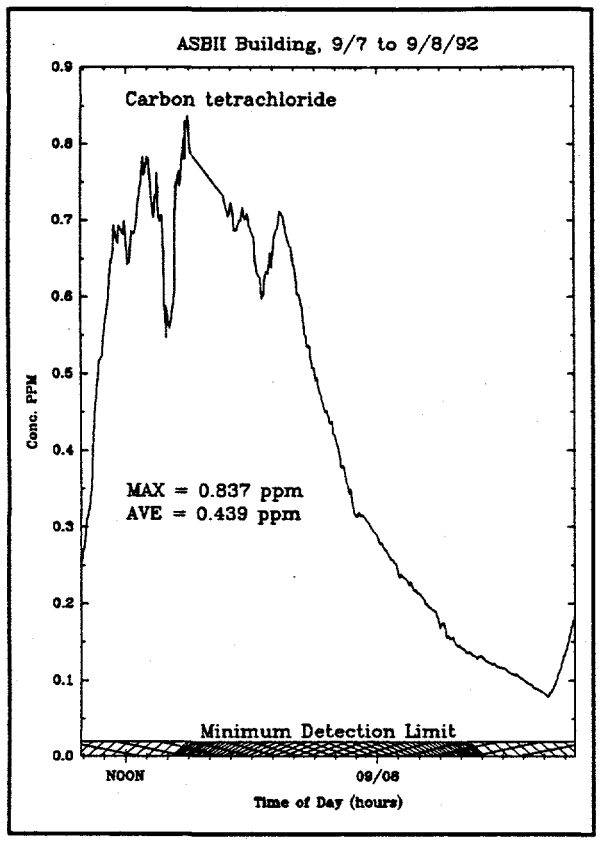


Figure 2 Graph of CCl_4 from Sept. 7th @ 9:53 am to the 8th @ 09:28 am in the east corridor. Max. conc. occurred on the 7th @ 2:58 pm.

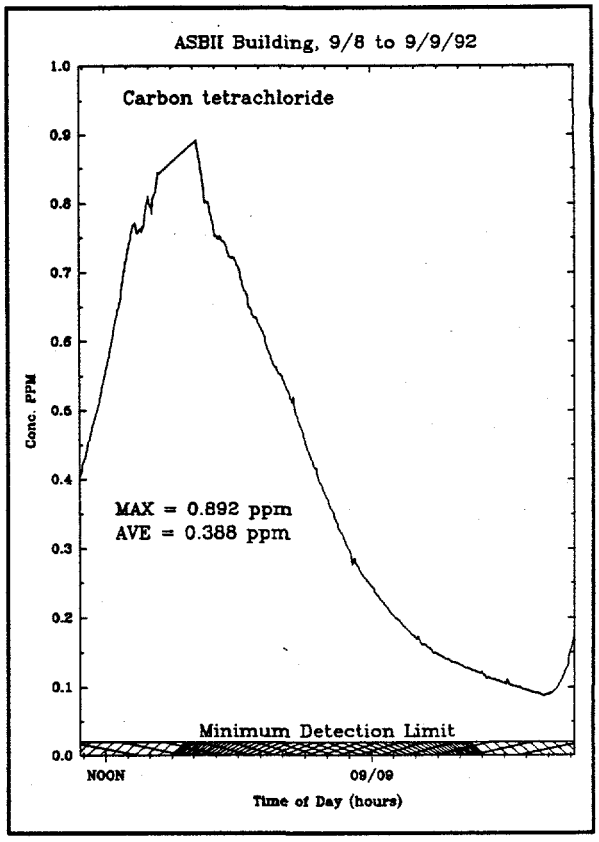


Figure 3 Graph of CCl_4 from Sept. 8th @ 10:51 am to the 9th @ 9:11 am. in the east corridor. Max. conc. occurred on the 8th @ 4:09 pm.

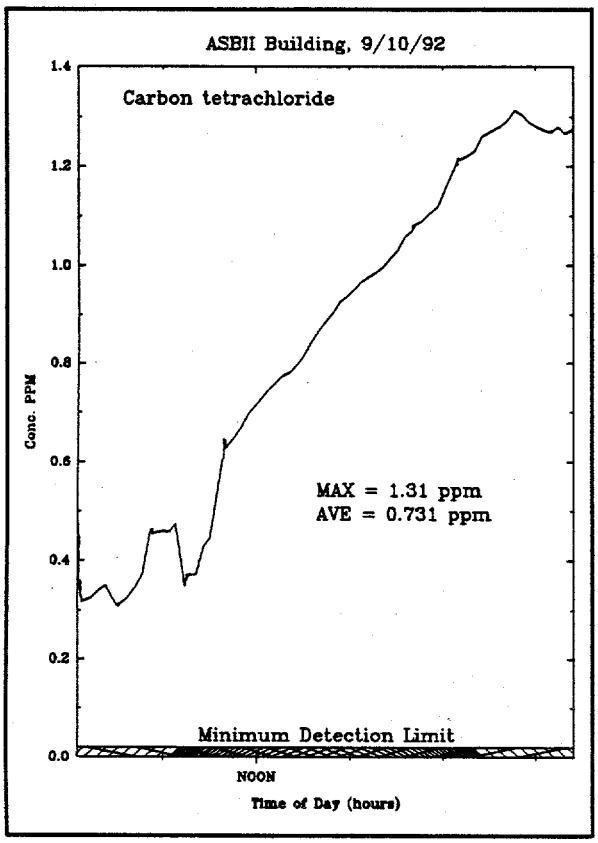


Figure 4 Graph of CCL_4 on Sept. 10th from 10:05 am to 3:24 pm. in the west corridor. Max. conc. occurred at 2:47 pm.

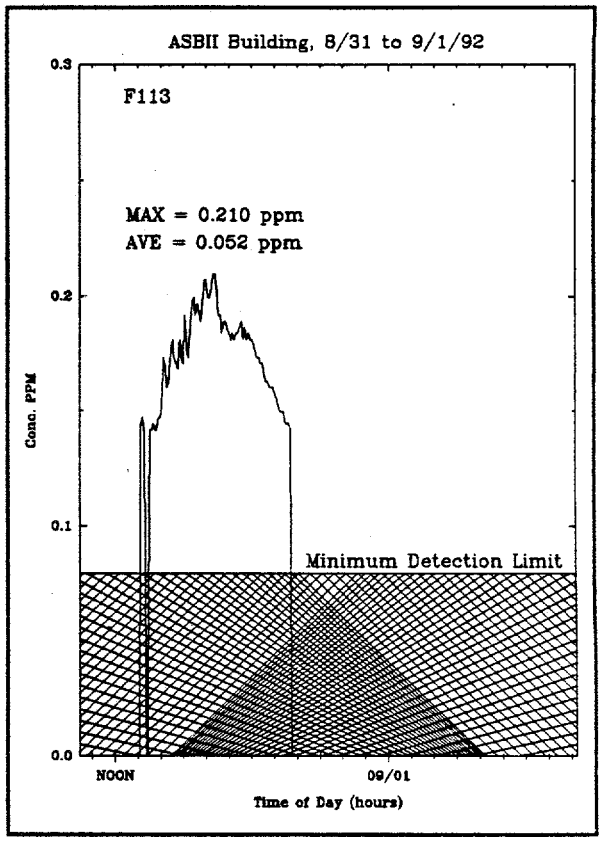


Figure 5 Graph of Freon 113 from Aug. 31st @ 10:26 am to Sept. 1st @ 8:14 am in the east corridor. Max. conc. occurred on Aug. 31st @ 4:17 pm.

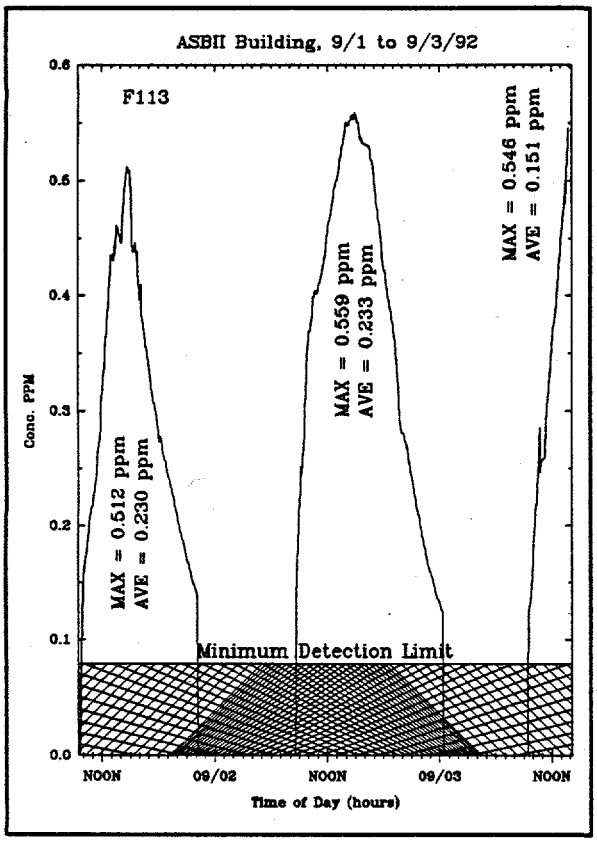


Figure 6 Graph of Freon 113. Center corridor was monitored Sept. 1st @ 09:26 am to 1:54 pm, while the west corridor was monitored Sept. 1st @ 2:00 pm to Sept. 3rd @ 2:10 pm. Max. conc. occurred 2:43 pm, 2:56 pm, and 1:52 pm, respectively.

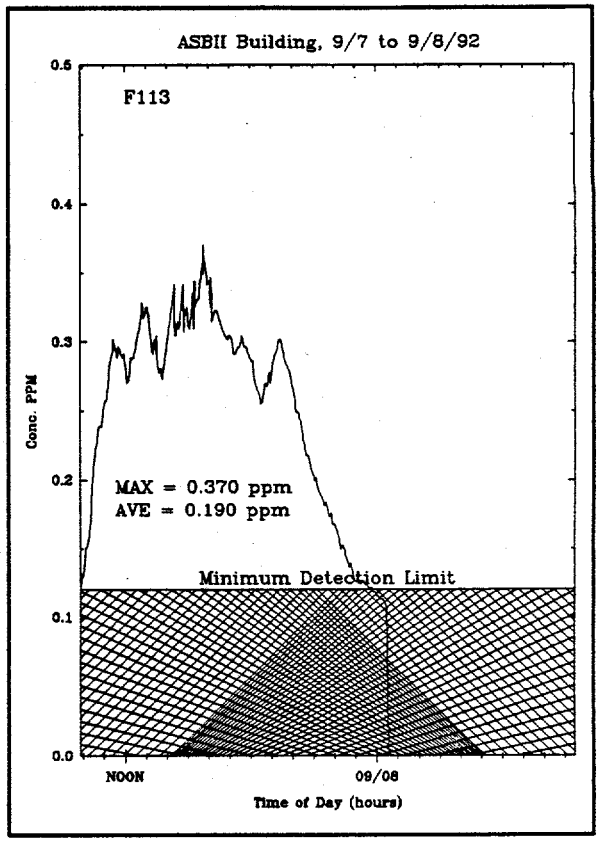


Figure 7 Graph of Freon 113 from Sept. 7th @ 9:53 am to the 8th @ 09:28 am in the east corridor. Max. conc. occurred on the 7th @ 3:45 pm.

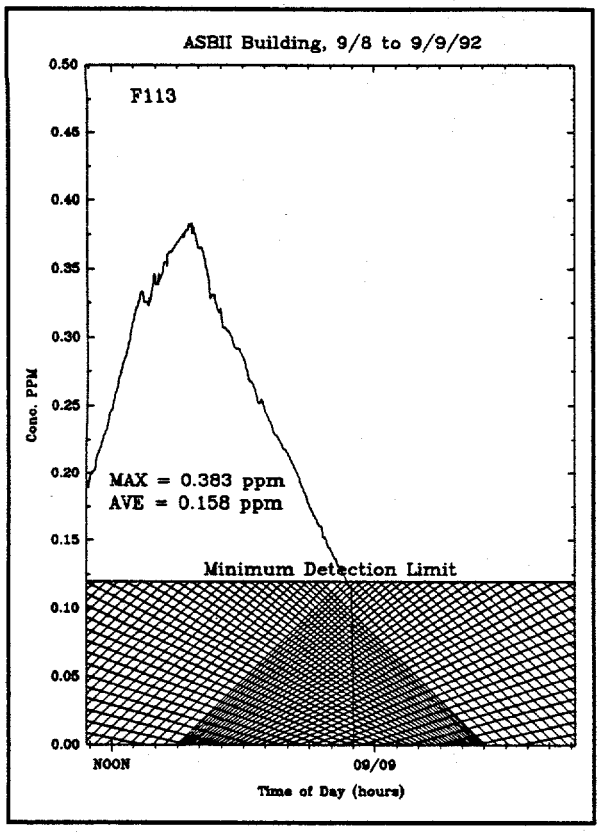


Figure 8 Graph of Freon 113 from Sept. 8th @ 10:51 am to the 9th @ 9:11 am. in the east corridor. Max. conc. occurred on the 8th @ 3:41 pm.

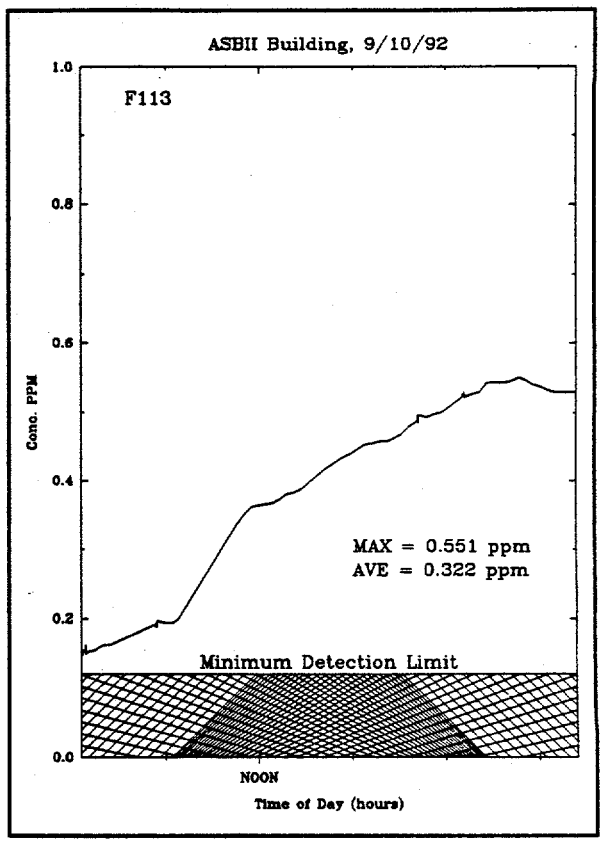


Figure 9 Graph of Freon 113 on Sept. 10th from 10:05 am to 3:24 pm. in the west corridor. Max. conc. occurred at 2:47 pm.

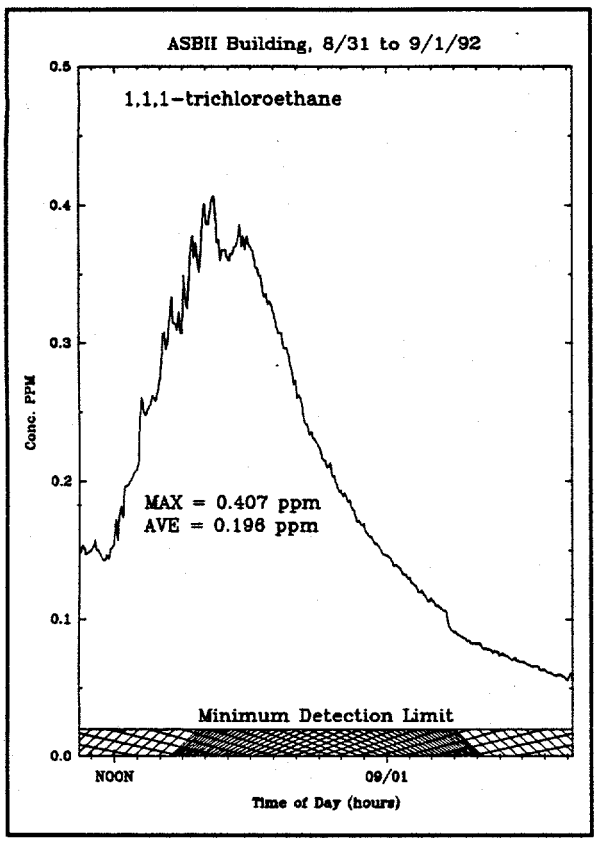


Figure 10 Graph of 1,1,1-TCA from Aug. 31st @ 10:26 am to Sept. 1st @ 8:14 am in the east corridor. Max. conc. occurred on Aug. 31st @ 4:22 pm.

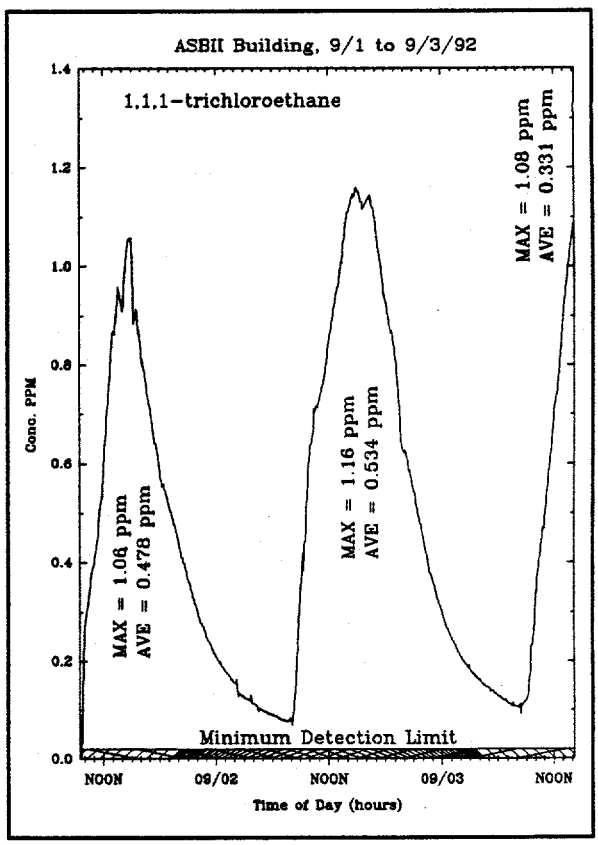


Figure 11 Graph of 1,1,1-TCA. Center corridor was monitored Sept. 1st @ 09:26 am to 1:54 pm, while the west corridor was monitored Sept. 1st @ 2:00 pm to Sept. 3rd @ 2:10 pm. Max. conc. occurred 2:53 pm, 3:01 pm, and 2:04 pm, respectively.

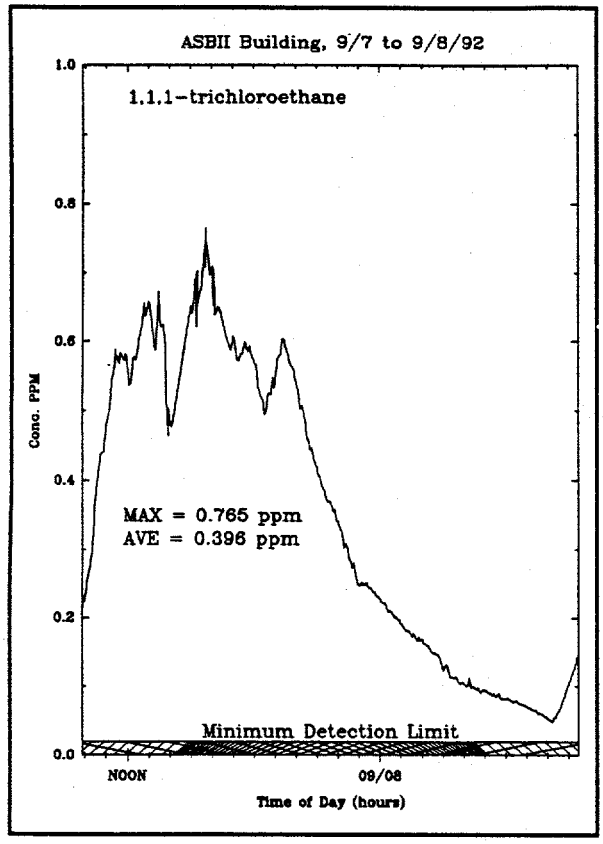


Figure 12 Graph of 1,1,1-TCA from Sept. 7th @ 9:53 am to the 8th @ 09:28 am in the east corridor. Max. conc. occurred on the 7th @ 3:45 pm.

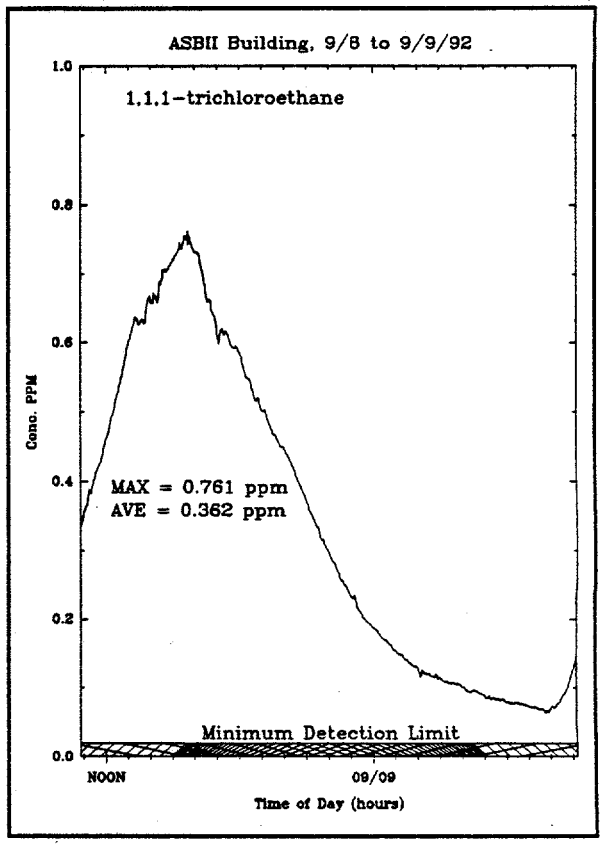


Figure 13 Graph of 1,1,1-TCA from Sept. 8th @ 10:51 am to the 9th @ 9:11 am. in the east corridor. Max. conc. occurred on the 8th @ 3:39 pm.

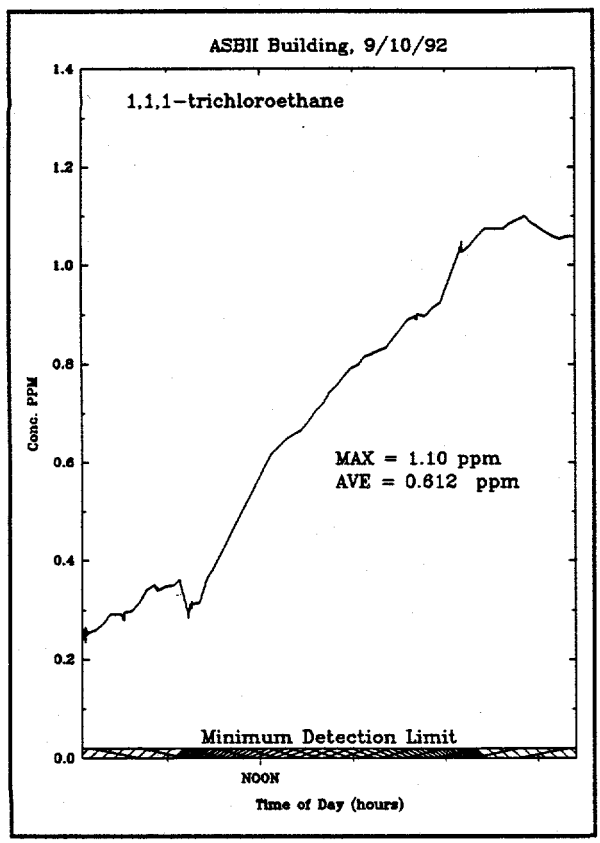


Figure 14 Graph of 1,1,1-TCA on Sept. 10th from 10:05 am to 3:24 pm. in the west corridor. Max. conc. occurred at 2:52 pm.

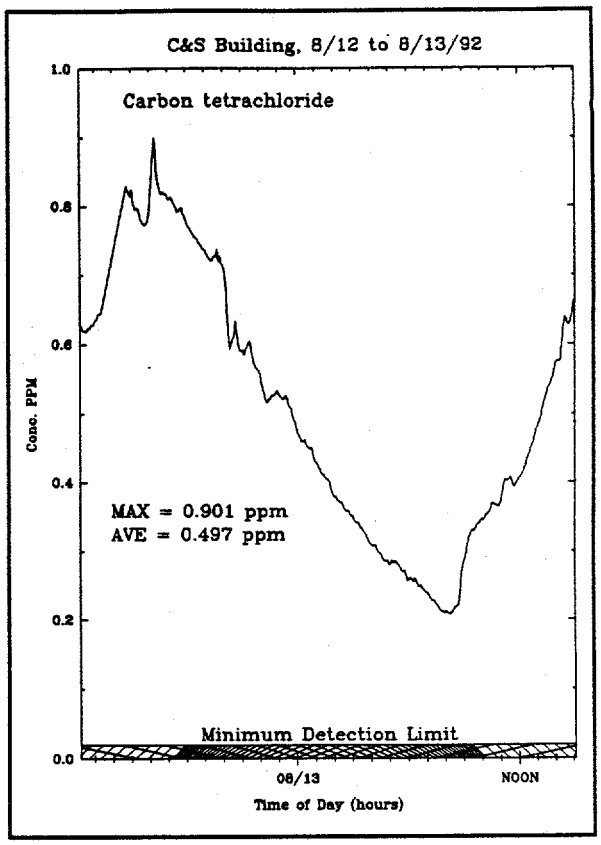


Figure 15 Graph of CCl_4 from Aug. 12th from 12:13 pm to the 13th @ 3:02 pm in the east corridor. Max. conc. occurred on the 12th @ 4:18 pm.

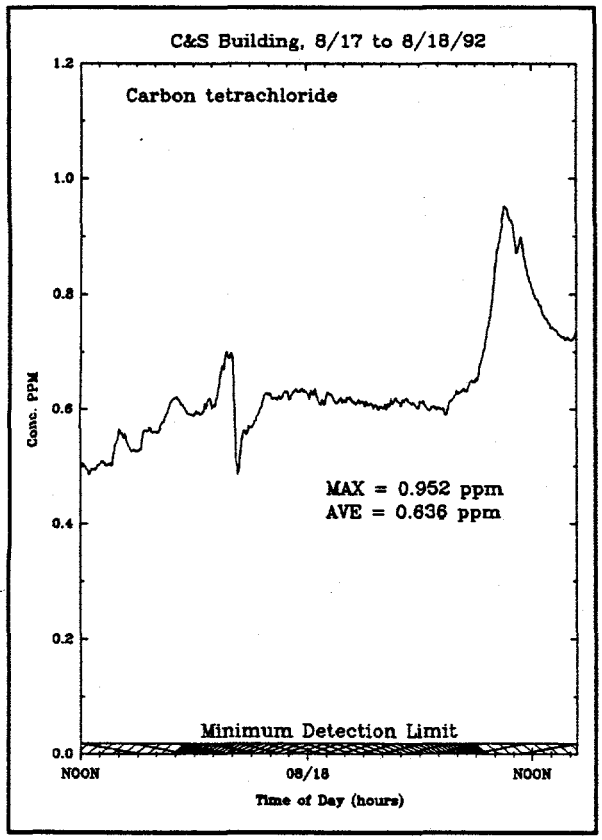


Figure 16 Graph of CCl_4 from Aug. 17th from 12:04 pm to the 18th @ 2:21 pm in the east corridor. Max. conc. occurred on the 18th @ 10:34 pm.

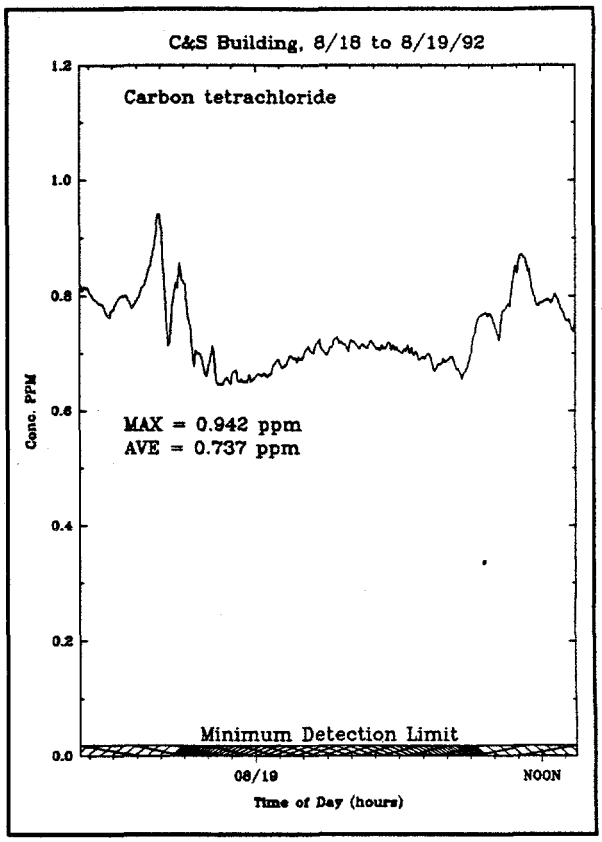


Figure 17 Graph of CCl_4 from Aug. 18th from 4:38 pm to the 19th @ 1:28 pm in the center corridor. Max. conc. occurred on the 18th @ 7:58 pm.

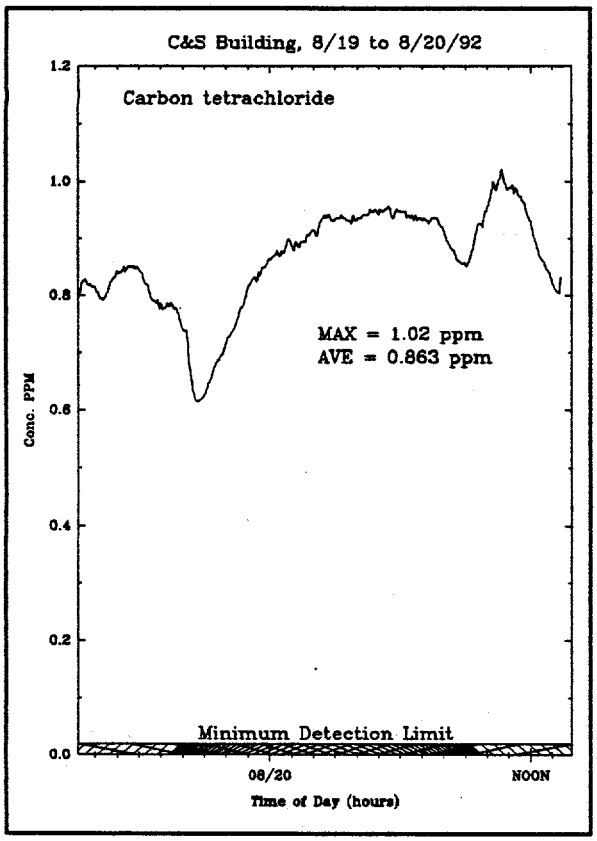


Figure 18 Graph of CCl_4 from Aug. 19th from 3:13 pm to the 20th @ 1:52 pm in the west corridor. Max. conc. occurred on the 20th @ 10:39 am.

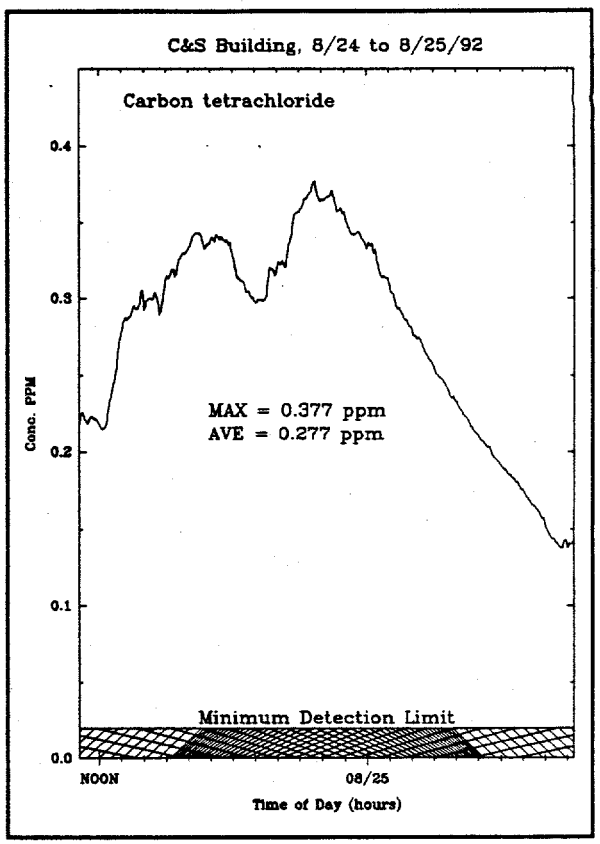


Figure 19 Graph of CCl_4 from Aug. 24th from 11:06 am to the 25th @ 9:16 am in the east corridor. Max. conc. occurred on the 24th @ 9:41 pm.

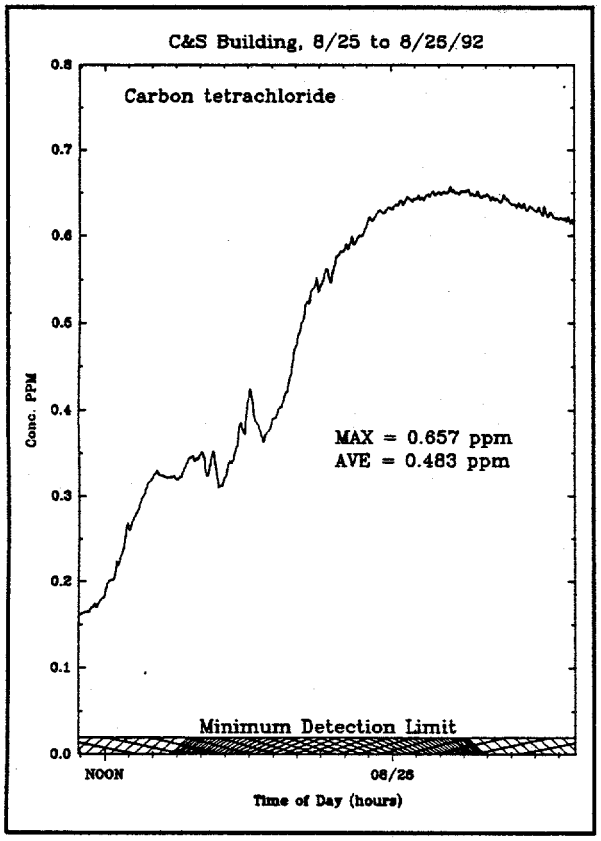


Figure 20 Graph of CCl_4 from Aug. 25th from 10:54 am to the 26th @ 7:41 am in the center corridor. Max. conc. occurred on the 26th @ 2:28 pm.

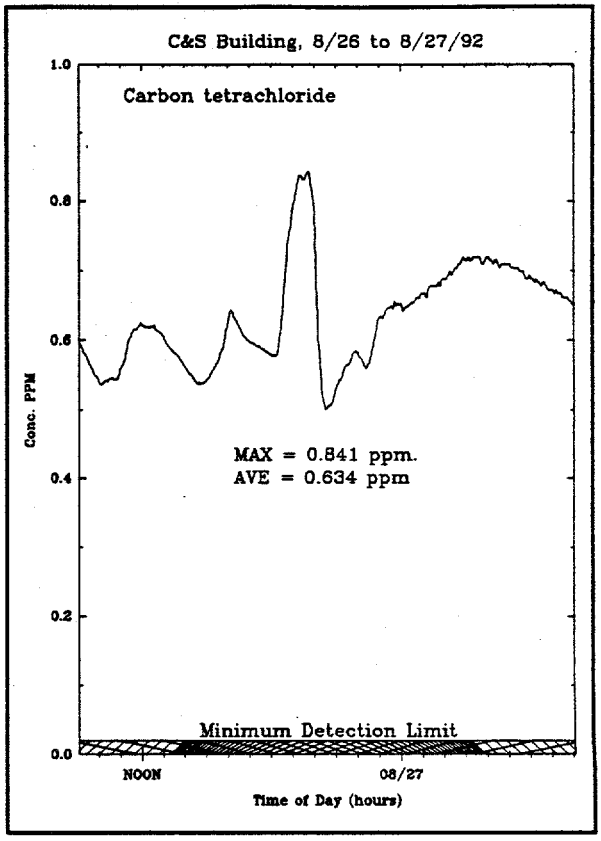


Figure 21 Graph of CCl_4 from Aug. 26th from 9:05 am to the 27th @ 8:06 am in the west corridor. Max. conc. occurred on the 26th @ 7:41 pm.

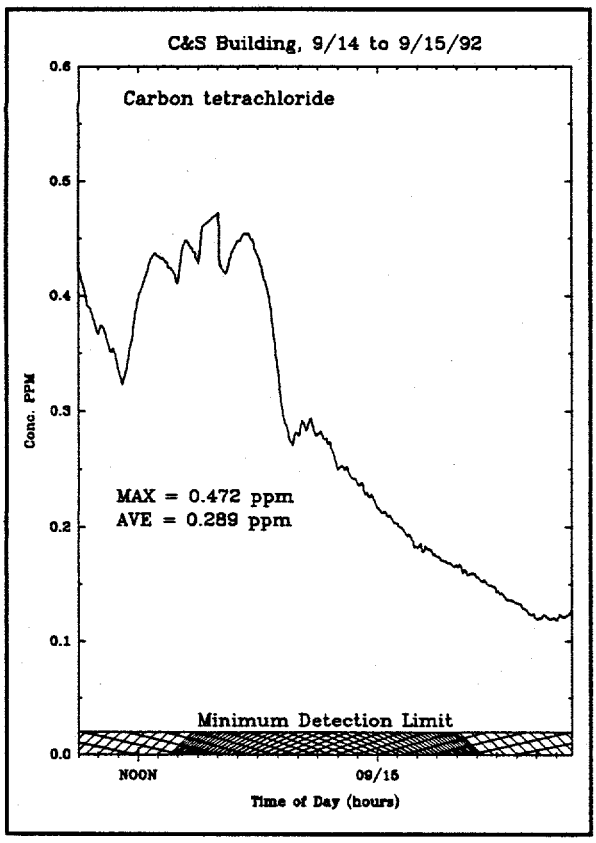


Figure 22 Graph of CCl_4 from Sept. 14th from 9:00 am to the 15th @ 9:44 am in the east corridor. Max. conc. occurred on the 14th @ 4:02 pm.

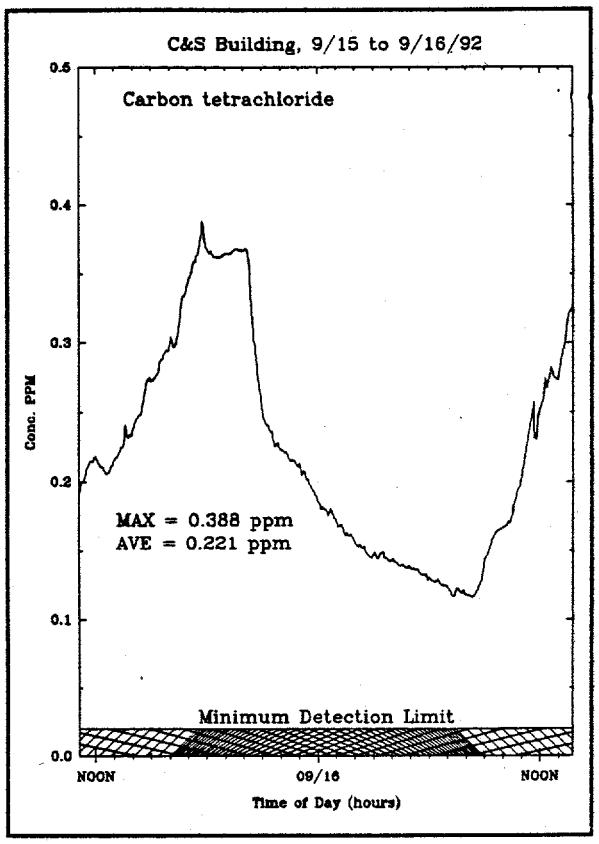


Figure 23 Graph of CCl_4 from Sept. 15th from 11:09 am to the 16th @ 1:45 pm in the center corridor. Max. conc. occurred on the 15th @ 5:47 pm.

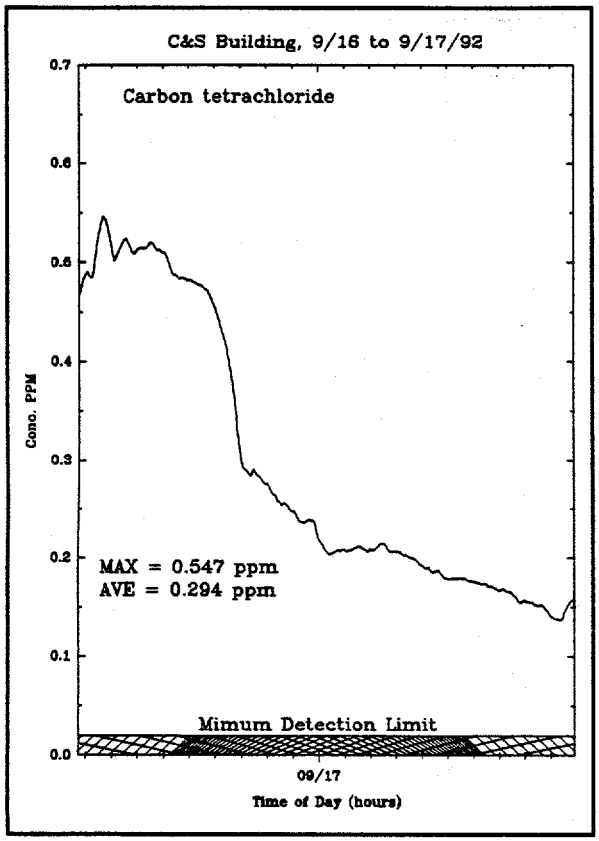


Figure 24 Graph of CCl_4 from Sept. 16th from 2:43 pm to the 17th @ 9:55 am in the west corridor. Max. conc. occurred on the 16th @ 3:39 pm.

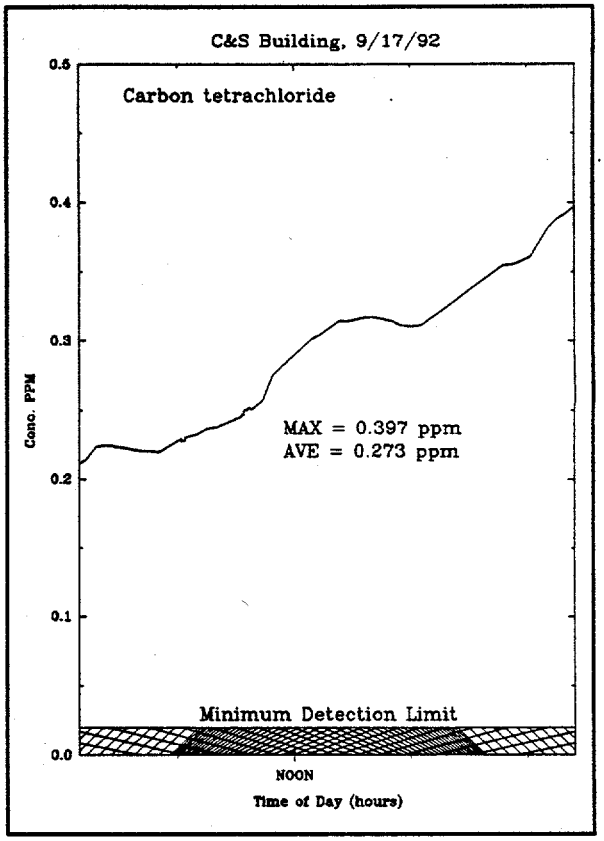


Figure 25 Graph of CCl_4 on Sept. 17th from 10:09 am to 2:25 pm in the west corridor. Max. conc. occurred at 2:25 pm.

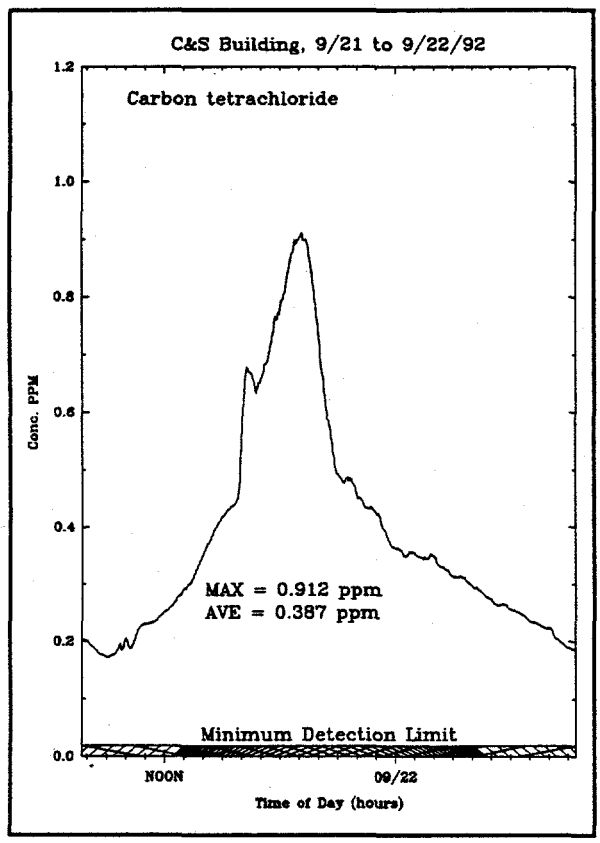


Figure 26 Graph of CCl_4 from Sept. 21st @ 7:43 am to the 22nd @ 9:22 am in the east corridor. Max. conc. occurred on the 21st @ 7:07 pm.

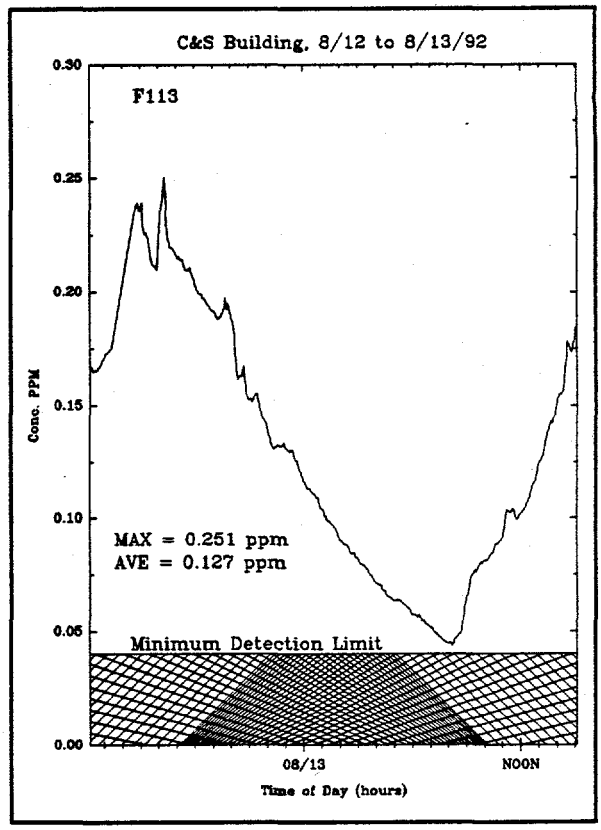


Figure 27 Graph of Freon 113 from Aug. 12th from 12:13 pm to the 13th @ 3:02 pm in the east corridor. Max. conc. occurred on the 12th @ 4:18 pm.

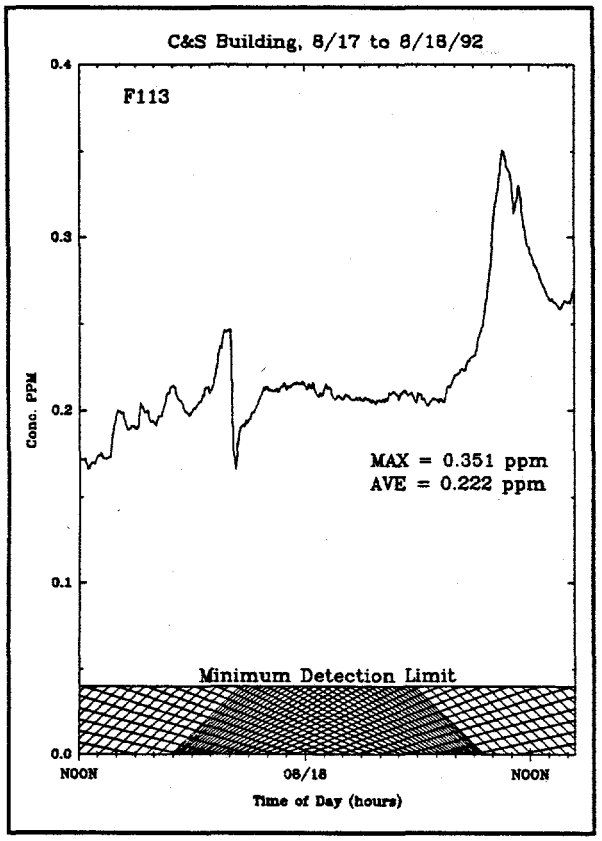


Figure 28 Graph of Freon 113 from Aug. 17th from 12:04 pm to the 18th @ 2:21 pm in the east corridor. Max. conc. occurred on the 18th @ 10:34 pm.

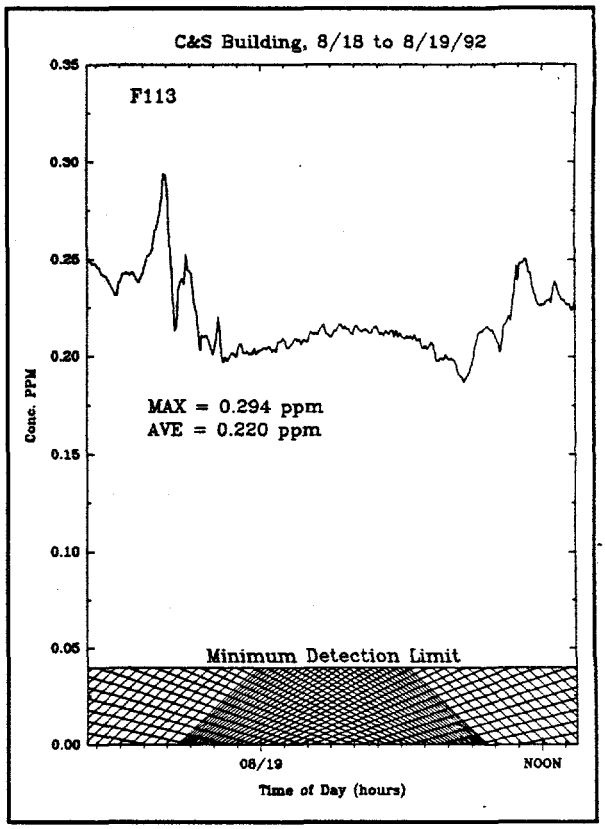


Figure 29 Graph of Freon 113 from Aug. 18th from 4:38 pm to the 19th @ 1:28 pm in the center corridor. Max. conc. occurred on the 18th @ 7:53 pm.

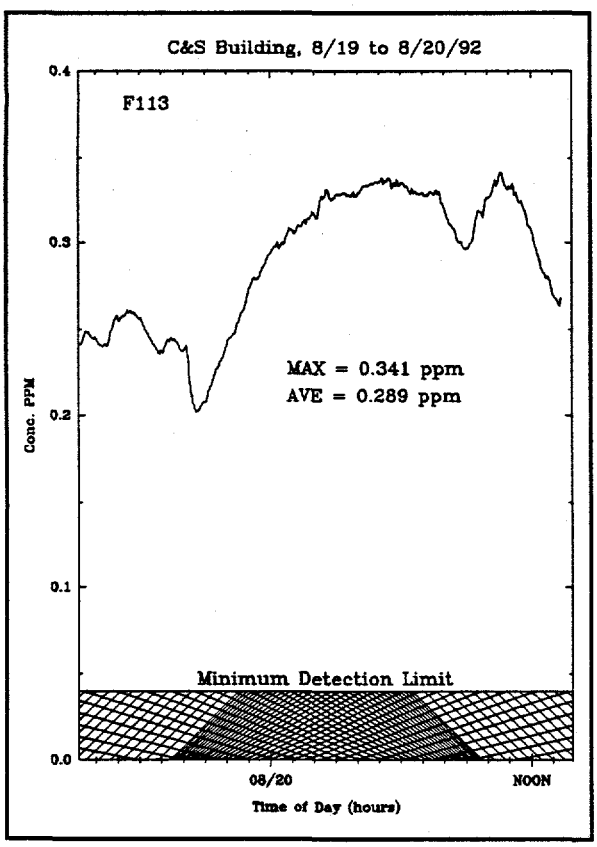


Figure 30 Graph of Freon 113 Aug. 19th from 3:13 pm to the 20th @ 1:52 pm in the west corridor. Max. conc. occurred on the 20th @ 10:39 am.

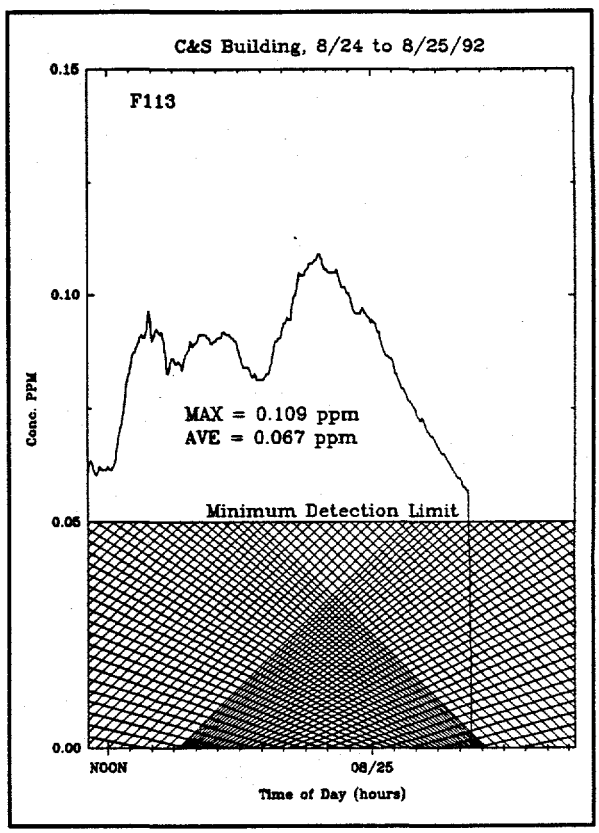


Figure 31 Graph of Freon 113 from Aug. 24th from 11:06 am to the 25th @ 9:16 am in the east corridor. Max. conc. occurred on the 24th @ 9:41 pm.

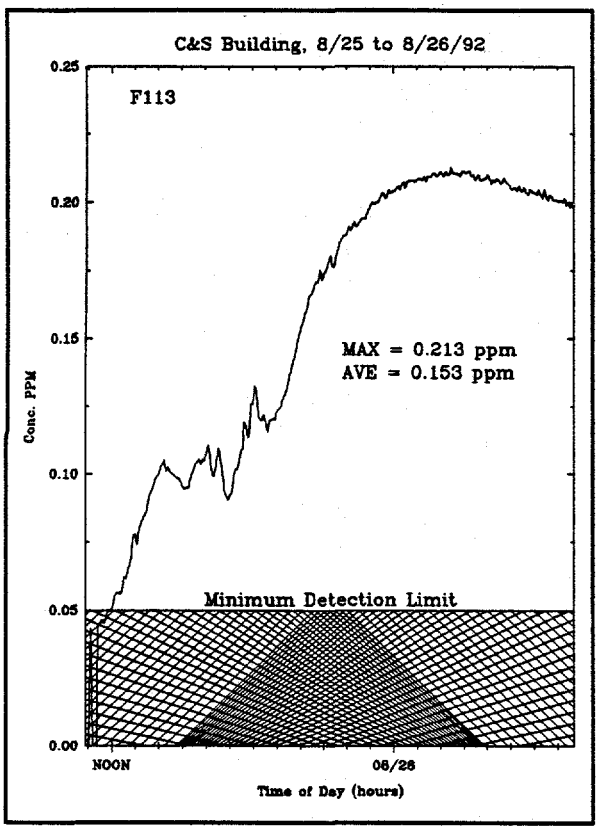


Figure 32 Graph of Freon 113 Aug. 25th from 10:54 am to the 26th @ 7:41 am in the center corridor. Max. conc. occurred on the 26th @ 2:28 pm.

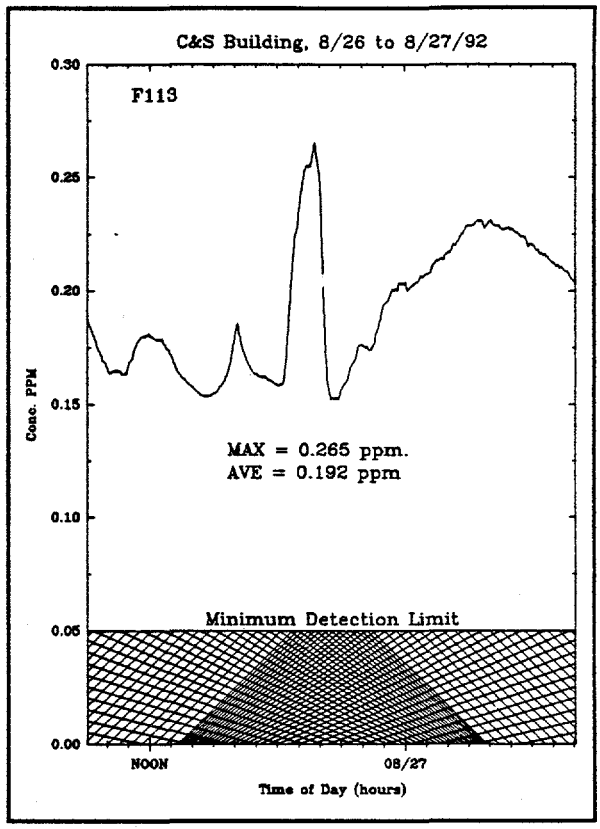


Figure 33 Graph of Freon 113 from Aug. 26th from 9:05 am to the 27th @ 8:06 am in the west corridor. Max. conc. occurred on the 26th @ 7:46 pm.

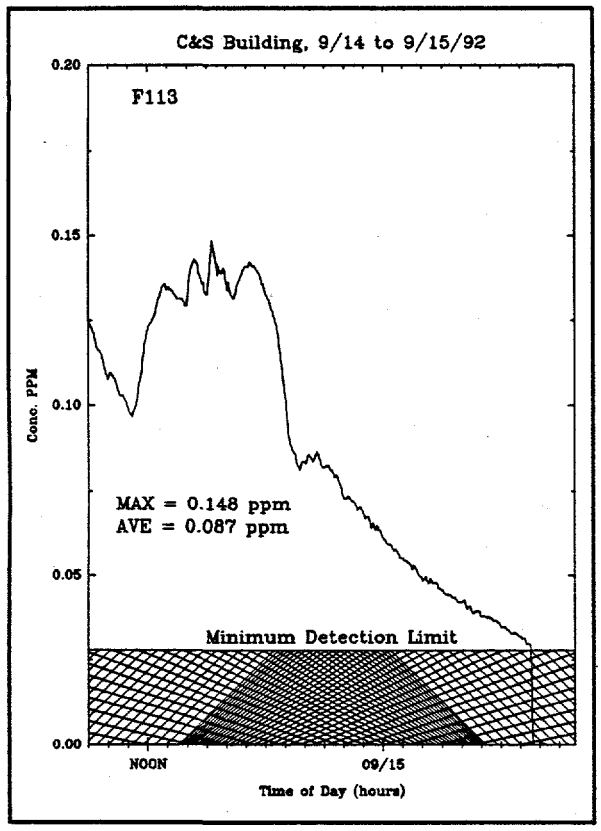


Figure 34 Graph of Freon 113. Sept. 14th from 9:00 am to the 15th @ 9:44 am in the east corridor. Max. conc. occurred on the 14th @ 3:17 pm.

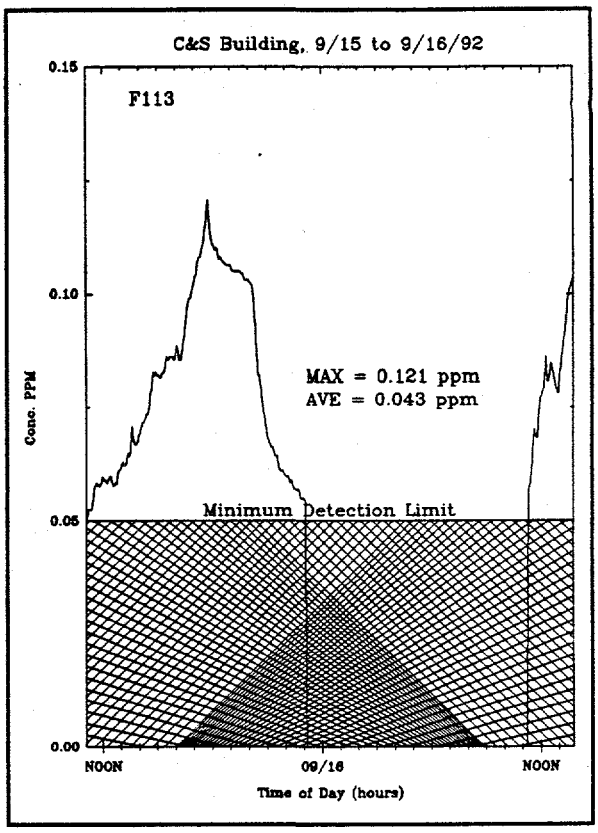


Figure 35 Graph of Freon 113 from Sept. 15th from 11:09 am to the 16th @ 1:45 pm in the center corridor. Max. conc. occurred on the 15th @ 5:47 pm.

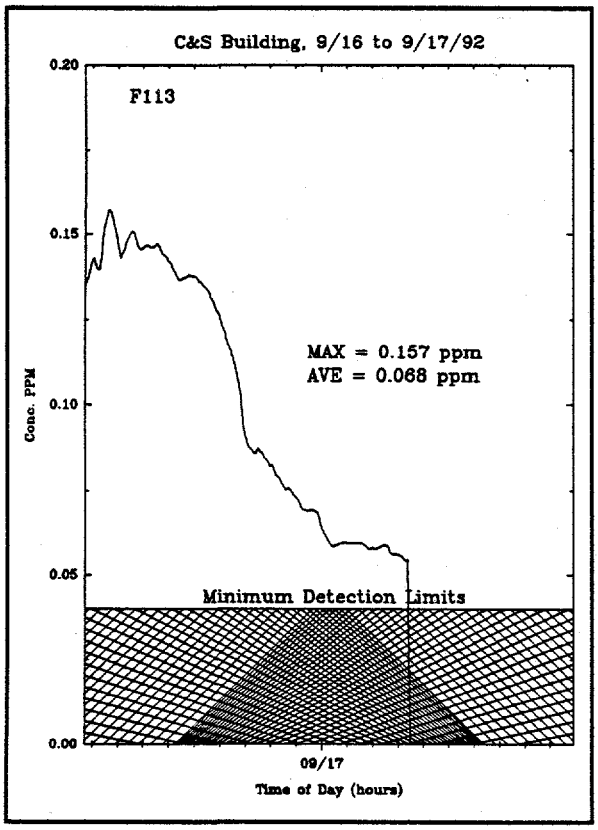


Figure 36 Graph of Freon 113 Sept. 16th from 2:43 pm to the 17th @ 9:55 am in the west corridor. Max. conc. occurred on the 16th @ 3:39 pm.

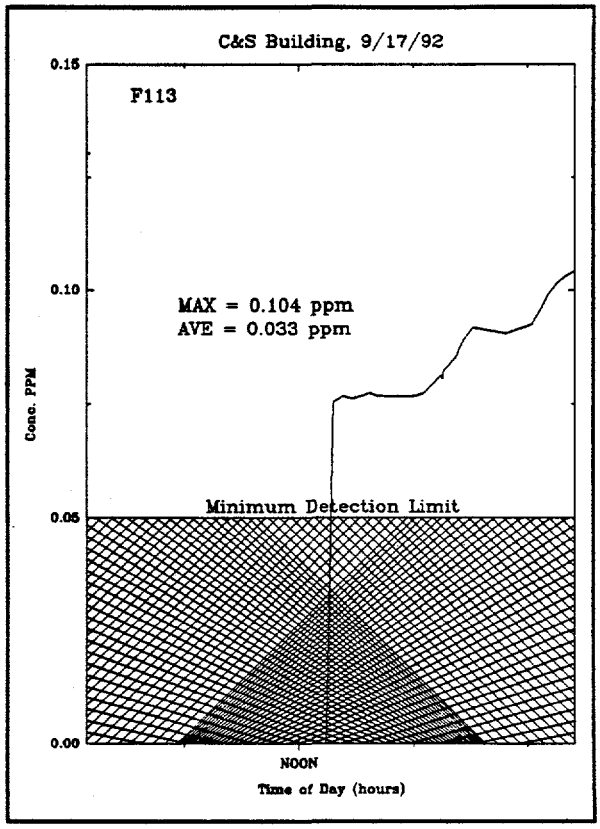


Figure 37 Graph of Freon 113 on Sept. 17th from 10:09 am to 2:25 pm in the west corridor. Max. conc. occurred at 2:25 pm.

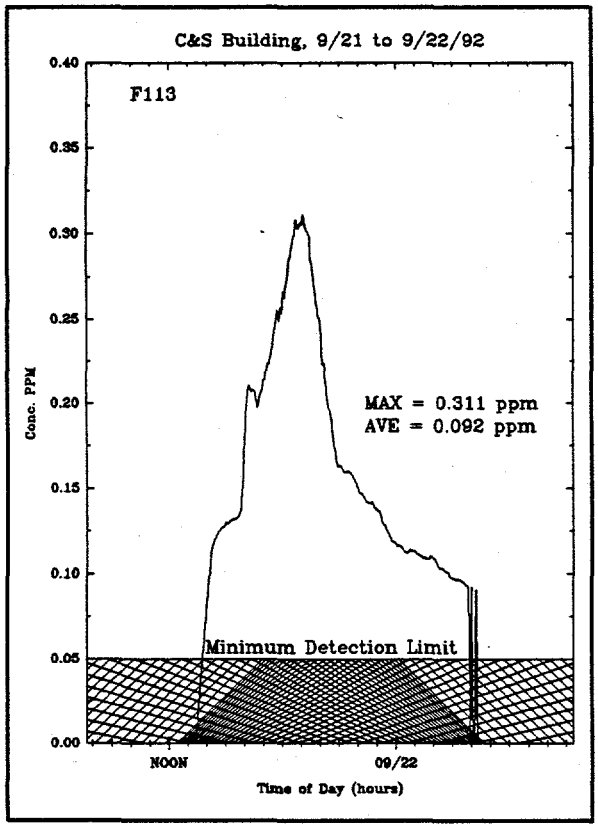


Figure 38 Graph of Freon 113 from Sept. 21st @ 7:43 am to the 22nd @ 9:22 am in the east corridor. Max. conc. occurred on the 21st @ 7:07 pm.

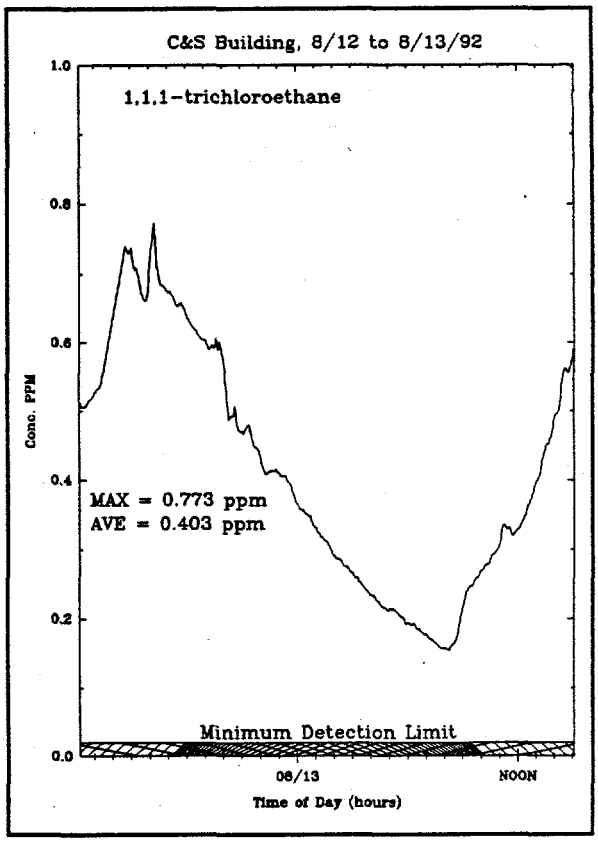


Figure 39 Graph of 1,1,1-TCA from Aug. 12th from 12:13 pm to the 13th @ 3:02 pm in the east corridor. Max. conc. occurred on the 12th @ 4:18 pm.

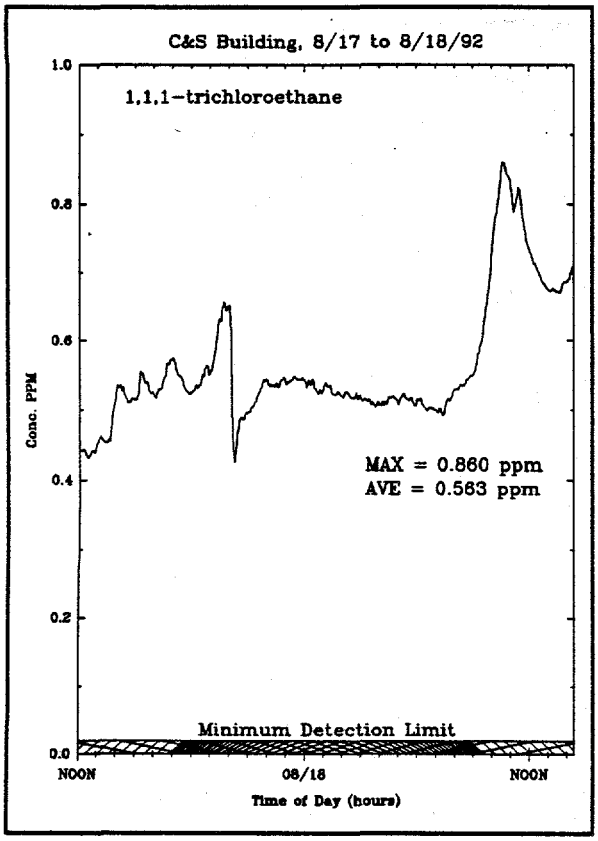


Figure 40 Graph of 1,1,1-TCA from Aug. 17th from 12:04 pm to the 18th @ 2:21 pm in the east corridor. Max. conc. occurred on the 18th @ 10:34 pm.

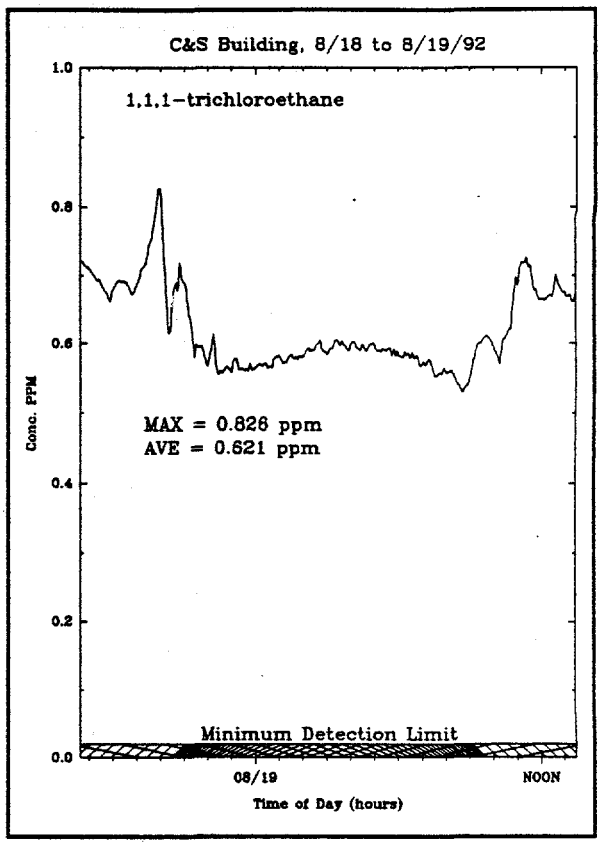


Figure 41 Graph of 1,1,1-TCA from Aug. 18th from 4:38 pm to the 19th @ 1:28 pm in the center corridor. Max. conc. occurred on the 18th @ 7:53 pm.

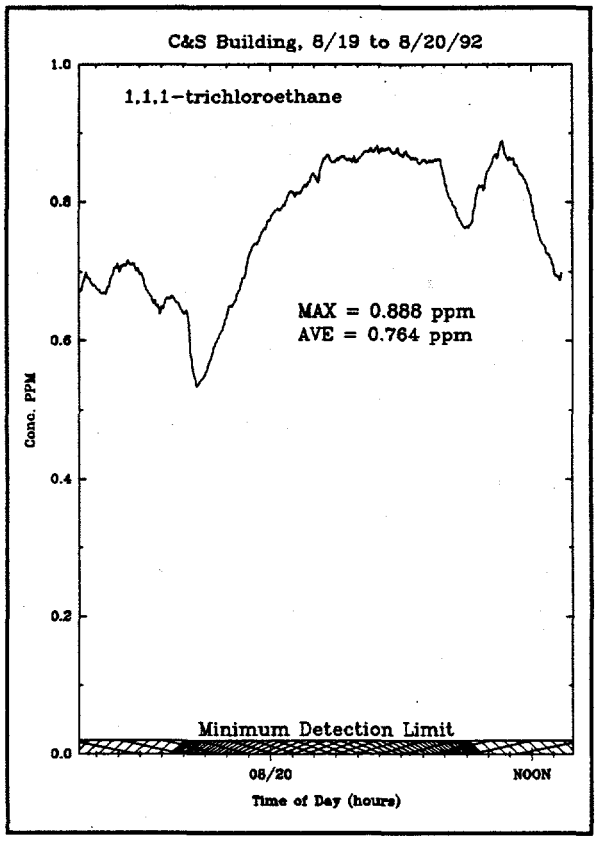


Figure 42 Graph of 1,1,1-TCA Aug. 19th from 3:13 pm to the 20th @ 1:52 pm in the west corridor. Max. conc. occurred on the 20th @ 10:39 am.

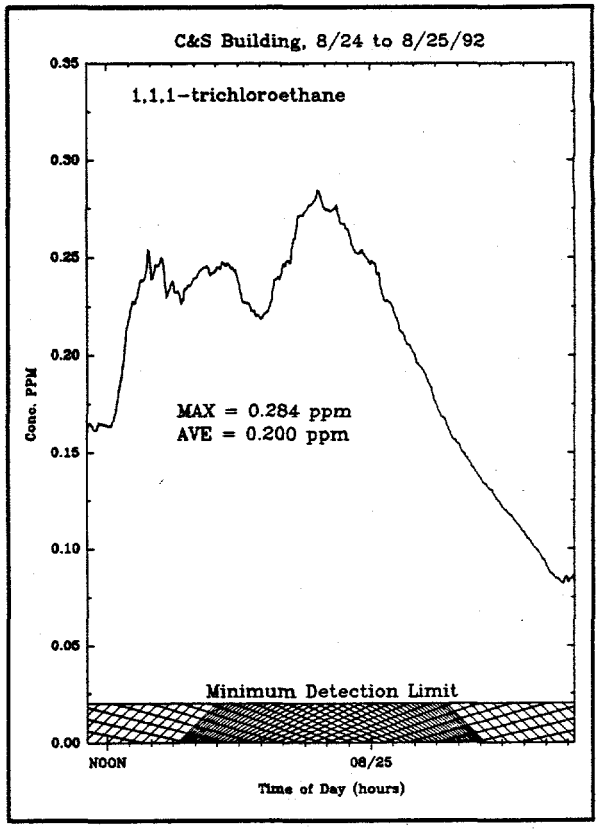


Figure 43 Graph of 1,1,1-TCA from Aug. 24th from 11:16 am to the 25th @ 9:06 am in the east corridor. Max. conc. occurred on the 24th @ 9:36 pm.

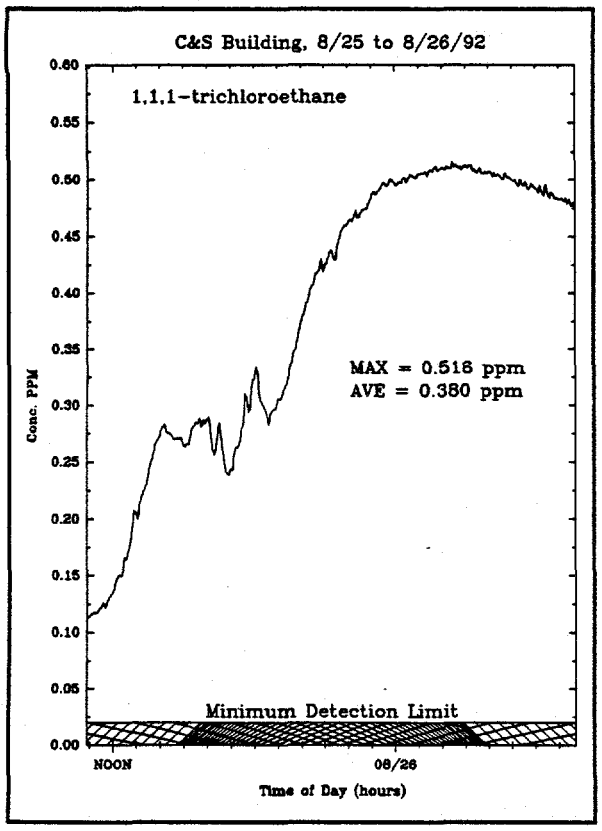


Figure 44 Graph of 1,1,1-TCA Aug. 25th from 10:54 am to the 26th @ 7:41 am in the center corridor. Max. conc. occurred on the 26th @ 2:28 pm.

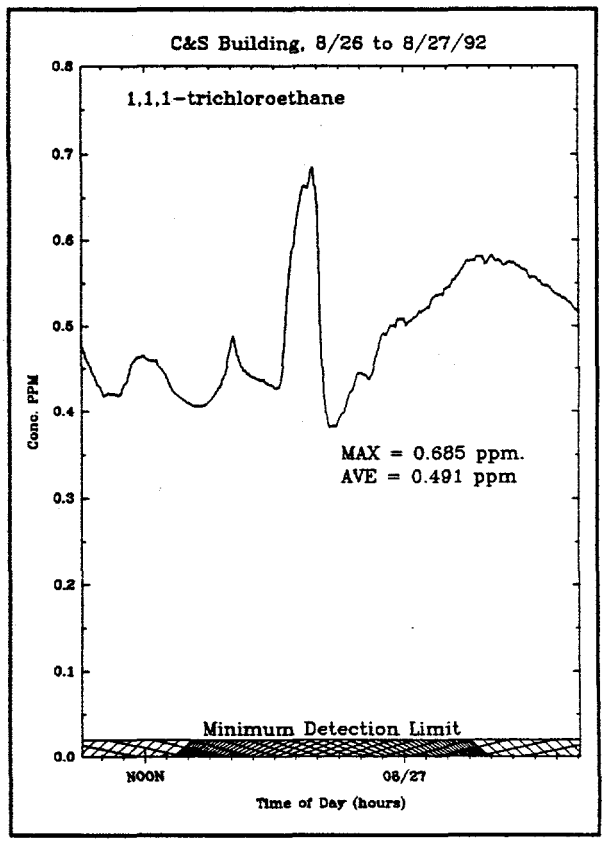


Figure 45 Graph of 1,1,1-TCA from Aug. 26th from 9:05 am to the 27th @ 8:06 am in the west corridor. Max. conc. occurred on the 26th @ 7:46 pm.

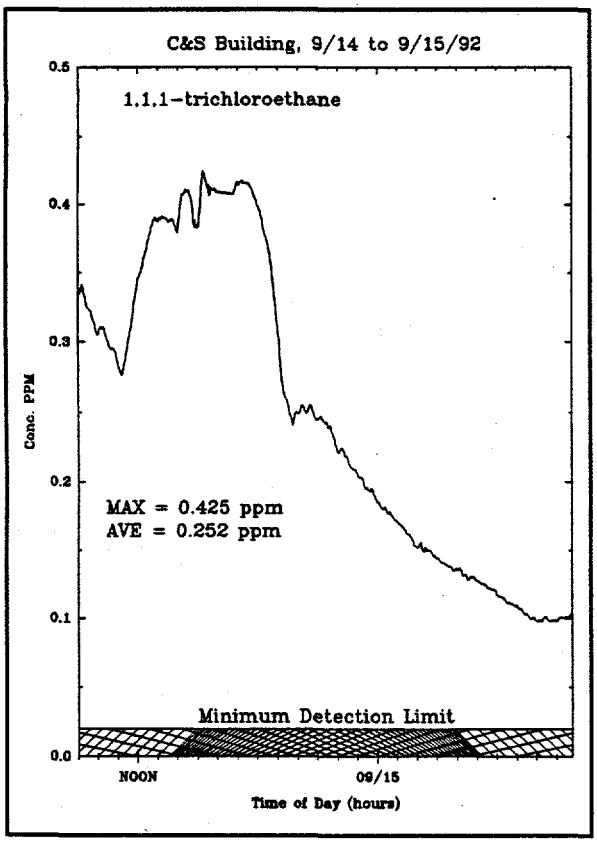


Figure 46 Graph of 1,1,1-TCA Sept. 14th from 9:00 am to the 15th @ 9:44 am in the east corridor. Max. conc. occurred on the 14th @ 3:17 pm.

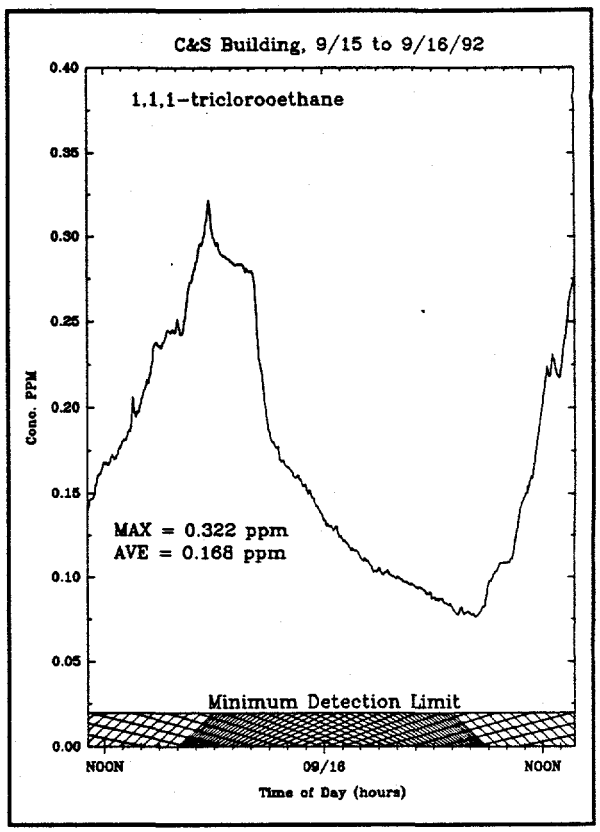


Figure 47 Graph of 1,1,1-TCA from Sept. 15th from 11:09 am to the 16th @ 1:45 pm in the center corridor. Max. conc. occurred on the 15th @ 5:47 pm.

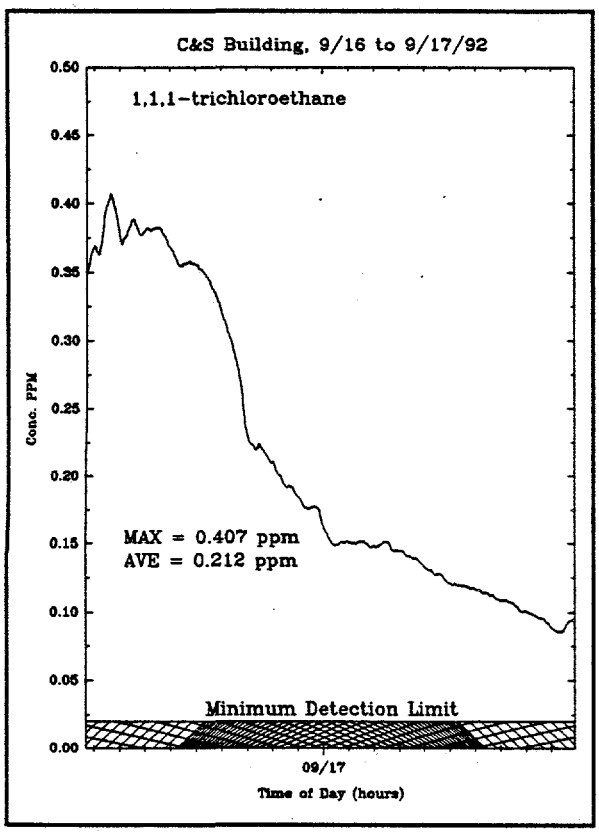


Figure 48 Graph of 1,1,1-TCA Sept. 16th from 2:43 pm to the 17th @ 9:55 am in the west corridor. Max. conc. occurred on the 16th @ 3:39 pm.

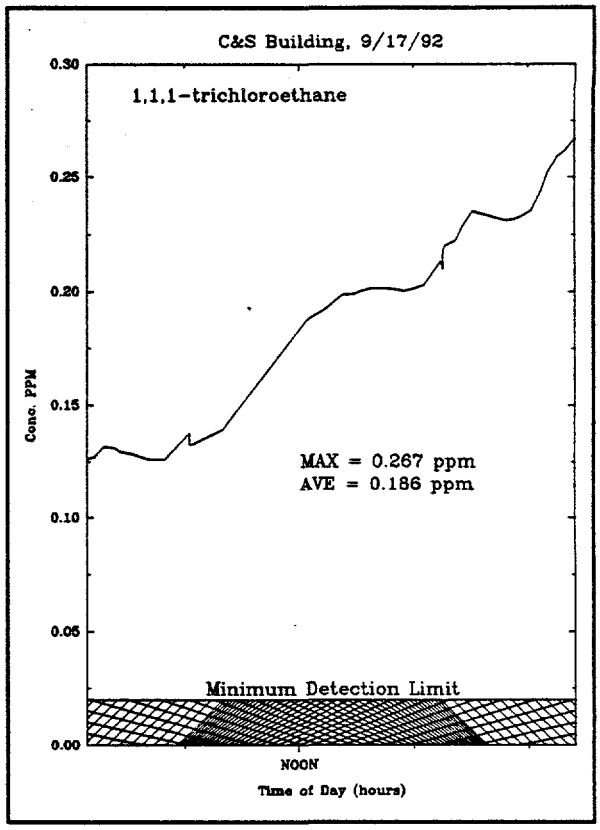


Figure 49 Graph of 1,1,1-TCA on Sept. 17th from 10:09 am to 2:25 pm in the west corridor. Max. conc. occurred at 2:25 pm.

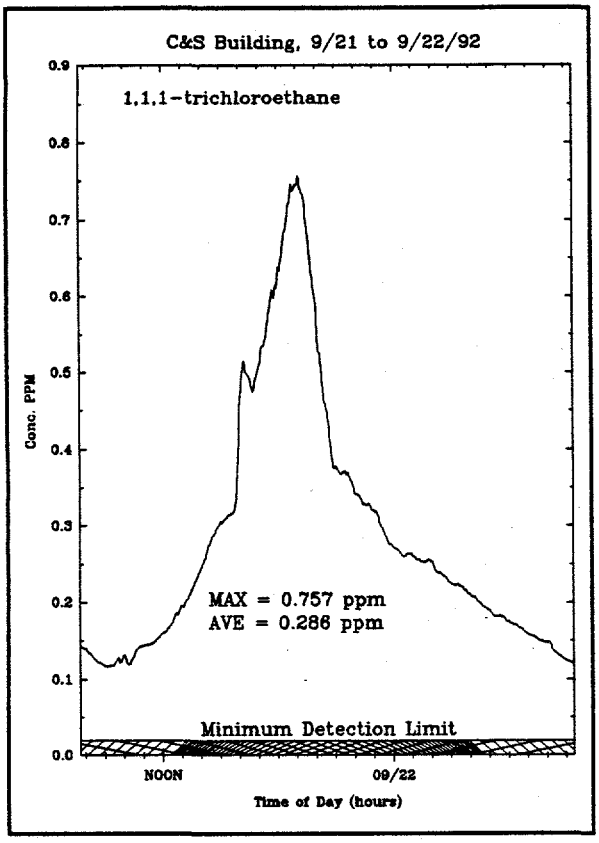
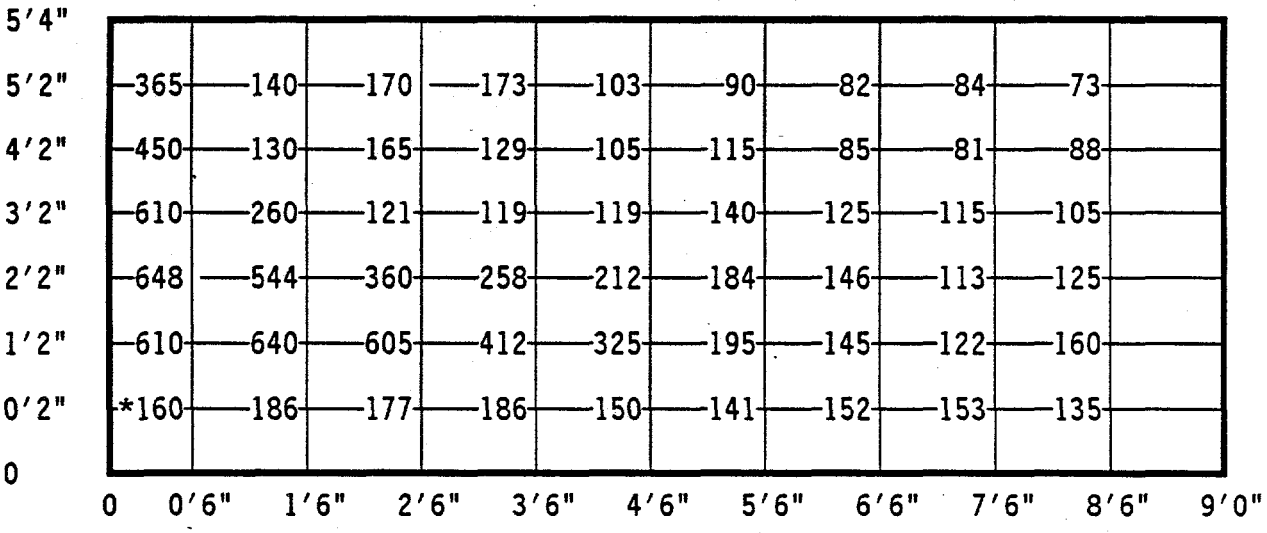


Figure 50 Graph of 1,1,1-TCA from Sept. 21st @ 7:43 am to the 22nd @ 9:22 am in the east corridor. Max. conc. occurred on the 21st @ 7:07 pm.

APPENDIX G

APPENDIX G

VELOCITY AND VOLUMETRIC FLOW RESULTS FOR THE C&S BUILDING



* = feet per minute

North blower operating only

Average velocity = 214.6 feet per minute (ft/min.)

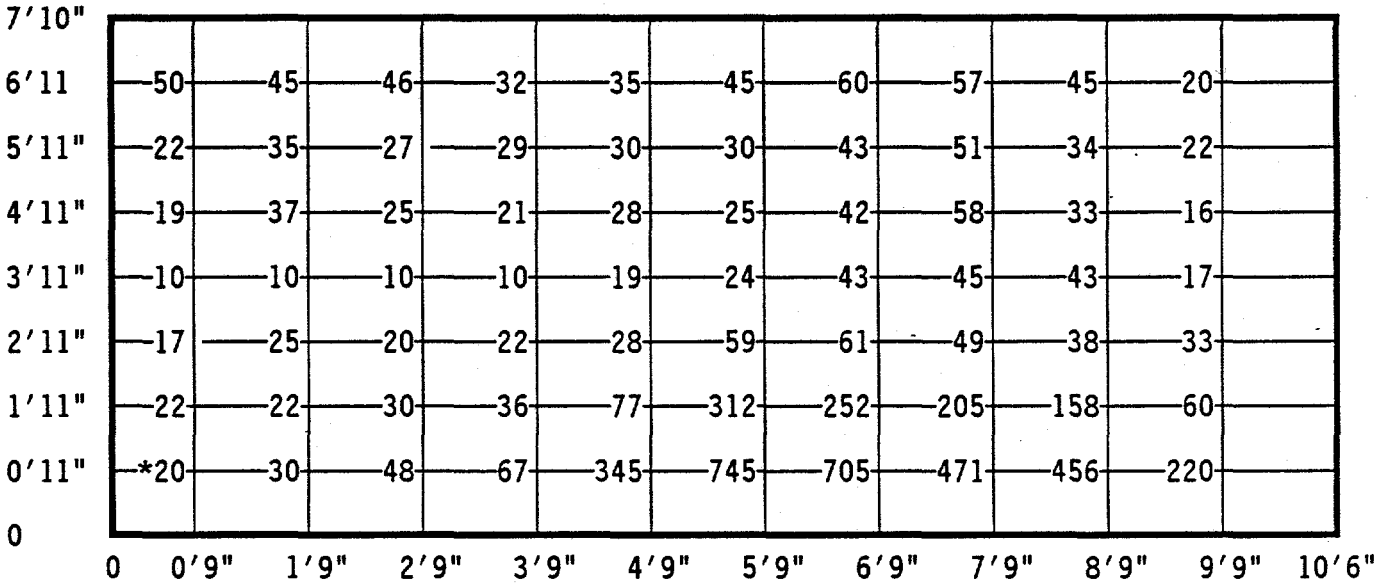
Area = 5'4" x 9'0" = 48 square feet (ft^2)

Volumetric Flow = 48 ft^2 x 214.6 ft/min. = 10299 cubic feet per minute (cfm)

Volumetric Flow = 617,940 or 6.18E+05 cubic feet per hour

APPENDIX G

VELOCITY AND VOLUMETRIC FLOW RESULTS FOR THE ASB II BUILDING



* = feet per minute

South blower operating only

Average velocity = 84.7 feet per minute (ft/min.)

Area = 7'10" x 10'6" = 82.25 square feet (ft^2)

Volumetric Flow = 82.25 ft^2 x 84.7 ft/min. = 6967 cubic feet per minute (cfm)

Volumetric Flow = 418,020 or 4.18E+05 cubic feet per hour