Health Consultation

Review of Air Quality Data

INTEL CORPORATION – NEW MEXICO FACILITY

RIO RANCHO, SANDOVAL COUNTY, NEW MEXICO

EPA FACILITY ID: NMD000609339

AUGUST 13, 2015

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

HEALTH CONSULTATION

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Prepared By:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)
Division of Community Health Investigations

Intel-New Mexico Public Health Consultation
Review of Air Quality Data

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List of Acronyms and Abbreviations

AEGL	Acute Exposure Guideline Level
AERMOD	American Meteorological Society/EPA Regulatory Model
ALS	Amyotrophic Lateral Sclerosis
ATSDR	Agency for Toxic Substances and Disease Registry
CAQTF	Corrales Air Quality Task Force
CVD	Chemical Vapor Disposition
CEWG	Community Environmental Working Group
COPD	Chronic Obstructive Pulmonary Disease
CRCAW	Corrales Residents for Clean Air and Water
DHHS	Department of Health and Human Services
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESL	Effects Screening Level
FTIR	Fourier transformed infrared spectroscopy
HAPs	Hazardous Air Pollutants (189 chemicals defined by EPA)
HFCs	Hydrofluorocarbons
HMDS	Hexamethyldisilazane
HMDSO	Hexamethyldisiloxane
IBM	International Business Machines
Intel-New Mexico	Intel Corporation facility in Rio Rancho, New Mexico
IPA	Isopropyl Alcohol
IPF	Idiopathic Pulmonary Fibrosis
Lbs/hr	Pounds per hour
MRL	Minimal Risk Level
NAAQS	National Ambient Air Quality Standards
NEIC	National Enforcement Investigations Center
NIOSH	National Institute for Occupational Health
NM	New Mexico
NMDOH	New Mexico Department of Health
NMED	New Mexico Environment Department
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen (nitric oxide and nitrogen dioxide)
PGMEA	Propylene glycol monomethyl ether acetate
$PM_{2.5}$	Particles less than 2.5 micrometers in diameter
PM_{10}	Particles less than 10 micrometers in diameter
ppb	Parts per billion
ppm	Parts per million
PSD	Prevention of Significant Deterioration
RCTO	Rotary Concentrator Thermal Oxidizer
REL	Reference Exposure Level
RTO	Regenerative Thermal Oxidizers
SES	Socioeconomic status
SO_2	Sulfur Dioxide
STTFC	Silica Testing Task Force

TAPs	Toxic Air Pollutants, defined by NMED
TCEQ	Texas Commission on Environmental Quality
TMS	Trimethylsilanol
TPY	Tons per Year
TRI	Toxics Release Inventory
TSP	Total Suspended Particulate
$\mu g/m^3$	micrograms per cubic meter
VOCs	volatile organic compounds

Summary

ATSDR received a petition from a community group in 2004 requesting ATSDR determine whether air emissions from the Intel Corporation facility in Rio Rancho, New Mexico (Intel-New Mexico) might pose a public health concern to community members who lived in communities adjacent to the facility. In response to this petition, ATSDR gathered and evaluated information from numerous sources about the Intel-New Mexico facility including relevant air sampling and monitoring studies. Specifically, ATSDR obtained documents and relevant insights from:

- Intel Corporation,
- New Mexico Department of Health (NMDOH),
- New Mexico Environment Department (NMED),
- U.S. Environmental Protection Agency (EPA),
- Corrales Residents for Clean Air and Water (CRCAW),
- Concerned community groups, and
- Individual community members.

ATSDR released a public comment version of this health consultation in 2009. ATSDR focused on air emissions, dispersion modeling information and outdoor air quality (ATSDR, 2009a). The following paragraphs summarize ATSDR's evaluation.

Air emissions. Intel-New Mexico's air permit requires both direct measurements of air emissions from certain facility processes and, through the use of calculations, an estimate of facility-wide emissions. These emissions data were useful for identifying chemicals to evaluate in public health evaluations. However, during the review of this information, ATSDR also identified several opportunities for providing greater confidence in the existing emissions data for Intel-New Mexico, which would also address some community concerns. ATSDR documented these opportunities in a letter to NMED (ATSDR, 2009a). EPA's National Enforcement Investigations Center (NEIC) conducted a Clean Air Compliance Inspection of Intel-New Mexico in December 2009 (USEPA, 2010). As a result of this EPA inspection, Intel-New Mexico has proposed a scrubber testing plan and is addressing areas of concern about its air emissions permit with NMED and EPA (Intel, 2010a).

Dispersion modeling information. ATSDR thoroughly reviewed available dispersion modeling information for Intel-New Mexico, focusing particularly on the modeling conducted as part of the Corrales Air Quality Task Force. ATSDR found this study useful but its inherent uncertainties and limitations such as accuracy of the emission rate inputs and allocation of emissions between different sources prevented ATSDR from basing health conclusions on the modeling estimates alone.

Outdoor air quality. During a span of approximately 10 weeks in 2003 and 2004, Intel-New Mexico and NMED used continuous, open path fourier-transformed infrared spectrophotometry (FTIR) monitoring to measure, adjacent to its facility, the ambient air concentrations of numerous chemicals. With the exception of carbon monoxide, these data were not adequate to evaluate the potential public health consequences of air contaminants due to low rates of detectability. (Carbon monoxide levels were below EPA National Ambient Air Quality (NAAQS) standards.) The open path FTIR detected some compounds that may be associated

with the Intel-New Mexico facility (e.g., ammonia, fluorine compounds). Some of the chemicals intermittently detected by open path FTIR monitors could be associated with odors reported by the community.

Since the release of the public comment version of this health consultation in 2009, ATSDR has reviewed and included in this final document a summary of the following:

- community concerns including perceived elevated rates of pulmonary disease and amyotrophic lateral sclerosis (ALS) in the community
- Community Environmental Working Group's Silica Task Force's report,
- EPA's Clean Air Act inspection report of 2009, and
- particulate air monitoring data collected near the Intel-New Mexico facility.
- ATSDR's responses to public comments are also included (Appendix O).

A timeline of ATSDR's activities at this site is contained in Appendix A. ATSDR's response to public comments from the community and others are included in Appendix O.

Limitations

Environmental Data:

- The 2003–2004 sampling and monitoring data span a total of approximately 10 weeks. While those data provide some limited insight into air quality during those periods, the data quality is not sufficient to evaluate for a public health determination.
- Also, because of the frequent changes in plant processes, production levels, and pollution control equipment, the 2003-2004 data are not representative of conditions during other periods.
- Open Path FTIR monitoring provides contaminant concentrations averaged over the beam length (around 100 meters). It does not provide maximum concentrations within that distance.

Air Dispersion Modeling

- EPA continues to refine its air dispersion modeling program. Overall modeling provides more accurate exposure estimates over long-term periods at greater distances from specific sources like the Intel-New Mexico facility.
- The accuracy of the modeling is dependent on accurate emissions (input) data.

Conclusions and Recommendations

Volatile Organic Compound (VOC) and acid aerosol air emissions

ATSDR cannot accurately evaluate volatile organic compounds (VOCs) and acid aerosols near the Intel-New Mexico facility. Therefore, ATSDR cannot determine whether these compounds could harm people's health.

The open path FTIR data were not sufficiently sensitive and reliable to draw health conclusions. Additional air monitoring data are not available to make this health determination.

The principal public health protection from Intel-New Mexico air emission resides with effective administration and compliance of a valid air permit. NMED has issued an air permit to the Intel-New Mexico facility that allows for the release of specific quantities of, carbon monoxide, Hazardous Air Pollutants (HAPs), nitrogen oxides, total suspended particulate and VOCs calculated on a rolling 12-month average system. Effective administration and enforcement of the Intel-New Mexico facility air permit is essential to maintaining air quality, i.e., preventing harmful exposure to the plant's air emissions (including short-term exposures), particularly to community members directly downwind of the facility.

Recommendations

As the result of its 2009 compliance inspection, EPA has noted several areas of concern and one area of non-compliance. Follow-up of these areas of concern noted in the EPA inspection are necessary to confirm the adequacy of the air permit's public health protections and improve the community's overall confidence in the air permit.

ATSDR encourages NMED, CEWG and Intel-New Mexico to evaluate the need to conduct additional air modeling, and possibly air monitoring for validation, following the results of any additional Intel-New Mexico air pollution control equipment stack testing i.e., acid scrubbers and RTOs, required in follow-up to EPA's 2009 compliance inspection. Particular attention should be given to acid aerosols and VOCs that may result in health effects from short-term exposure.

EPA Region 6, NMED and Intel-New Mexico are encouraged to communicate the resolution of air permit and enforcement issues identified from the EPA's 2009 inspection of the Intel-New Mexico facility to the community.

ATSDR encourages NMED to evaluate whether air modeling should include other local point emission sources e.g., crematoriums.

Residents concerned about air emissions from the Intel-New Mexico Plant can voice their questions and comments through participation in the Community Environmental Working Group (CEWG) meetings. The CEWG provides a forum for addressing the community's environmental and public health concerns related Intel-New Mexico air emissions and communicating findings and actions.

Carbon Monoxide

Conclusions

ATSDR concludes that breathing carbon monoxide from the Intel-New Mexico facility in 2003-2014 will not harm people's health.

The measured levels of carbon monoxide in 2003 and 2004 using the open path FTIR were below levels of health concern and EPA's National Ambient Air Quality Standards.

Recommendation

None

Crystalline Silica

Conclusion

ATSDR concludes that crystalline silica emissions from the Intel New-Mexico facility are not expected to harm people's health.

The Silica Task Force's crystalline silica emissions testing and long-term ambient particulate monitoring for PM_{10} and $PM_{2.5}$ do not indicate that community members are exposed to elevated levels of crystalline silica.

Recommendation

No recommendations are provided.

Environmental Odors

Conclusion

ATSDR has received numerous environmental odor complaints from residents living immediately southeast of the Intel-New Mexico facility. Some of these odors may be related to the Intel-New Mexico plant air emissions. In some studies, environmental odors have been associated with health symptoms (Schiffman and Williams, 2015; Aatamilia et al, 2011).

Residents living immediately southwest of the Intel-New Mexico facility have reported environmental odors during late evening and early morning periods when local wind rose data indicate that the Intel-New Mexico is frequently upwind of these residents. Other sources may include the crematorium near the northeast side of the Intel-New Mexico facility.

Recommendation

ATSDR encourages Intel-New Mexico to continue its ongoing efforts to reduce and control air emissions through improvements in its engineering and administrative controls. Avoiding operations that may result in uncontrolled air emissions during periods of atmospheric stability (late night and early morning), to the extent feasible, may reduce community odor complaints. The CEWG provides a forum for Intel-New Mexico to review their odor complaint reporting and investigating activities, particularly those related to the "burnt coffee odor" complaints.

Idiopathic Pulmonary Fibrosis

Conclusion

New Mexico Health Department conducted an epidemiologic investigation of the ten alleged cases in the Corrales New Mexico area in 2011. New Mexico Health Department did not observe a cluster of Idiopathic Pulmonary Fibrosis (IPF) in this investigation.

Recommendation

Area residents concerned that a specific disease or health concern may be attributed to environmental exposure can request that their physicians report this information to epidemiology and response division, NM Department of Health, P.O. Box 26110, Santa Fe, NM 87502-6110; or call 505-827-0006.

Amyotrophic lateral sclerosis

Conclusion

ATSDR cannot determine whether the ten purported cases of Amyotrophic lateral sclerosis (ALS) represent an increased rate.

The prevalence rate of ALS has not been well established and sufficient reporting data are not currently available to calculate state and local ALS rates.

Recommendation

New Mexico residents who have been diagnosed with ALS are encouraged to participate in ATSDR's ALS registry. This registry will be used to examine potential risk factors for ALS. ATSDR's ALS registry is accessible at **http://wwwn.cdc.gov/ALS/Default.aspx.**

Particulate Matter

Conclusion

ATSDR concludes that exposure to coarse airborne particulate (PM_{10}) may harm people's health in the greater Albuquerque area, including Rio Rancho and Corrales communities, during infrequent high wind conditions. Persons with respiratory disease are most vulnerable to exposure to elevated PM_{10} levels. Exposure to excess PM_{10} increases the likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease, older adults, and people of lower SES. Extremely high exposures may result in respiratory effects in the general population.

> PM_{10} levels exceeded the Environmental Protection Agency's 24-hour standard of 150 micrograms per cubic meter (µg/m^3) for PM_{10} during six high wind events from 2000 to 2008.

ATSDR concludes that fine airborne particulate ($PM_{2.5}$) may harm people's health to the Rio Rancho and Corrales communities (and greater Albuquerque) during large wildland fires that periodically occur in the Southwestern United States.

> $PM_{2.5}$ levels in the Albuquerque area exceeded the Environmental Protection Agency's 24-hour standard of 35 micrograms per cubic meter (µg/m^3) for $PM_{2.5}$ in June 2011 when the greater Albuquerque airshed was impacted by Wallow Arizona wildlands fire.

Recommendation

Area residents, particularly sensitive groups, are urged to take action to avoid exposure to unhealthy air from dust storms and wildland fires by following recommendations noted in the EPA Air Quality Index at http://airnow.gov/ (for Albuquerque) or http://www.cabq.gov/airquality/.

Statement of Issues

A community group in New Mexico petitioned the Agency for Toxic Substances and Disease Registry (ATSDR) to investigate the Intel Corporation's semiconductor manufacturing facility in Rio Rancho (Intel-New Mexico), Sandoval County, New Mexico (Petitioner's letter, 2004).

ATSDR was asked to determine whether air emissions from Intel-New Mexico presented a public health hazard to residents. To address the community's public health concerns, ATSDR released a health consultation in February 2009 that evaluated available emissions data, dispersion modeling information, and outdoor ambient air monitoring data. This public health consultation addresses public comments that ATSDR received about the 2009 health consultation and includes additional information obtained after 2009 to address community concerns.

Air Emissions Data ATSDR reviewed and considered information from 1989 through 2012 for airborne particulate for this final health consultation. An initial step in preparing this health consultation was to use the concerns expressed to ATSDR by community members to define the scope of the evaluation. Accordingly, listed below are some important decisions about the scope of this document:

- **What are the communities' concerns regarding air quality in the Corrales-Rio Rancho area?** These concerns are described on page 12.
- **What time period does this health consultation address?** The 2009 public comment health consultation focused largely on air quality issues from 2000 to 2004. This period was selected because community concerns had increased in response to facility expansions. This final report includes particulate monitoring data from1989 to 2012.
- **Which emission sources does this health consultation consider?** The community health concerns communicated to ATSDR specifically addressed air pollutants released from the Intel-New Mexico facility. This health consultation focuses on Intel-New Mexico's emission sources, particularly those known or suspected to release the greatest amount of air pollutants.
- **Which exposure scenarios does this health consultation consider?** Consistent with the community concerns, this health consultation focuses on outdoor air quality issues potentially related to Intel-New Mexico's air emissions. Occupational exposures that may occur at the Intel-New Mexico facility or exposures to contaminants possibly found in other environmental media are not addressed in this health consultation. However, some occupational epidemiology studies are included in this health consultation for additional information.

ATSDR did not evaluate ingestion or skin contact (dermal) exposure pathways in this public health consultation.

The Objectives of this Health Consultation are to respond to specific community concerns regarding air pollutants released from the Intel facility:

- Are the measured air pollution levels near Intel-New Mexico indicative of a public health concern?
- What air pollutants does Intel-New Mexico release? Are the estimated and measured emission rates accurate?
- Do the modeling studies provide definitive health conclusions about how Intel-New Mexico's air emissions affect local air quality?
- What additional data are available to address public comments about ATSDR's 2009 Health Consultation?

Background

Site History and Operations

Intel-New Mexico is located at 4100 Sara Road, Rio Rancho, New Mexico, approximately 15 miles north of downtown Albuquerque. The Rio Grande River flows from north to south in the region. Intel-New Mexico is located on a mesa to the west of the Rio Grande, near commercial and residential areas, and between the City of Rio Rancho and Village of Corrales. Intel-New Mexico employs approximately 3,300 workers at its Rio Rancho facility.

Intel Corporation began New Mexico operations in 1980. In the early years, most production occurred in two fabrication lines (also known as "fabs"): Fab 7 and Fab 9. These fabrication lines produced wafers and flash memory (used for memory cards and flash drives), but currently these lines are no longer in operation. Intel-New Mexico's current operations take place largely in Fab 11 and Fab 11X. The Intel-New Mexico campus presently includes more than four million square feet of manufacturing facilities and office space (Intel Corp 2008). In Fab 11X, Intel-New Mexico manufactures 12-inch (300 mm) wafers 24 hours a day, 7 days a week. In Fab 11, from 1993 through August, 2007 the facility manufactured 8-inch silicon wafers— in the second half of 2008 this fab began producing the facility's next generation 300 mm processors, using 45 nanometer (nm) process technology. In 2010, Intel-New Mexico also started producing 300 mm microprocessors using a 32 nm process technology (Intel, 2010b.)

Like other semiconductor manufacturers, Intel-New Mexico's production processes have changed considerably over the years. Some changes were made to accommodate changing production demands, some were to comply with environmental regulations, and still others were to keep up with scientific and technological advances in the field of microelectronics.

The evolving nature of this facility is an important factor to consider when evaluating the facility's air emissions. With frequent alterations in, among other things, production rates, chemical usage, and pollution control equipment, air emissions observed at any point in time might differ from those observed over the long term.

Throughout its production processes, Intel-New Mexico uses many chemicals. Every day large quantities of volatile organic compounds (VOCs), acids, and various inorganic compounds flow through Intel's production facilities. Some of these chemicals are not incorporated into a finished semiconductor product. They are part of the production processes, and are either

- consumed in chemical reactions,
- captured in air pollution control devices,
- collected as hazardous or non-hazardous waste,
- emitted from pollution control devices into the air, or
- released in wastewater[1].

Figure 1 provides an illustration of the sources and internal pathways for Intel-New Mexico air emissions. This health consultation, as with the 2009 health consultation, focused on Intel-New Mexico's air emissions.

In that regard, the first point to consider is that Intel-New Mexico air emissions originate from many sources. Fabrication lines, boilers, emergency generators, cooling towers, and tanks can all emit chemicals to the air. Intel-New Mexico is required to report to the New Mexico Environment Department (NMED) the amounts of chemicals it uses—the reported information assists in estimation of air emission rates. Intel-New Mexico's air permit requires venting through thermal oxidizers air exhaust streams containing VOCs, and venting through scrubbers exhaust streams containing inorganic pollutants. Most "clean room" air exhaust from Intel-New Mexico's fabrication areas is continuously vented through air pollution control devices before entering the atmosphere.

An environmental manager at one of Intel's sister facilities in Oregon reported that about 50 percent of its VOC Fab emissions were from isopropyl alcohol (IPA) used during cleaning operations (Stewart, 2007). These emissions were not controlled by air pollution control devices but by employees bagging used IPA-containing wipes. The amount of emissions controlled were dependent on employee work practices. Intel Corporation uses identical manufacturing processes and equipment for each specific product line at all its manufacturing facilities. Intel-New Mexico's IPA emissions are regulated as VOCs in its air permit.

[1]" Intel has a wastewater discharge permit to a WWTP (wastewater treatment plant) on adjoining property…Unless wastewater containing the chemicals mentioned above, are impounded on Intel property, transported to another site, or otherwise disposed of, they are generally not released in wastewater to the WWTP without pretreatment…" (USEPA 2009)

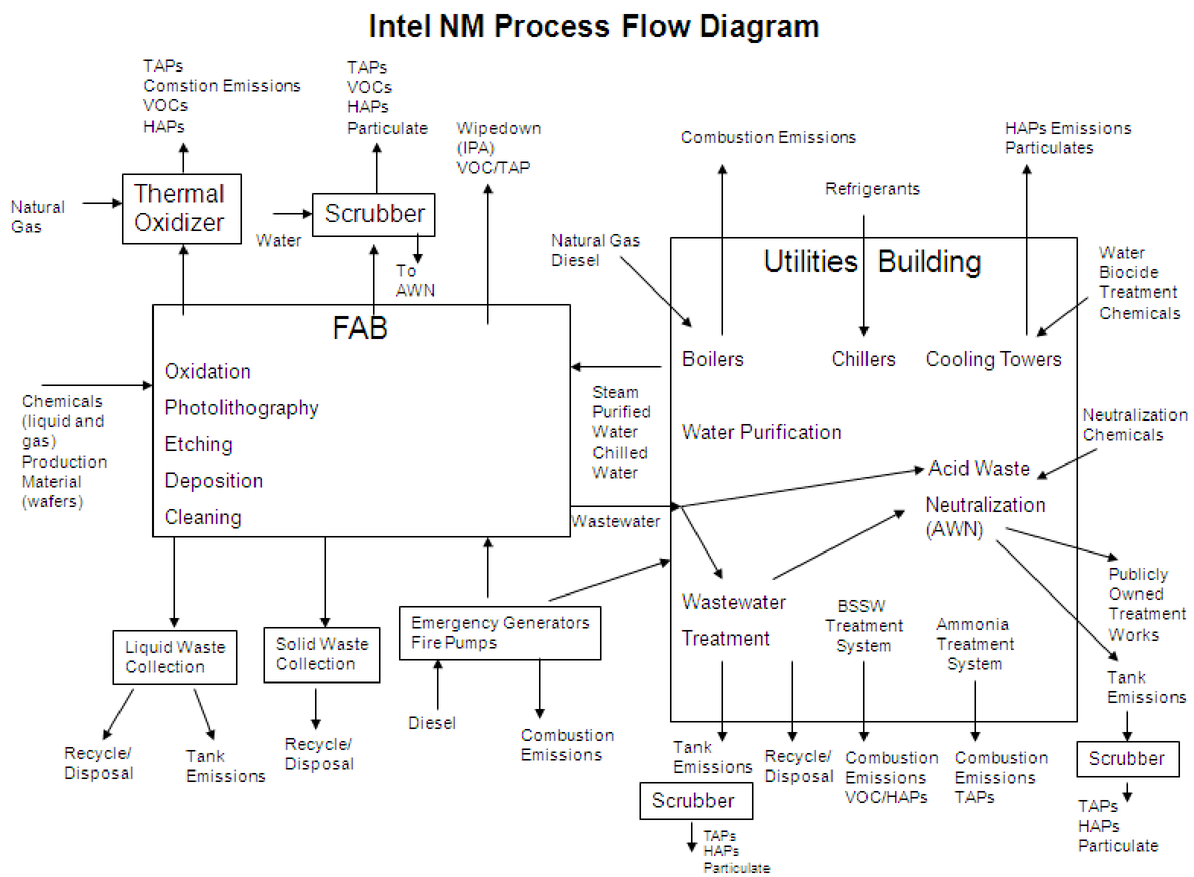


Figure 1 – Intel-New Mexico Process Flow Diagram (Intel, 2011)

Air Permit History

NMED is the authority responsible for issuing and enforcing Intel's facility-wide air permit. Intel-New Mexico submitted its first permit application on July 31, 1980, and NMED issued the facility's first permit (No. 325) on October 21, 1980. Source operations began in 1982 with only one fabrication line ("Fab 7"). In the years since, Intel-New Mexico has submitted several applications for process modifications and facility expansions. Appendix B provides a chronology of Intel-New Mexico's air permit history from October 1980 through December 2013 noting reasons for various modifications and revisions (NMED, 2013)

In general, the permit changes accommodated upgrades at the facility and reflected newly acquired information. While Intel-New Mexico changed its operations numerous times, the facility's major expansions are listed in Appendix B (and process modifications continue to occur).

The first major facility expansion was in the 1980s and consisted of the construction of Fabs 9.1 and 9.2. The second major facility expansion in the early 1990s was authorized through multiple permit revisions (i.e., 325-M-3 through 325-M-6). In this expansion, Intel-New Mexico increased the capacity of Fabs 9.2 and 9.3. The third major facility expansion occurred in the middle 1990s. This expansion added Fab 11, Fab EP2, and several large boilers. This expansion was approved under several permit revisions (i.e., 325-M-6 through 325-M-9). In addition to doubling the size of the facility, Intel-New Mexico renamed Fab 9.3 to Fab 11 EP1 and added several generators, boilers, and air pollution control devices.

Intel-New Mexico has since replaced its thermal oxidizers, added cooling towers, ammonia and solvent wastewater treatment systems (NMED, 2011). Intel-New Mexico's current air permit identifies 109 point emission sources including fab thermal oxidizers (17), fab scrubbers (33), utility building scrubbers (9), cooling towers (32), boilers (13), ammonia treatment systems (4), and a bulk waste tank (1).

Some of the more recent permit revisions were either administrative in nature or added emissions limits and other requirements to keep Intel-New Mexico within federal environmental "synthetic minor" policies and guidance. "Synthetic minor" refers to facilities that accept permit conditions limiting emissions below thresholds that would, if exceeded, designate the facility as a "major source." These permitted emission limits (quantities) are listed on a 12-month rolling basis in Table 1. Because of its minor source status, Intel-New Mexico's air permit contains no short-term (24-hour) limits. Short-term over-exposure to some of the permitted air contaminants e.g. carbon monoxide, sulfur dioxide, and specific hazardous air pollutants such as hydrogen fluoride and hydrochloric acid, can result in adverse health effects.

Table 1 - Intel-New Mexico Plant Site Permitted Emissions (NMED, 2012)

Air Contaminant	Tons/Year (12-month rolling)
Carbon Monoxide	94.7
Hazardous Air Pollutants (HAPs)	24
Oxides of Nitrogen (NOx)	95.7
Sulfur Dioxide (SO_2)	95
Total Suspended Particulates (TSP)	95
Volatile Organic Compounds (VOCs)	96.5

In accordance with EPA greenhouse gas regulations issued in 2011, Intel-New Mexico obtained a Title V (major source) operating permit (#257) from NMED in December 2013 (NMED, 2013). On June 23, 2014, the United States Supreme Court ruled that EPA can impose carbon limits on facilities that already fall under Title V (and Prevention of Significant Deterioration (PSD)) permitting programs for other non-greenhouse gas requirements but that EPA could not require Title V (and PSD) permits based solely on greenhouse gas emissions (USEPA, 2014a). As a result of this ruling, Intel-New Mexico Title V operating permit may be under review by NDEM and Intel–New Mexico.

Intel-New Mexico's 2009 and current air operating permits appear to be consistent with past Intel permits which require specific pollution control equipment operation, emissions testing and reporting, and other on-site recordkeeping and monitoring requirements.

Demographics

The 2010 U.S. Census estimated that 131,561 persons live in Sandoval County. This is a 46 percent increase from the county's 2000 population. Within this population, 6.5% were under 6 years of age; 80.9% between 5 and 64 years, and 12.7% were 65 years and older (Bureau of the Census, 2012a). The U.S Census reported that the City of Rio Rancho's population grew from 51,765 in 2000 to 87,521 in 2010 (Bureau of the Census, 2012b). The U.S. Census reported that the Village of Corrales' population rose from 7,334 in 2000 to 8,329 in 2010 (Bureau of the Census, 2012c). An estimated 13,014 persons live within 1 mile (1.6 kilometers) of the site; additional demographic data are also listed in Figure 2.

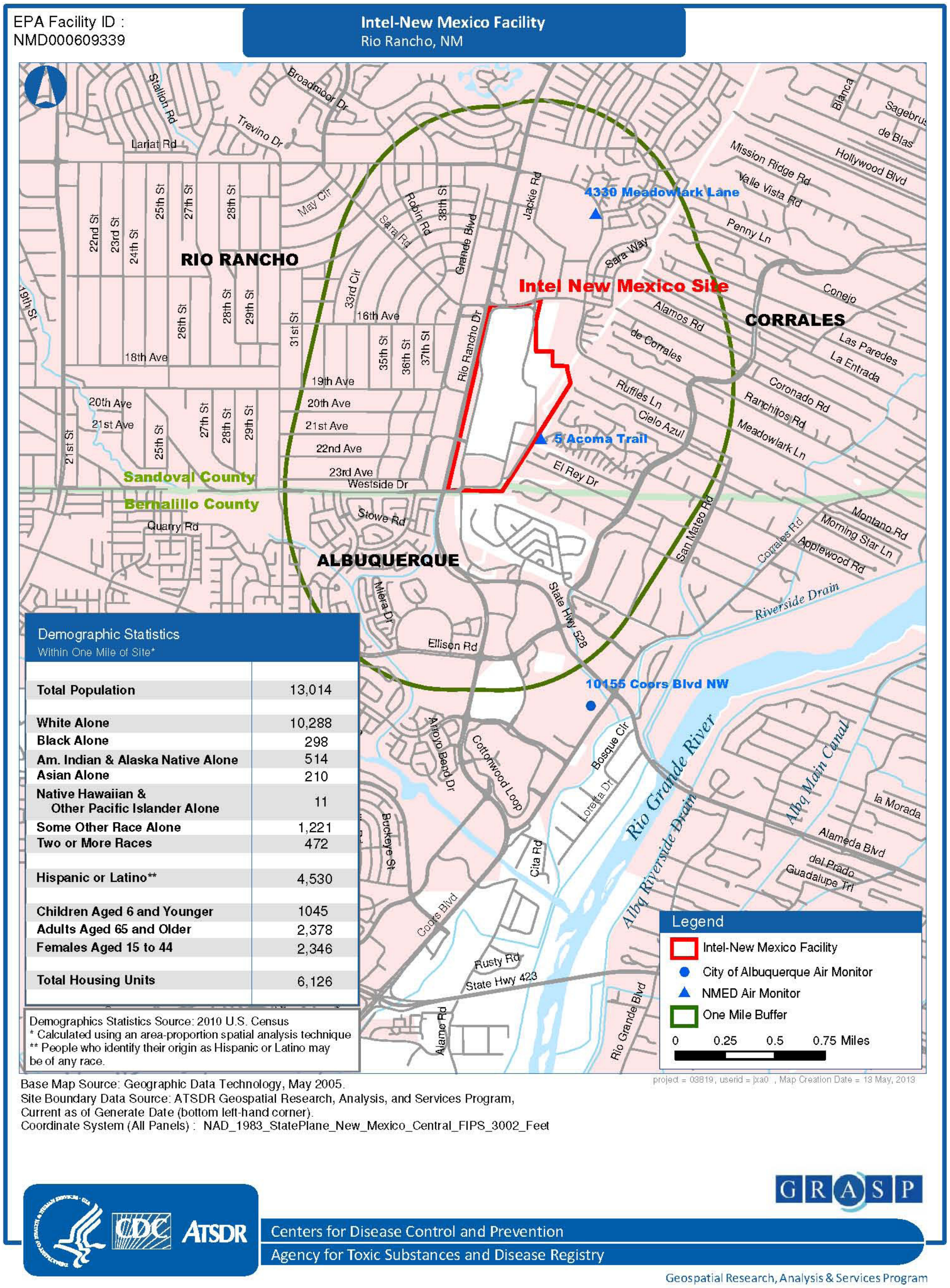
Community Health Concerns

The Corrales and Rio Rancho communities surround and abut Intel-New Mexico. Residents have reported many physical symptoms that they believe are associated with exposure to Intel-New Mexico's air emissions. Some residents were concerned for themselves and their families, and others have even moved out of the area to seek refuge from chemical exposures (Petition letter, 2004). Some symptoms residents reported included, but were not limited to, headache, cough, migraine, irritability, inability to breathe, seizures, throat irritation, eye irritation, nausea, vomiting, and dizziness. Community members also complained about strong odors of burnt coffee, acid, perfume, burnt wood, and vinegar. Some residents who live immediately east of the facility have reported and continue to report air quality/ and environmental odor complaints to NMED and ATSDR by email.

In 2002, the SouthWest Organizing Project, a regional environmental and community group, in collaboration with Oregon-based River Networks, conducted a symptom and prevalence survey in the area. These organizations have not released a formal report on their efforts including methods and conclusions. The *Corrales Comment,* a local newspaper, after interviews with the representatives of the organizations that conducted the survey, reported that residents living closer to Intel-New Mexico were more likely to report symptoms of persistent cough, frequent headaches, sore throats, and allergy-like symptoms (Radford 2005).

Some community members were particularly concerned about how much protection the Intel-New Mexico air permit afforded them, how thoroughly the NMED enforced the permit's limits, and the lack of air monitoring requirements for Intel-New Mexico air emissions. NMED administers the air permit under authority delegated by the EPA. ATSDR does not have the legal authority to resolve regulatory issues. However, ATSDR has shared these community concerns with NMED and EPA Region 6 (ATSDR, 2009a).

Figure 2 Intel-New Mexico Area Map with Particulate Air Monitoring Locations and Demographics



Demographic Statistics Within One Mile of Site*	
Total Population	13,014
White Alone	10,288
Black Alone	298
Am. Indian & Alaska Native Alone	514
Asian Alone	210
Native Hawaiian & Other Pacific Islander Alone	11
Some Other Race Alone	1,221
Two or More Races	472
Hispanic or Latino**	4,530
Children Aged 6 and Younger	1045
Adults Aged 65 and Older	2,378
Females Aged 15 to 44	2,346
Total Housing Units	6,126

Corrales Air Quality Task Force

At various times in the 1990s, citizens submitted complaints to NMED about health problems that they considered attributable to air pollution from Intel-New Mexico. The Mayor of Corrales compiled these complaints and presented them to NMED. To help investigate and address these concerns, in October 2002, NMED's Air Quality Bureau applied for and received a grant from EPA Region 6 to establish the Corrales Air Quality Task Force (CAQTF) and to investigate air pollution levels in and near Corrales and Rio Rancho.

In November 2002, NMED formed the CAQTF to provide NMED with input and comments on a range of issues related to the EPA-funded air quality study. Active from December 2002 until June 2004, the CAQTF also investigated Corrales-area citizens' health concerns that could be related to toxic air pollution in the area. Through the CAQTF, NMED's Air Quality Bureau conducted a series of meetings with Corrales citizens to address their complaints. Citizens communicated their various health complaints at monthly meetings, and their suggestions were instrumental in designing and implementing an ambient air monitoring program (NMED 2004a).

The Corrales Air Quality Task Force Study had five key objectives (NMED 2004b):

1. Identify potential location of elevated levels of contaminants and specific air toxics of concern in the area.
2. Develop an emissions inventory for the area.
3. Perform an air dispersion modeling analysis.
4. Perform an ambient air monitoring study to characterize exposure levels.
5. Characterize toxicological risk considering the monitoring and modeling results and dose-response assessment.

The study culminated with NMED releasing a toxicological risk characterization. The report, "Human Health Risk Characterization, Corrales Environmental Health Air Quality Evaluation," was prepared by Gradient Corporation, an environmental consulting firm working under contract to NMED (Gradient, 2004). The primary goal of the Corrales Environmental Health Air Quality Evaluation was to assess the potential for acute health impacts associated with measured and modeled concentrations of chemicals in outdoor air. In that regard, the report estimated whether adverse health outcomes could be associated with exposure to air pollution in the Village of Corrales. Chronic health risks were also evaluated in addition to acute human health risk characterization. To evaluate those risks the air modeling estimates were used since the available air monitoring data were not representative of long-term (chronic) air concentrations.

The risk assessment concluded that the measured and modeled exposure concentrations of the chemicals of interest were not associated with increased acute or chronic health risks. The report also noted however, that the health complaints of Corrales citizens might be related to local pollutant emission sources:

> . . . this risk assessment did not find evidence that any of the measured or modeled chemicals are associated with increased acute or chronic health risks…it still remains possible that the health complaints of Corrales citizens are related to local pollutant emission sources. However, this assessment did not find sufficiently elevated concentrations of a particular compound such that adverse health effects would be expected. (Gradient, 2004)

Other Efforts to Address Community Health Concerns

In addition to the Corrales Air Quality Task Force efforts, in October 2001 the Mayor of Corrales requested that NMED conduct a health risk assessment for the Village of Corrales. NMED's Air Quality Bureau proposed a stakeholder-based health risk assessment process to develop a plan to research, identify, and quantify potential air quality health risks from toxic air pollutants in the Village of Corrales. From April 2003 to May 2004, NMED collected information regarding health and odor complaints from residents of Corrales, Rio Rancho, and Albuquerque. A total of 266 reports were received during this time period. Two persons submitted 54% of the total reports and five persons submitted 79% of the total reports. The reported health symptoms and odor descriptors were diverse (NMED 2004c). Using the emissions inventories, monitoring and modeling data, and the odor complaint information, NMED's health risk assessment concluded that the evidence did not support a hypothesis that any of the modeled or measured chemicals were associated with increased acute or chronic health risks (NMED 2004c). NMED noted, however, that uncertainties adversely affected the admittedly limited amount of available monitoring and modeling data (NMED 2004c).

Community Environmental Working Group

In November 2003, Intel-New Mexico established a process to address community concerns: a "Community Information" line to provide information about operations and associated emissions. In 2004, Intel-New Mexico also established the Community Environmental Working Group (CEWG) to provide a community process for addressing environmental, health, and safety issues. CEWG meeting minutes are posted at: http://www.cewg.org. Some of the CEWG most important initiatives include:

1. encouraging Intel-New Mexico to raise the height of Intel stacks to reduce maximum pollutants concentrations at ground level
2. supporting the installation of redundant (backup) units to the thermal oxidizer air pollution controls
3. convening a Silica Testing Task Force to investigate community concerns about crystalline silica, and
4. performing air modeling to estimate hydrogen fluoride levels

Environmental Protection Agency 2009 Inspection

EPA's National Enforcement Investigations Center (NEIC) conducted a Clean Air Compliance Inspection of Intel-New Mexico in December 2009 (USEPA, 2010). In addition to under reporting of ethyl lactate emissions, EPA noted several areas of concern regarding the Intel-New Mexico permit. EPA states that "areas of concern" are "inspection observations of potential problems that could result in environmental harm, noncompliance with a permit or regulatory requirement or are associated with other pollution prevention issues." EPA areas of concern included:

- concerns regarding the efficiency of scrubbers and the accuracy of scrubber emission reporting,
- lack of continuous parametric monitoring e.g., pH or operation ranges of the scrubbers,
- lack of permit conditions that link minimum operating temperature to thermal oxidizers efficiency or emission rate,
- lack of accurate listing of emissions units, and
- other permit-related concerns: 1) permit limits are much higher than have been reported suggesting that the permit does not represent the actual conditions at the site, and 2) permit contains no short-term limits and does not require monitoring of emissions during upsets.

Intel-New Mexico has been working with NMED and EPA Region 6 to address these concerns (Intel, 2010a). For example, Intel-New Mexico's most recent permit includes an update listing of its 109 emission units. In 2010, Intel-New Mexico submitted a draft scrubber testing protocol to EPA for approval. This protocol, when approved and implemented, will further verify the effectiveness of scrubbers' emission controls. NMED's Air Quality Bureau provided ATSDR additional information on follow-up actions taken as a result of "areas of concern" findings in the EPA"s Clean Air Compliance Report (NMED, 2014).

Public health protection of the community near the Intel-New Mexico facility relies to a large extent on accurate characterization and quantification of Intel-New Mexico stack emissions. Thus the EPA findings and Intel-New Mexico follow-up are essential to protecting the public from exposure to hazardous air contaminants.

Toxic Release Inventory (TRI) Data

The Federal Emergency Planning and Community Right-to-Know Act (EPCRA) requires facilities—such as Intel-New Mexico—that manufacture, process, or otherwise use significant amounts of toxic chemicals, to report annually their releases of these chemicals. The report, known as the Toxics Release Inventory (TRI), contains information about the types and amounts of toxic chemicals that are released each year to the air, water, and land. The primary purpose of EPCRA is to inform communities of chemical hazards in their

> **What Is the Toxics Release Inventory (TRI)?** Starting in 1987 the EPA required facilities in certain industries to disclose the amounts of specific toxic chemicals that they release to the environment or manage as waste (USEPA, 2014b). The TRI is the publicly accessible database that contains the information submitted by facilities that meet the reporting requirements. EPA's Web site on the TRI program (www.epa.gov/tri) presents extensive additional information on the strengths and limitations of using TRI data.

communities (USEPA, 2012).

ATSDR uses TRI data as part of the evaluation of facilities that release toxic chemicals into the environment. TRI data are useful for indicating the types and amounts of annual air emissions from industrial facilities that use reportable chemicals and how the reportable emissions change over time. However, these data have limitations. For instance, TRI data are self-reported by industry, and the accuracy of these data is not known. Further, while TRI data offer extensive insights into large air emission sources, the data are not comprehensive because of various reporting exemptions. For example, facilities in certain industrial sectors, facilities with fewer than 10 employees, and facilities with relatively small toxic chemical uses are exempt from reporting. In addition, TRI data do not include emissions data from non-industrial sources, like motor vehicles. Finally, TRI reporting requirements have changed over the years, which can complicate efforts to interpret trends.

In general, TRI data provide useful insights into the relative magnitude of certain industrial emissions sources and help identify site-related pollutants of potential concern, but these data alone often are insufficient for drawing inferences about exposures and potential health effects. TRI air emissions data alone cannot determine whether air emissions present a public health hazard.

Intel-New Mexico's TRI total air emissions for the period 1988 through 2013 are graphed in Appendix C. These graphs indicate that the facility's air emissions have greatly varied over time (from 3,765 pounds in 2008 to 133,953 pounds in 1993). These variations are due to changing plant operations and production volume and to changes in the TRI reporting requirements. Several changes to the TRI reporting requirements pertain to chemicals that are widely used in the semiconductor manufacturing industry.

EPA removed acetone from the TRI reporting requirements in 1995 (USEPA, 1999b). U.S. EPA added N-methyl-2-pyrrolidone to the reporting requirements in 1995. U.S. EPA modified the listing of isopropyl alcohol in a manner that limited reporting to facilities that manufacture the chemical in a specific manner. As a result of this modification, facilities such as Intel-New Mexico that simply use the chemical no longer had to report chemical releases to TRI. Thus, emissions of isopropyl alcohol are not documented in Appendix C, despite Intel-New Mexico's emissions inventories document identifying releases of this chemical. Excluding acetone emissions (exempted starting in 1995), Intel-New Mexico's total TRI air emissions peaked in 2004 at 107,000 pounds. Ammonia emissions (89,705 pounds) in 2004 comprised over 80 percent of this amount. Intel-New Mexico's ammonia air emissions for 2012 dropped to 12,005 pounds.

Intel-New Mexico is the largest single source of TRI air emissions in Rio Rancho. Form-Cove MFG, about 3 miles northeast of the Intel-New Mexico facility, is the second largest source. Form-Cove reported releasing between to 2,000 and 15,000 pounds per year of styrene via air emissions from 2004 through 2013. This included 9,000 pounds in 2003, 8,800 pounds in 2004, and 15,000 pounds in 2005, all released as fugitive emissions.

In 2013, Intel-New Mexico reported emitting 24,505 pounds of TRI-reportable chemicals into the air. Ammonia comprised 53 percent of these TRI-emissions. Hydrogen fluoride and nitric acid comprised 38 percent - most of the remainder.

Recent Intel-New Mexico TRI reporting trends from 2008 to 2012 include: 1) maintaining annual releases of reportable VOCs air emissions below 1,000 pounds per year, and 2) increasing annual air emissions of hydrochloric acid aerosol from 1,480 pounds to 5,600 pounds, glycol ethers from 5 pounds to 845 pounds, and hydrogen fluoride from 995 to 1,805 pounds.

Intel-New Mexico reported increasing its hydrogen fluoride emissions from 1,805 pounds in 2012 to emissions to 4,705 pounds in 2013 and reducing its hydrogen chloride aerosol emissions from 5,605 pounds in 2012 to 605 pounds in 2013 (USEPA, 2014c).

The majority of Intel-New Mexico's TRI emissions occurred from point sources (e.g., thermal oxidizer stacks, scrubbers, and cooling towers). Some, however, were fugitive emissions best characterized as passive releases that did not occur through a confined process stream, such as a vent or a stack. Excluding acetone, total fugitive air emissions ranged from 20 pounds in 2008 to 3,536 pounds in 1996. From 2004 through 2007, total fugitive emissions ranged from 990 to 1882 pounds. In 2004 and 2005, Intel-New Mexico released via fugitive emissions 750 and 746 pounds of hydrofluoric acid, respectively. In 2006, Intel-New Mexico released 1882 pounds of TRI-reportable chemicals via fugitive air emissions. The majority of these fugitive emissions were methanol (1802 pounds). From 2008-2013, Intel-New Mexico reported releasing no more than 35 pounds of fugitive air emissions per year and no more than 5 pounds of any one chemical.

Methodology

A critical element of this health consultation is *exposure*, or how humans come into contact with air pollutants. Analyzing exposure is important: if residents are not exposed to air pollutants, then the pollutants cannot pose a public health hazard and additional analyses are not necessary. If residents are exposed, then further analysis is needed to evaluate the exposure. Even if an exposure has occurred, that does not mean the exposed residents will have adverse health effects or get sick. In cases where exposures have occurred, ATSDR considers several questions when determining if adverse health effects could occur (ATSDR, 2005):

- To what pollutants are people exposed?
- How often are people exposed, and for how long?
- What are the pollution levels to which people are exposed?

When evaluating sites with outdoor air quality issues, ATSDR needs information on air pollution levels and how these levels change with location and time. ATSDR uses various approaches to evaluate air pollution. The preferred approach is to review air sampling data, or direct measurements of pollutants in the air that people breathe. However, for most sites that ATSDR evaluates, air sampling data are not available for the entire range of pollutants, locations, and time frames of interest. In these cases, ATSDR uses other approaches to evaluate potential exposures. These approaches include reviewing air emissions data, dispersion modeling information, and outdoor air quality data.

ATSDR evaluates contaminants detected in environmental media at hazardous waste sites or facilities and determines whether an exposure to those contaminants has public health significance. This section documents the environmental data that ATSDR reviewed, which included air emissions data (or the amount of chemicals that Intel-New Mexico releases into the air), dispersion modeling information, and outdoor air quality data. These three datasets were chosen because they paralleled the specific objectives of this health consultation.

ATSDR's evaluation of environmental data for the air exposure pathway focused on whether airborne levels of contaminants were above health-based comparison values. Health-based comparison values are specific concentrations of chemicals determined unlikely to result in adverse health effects. It is important to note that comparison values are not thresholds of toxicity; exceeding a comparison value does not by that fact alone result in an adverse health effect.

Once the environmental data have been obtained and evaluated, ATSDR scientists determine whether people are exposed to the contaminants. ATSDR's methodology for evaluating the potential public health consequence of environmental contamination is described in ATSDR's Public Health Assessment Guidance Manual (ATSDR, 2005).

Climate and Meteorology

Local wind patterns affect how air pollutants move from a source to downwind locations. Several factors influence prevailing wind patterns near the Intel-New Mexico facility. Weather fronts, local terrain features, and seasonal and diurnal effects all affect wind direction, duration, and velocity.

Appendix E depicts windrose graphs for the former NMED meteorology station at 4335 Meadowlark Lane in Rio Rancho, for 2006-2008. This station is approximately ½ mile from the Intel-New Mexico facility and closely represents wind patterns at Intel-New Mexico facility. A wind rose displays the frequency the wind blows *from* a particular direction and its wind speed at a specific location. Appendix D displays the wind patterns by season for daytime and nighttime for 4335 Meadowlark Lane, Rio Rancho.

These wind roses indicate that daytime south, south-southeast, and south-southwest winds occur most frequently, and at low wind speed, during the spring, summer and fall (about 30 to 40 percent). In the spring, daytime westerly wind occurs about one-third of the time. In winter, daytime winds north-northeast, north-northwest winds and southerly winds occur most frequently (30 percent). The highest wind speeds occur from westerly winds during the winter and spring months. These winds occur when deep upper level low pressure troughs push across the southwestern United States (Shoemake, 2010).

Nighttime winds are light and blow most frequently from the north, northwest, or northeast throughout the year (about 45 to 55 percent frequency). Nighttime winds also blow from west, west-southwest, and west-southwest (20-30 percent frequency). Overall, portions of Corrales are downwind of the Intel-New Mexico facility during nighttime approximately 50 percent of the time during south-southwest, west-southwest, west-northwest, and north-northwest winds.

Air Emissions Data

Air emissions data—or information on the amount of pollutants that a facility releases into the air—help provide insight on how that facility might affect air quality and whether exposures are of potential health concern.

Air emissions are typically characterized by direct measurement (or source testing) or by estimation. Examples of estimation include mass balances, application of air emission factors, and engineering calculations. Intel-New Mexico's emissions were characterized using both direct measurement and estimation, and both are reviewed below.

ATSDR considered emissions data in responding to community concerns since emission rates are used for air modeling inputs (see Dispersion Modeling Information below). ATSDR cannot base public health conclusions on emissions data alone—residents are almost never exposed directly to pollutants emitted from a facility's stacks. Rather, a facility's emissions first move through and disperse into the air, where they often mix with emissions from other sources, before they reach areas where residents might be exposed.

When evaluating emissions data, researchers must consider any differences or changes in a facility's production processes. For instance, Intel-New Mexico's production levels, unit operations, and chemical usage change considerably over time. Thus, site-specific emissions data from one time period are not necessarily representative of other periods. Similarly, measured emission rates for Intel-New Mexico can vary considerably from hour to hour within a day. Consequently, when responding to community health concerns and when interpreting relevant measurements for this site, time-based variations should be considered.

To understand the nature and magnitude of air emissions from Intel-New Mexico, ATSDR thoroughly reviewed numerous emissions inventories, testing reports, permit applications, and other documents. ATSDR conducted this review primarily to inform the evaluation of dispersion modeling information and outdoor air quality data (reviewed later in this section). However, during the review of this information, ATSDR also identified several opportunities for providing greater confidence in the existing emissions data for Intel-New Mexico, which would also address some community concerns. ATSDR documented these opportunities in a letter to NMED (Appendix E). These opportunities included: supplemental testing of the thermal oxidizers and scrubbers to verify control efficiencies and reviewing proposed changes to emission factors.

Dispersion Modeling

Dispersion modeling studies offer a means for *estimating* a facility's air quality effects, based on inputs that characterize pollutant-specific emission rates and local meteorological data. Air modeling is widely used: it can provide insight on air quality effects for many locations and averaging times without the expense of conducting extensive ambient air monitoring. Modeling can identify locations likely to have the highest pollutant levels. This is helpful in determining potential exposures, whether air monitoring is needed and where to locate air monitors. Modeling can also be used to predict air quality improvements that may occur by modifying a source e.g., raising stack heights.

Main finding on dispersion modeling information: ATSDR reviewed available dispersion modeling information for Intel-New Mexico, focusing particularly on recent modeling conducted as part of the Corrales Air Quality Task Force. ATSDR found this study's findings were useful, but inherent uncertainties and limitations prevent the agency from basing health conclusions on the study's modeling estimates alone.

When conducting dispersion modeling studies, and especially when representing facility configurations, principal investigators must make numerous assumptions. These assumptions can have significant bearing on the modeling results. The greatest limitation of these studies is that they can only *estimate* air quality impacts based on current scientific understanding of how pollutants move through the air.

The accuracy of model predictions depends on both the quality of model inputs and how accurately a model reflects actual atmospheric and topographic conditions. For the later, modeling experts continue to refine and improve dispersion models to address their inherent limitations. EPA continues to work on improving model performance related to building downwash i.e., turbulent air flow of buildings, and low-wind conditions (USEPA, 2014d). Thus, a thorough review of modeling studies is critical, especially to determine whether their predictions should be used in public health evaluations.

Numerous atmospheric dispersion modeling studies have been conducted for the Intel-New Mexico facility. Some of these studies were conducted to support human health risk assessment, while others were to support permit applications. ATSDR conducted detailed reviews of multiple studies; this section reviews the findings from the dispersion modeling conducted by two independent researchers as part of the Corrales Air Quality Task Force Study. Funded by EPA and NMED, this study represents the most widely publicized effort to-date to address community concerns regarding how Intel-New Mexico has affected air quality.

NMED sponsored the Corrales Air Quality Task Force "to identify and analyze potential air quality health risks due to toxic air pollution in the Village of Corrales" (NMED 2003a, NMED 2004c). This study involved several separate tasks, such as emission inventory development, air dispersion modeling, and ambient air monitoring—all conducted to provide input to a human health risk assessment. Different contractors supported NMED on these tasks, with scientists from Desert Research Institute and Worldwide Environmental Corporation serving as the principal investigators for the dispersion modeling study (Koracin and Watson, 2003). This modeling study was a high-visibility project: through a series of public meetings, local residents actively participated, and the eventual results were widely publicized.

In this study, CALPUFF[2] modeling system was used for the dispersion modeling—an appropriate model selection for the intended application. The CALPUFF simulations estimated air quality impacts of 10 organic pollutants emitted from Intel-New Mexico's regenerative thermal oxidizers RTOs and 17 inorganic pollutants emitted from Intel-New Mexico's scrubbers. According to the final modeling report, NMED provided the principal investigators all emissions data for use as model inputs. The modeling inputs are reasonably consistent with emission rates documented in Intel-New Mexico's quarterly reports from 2002.

The modeling analysis included a thorough evaluation of local meteorology, making good use of all available datasets. The meteorological modeling domain for this evaluation was larger than that considered in other modeling efforts and was inclusive of actual observations. The description of the meteorological modeling approach and results appear reasonable and consistent with standard modeling practice. Tracer gas (sulfur hexafluoride) was also used in combination with the FTIR monitoring to add confidence to the modeling efforts.

In this particular study, some assumptions were made such as aggregating emissions from multiple sources into single sources, not fully considering building downwash e.g., downward flow of air after moving across buildings, and wake effects, and estimating concentrations at a handful of discrete receptors (rather than using a receptor grid). Exactly how these assumptions

[2] A non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. CALPUFF can be applied for long-range transport and for complex terrain. See http://www.epa.gov/scram001/dispersion_prefrec.htm.

affected the modeling results is not easily quantified, without replicating the entire study using different approaches.

Overall, the Corrales Air Quality Task Force's modeling provided useful insights into the meteorological conditions around Intel-New Mexico. It also predicted outdoor air pollution levels for several pollutants, but these estimated levels have inherent uncertainties and limitations that prevent ATSDR from basing health conclusions on these modeling estimates alone. For example, the accuracy of the modeling results depends on the accuracy of the emission rate inputs: any positive or negative biases in the emission rate inputs propagate through the dispersion models and into the modeling results. Additionally, assumptions made when running the model (such as how to allocate emissions between different sources) can affect the modeling results. These inputs and assumptions impact the model's output, i.e., actual air pollution levels may have been lower or higher than the model predictions.

EPA recommends the use of AERMOD software for regulatory compliance air modeling. EPA allows CALPUFF to be used for near field modeling (less than 30 miles like Intel-New Mexico) when specific criteria are met including a determination that AERMOD is less appropriate than CALPUFF for the specific situation (USEPA, 2008a). In recent air permit applications Intel-New Mexico uses AERMOD to estimate maximum concentrations of carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate in the nearby community.

In addition to reviewing the air modeling estimates, ATSDR reviewed outdoor air quality measurements collected near Intel-New Mexico noted below. When available, ambient air monitoring provides information to more fully evaluate possible community exposures to several pollutants.

Community Environmental Working Group Modeling

In follow-up to ATSDR's recommendation, CEWG conducted the air modeling to estimate short-term levels of hydrogen fluoride in the community using EPA's AERMOD and on-site meteorology data for the years 2010-2012 (CEWG, 2013). Intel-New Mexico provided median stack hydrogen fluoride stack emission rates for the modeling. Twenty-two emission points were included in the modeling. Highest estimated concentration (7.5 $\mu g/m^3$) of hydrogen fluoride occurred southeast of the plant in 2012 at 4 AM (November 25, 2012). This estimated peak concentration is less than ATSDR's acute Minimal Risk Level (MRL) for hydrogen fluoride of 16 $\mu g/m^3$. CEWG's air modeling accounted for low wind speed conditions and air flow disturbance over the buildings (building downwash). This model effort is still subject to the same limitations noted previously i.e., the accuracy of the modeling results depends on accuracy of the emission rate inputs.

Outdoor Air Quality

For this health consultation, ATSDR reviewed outdoor air quality data (also referred to as "ambient air monitoring data" or "air sampling data") collected by several parties. The most extensive data were collected as part of the following two studies:

- Outdoor air monitoring data collected by NMED and Intel-New Mexico contractors in 2003 and 2004, using open path Fourier-Transform Infrared (FTIR) spectrophotometers for volatile organic compounds (VOCs) and other Hazardous Air Pollutant (HAPs). This method was selected by NMED and the citizens group because of its ability to measure relatively low concentrations of many chemicals of concern.

- Outdoor air samples collected by NMED in residential areas near Intel-New Mexico in 2002 and 2003. These samples were analyzed in a laboratory for volatile organic compounds (VOCs).

NMED and Intel-New Mexico performed extensive monitoring and sampling as voluntary efforts to address community concerns about local air quality. Input from the CAQTF was considered in the design and implementation of these studies. Both NMED's and Intel-New Mexico's monitoring evaluated the potential effect of the facility's air emissions, but was not intended as a full-scale exposure assessment.

Intel-New Mexico - Open Path FTIR Data

ATSDR reviewed the open path FTIR datasets collected by Intel-New Mexico listed in Table 2.

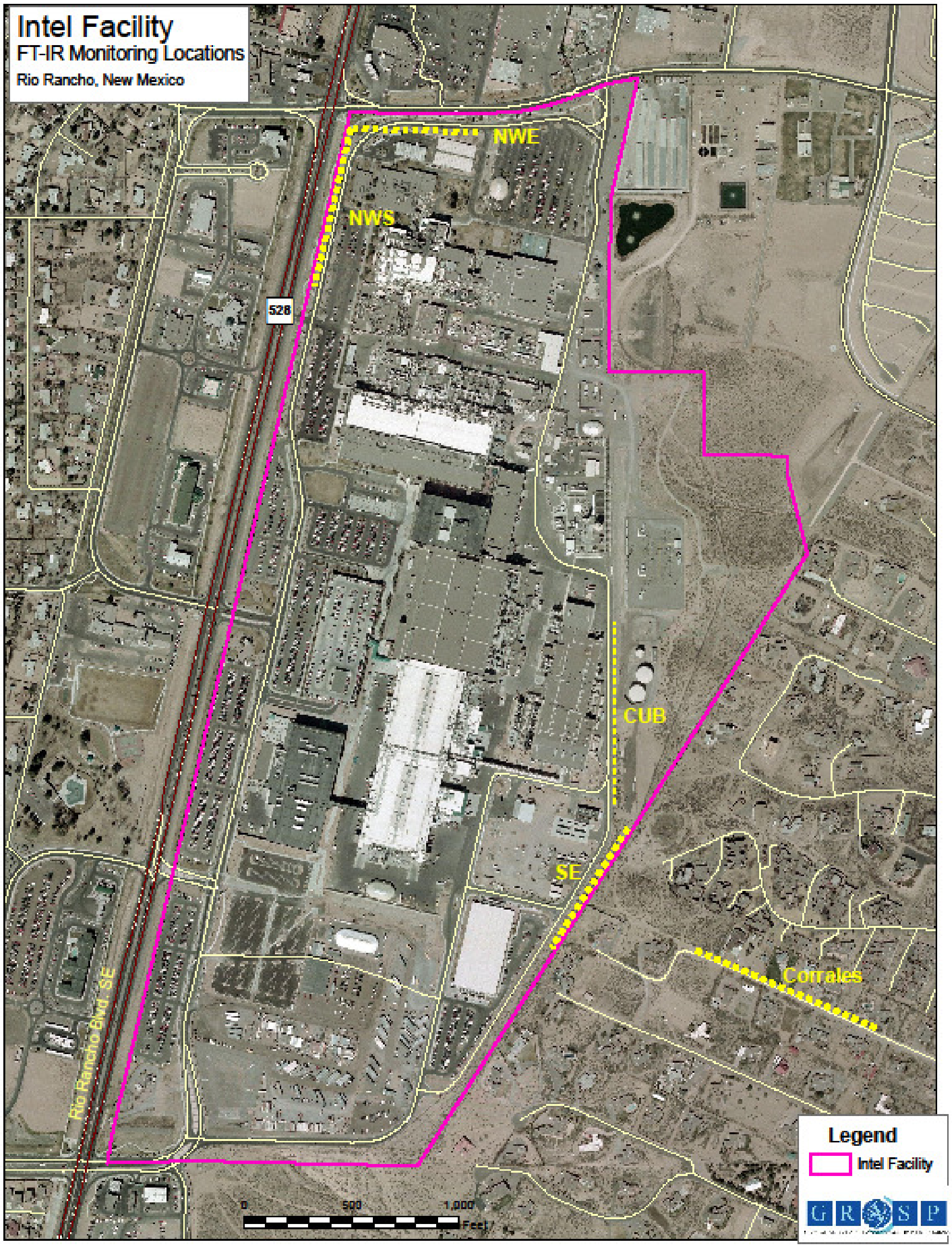
Table 2 – Intel-New Mexico 2004 FTIR Monitoring Datasets - Rio Rancho/Corrales, NM

Organization/Data Name	Dates	Location
(1) Intel - NW South	Aug 1- 8, 2003	Intersection of 528 and Sara Road (south orientation)
(2) Intel - NW East	Aug 12 - 21, 2003	Intersection of 528 and Sara Road (east orientation)
(3) Intel – South East property line	Aug 21 - Sept 7, 2003	Southeast property line
(4) Intel – Mariquita Lane	Feb 16 – 21, 2004	517 to 625 Mariquita Lane, Corrales (2 miles east of the facility)
(5) Intel - CUB	Feb 24 - March 13, 2004	East property line near the Central Utilities Building (CUB)

The open path FTIR monitoring procedures employed by Intel-New Mexico are described in detail in their consultants' reports (TRC 2003). Intel-New Mexico's open path FTIR monitor was stationed at five locations: monitoring was conducted at three locations over a 5-week period in the summer of 2003, and additional monitoring was conducted at two locations over 4-week period in the winter of 2004. ATSDR received Intel-New Mexico monitoring data (results) both in spreadsheet format (70-second increments) and in summary reports.

Intel-New Mexico also operated a meteorological station at the open path FTIR locations to measure prevailing wind patterns and other parameters. Additional meteorological monitoring occurred at Intel-New Mexico's permanent station located at the southern portion of its property. Figure 3 shows the open path FTIR monitoring location, except for the Mariquita Lane monitoring location, approximately 2 miles east of Intel-New Mexico.

Figure 3 – 2003-2004 Intel-New Mexico and MNED Open Path Monitoring Locations



Note: FTIR monitoring locations are noted in yellow dotted lines.

NMED Open Path FTIR Data

NMED's contractor operated an open path FTIR at two locations over a 5-week period in the summer of 2003. ATSDR received NMED monitoring data in summary reports. The datasets are listed in Table 3.

Table 3 – NMED FTIR Monitoring Datasets – Rio Rancho-Corrales NM (2003)

NMED – "Corrales"	July 29 - Aug 24 2003	SE of plant ("Corrales")
NMED – 'NW"	Aug 25 - Sept 2, 2003	Intersection of 528 and Sara Road

Quality Assurance and Quality Control

When standardized methods are used, ATSDR typically relies on the information provided in the referenced documents and assumes that adequate quality assurance and quality control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analysis and conclusions drawn for this health consultation is determined by the comprehensive and reliable nature of the referenced information.

Intel-New Mexico and NMED reported collecting open path FTIR data in accordance with EPA methods (USEPA, 1996a, USEPA, 1999a), which calls for specific statistical methods to interpret measurement results. This method also allows additional analysis of the spectra by trained chemists called spectroscopists. Nevertheless, despite the availability of this published method, no single standardized method exists to analyze open path FTIR data (ATSM 2007); thus, different statistical methods are often used to interpret data. As evidence of this, Intel-New Mexico's FTIR data are based on statistical analyses using least-squares methods, whereas NMED's FTIR data are based on statistical "goodness of fit" analyses and supplemental spectral analyses.

ATSDR has made the following observations about the open path FTIR data collected at Intel-New Mexico in 2003 and 2004:

- Detection limits varied widely for many chemicals. This suggests that environmental conditions (e.g., water vapor, compounds with similar peaks, or beam misalignment) affected the ability of instruments to identify and quantify ambient air concentrations. ATSDR considered as unreliable any data for compounds with high detection-limit variability.
- A majority of compounds were detected infrequently. There is no effective method for determining mean air contaminant concentrations when more than 70 percent of the values are censored i.e., contaminant levels were less than the method detection limits ("non-detects") (Antweiler and Taylor, 2008, Helsel 2012). Only one chemical, carbon monoxide, was measured more than 70 percent of the time periods i.e., less than 30 percent censored values.
- The detection limits for chemicals of interest often exceeded their corresponding health-based comparison values. Thus, because ambient air concentrations were not quantified

in the range of potential interest, this limitation prevented ATSDR from evaluating air contaminants.

- Due to the local topography and large size of the plant, FTIR fence-line monitoring may not represent community exposure. Because of the close proximity of the plant to the residential area and because of the higher elevation of the plant relative to the residential area, fence line monitoring may not accurately estimate exposure to residents living next to the plant's eastern border. (This also is a source of error for air pollution modeling as well).
- Air monitoring data collected during 2003-2004 represent a "snapshot" for that manufacturing period. Intel-New Mexico periodically changes its production lines to keep-up with advancements in semiconductor technology. Consequently Intel-New Mexico air emissions also change as evidenced by changes in its TRI reporting profile.
- Six chemicals—carbonyl fluoride, hydrofluoric acid, silane, propylene glycol monomethyl ether acetate (PGMEA), phosgene, and methyl methacrylate—were initially detected, albeit infrequently, by NMED when using the "goodness of fit" statistical analysis. Later, however, NMED classified these chemicals as false positives, based on the spectral analyses of data subsequently conducted by NMED's consultants (NMED 2004b). ATSDR did not attempt to reevaluate the false positive determination by the spectroscopists. Ideally, the monitoring plan would describe in advance how data would be handled, particularly in cases when different statistical analyses reveal different results.
- Simultaneous upwind and downwind FTIR monitoring occurred. During some periods, Intel-New Mexico operated its FTIR monitoring device on one side of the facility, while NMED operated its FTIR monitoring on the other side of the facility. Comparing these data should be viewed with caution: the upwind and downwind monitoring occurred using different monitoring equipment, software, and methods of analyses.

Because of the limitations inherent in the FTIR analyses and the site-specific ways in which the data were collected, ATSDR cannot rely on these open path FTIR data to make public health determinations. Nevertheless, these open path FTIR datasets contain some valuable information about air quality during the monitoring periods. ATSDR used ***R*** software with a supplemental package of computer code called "openair" to further evaluate the FTIR results (Carslaw DC and Ropkins K, 2012).

NMED Canister Sampling for Volatile Organic Compounds

Evacuated canister sampling was conducted in 2002 and 2003 to measure VOC ambient air concentrations. Detailed results of these data are contained in NMED's Corrales Project Monitoring Data Report (NMED 2004b). Samples were collected and analyzed according to a method developed and published by EPA (NMED, 2003b). Sampling results follow.

- Between December 26, 2002, and January 13, 2003, NMED collected eight 24-hour canisters samples for VOCs in the community. Several VOCs were detected in these samples, but all of the measured concentrations were lower than ATSDR health-based comparison values. The highest concentration of a VOC measured from these samples was 2.2 parts per billion of Freon 11 in a sample collected on January 13, 2003.

- Citizens collected nine 15-second grab samples between June 17, 2003, and August 8, 2003. The samples were collected during times when residents detected foul odors. Some VOCs were detected in these samples, but all measured concentrations were lower than health-based comparison values. The highest concentration of a VOC measured from these samples was 0.9 parts per billion of total xylene in a sample collected on August 8, 2003. Grab samples are designed to quantify the presence of VOCs during a particular brief period (e.g., during the presence of transient odors). Due to their very limited sampling durations, one-time grab samples may not be representative of community exposure.
- NMED collected four 1-hour canisters samples for VOCs analyses in the community between August 5, 2002, and August 29, 2003. Several VOCs were detected in these four samples, but all detections were lower than ATSDR health-based comparison values. The highest concentration of a VOC measured in these four samples was 11.1 parts per billion of toluene in the sample collected on August 11, 2003.

NMED and City of Albuquerque Airborne Particulate Monitoring Data

ATSDR obtained the following particulate (dust) monitoring data:

- PM_{10} data from the City of Albuquerque's air monitoring station at 10155 Coors Boulevard NW in Albuquerque (EPA Site 35-001-1014) from EPA Air Now website.
- $PM_{2.5}$ data from the NMED air monitoring station at 4335 Meadowlark Lane in Rio Rancho, NM (EPA Site ID 35-043-1003) from EPA Air Now website.
- $PM_{2.5}$ data from the NMED portable air monitoring station near 5 Acoma Trail in Corrales, NM from NMED Air Quality Bureau.

The City of Albuquerque collected PM_{10} air samples at its 10155 Coors Boulevard NW, Albuquerque Monitoring Station every sixth day from 1991 – 2002, and every third day from 2002-2008. PM_{10} is particulate matter that has an aerodynamic diameter of less than 10 micrometers, less than the diameter of a human hair. The Coors Boulevard air monitoring station was less than 1.5 miles from the Intel-New Mexico Facility (Figure 2) and downwind from Intel-New Mexico facility during northerly and north-northwesterly winds - a frequent occurrence particularly during the nighttime and winter months (Appendix E).

NMED collected $PM_{2.5}$ samples at its Meadowlark Lane, Rio Rancho NM station approximately every third day from 1999 - 2008. $PM_{2.5}$ are particles that have an aerodynamic diameter less than 2.5 micrometers. The Meadowlark Lane station was less than one-half mile north of the Intel-New Mexico facility (Figure 2) and downwind from the facility during prevailing southerly and south-southwesterly wind conditions that frequently occur during daytime periods (Appendix E).

NMED collected daily $PM_{2.5}$ samples at its portable air monitoring station, located at 5 Acoma Trail, Corrales, from June 2012 through November 2012. The portable air monitoring trailer, stationed near 5 Acoma Trail, was less than one quarter mile from the Intel-New Mexico facility. This location is downwind from various portion of the Intel-New Mexico facility during southwest, west and northwest winds because of its close proximity to the Intel-New Mexico facility and the size of facility.

The results of the Coors Boulevard PM_{10}, Meadowlark Lane $PM_{2.5}$, and Acoma Trail $PM_{2.5}$ monitoring are graphically displayed in Appendix F.

PM: Particle Size and Public Health.

Particulate matter smaller than 10 microns *(*PM_{10}*)* is composed of particles and droplets with aerodynamic diameters of 10 microns or less—a diameter much smaller than that of human hair. EPA has focused on PM_{10} because research indicates that these particles were more likely to pass through the nose and mouth and enter the lungs, i.e., respirable. EPA requires that PM_{10} levels, measured as 24-hour average PM_{10} concentrations, do not exceed 150 $\mu g/m^3$ more than once per year (on average) over a 3-year period. Scientific evidence indicates that breathing in larger sizes of particulate matter, coarse particles (PM_{10}), may also have public health consequences. Studies suggest that short-term exposure to PM_{10} may be linked to premature death and hospital admissions and emergency department visits for heart- and lung-related diseases (USEPA, 2012).

Particulate matter smaller than 2.5 microns *(*$PM_{2.5}$*)* or "fine particulate"—is the subset of PM_{10} composed of particles and droplets with aerodynamic diameters of 2.5 microns or less. EPA requires that annual average concentrations of $PM_{2.5}$, averaged over three consecutive calendar years, do not exceed 12 $\mu g/m^3$. EPA lowered this standard from 15 to 12 $\mu g/m^3$ in 2012. EPA also maintains a 24-hour $PM_{2.5}$ standard of 35 $\mu g/m^3$.

Health studies indicate that breathing in $PM_{2.5}$ over the course of hours to days (short-term exposure) and months to years (long-term exposure) can cause serious public health effects that include premature death and adverse cardiovascular effects. The evidence also links $PM_{2.5}$ exposure to harmful respiratory effects. The EPA standards are intended to reduce the incidence of cardiovascular and respiratory disease associated with particulate exposure.

Discussion

Environmental Data - FTIR

ATSDR focused on the open path FTIR monitoring data (TRC, 2005) in the 2009 Public Health Consultation. ATSDR summarized open path FTIR data (Table 2) to include chemical detected, percent of the time the chemicals were detected, the average detection limit of the datasets, relative average concentrations (assuming non-detects were zero), mean concentration (excluding non-detections), maximum 1-hour and 24-hour levels, and health-based comparison values (ATSDR, 2009a). Substituting or assigning values e.g., zero, ½ the detection limit, or the detection limit to calculate means is no longer appropriate for censored (non-detect) environmental data (Antweiler and Taylor, 2008 and Helsel, 2012). Statistical methods can be used to estimate mean concentrations when less than 70 percent of the data points are censored. Unfortunately this excludes the Intel-New Mexico FTIR data (more than 70 percent censored) except for carbon monoxide. The measured carbon monoxide levels were below EPA National Ambient Air Quality Standard (NAAQS) for 1 hour and 8 hour periods of 9 and 35 parts per million, respectively, not to be exceeded more than once per year. Peak daily carbon monoxide levels coincided with morning and evening rush hour traffic.

In ATSDR's 2009 Public Comment Health Consultation ATSDR summarized selected 1-hour peaks levels (Table 3) for those chemicals having average detection limits below the corresponding health-based MRLs for acute exposure. In this health consultation, ATSDR choose to plot limited data using data visualization methods e.g., polar frequency and polar annulus graphs.

For a majority of the compounds, the lower detection limits exceeded ATSDR, EPA, or state agency health-based comparison values due to the open path FTIR technology. Because of this issue and the data quality concerns noted previously, results could not be used to determine potential public health issues.

However, ATSDR did use the open path FTIR data to explore the air contaminant pattern for selected chemicals to gain some insight into local air pollution emissions. ATSDR plotted the open path FTIR data for selected chemicals using ***R*** software and *openair* package. ATSDR developed polar annulus plots for ammonia, acetaldehyde, fluorine compounds and phosgene and other compounds noted below. These plots provide a means of visualizing pollutant concentration by wind direction and time of day (for the monitoring period) as an annulus. ATSDR selected these compounds based on combustion sources (acetaldehyde), extensive TRI emissions (ammonia), association with semiconductor emissions (fluorine compounds), and community concern (phosgene).

Acetaldehyde and other Compounds

Appendix G contains a polar plot of acetaldehyde levels for the periods August 1 - 9, 2003 and August 21 through September 7, 2003. Acetaldehyde is produced as a by-product of combustion, e.g., generators, engines, including motor vehicles, and crematorium furnaces. The highest levels were detected when the wind was blowing from the direction of the Intel-New Mexico Plant between 4 PM and 8 PM on August 2, 2003. (Sara Road, a Rio Rancho waste water plant and the crematorium were also upwind.) The maximum value measured on August 2, 2003 (800 ppb) exceeded the EPA Reference Concentration of 5 parts per billion for chronic exposure. (The Reference Concentration is the estimate of continuous inhalation exposure to the human population, including sensitive groups, that is likely to be without an appreciable risk of harmful effects over a lifetime of exposure.) EPA and ATSDR have not established comparison values for short-term exposure to acetaldehyde. For the monitoring period including maximum (August 2nd), acetaldehyde was detected 18.5 percent of the monitoring period with a mean minimum detection limit (MDL) of 25 ppb (TRC, 2003). Peak levels of formaldehyde and n-hexane were also measured between 4 PM and 8 PM on August 2, 2003 (Appendix G). This peak levels exceeded the ATSDR's acute Minimal Risk Level (MRL) for formaldehyde and the Texas Commission on Environmental Quality' acute Effects Screening Level (ESL) for n-hexane. N-hexane and formaldehyde are also formed as byproducts of combustion.

Ammonia

Polar annulus plots for ammonia (Appendix H) suggest Intel-New Mexico as a source of ammonia at night and during the early morning hours. Intel-New Mexico did not report ammonia stack or fugitive emissions in 2003 but reported releasing 5 pounds of fugitive emissions and 89,700 pound of stack emissions in 2004. The levels measured by the FTIR are well below ATSDR's 100 parts per billion (ppb) Minimal Risk Level (MRL) for chronic exposures to ammonia. The maximum 70-second reading measured 76 ppb during the August 9 through August 21, 2003 monitoring. Some ammonia maybe attributed to the motor vehicle traffic. Intel-New Mexico abuts New Mexico Highway 528, a major north-south artery on the northwest side of the greater Albuquerque metropolitan area.

Carbon Tetrachloride

Appendix I contains a polar annulus graph showing the carbon tetrachloride pattern for August 21 through September 7, 2003. (Carbon tetrachloride has been used as a solvent in semiconductor manufacturing.) The carbon tetrachloride highest levels were detected when the wind was blowing from the northwest (from the direction of the Intel-New Mexico Plant) to the monitor around 7 - 8 PM. The levels of carbon tetrachloride measured were below ATSDR's MRL of 30 parts per billion for long-term chronic exposure.

Select fluorine-containing compounds

Polar annulus plots for carbonyl fluoride, carbon tetrafluoride and hexafluoroethane indicate that fluorine compounds were detected downwind of the Intel-New Mexico plant (Appendix J). The carbonyl fluoride levels were well below the exposure guidelines designed to describe the risk to humans resulting from once-in-a-lifetime, or rare, exposure to airborne chemicals. ATSDR and EPA have not established health-based comparison values for carbon tetrafluoride and hexaflouroethane.

Phosgene

The community raised concerns about possible exposure to phosgene since this air contaminant was detected by the Intel-New Mexico and NMED open path FTIRs. Phosgene can be formed when chlorinated hydrocarbon compounds (e.g., chloroform) are exposed to high temperatures, such as what occurs in thermal oxidizers. Intel-New Mexico reports, however, that its exhaust ventilation system is designed to prevent corrosive chlorine-containing gases from being vented to the thermal oxidizers. This would preclude the formation of phosgene from Intel-New Mexico operations.

NMED later determined the phosgene detections to be false positives through additional spectral analysis. ATSDR did not attempt to reevaluate false positive determinations made by NMED. For several reasons cited in this health consultation, ATSDR does not have confidence in the open path FTIR monitoring data for evaluating potential health impacts of air emissions on the community. Therefore, ATSDR previously recommended that Intel-New Mexico, in partnership with CEWG and NMED, provide information to the community on the process controls and safety measures that prevent the formation of phosgene during Intel-New Mexico plant operations.

ATSDR used *R* software with the *openair* package to plot the phosgene detections by wind direction (Appendix K). The phosgene detections show a scattered pattern and do not indicate a specific source for the detections of phosgene.

Phosgene levels have been measured in ambient air in the United States at levels from 22 (rural) to 32 (urban) parts per trillion (USEPA, 2005).

Environmental Data

Particulate Monitoring

ATSDR included and reviewed particulate monitoring data from monitors near the Intel-New Mexico Plant to address particulate-related air quality concerns. (ATSDR also examined the levels of other criteria air pollutants including carbon monoxide, nitrogen dioxide, ozone, and sulfur oxide).

PM_{10} levels (24-hour) at the Coors Boulevard monitoring station exceeded the 24-hour EPA Standard of 150 µg/m^3 on 6 occasions from 1991 to 2008 (Appendix F). Weather observations for Albuquerque International and Double Eagle Airport (Albuquerque) indicated that high wind conditions occurred on each of these days, as noted in Table 2 below.

Table 4 - Albuquerque Wind Speeds when 24-hour PM_{10} levels exceeded 150 µg/m^3 from January 1989 through August 2008 (www.epa.gov/air data, www.wrcc.dri.edu)

Date	**PM_{10} Concentration** (µg/m^3) Coors Road Station (ID 35-001-1014)	**Maximum Hourly Average Wind Speed** (mph)/ **Wind Direction** (at maximum wind speed) Albuquerque Int. Airport (KABU)	Double Eagle Airport (KAGE)
3/19/1991	151	40.3/SW	Not available
12/21/ 2001	174	40.1/W	38.0/W
2//25/ 2002	176	29.9/NW	31.8/WNW
4//20/2002	195	32.2/W	32.6/W
4//6/2002	517	34.5/W	37.7/W
6/1/2002	443	27.6/W	31.5/W

A City of Albuquerque study estimated that 95 percent of Bernalillo County PM_{10} emissions in 2004 were attributed to wind erosion (Desert Research Institute, 2006). Even though these elevated PM_{10} levels likely resulted from naturally occurring events (high wind conditions), these events do pose a health risk to the greater Albuquerque community.

Twenty-four hour PM_{10} levels were measured from 174 - 195µg/m^3 three times during a four month period from December 21, 2001 to April 20, 2002. EPA's Air Quality Index considers these PM_{10} levels to be *unhealthy for sensitive groups* with people with respiratory disease at most risk. These levels pose "Increasing likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease, older adults, and people of lower socio-economic status (SES)". (USEPA, 2013).

Twenty-four hour PM_{10} levels exceeded 400µg/m^3 twice in 2002. EPA's Air Quality Index considers these PM_{10} levels to be *hazardous* with people with respiratory disease at most risk. These levels pose "Serious aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease, older adults, and people of lower SES; serious risk of respiratory effects in general population" (USEPA, 2013).

During the period of operation (1989 to 2008), the average annual PM_{10} levels at the Coors Boulevard monitoring station remained below EPA's National Ambient of Air Quality Standard (NAAQS) of 50 µg/m^3 of PM_{10}, measured on annual average. The average annual PM_{10} levels ranged from 20.3 µg/m^3 (2004) to 47.7 µg/m^3 (2002). The annual average PM_{10} concentration at Coors Boulevard air monitoring station exceeded 40 µg/m^3 two of 20 years that the station operated, 1989 (45.1 µg/m^3) and 2002 (47.7 µg/m^3).

Meadowlark Lane fine particulate $PM_{2.5}$ levels (Appendix F) were below the EPA National Ambient Air Quality Standard of 12 µg/m^3. Annual average $PM_{2.5}$ levels ranged from 4.7 to 5.2 µg/m^3 during operation of this monitoring station (1999-2008). All 24-hour $PM_{2.5}$ results were below the EPA 24-hour standard of 35 µg/m^3.

NMED provided results of $PM_{2.5}$ monitoring at its portable station near 5 Acoma Trail in Corrales NM, from June 7, 2011 through November 11, 2012 (personal communication with Terry Hertel, NMED, November 19, 2012). For this period, the arithmetic mean concentration (for 440 observations) was 5.4 µg/m^3. The highest 24-hour level measured by NMED, 40 µg/m^3, was observed on June 8, 2011. This also was the only reading at 5 Acoma Trail greater than 35 µg/m^3. Similar $PM_{2.5}$ values (35 to 48 µg/m^3) were reported at the three City of Albuquerque monitoring stations on June 8, 2011. During this period, the City of Albuquerque issued air quality alerts as the result of the Wallow, Arizona wildfire smoke plume (Albuquerque Journal, 2011). EPA's Air Quality Index considers these $PM_{2.5}$ levels to be *unhealthy for sensitive groups* of people with respiratory disease. The levels pose "Increasing likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease, older adults, and people of lower SES (USEPA, 2013).

The New Mexico Health Department compared the rates of emergency department visits in Albuquerque area hospitals during the period when the Wallow fire affected the Albuquerque airshed to the period prior to the fire (Resnick, Woods, Krapfl and Toth, 2013). They observed increased risk of emergency department visits for respiratory and cardiovascular conditions, for all ages, during this period (June 1 through June 13, 2011).

Despite the infrequent $PM_{2.5}$ and PM_{10} excursions from wind storms and wildland fires, the greater Albuquerque area's airshed is in compliance with the National Ambient Quality Standards (NAAQS) for carbon monoxide, nitrogen dioxide, ozone, $PM_{2.5}$ and PM_{10}, and sulfur dioxide (USEPA, 2014e).

Crystalline Silica

The community raised concerns about the possibility of exposure to crystalline silica from Intel-New Mexico Plant air emissions. Intel-New Mexico uses hexamethyldisilizane (HMDS), a silicon-based compound, in semiconductor lithography processes. HMDS is evaporated and captured in process exhaust. HMDS hydrolyzes in humid air to trimethylsilanol (TMS) and ammonia (NH_3). TMS can dimerize (change) in the presence of oxygen, or on specific types of adsorption media, to form hexamethyldisiloxane (HMDSO). Saturated vapor of HMDS (i.e., xylene or toluene solvent) is injected onto a quartz surface layer and thermally decomposed to form a dense silica as a coating to the wafer surface. This process does not exhaust any HMDS or silica to the RTOs stacks, but as by-products such as solvent vapors, TMS or HMDSO and NH_3 may be released. Although not expected, in an event of unsuccessful chemical vapor deposition (CVD) process, build up in RTOs of HMDS CVD by-products may occur. It is unlikely that crystalline silica would be present, but amorphous silica contained in products of silylation (process of converting organic compounds into organo-silicon compounds) may be present additionally to ammonia (Seguin et al. 2008; Zhan et al., 2005; Luo et al., 2007).

The formation of crystalline silica from amorphous silica dioxide (found in HMDS) requires extreme temperature and slow cooling times (NIOSH 2003). The transformation also depends on other parameters including, pressure, run duration and state of the starting materials i.e., crystallinity and initial structural perfection (Wahl et a. 1961; Bettermann and Liebau, 1975).

Previous sampling by Intel-New Mexico did not detect the presence of crystalline silica in the thermal oxidizer air stream exhaust (Intel Corporation, 2004). In 2009, ATSDR recommended additional bulk sampling of thermal oxidizer residue for crystalline silica to verify this finding.

In 2010 and 2011, the CEWG investigated community concerns about possible crystalline silica air emissions from Intel-New Mexico thermal oxidizers. The CEWG established the Silica Testing Task Force (STTF) to design and carry out an evaluation of crystalline silica emissions from the Intel-New Mexico thermal oxidizers (CEWG, 2011). The objectives of the STTF were to: 1) determine whether crystalline silica concentrations were above a CEWG provisional level of 1 $\mu g/m^3$ annual average at the Intel-New Mexico fence-line, and 2) determine whether the levels and size distribution of crystalline silica emitted from recuperative thermal oxidizers (RCTO) stacks constitute a public health concern.

The Task Force planned and conducted the air sampling plan for crystalline silica emissions, with assistance of Environmental Resource Management (an Intel-New Mexico contractor). The sampling collection was observed by community members. The National Institute for Occupational Safety and Health (NIOSH) directed the laboratory analyses of air samples. The sample analyses were performed by a NIOSH contract laboratory (Bureau Veritas, Inc.) that is accredited by the American Industrial Hygiene Association (AIHA).

The Task Force’s sampling followed EPA reference methods noted in Appendix L and the NIOSH Analytical Method 7500. One of the methods (EPA Reference Method 17) was modified to prevent elevated exhaust stream temperature from degrading the sample filters. Exhaust stream samples were collected using Teflon™ coated glass fiber filters. Sampling was conducted simultaneously in all five thermal oxidizer stacks (3-Munters and 2-Durr) within volatile organic compound (VOC) abatement systems. The Task Force’s testing protocol took into account potential changes in production levels.

Twenty individual test runs (samples) were collected over 4-hour periods during 2 early morning (12 AM – 4 AM) and 2 later mornings (8AM -12 PM). The glass filters were weighed (gravimetric analysis) for particulate (dust) loading. Crystalline silica analysis was performed using X-ray diffraction spectrometry in accordance with NIOSH Method 7500.

The silica test plan including sampling, laboratory analysis, data analysis and follow-up actions were reviewed by the stakeholders in advance of the sampling effort. Air samples and field blanks were maintained in a chain-of-custody from sample collection through receipt by the accredited contract laboratory. NIOSH performed quality assurance of the laboratory data.

Emissions were calculated in pound per hour based on filter mass loading and air sample volume. Dispersion models were performed to estimate fence line concentrations.

The testing determined that overall particulate matter (PM) emissions for the five thermal oxidizer exhausts was 0.066 lbs/hr. NMED allows Intel-New Mexico to release up to 1.0 lbs/hour of particulate emissions under its current air permit.

Particulate matter was found on all thermal oxidizer exhaust samples. Crystalline silica was detected and measured on only one of the 20 filters. This sample, from Munters TO-3, yielded a quartz concentration of 103.1 $\mu g/m^3$ and emission of 0.0005 lbs/hr. Based on this information, the Task Force estimated a fenceline crystalline silica concentration of 0.0016 $\mu g/m^3$. This level is well below the CEWG's provision level of 1 $\mu g/m^3$, as an annual average. CEWG noted that even if all particulate measured during the testing were assumed to be silica, the fenceline crystalline silica concentrations would be less than 1 $\mu g/m^3$. The Task Force concluded that there was no potential public health concern from crystalline silica emissions. In summary, the results from initial Intel-New-Mexico bulk sampling collected in 2004, the findings of the Silica Testing Task Force, and the literature review suggest that it is unlikely that crystalline silica is released from Intel-New Mexico's thermal oxidizers in the chemical vapor deposition process.
The absence of elevated $PM_{2.5}$ at NMED Meadowlark and 5 Acoma Trail air monitoring stations, and PM_{10} at Coors Boulevard air monitoring station, are consistent with this observation. EPA has not established an air quality standard for crystalline silica but it is a component of $PM_{2.5}$ and PM_{10}. EPA estimates that PM_{10} in U.S metropolitan areas contains up to 10 percent crystalline silica. EPA concluded in its Health Assessment of Crystalline silica (USEPA, 1996b) that "for healthy individuals not compromised by other respiratory ailments and for ambient environments expected to contain 10% or less crystalline silica fraction in PM_{10}, maintenance of the 50 $\mu g/m^3$ annual National Ambient Air Quality Standard for PM_{10} should be adequate to protect against silicotic effects from ambient crystalline silica exposures".

The state of California has established a Recommended Exposure Limit (REL) of 3 $\mu g/m^3$ for crystalline silica, measured as respirable dust (a 50% cut-point at 4 µm particle aerodynamic diameter) to prevent silicosis (OEHHA, 2005) in the general public.

Health Concerns/Issues

Idiopathic Pulmonary Fibrosis (IPF)

In response to community concerns about purported high rates of idiopathic pulmonary fibrosis in Corrales, New Mexico Department of Health (NMDOH) conducted an epidemiologic investigation (Appendix M). NMDOH identified 10 potential cases of idiopathic pulmonary fibrosis in Corrales. Of these ten, NMDOH identified one confirmed and two suspect cases of idiopathic pulmonary fibrosis. Six of the ten cases were classified as other types of lung disease, e.g., chronic obstructive pulmonary disease (COPD), sarcoidosis, and hypersensitivity pneumonitis. Another case was excluded because the person developed lung disease prior to moving to Corrales. Using census data, NMDOH calculated the idiopathic pulmonary fibrosis prevalence rate (based on one confirmed case) for Corrales and compared it to Bernalillo County prevalence rates. NMDOH concluded that "an IPF cluster was not identified".

Amyotrophic lateral sclerosis (ALS) in the Community

ATSDR received reports that 10 persons in the Rio Rancho - Corrales community have been diagnosed with Amyotrophic Lateral Sclerosis (ALS), also known as Lou Gehrig's disease. ALS is a fatal condition that affects the nerve cells that make muscles work. ALS causes the muscles to become weak which leads to paralysis. Approximately 80% of those with the disease die within 2-5 years of diagnosis. The cause(s) of ALS are not well known in most cases. About 5–10 percent of ALS cases occur within families with a history of the disease. Age is also a risk factor for ALS. Most people find out they have it when they are between the ages 55 and 75 (ATSDR, 2014).

An estimated 20,000–30,000 people in the United States have ALS and about 5,000 people are diagnosed with ALS each year. Because records on ALS have not been kept uniformly throughout the country, it is difficult to accurately estimate the number of ALS cases, i.e., the prevalence of ALS in the United States (ATSDR, 2013). Without an accurate baseline for comparison and sufficient reporting to calculate stable state and local ALS rates ATSDR cannot determine whether the 10 reported ALS cases in the Rio Rancho-Corrales area are greater than expected. ATSDR has developed the National ALS Registry to improve understanding the incidence and prevalence of ALS in the United States. The Registry may help to determine 1) demographic factors (such as age, race or ethnicity, gender, and family history of individuals diagnosed with ALS) associated with the disease and 2) identify environmental and occupational risk factors that may be associated with the disease. U.S residents who have been diagnosed with ALS are encouraged to join the National ALS Registry. Additional information can be found at https://wwwn.cdc.gov/als/ALSCreateAccount.aspx (ATSDR, 2014).

Occupational Epidemiology Studies

Occupational epidemiology studies have been helpful in evaluating potential occupational health hazards for semiconductor workers. These studies may be somewhat useful in evaluating community health concerns. While the general public (i.e., community) may be more sensitive to chemical exposures than are workers, community exposures to air contaminants are typically much lower than workplace exposures. Moreover, community exposure to semiconductor emissions is less likely to involve multiple pathway exposure (e.g., inhalation and dermal).

Occupational epidemiology studies, including one semiconductor industry-funded study, found some evidence of increased spontaneous abortions among women working at semiconductor facilities (Schenker, 1995). These reports prompted Intel-New Mexico in the mid-1990s to remove, or limit, glycol ethers in the manufacturing process. The last year that Intel-New Mexico reported releasing greater than 1,000 pounds of glycol ethers via air emissions was 1994 (USEPA, 2014c).

In 2007, the University of Alabama published the results of one of the largest cancer study of semiconductor workers to date. Funded by IBM, this study found fewer expected cases of cancer among semiconductor workers compared with the general population (Bender et al 2007). Yet this study has some important limitations: 1) the young age of the workers compared with the general population, 2) possible selection bias due to temporal and geographical restrictions, and 3) lack of chemical-specific exposure information (Bender et al 2007).

The Semiconductor Industry Association funded Vanderbilt University to conduct a cancer epidemiology study of 100,000 semiconductor workers, employed between 1968 and 2002. Researchers reported that wafer fabrication was not associated with increased rates of cancer mortality (Boice et al, 2010). This study's limitations were similar to the Bender study i.e., young work force and lack of detailed exposure measurements.

Odors and Health

Corrales residents report noticing various odors, including burnt coffee, solvent, and acetone-like odors (Petitioner 2004; NMED 2004c). The reported symptoms included a "seizing feeling in the upper respiratory tract," temporary loss of vision, breathlessness, sinus irritation, pneumonia, nightmares, and insomnia. Some residents reported numerous complaints about these odors, often describing them as "burnt coffee-like". Residents continue to detect odors and report odor complaints to Intel-New Mexico and NMED. Odors are reported most often in the late evening and early morning periods by residents living southeast of the plant. The odor is frequently reported as strong "burnt coffee". This time of day is indicative of stable atmospheric conditions of no wind or light wind blowing from the south-southwest from the Intel-New Mexico Plant toward Corrales (Appendix D). It is not possible to identify the source of the odor without additional information. A number of chemicals are described as having "burnt" odor. These include butyraldehyde, tetramethylpyrazine, and pyridine. Some of these compounds are used in the semiconductor manufacturing industry.

NMED previously reported that the majority of complaints were made by a limited number of persons who live on the hillside east of the plant. Despite high rates of non-detections, Intel-New Mexico's open path FTIR monitoring results suggest that some chemicals may be found in the community at levels above their corresponding odor thresholds during short periods. These chemicals include acetaldehyde which is a chemical often associated with fuel combustion.

Intel-New Mexico emits chemicals (e.g., ammonia, hydrochloric acid) capable of resulting in unpleasant odors in the community, but the facility has implemented several strategies to reduce emission of such odorous substances. Thermal oxidizers that have operated at the facilities for many years reduce emissions of odorous substances. Exposures to these odorous substances, however, may have been greater before the thermal oxidizers were installed and may continue to be higher when the thermal oxidizers are shut down for maintenance. To further address this issue, Intel-New Mexico has taken steps to reduce substantially the down time of air pollution control equipment through the installation of redundant thermal oxidizers.

The semiconductor industry recognizes the management of ammonia waste streams as a particular challenge (Sherer, 2005). Ammonia gas streams should be separated from acid gas streams since the ammonium compounds can pass through scrubbers. Intel-New Mexico has recently installed three new ammonia waste treatment systems. This action, along with new greenhouse gas control measures (Intel, 2012) may help reduce plant-associated odors.

Other odor-producing industries are present near Intel-New Mexico and include a high traffic state highway, motor vehicle fuel-filling stations, a crematorium, a waste water treatment plant, and agricultural operations. These sources are all within close proximity to Intel-New Mexico and may contribute to odors detected by the community.

The relationship between odor and human health is not fully understood. Odors are complex and therefore quantifying odorous compounds is difficult. Also human detection of and response to odors varies greatly. Unpleasant environmental odors have been traditionally recognized as "warning" signs of potential risks to human health and not direct triggers of health effects.

Odors from environmental sources may cause health symptoms, depending on many individual and environmental factors. Adverse health symptoms such as headaches and nausea have been associated with environmental odors (Shiffman and Williams, 2005, Aatamila et al. 2011). One recent study suggests that perceived pollution and health risk perception may play an important role in determining whether environmental odors result in annoyance and health symptoms (Claeson et al, 2013). Another recent study suggests a dose–response association between low level ammonia exposure from environmental odors in residential outdoor settings and psychosocial effects (Blanes-Vidal et al, 2014).

ATSDR and EPA have established their comparison values (i.e., Minimal Risk Levels and Reference Concentrations) based on adverse toxicological effects rather than odor perception. Consequently, ATSDR bases its public health conclusions on exposure to environmental contaminants in excess of health-based screening values rather than on the presence of odors.

Limitations

Several important limitations influence this health consultation and ATSDR's ability to draw conclusions from this data review. These limitations include but are not limited to:

Environmental Data:

- The 2003–2004 sampling and monitoring data span a total of approximately 10 weeks. While those data provide some limited insight into air quality during those periods, the data quality is not sufficient to evaluate for a public health determination.
- Also, because of the frequent changes in plant processes, production levels, and pollution control equipment, the 2003-2004 data are not representative of conditions during other periods.
- Open Path FTIR monitoring provides contaminant concentrations averaged over the beam length (around 100 meters). It does not provide maximum concentrations within that distance.

Air Dispersion Modeling

- EPA continues to refine its air dispersion modeling program. Overall modeling provides more accurate exposure estimates over long-term periods at greater distances from specific sources like the Intel-New Mexico facility.
- The accuracy of the modeling is dependent on accurate emissions (input) data.

Conclusions and Recommendations

Volatile Organic Compound (VOC) and acid aerosol air emissions

ATSDR cannot accurately evaluate volatile organic compounds (VOCs) and acid aerosols near the Intel-New Mexico facility. Therefore, ATSDR cannot determine whether these compounds could harm people's health.

The open path FTIR data were not sufficiently sensitive and reliable to draw health conclusions. Additional air monitoring data are not available to make this health determination.

The principal public health protection from Intel-New Mexico air emission resides with effective administration and compliance of a valid air permit. NMED has issued an air permit to the Intel-New Mexico facility that allows for the release of specific quantities of, carbon monoxide, Hazardous Air Pollutants (HAPs), nitrogen oxides, total suspended particulate and VOCs calculated on a rolling 12-month average system. Effective administration and enforcement of the Intel-New Mexico facility air permit is essential to maintaining air quality, i.e., preventing harmful exposure to the plant's air emissions (including short-term exposures), particularly to community members directly downwind of the facility.

Recommendations

As the result of its 2009 compliance inspection, EPA has noted several areas of concern and one area of non-compliance. Follow-up of these areas of concern noted in the EPA inspection are necessary to confirm the adequacy of the air permit's public health protections and improve the community's overall confidence in the air permit.

ATSDR encourages NMED, CEWG and Intel-New Mexico to evaluate the need to conduct additional air modeling, and possibly air monitoring for validation, following the results of any additional Intel-New Mexico air pollution control equipment stack testing i.e., acid scrubbers and RTOs, required in follow-up to EPA's 2009 compliance inspection. Particular attention should be given to acid aerosols and VOCs that may result in health effects from short-term exposure. EPA Region 6, NMED and Intel-New Mexico are encouraged to communicate the resolution of air permit and enforcement issues identified from the EPA's 2009 inspection of the Intel-New Mexico facility to the community.

ATSDR encourages NMED to evaluate whether air modeling should include other local point emission sources e.g., crematoriums.

Residents concerned about air emissions from the Intel-New Mexico Plant can voice their questions and comments through participation in the Community Environmental Working Group (CEWG) meetings. The CEWG provides a forum for addressing the community's environmental and public health concerns related Intel-New Mexico air emissions and communicating findings and actions.

Carbon Monoxide

Conclusions

ATSDR concludes that breathing carbon monoxide from the Intel-New Mexico facility in 2003-2014 will not harm people's health.

The measured levels of carbon monoxide in 2003 and 2004 using the open path FTIR were below levels of health concern and EPA's National Ambient Air Quality Standards.

Recommendation

None

Crystalline Silica

Conclusion

ATSDR concludes that crystalline silica emissions from the Intel New-Mexico facility are not expected to harm people's health.

The Silica Task Force's crystalline silica emissions testing and long-term ambient particulate monitoring for PM_{10} and $PM_{2.5}$ do not indicate that community members are exposed to elevated levels of crystalline silica.

Recommendation

No recommendations are provided.

Environmental Odors

Conclusion

ATSDR has received numerous environmental odor complaints from residents living immediately southeast of the Intel-New Mexico facility. Some of these odors may be related to the Intel-New Mexico plant air emissions. In some studies, environmental odors have been associated with health symptoms (Schiffman and Williams, 2015; Aatamilia et al, 2011).

Residents living immediately southwest of the Intel-New Mexico facility have reported environmental odors during late evening and early morning periods when local wind rose data indicate that the Intel-New Mexico is frequently upwind of these residents. Other sources may include the crematorium near the northeast side of the Intel-New Mexico facility.

Recommendation

ATSDR encourages Intel-New Mexico to continue its ongoing efforts to reduce and control air emissions through improvements in its engineering and administrative controls. Avoiding operations that may result in uncontrolled air emissions during periods of atmospheric stability (late night and early morning), to the extent feasible, may reduce community odor complaints. The CEWG provides a forum for Intel-New Mexico to review their odor complaint reporting and investigating activities, particularly those related to the "burnt coffee odor" complaints.

Idiopathic Pulmonary Fibrosis

Conclusion

New Mexico Health Department conducted an epidemiologic investigation of the ten alleged cases in the Corrales New Mexico area in 2011. New Mexico Health Department did not observe a cluster of Idiopathic Pulmonary Fibrosis (IPF) in this investigation.

Recommendation

Area residents concerned that a specific disease or health concern may be attributed to environmental exposure can request that their physicians report this information to epidemiology and response division, NM Department of Health, P.O. Box 26110, Santa Fe, NM 87502-6110; or call 505-827-0006.

Amyotrophic lateral sclerosis

Conclusion

ATSDR cannot determine whether the ten purported cases of Amyotrophic lateral sclerosis (ALS) represent an increased rate.

The prevalence rate of ALS has not been well established and sufficient reporting data are not currently available to calculate state and local ALS rates.

Recommendation

New Mexico residents who have been diagnosed with ALS are encouraged to participate in ATSDR's ALS registry. This registry will be used to examine potential risk factors for ALS. ATSDR's ALS registry is accessible at **http://wwwn.cdc.gov/ALS/Default.aspx.**

Particulate Matter

Conclusion

ATSDR concludes that exposure to coarse airborne particulate (PM_{10}) may harm people's health in the greater Albuquerque area, including Rio Rancho and Corrales communities, during infrequent high wind conditions. Persons with respiratory disease are most vulnerable to exposure to elevated PM_{10} levels. Exposure to excess PM_{10} increases the likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in people with cardiopulmonary disease, older adults, and people of lower SES. Extremely high exposures may result in respiratory effects in the general population.

> PM_{10} levels exceeded the Environmental Protection Agency's 24-hour standard of 150 micrograms per cubic meter ($\mu g/m^3$) for PM_{10} during six high wind events from 2000 to 2008.

ATSDR concludes that fine airborne particulate ($PM_{2.5}$) may harm people's health to the Rio Rancho and Corrales communities (and greater Albuquerque) during large wildland fires that periodically occur in the Southwestern United States.

> $PM_{2.5}$ levels in the Albuquerque area exceeded the Environmental Protection Agency's 24-hour standard of 35 micrograms per cubic meter ($\mu g/m^3$) for $PM_{2.5}$ in June 2011 when the greater Albuquerque airshed was impacted by Wallow Arizona wildlands fire.

Recommendation

Area residents, particularly sensitive groups, are urged to take action to avoid exposure to unhealthy air from dust storms and wildland fires by following recommendations noted in the EPA Air Quality Index at http://airnow.gov/ (for Albuquerque) or http://www.cabq.gov/airquality/.

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Appendix A Timeline of ATSDR Activities at Intel-New Mexico Site

July 2004	ATSDR received a petition from a community group.
Aug 2005	ATSDR held public availability sessions to hear community concerns.
Aug 2007	ATSDR conducted a follow-up visit, met with the petitioner, held public meetings and provided health education to the community, and held meetings w/ NM Health Department, and Intel managers.
Oct 2008	ATSDR Intel-New Mexico team met with EPA Region 6 air program in Dallas.
Jan 2009	ATSDR wrote to NMED outlining observations about air emission reporting and recommending additional emission testing of air pollution control equipment.
Feb 2009	ATSDR released a public comment version of the health consultation.
Feb 2009	ATSDR conducted physician health education (UNM Hospital) to inform local area physicians about environmental odors and air contaminants, and held public availability meetings to discuss the public comment health consultation.
April 2010	ATSDR provides information on 1-Heptanethiol to the CEWG.
Jan 2011	ATSDR shared link to its ATSDR ALS webpage with community in response to community concerns.
April 2011	CEWG's Silica Testing Task Force issued a stack testing/modeling report about crystalline silica emissions in response to community concerns. ATSDR facilitated NIOSH laboratory support of the stack testing samples.
April 2011	ATSDR and NM DOH discussed ways to address to community concerns about a possible cluster of cases idiopathic pulmonary fibrosis (IPF) – After considering options, NMDOH conducts a case finding investigation and identified a dissimilar group of lung disease due to various causes.
Jan 2012	ATSDR provided toxicological information on hydrogen fluoride to CEWG, in response to a CEWG request.
Dec 2012	ASTD requested and received additional $PM_{2.5}$ and meteorology data from NMED's portable air monitoring stations, located at Acoma Trail in Corrales.
Aug 2013	ATSDR initiated monthly calls with John Bartlit (Chair - CEWG).
Mar 2014	ATSDR shared draft of final document with NMED, NM DOH, and EPA
April 2014	ATSDR provided toxicological information on chlorine and hydrogen chloride to CEWG in response to a CEWG request.

Appendix B Intel-New Mexico's Air Permit History

Permit Number	Month Year Issued	Selected Reasons for Permit
325	October 1980	Permit for original construction (Fab 7)
325-M-1	August 1984	Expansion to add Fab 9.1, 9.2, 9.3, and 9.4
325-M-2	February 1986	Increased VOC emission limits
325-M-3	February 1991	Upgraded boilers and increased VOC limits
325-M-4	July 1991	Removed Fab 9.4 from the plan
325-M-5	May 1992	Reconfigured scrubber exhaust
325-M-6	December 1992	Added new fabrication line and boilers
325-M-7	August 1994	Added a RCTO and changed boilers
325-M-8	January 1995	Installed another RCTO
325-M-8 R1	February 1997	Added new controls and agreed to stack testing
325-M-9	March 2000	Set limits for a "synthetic minor" source
325-M-9 R1	September 2000	Added an additional emergency generator
325-M-9 R2	December 2000	Re-designated two acid gas scrubbers
325-M-9 R3	December 2000	Relocated two acid gas scrubbers
325-M-9 R4	March 2001	Updated emission factors for boilers
325-M-9 R5	May 2001	Added four emergency generators
325-M-9 R6	September 2001	Relocated and installed scrubbers and an RCTO
325-M-9 R7	March 2002	Updated emission factors for the boilers
325-M-9 R8	September 2002	Updated emission factors for various sources
325-M-9 R9	March 2003	Updated emission factors for the boilers
325-M-9 R10	April 2003	Corrected two typographical errors in the permit
325-M-9 R11	April 2004	Updated emission factors for the boilers
325-M-9 R12	April 2004	Updated emission factors for RCTOs and scrubbers
325-M-9 R13	April 2006	Updated emission factors for several sources
325-M-9 R14	April 2007	Updated emission factors for several sources
325-M-9 R15	January 2008	Revisions to reflect installation of new RCTOs
325-M-9 R16	April 2008	Updated emission factors (e.g., for RCTOs, boilers)
325-M-9 R17	September 2008	Correction to typographical error in earlier permit
325-M-9 R18	November 2008	Revision to reflect removal of retired boilers
325-M-9 R19	February 2009	Installation of an ammonia treatment system
325-M9-R20	April 2009	Updated emission factors for several sources
325-M9-R21	June 2009	Renaming scrubber stacks
325-M9-R22	August 2009	Renaming scrubber and VOC stacks
325-M9-R23	January 2010	Updated emission factors for several sources

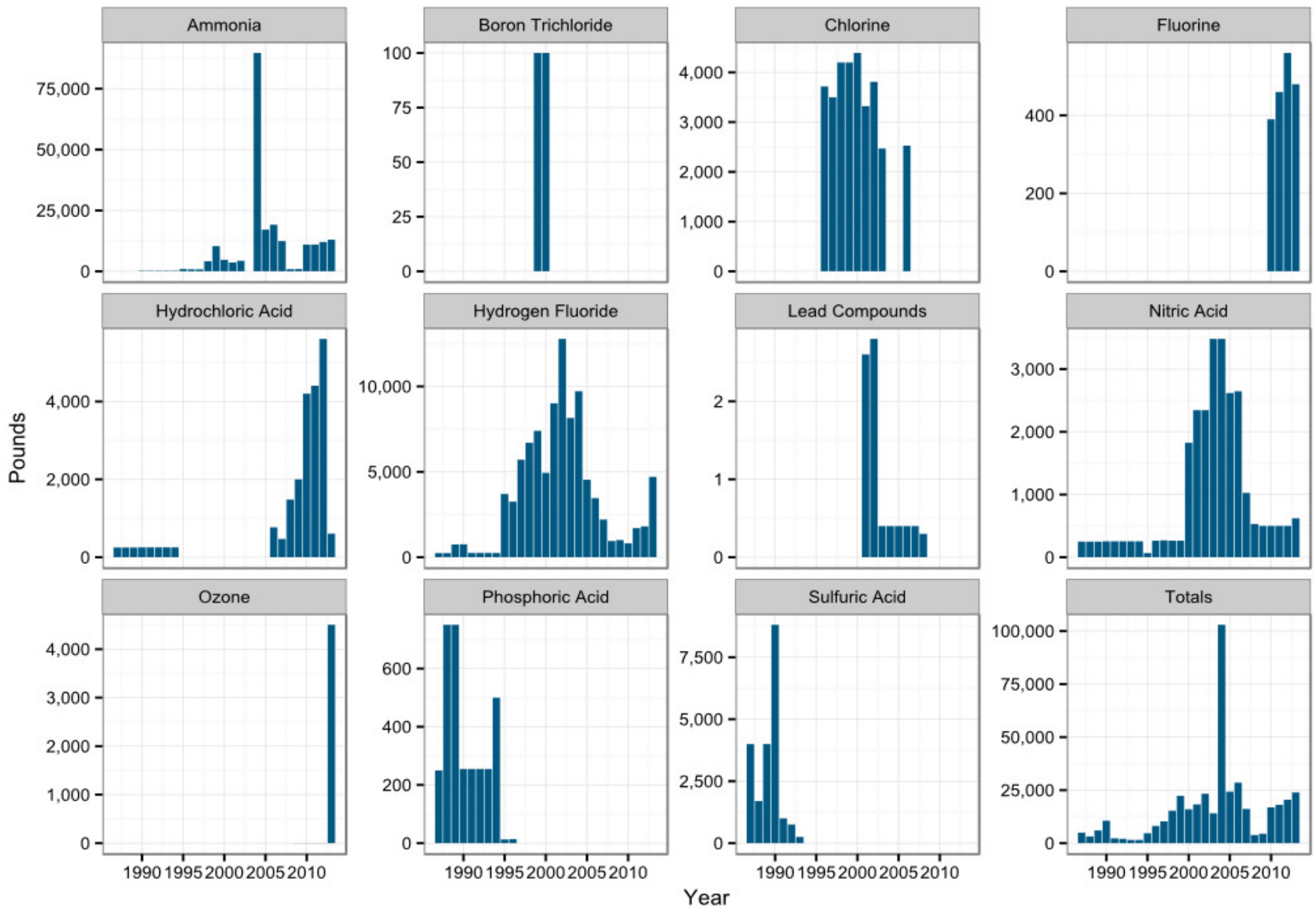
325-M9-R23	May 2010	Updated emission factors for several sources
325-M-10	December 2010	Installation of 5 thermal oxidizers; increased stack heights on all 10 RTOs (from 30 to 40 m)
325-M10-R1	February 2011	Reduction of TSP/PM10 emission limits for RTOs; relocation of 3 RTOs, 15 scrubbers, 5 cooling towers, and 4 boilers to the new Fab 11Xe area
325M10-R2	April 2011	Annual emission factor update
325-M-11	May 2011	Installation of 7 RTOs, 1 boiler, 10 cooling towers, 3 ammonia and 1 solvent wastewater treatment systems.
325-M11-R1	July 2011	Expand operating temperature range for the four ammonia treatment systems
325-M11-R2*	February 2012	Reduce maximum capacity of 5 permitted boilers
325-M11-R3	August 2012	Annual emission factor update
325-M11-R4	December 2012	Change permit to block-format; modified monitoring, recordkeeping, and reporting
325-M11-R5	April 2013	Modified fuel sulfur limit to reflect natural gas used at the facility
P257**	December 2013	Initial Title V permit established to maintain the facility as a Greenhouse Gas only major source

Notes: NMED assigned the Intel-New Mexico facility Permit Number 325. Permit modifications are designated by different "M" numbers, and permit revisions by different "R" numbers.

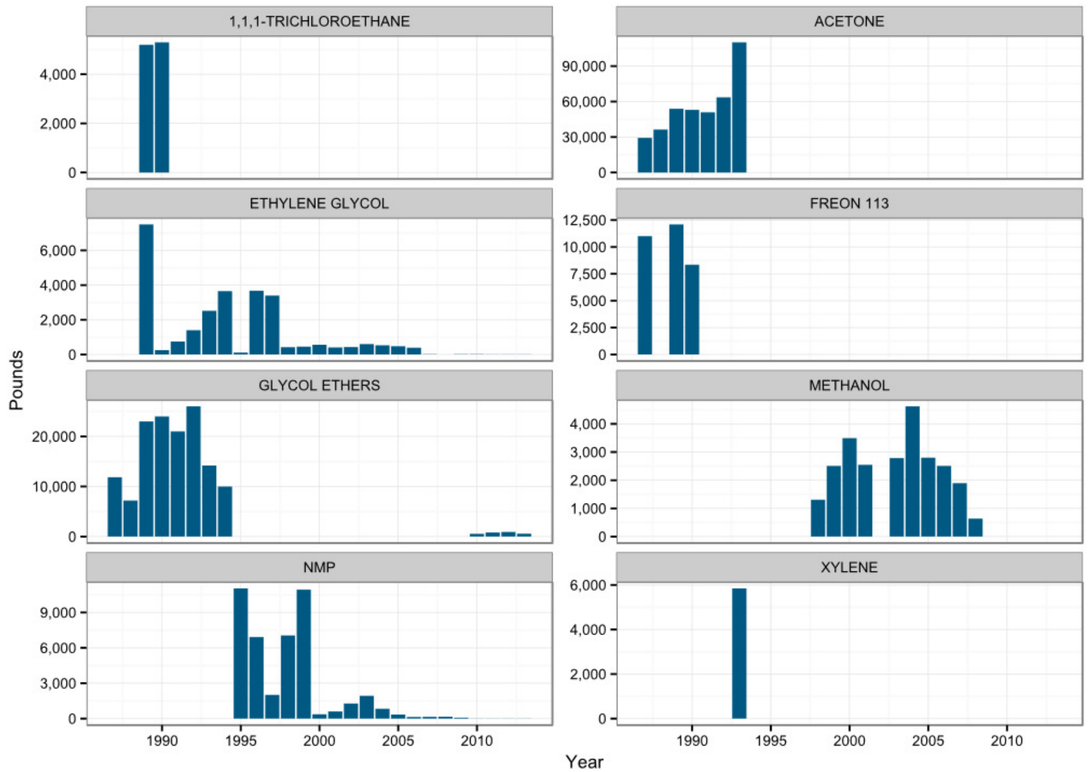
Permit modifications and revisions are typically issued for multiple reasons. The table lists some, but not all, of the reasons that updated permits were issued.

**No longer applicable as the result of a United States Supreme Court Decision (EPA, 2014a)

Appendix C Intel-New Mexico Toxic Release Inventory (TRI) Air Emissions, 1987-2013

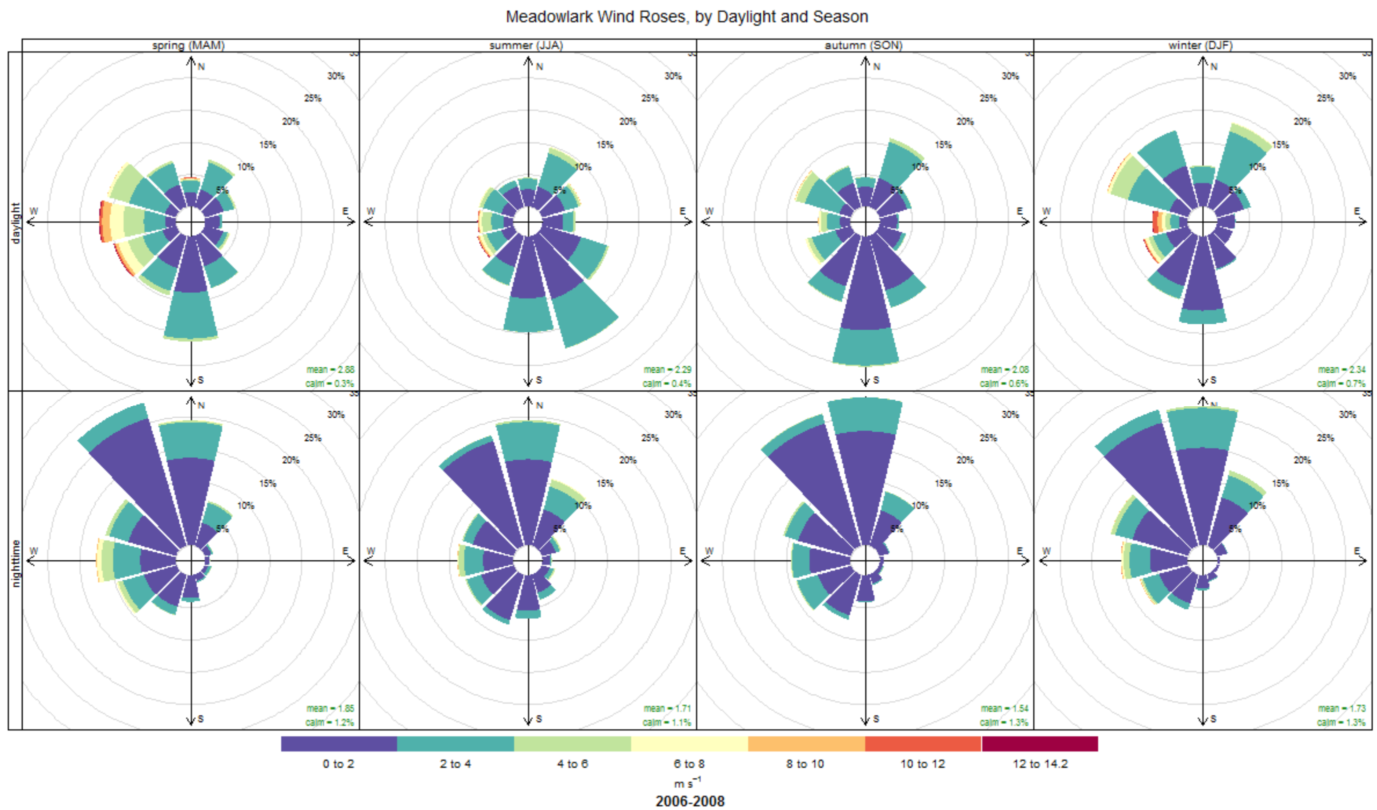


Appendix C Intel-New Mexico Toxic Release Inventory (TRI) Air Emissions, 1987-2013 - continued



Notes:
EPA did not require reporting of acetone after 1993
NMP = *N*-Methyl-2-pyrrolidone

Appendix D Wind Rose Graphs for NMED station at 4335 Meadowlark Drive



Appendix E ATSDR Letter to New Mexico Environment Department

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

JAN 30 2009

Mary Uhl
Air Quality Bureau Chief
New Mexico Environment Department
1301 Siler Road, Building B
Santa Fe, New Mexico 87507

Dear Ms. Uhl:

In June 2004, the Agency for Toxic Substances and Disease Registry (ATSDR) received a letter from a community group that petitioned our agency to address numerous health concerns specific to the Intel facility in Rio Rancho, New Mexico (referred to in this letter as "Intel-New Mexico"). Following our standard petition review process, a team of ATSDR environmental scientists, physicians, toxicologists, and other staff members carefully reviewed and accepted the request. In response, ATSDR is conducting multiple public health activities, including preparing a public health consultation on outdoor air pollution levels near Intel-New Mexico. ATSDR appreciates your agency's cooperation with the health assessment activities to date, and this letter is intended to inform New Mexico Environment Department (NMED) of some observations and findings that ATSDR made while evaluating the site data.

A key component of ATSDR's mission is to provide trusted health information to communities and to prevent harmful exposures to toxic substances. Consistent with this mission, ATSDR agreed to address numerous community concerns regarding Intel-New Mexico, given that these concerns were primarily motivated out of concerns about public health and welfare. Community members have asked ATSDR if the facility's air emissions are adequately characterized and if the available dispersion modeling studies offer reasonable portrayals of local air pollution levels. ATSDR recognizes that these activities fall under the mandates of environmental regulatory agencies, but decided to address these and other underlying concerns to be responsive to the community's original petition and more specifically to respond to community concerns about public health impacts resulting from potential exposures to air emissions from Intel-New Mexico.

The list below documents some findings and observations that ATSDR would like to bring to NMED's attention in the interest of addressing community health concerns regarding Intel-New Mexico's air emissions. This list is based primarily on a review of records maintained at NMED's Air Quality Bureau. However, ATSDR recognizes that NMED has a far broader knowledge base of the Intel-New Mexico facility through more than two decades of permitting activities, and that NMED may have already considered or even implemented some of the suggestions listed below. ATSDR offers the following suggestions strictly to ensure that current and future health evaluations of the facility's emissions data are based on the best available information and in a manner that is transparent to the local community. Some of these suggestions can be implemented with minimal expense to NMED or Intel-New Mexico:

- **Consider supplemental testing at the rotary concentrator thermal oxidizers.** The flame ionization detection (FID) method used to measure emissions from Intel's rotary concentrator thermal oxidizers (RCTOs) are useful for gathering quick insights on total organic compound emissions, but are also known to respond poorly when used to measure concentrations of oxygenated compounds, like many chemicals that Intel-New Mexico uses in large quantities. If Intel-New Mexico were to use a method more sensitive to oxygenated compounds (e.g., EPA Method 25) during at least some RCTO tests, NMED can have greater confidence in Volatile Organic Compounds (VOC) emissions data being reported for the RCTOs.

- **Consider supplemental testing at the scrubbers.** NMED may want to consider two enhancements to the testing strategy for Intel-New Mexico's scrubbers. First, the testing method Intel-New Mexico uses to measure chlorine emissions from the scrubbers (i.e., Environmental Protection Agency (EPA) Method 26A) can also be used to measure emissions of hydrochloric acid and hydrofluoric acid, without the need to collect any additional samples. If Intel-New Mexico were to use EPA Method 26A to measure these chemicals, this change could provide independent verification of the concurrent FTIR testing results, and with minimal increase in testing costs. Second, limited testing for VOCs (e.g., using EPA Method 18) in some of the scrubbers' exhaust streams could provide confirmation of several assumptions inherent in Intel-New Mexico's emissions inventory.

- **Consider additional testing to verify control efficiencies.** Intel-New Mexico currently calculates facility-wide emissions assuming that the RCTOs and scrubbers capture and destroy a certain proportion of the pollutants entering these devices. While these cut-offs are apparently based on existing testing data conducted by Intel-New Mexico, the facility has recently installed a new set of RCTOs and it is unclear if the previous testing of the retired RCTOs are directly applicable. If concurrent inlet and outlet measurements on at least some of the emissions tests for these RCTOs and scrubbers are conducted, NMED can continue to verify that Intel-New Mexico's RCTOs and scrubbers achieve the necessary level of pollution control.

- **Continue to implement thorough review of proposed changes to emission factors.** Intel-New Mexico's facility-wide emissions are estimated largely from emission factors, any changes to which NMED reviews and approves. ATSDR encourages NMED to continue this practice in the interest of transparency to community members, and to carefully review all underlying assumptions. In one instance, ATSDR identified some assumptions in a permit application that seemed unjustified. In this instance, Intel-New Mexico assumed that methanol emissions from an etch process would be zero because the process operated at a temperature

> greater than the auto-ignition temperature of methanol; however, the documentation does not refer to the correct auto-ignition temperature. In light of this example, ATSDR encourages NMED to continue to question assumptions such as these that might have an important bearing on Intel's emissions of toxic chemicals, which ultimately can cause nearby residents to be exposed.

ATSDR plans to release the health consultation titled "Review of Air Quality Data Intel Corporation" for public comment. The release date for the health consultation is February 2, 2009. The health consultation makes reference to this letter from ATSDR addressed to New Mexico Environment Department.

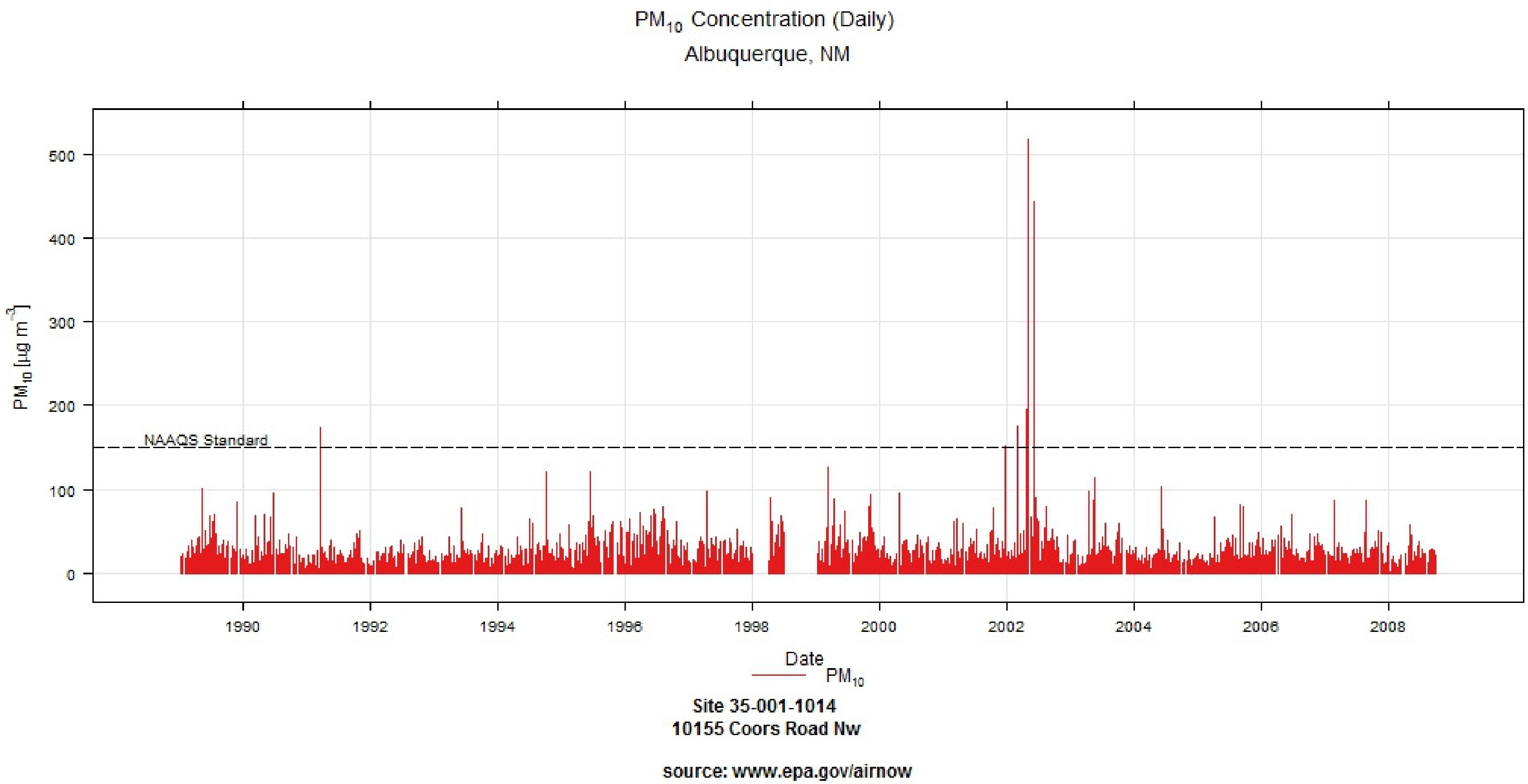
In addition, ATSDR will hold public availability sessions at the Inn at Rio Rancho at 1465 Rio Rancho Drive SE, Rio Rancho, New Mexico, 87124, on February 10, 2009 from 7 pm to 9:30 pm and on February 11, 2009 from 2 pm to 4 pm. The purpose of these meetings is to provide an overview of the public health consultation and answer questions.

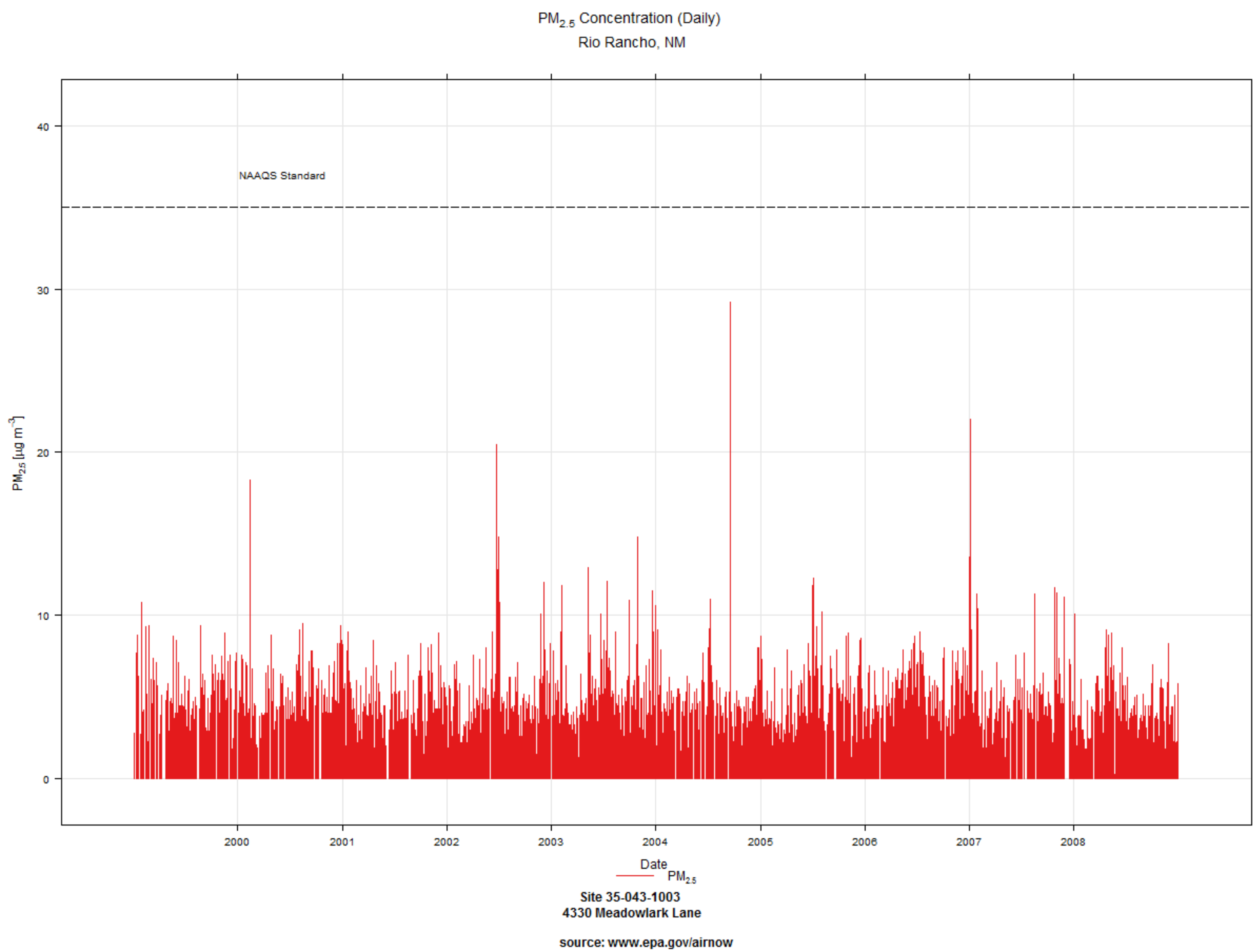
We appreciate the efforts taken by New Mexico Environment Department, New Mexico Health Department, and EPA Region 6 in attempting to resolve community concerns about air quality in Corrales, New Mexico. Please feel free to contact me at (770) 488-0606 or sym8@cdc.gov , or Peter Kowalski at (770) 488-0776 or pek2@cdc.gov, if you have any questions.

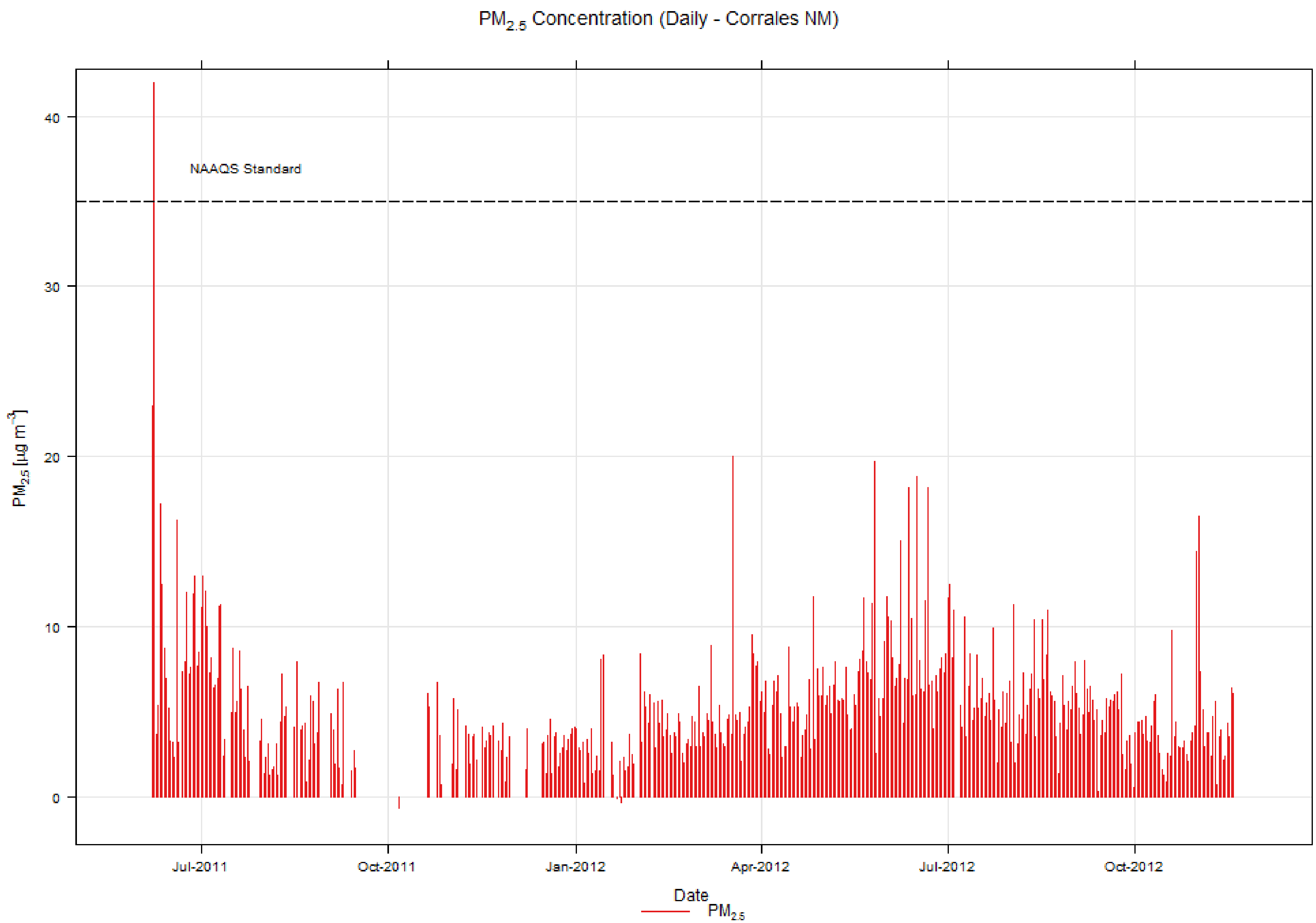
Sincerely,

Susan McAfee Moore
Chief
Exposure Investigation and Site Assessment Branch
Agency for Toxic Substances and Disease Registry

Appendix F Area Dust (Particulate) Monitoring Results




PM2.5 Concentration (Daily)
Rio Rancho, NM
NAAQS Standard
PM2.5 [µg m-3]
40
30
20
10
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
Date
PM2.5
Site 35-043-1003
4330 Meadowlark Lane
source: www.epa.gov/airnow

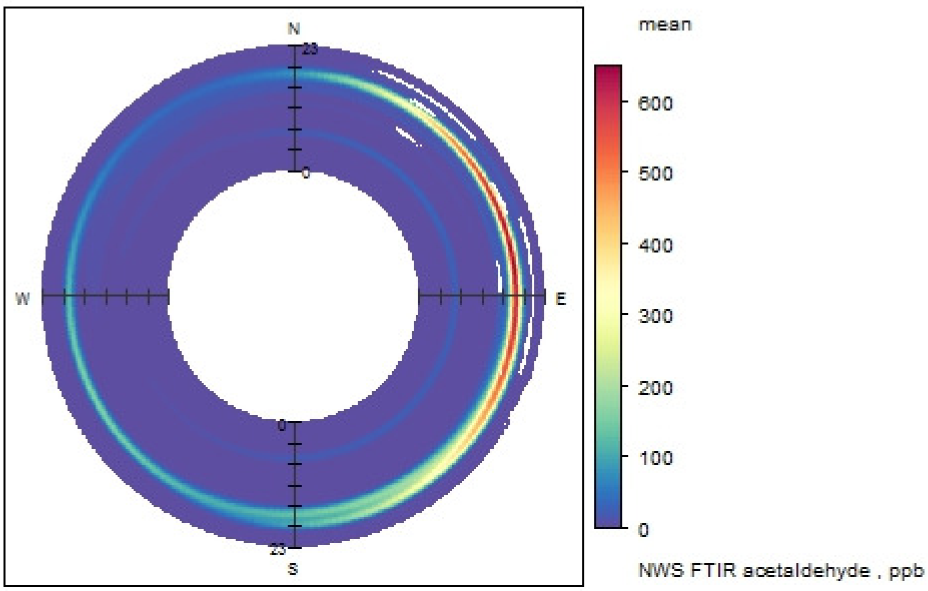


NMED Portable Monitoring Trailer

at 5 Acoma Trail Corrales NM

Appendix G Polar Annulus Plots - Acetaldehyde

Figure G – 1 Acetaldehyde levels (in parts per billion) by wind direction (from) and hour of day for the period August 1 - 9, 2003.

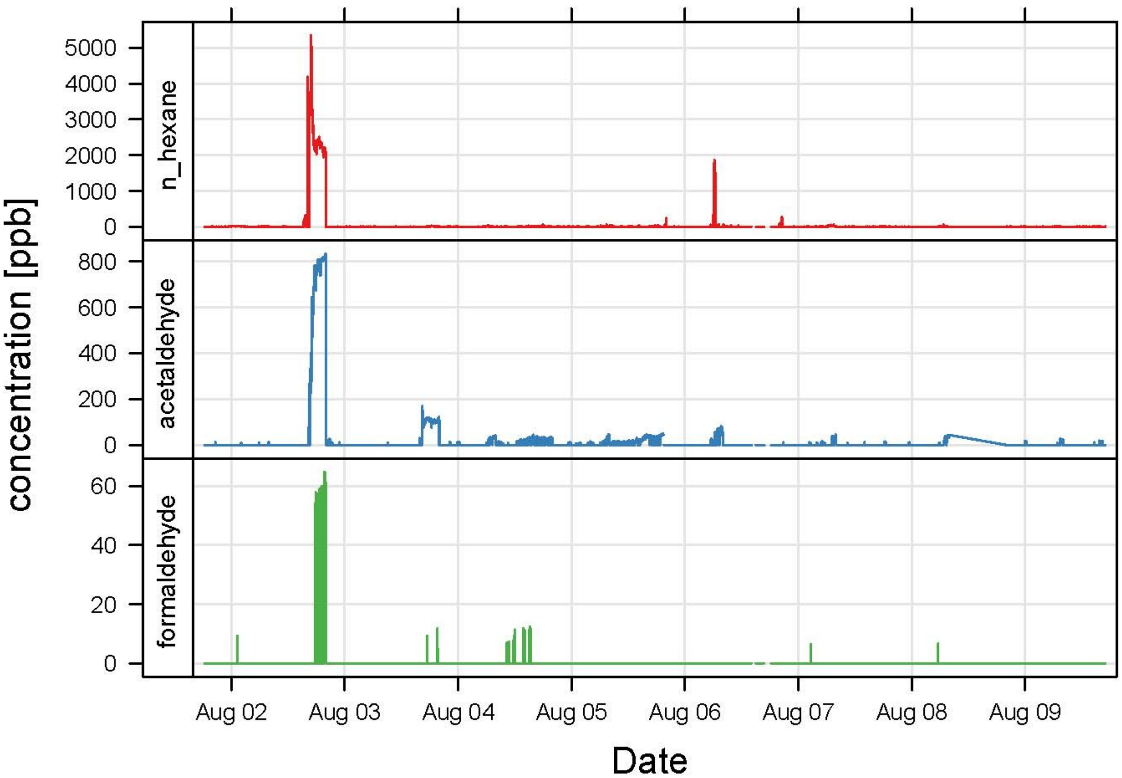


The highest levels were detected when the wind was blowing from the east around 6 PM on August 2, 2003. Peak levels of formaldehyde and n-hexane were also detected during this period as noted in the times series graph below. Acetaldehyde, n-hexane and formaldehyde are formed as byproducts of combustion, including stationary (e.g., boilers) and mobile sources (e.g., motor vehicles). The Intel- New Mexico plant was southeast of the monitor during this monitoring period (Figure 3). Intel-New Mexico's Central Utilities Building (CUB), Rio Rancho wastewater plant, and the crematory were east of the monitor during this period.

The maximum value (800 ppb) exceeded the EPA Reference Concentration of 5 parts per billion for chronic exposure. (The Reference Concentration is the estimate of continuous inhalation exposure to the human population, including sensitive sub-groups that is likely to be without an appreciable risk of harmful effects over a lifetime of exposure.) Acetaldehyde was detected 18.5 percent of the monitoring period (1805 of 9,747 data frames).

Figure G – 2

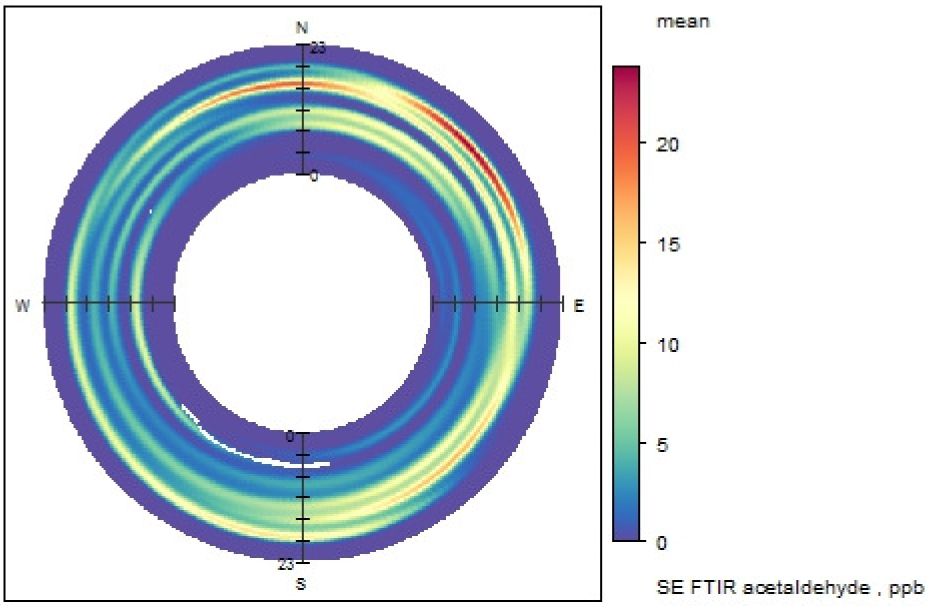
Acetaldehyde, Formaldehyde and N−Hexane Time Series − NWS Station FTIR



Formaldehyde levels exceeded ATSDR's acute MRL of 40 ppb during a 3 hour period on August 2, 2002. During this period formaldehyde was detected 1 percent of the period (101 of 9,747 data frames).

The n-hexane levels exceeded the Texas Commission on Environmental Quality's acute Effects Screening Level (ESL) of 1,800 ppb during a 3-hour period on August 2, 2002 (TCEQ, 2007). N-hexane was detected 24.7 percent of the monitoring period (2,406 of 9,747 data frames).

Figure G – 3 Acetaldehyde levels (in parts per billion) by wind direction (from) and hour of day for the period August 21 - September 7, 2003

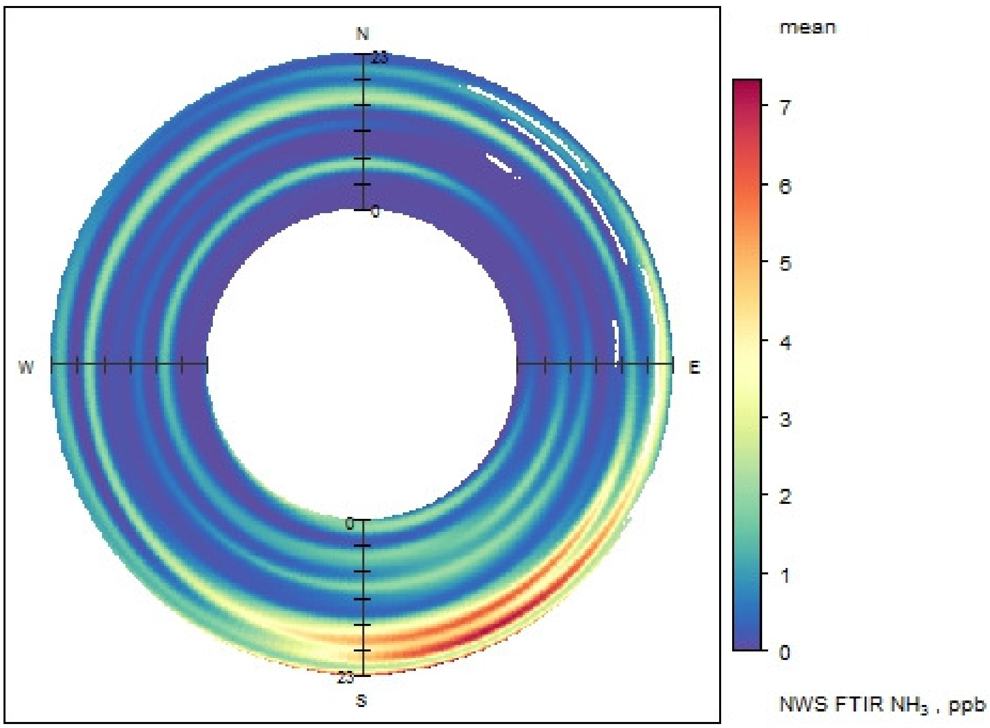


This polar annulus graph shows. Acetaldehyde is formed as a byproduct of combustion. The highest levels were detected when the wind was blowing from the northeast between 4 PM and 8 PM. The monitor was located on the southeast fence line of the facility (Figure 3). Intel-New Mexico's Central Utilities Building (CUB), Rio Rancho wastewater plant, and the crematory were north and northeast of the monitor during this period.

The maximum value (25 ppb), measured between 4 and 8 PM, exceeded EPA's Reference Concentration of 5 parts per billion for chronic exposure. (The Reference Concentration is the estimate of continuous inhalation exposure to the human population, including sensitive subgroups, that is likely to be without an appreciable risk of harmful effects over a lifetime of exposure.) Acetaldehyde was detected 12.8 percent of the monitoring period.

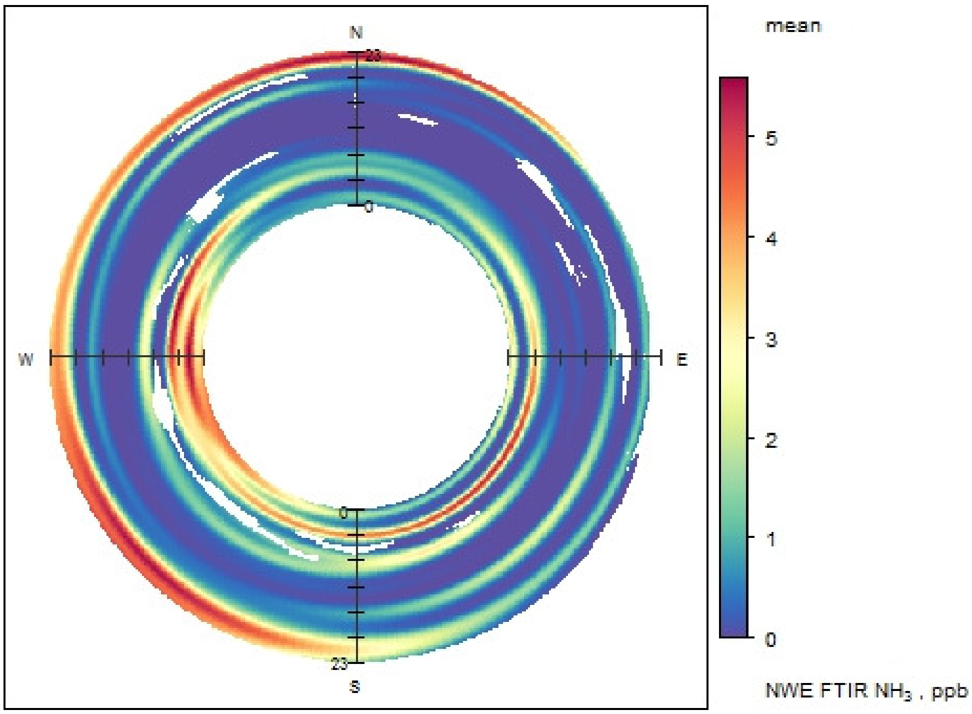
Appendix H Polar Annulus Plots – Ammonia

Figure H-1 - Ammonia levels (in parts per billion) by wind direction (from) and hour of day for the period Aug 1 - 9, 2003



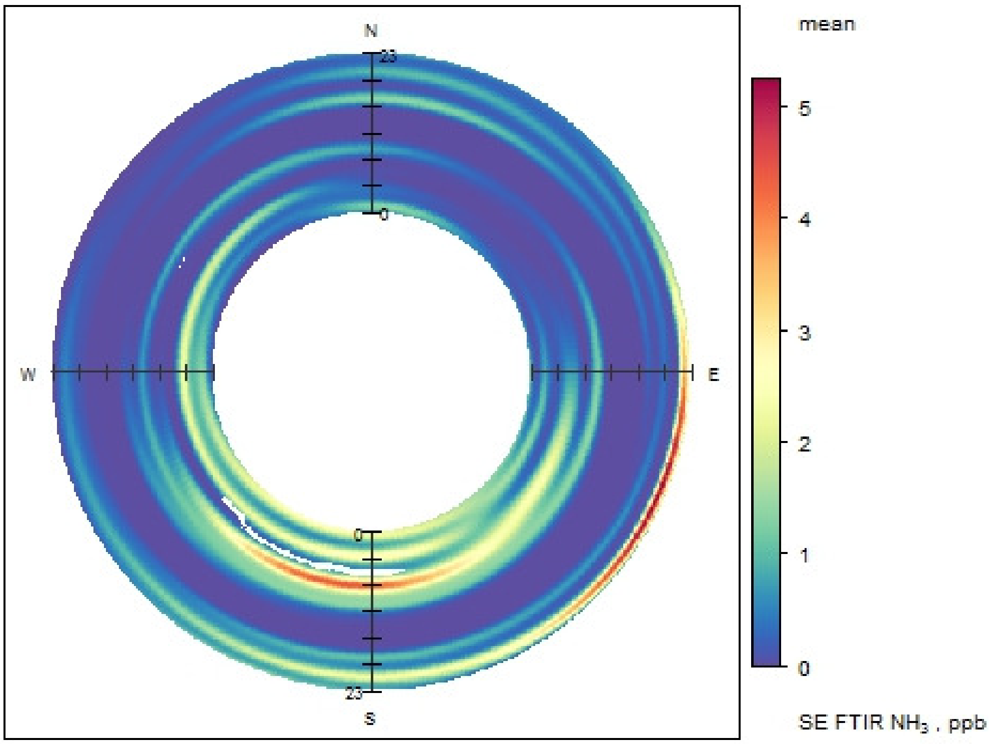
The highest ammonia levels were detected when the wind was blowing from the south-southeast (from the direction of the Intel-New Mexico Plant) between 4 PM and midnight. The Intel- New Mexico plant was southeast of the monitor during this monitoring period. The levels measured were below ATSDR's chronic Minimal Risk Level (MRL) of 100 parts per billion. Ammonia was detected 19 percent of the monitoring period.

Figure H -2 Ammonia levels (in parts per billion) by wind direction (from) and hour of day for the Aug 12 - 21, 2003



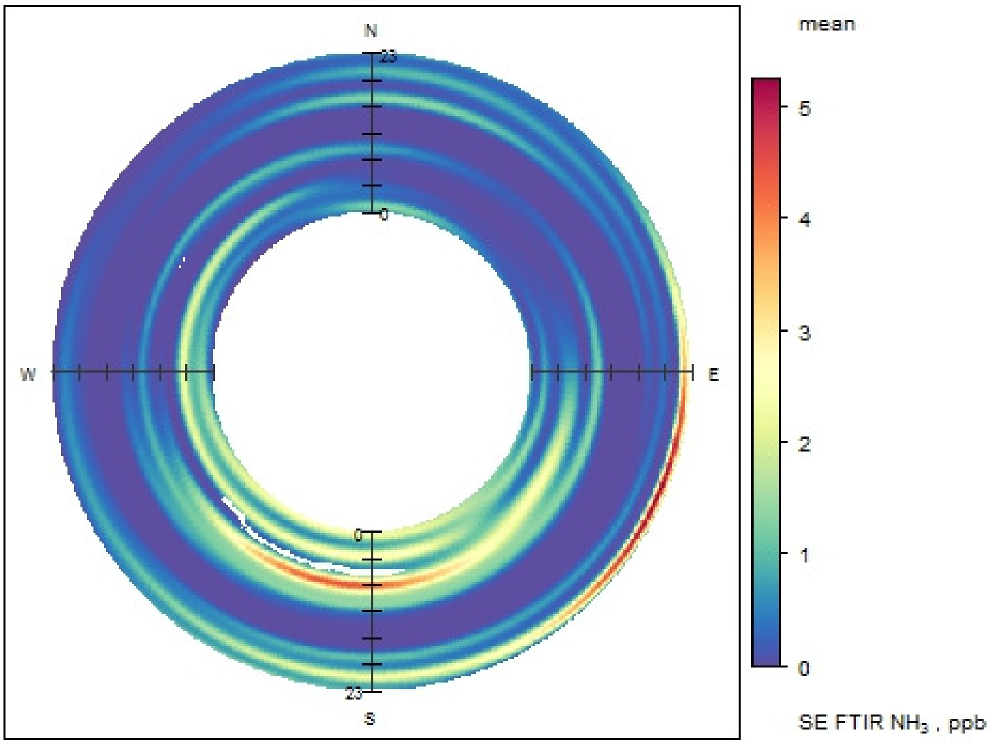
The highest ammonia levels were detected when the wind was blowing from the southwest between 8 PM and midnight and from the west from midnight to 4 AM. The Intel-New Mexico plant was south of the monitor during this monitoring period. The levels detected are below ATSDR's chronic Minimal Risk Level (MRL) of 100 parts per billion. Ammonia was detected 27.5 percent of the monitoring period.

Figure H -3 Ammonia levels (in parts per billion) by wind direction (from) and hour of day for Aug 21 - Sept 7, 2003



This polar annulus graph shows ammonia levels (in parts per billion) by wind direction (from) and hour of day for Aug 21 - Sept 7, 2003. Highest levels were detected when the wind was blowing from the south at 8 AM and when the wind was blowing from the southeast (toward plant) around midnight. The Intel-New Mexico plant was northwest of the monitor during this period. The 8 AM peak may be associated with morning rush hour motor vehicle traffic. Motor vehicles comprise 5 percent of the national air emissions of ammonia, second only to agricultural sources (EPA, 2003). The levels detected are below ATSDR's chronic Minimal Risk Level (MRL) of 100 parts per billion. Ammonia was detected 12.8 percent of the monitoring period.

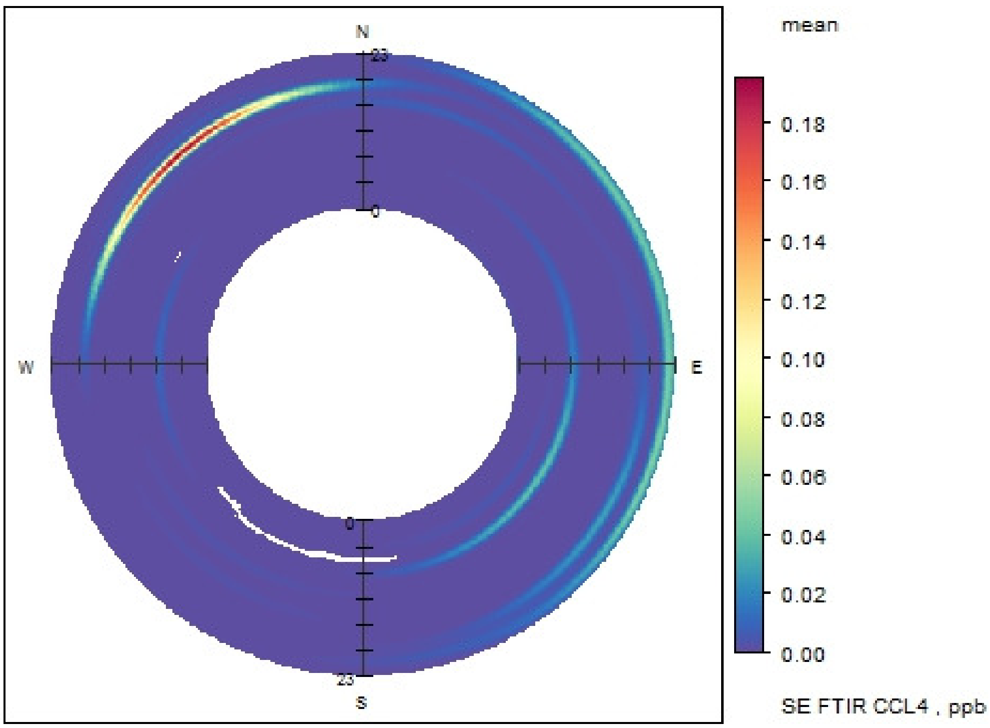
Figure H -4 Ammonia levels (in parts per billion) by wind direction (from) and hour of day Feb 24 - March 13, 2004



This polar annulus graph shows ammonia levels (in parts per billion) by wind direction (from) and hour of day Feb 24 - March 13, 2004. Highest levels were detected when the wind was blowing from the west (from the plant) at 3 to 7 AM and when the wind was blowing from the southeast (toward plant) around 8 AM. The Intel-New Mexico plant was west of the monitor during this period. The 7 - 8 AM peak may be associated with morning rush hour motor vehicle traffic.

Appendix I Polar Annulus Plot – Carbon Tetrachloride

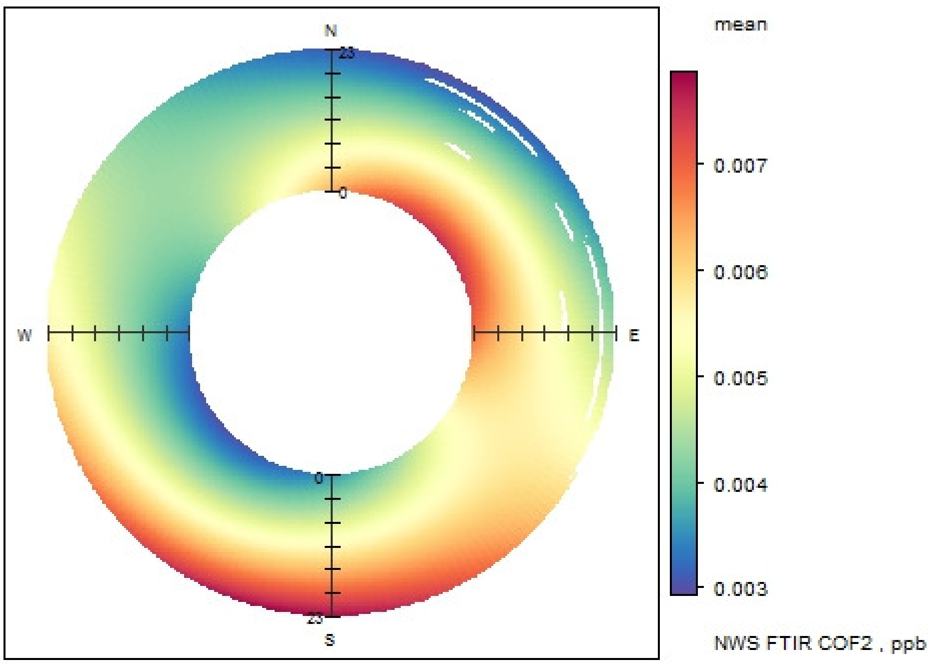
Figure 1 - 1 Carbon tetrachloride levels (in parts per billion) by wind direction (from) and hour of day for the period August 21 - September 7, 2003



The highest levels were detected when the wind was blowing from the northwest (from the direction of the Intel-New Mexico Plant) around 7 - 8 PM. The monitor was located on the southeast fence line of the facility (Figure 3). The measured levels were below ATSDR's Minimal Risk Level (MRL) of 30 parts per billion for long-term chronic exposure.

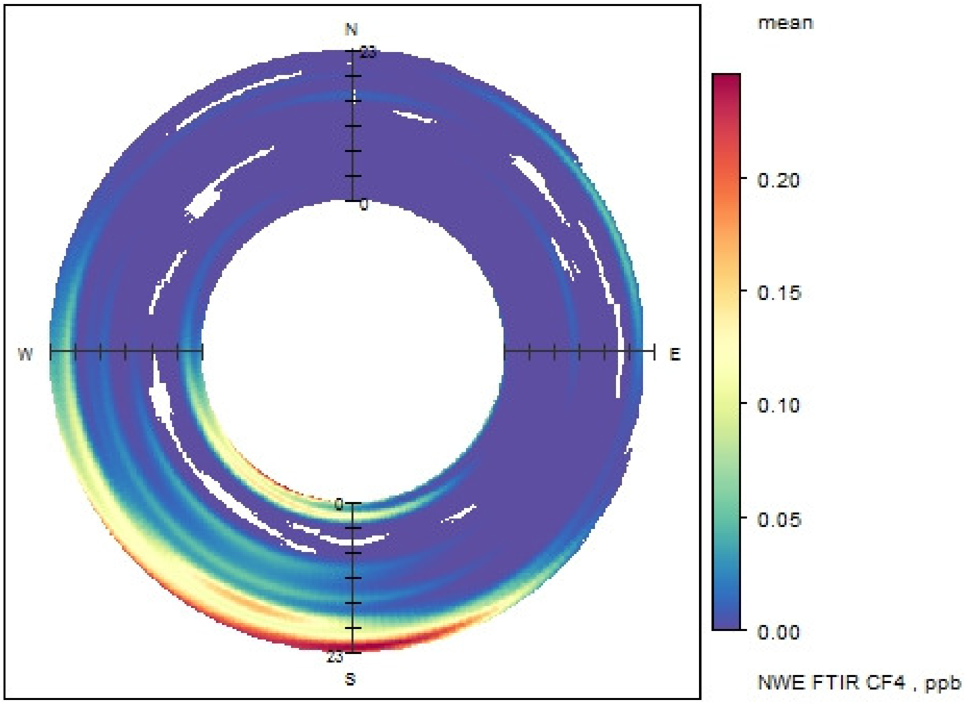
Appendix J Polar Annulus Plots – Select Fluorine-Containing Compounds

Figure J - 1 Carbonyl fluoride levels (in parts per billion) by wind direction (from) and hour of day for the period Aug 1 - 9, 2003.



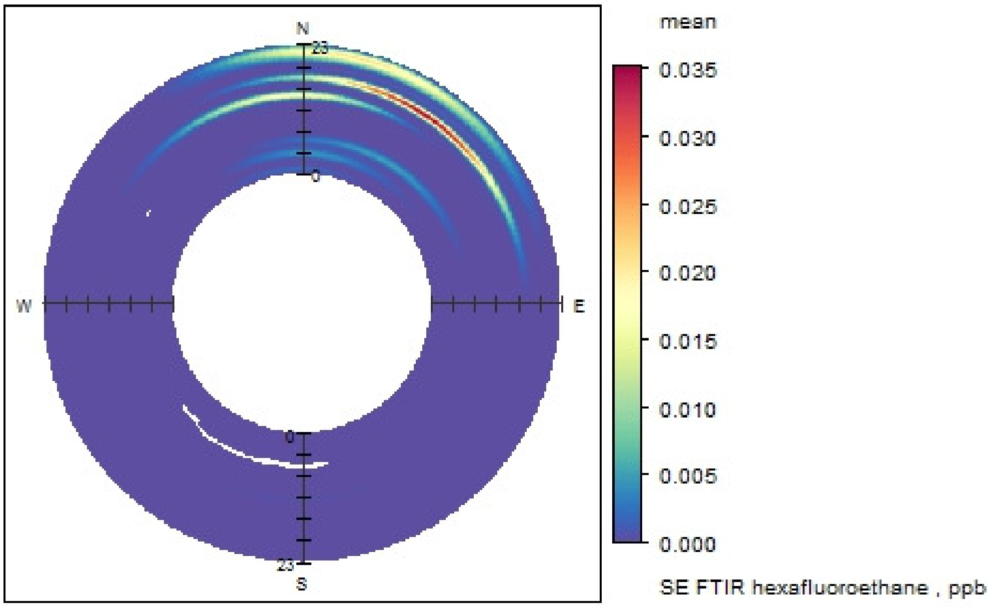
The highest levels were detected when the wind was blowing from the south (from the direction of the Intel-New Mexico Plant). The Intel-New Mexico plant is south/southeast of the monitor during this monitoring period. Carbonyl fluoride was detected 1.5 percent of the monitoring period (142 of 9,747 70-second data frames). There are no Minimal Risk Levels or Reference Concentrations for carbonyl fluoride. EPA has set an Acute Exposure Guideline Level-2 (AEGL-2) for carbonyl fluoride of 87 parts per billion for an eight hour exposure (USEPA, 2008b). AEGL-2 is the airborne concentration above which it is estimated that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure. The maximum level detected level (0.015 ppb) was approximately 5000 fold less than the AEGL-2 (87 ppb).

Figure J – 2 Carbon tetrafluoride levels (in parts per billion) by wind direction (from) and hour of day for the period Aug 9 - 21, 2003



This polar annulus graph shows carbon tetrafluoride levels (in parts per billion) by wind direction (from) and hour of day for the period Aug 9 - 21, 2003. The highest levels were detected when the wind was blowing from the south (from the direction of the Intel-New Mexico Plant) between 10 PM and 1 AM. The Intel-New Mexico plant is south of the monitor during this monitoring period. Carbon tetraflouride was detected in 10% of the monitoring period (1,095 of 10,986 dataframes.) The white space with the annulus shows periods when no carbon tetrafluoride was detected. ATSDR and EPA have not established health-based comparison values for carbon tetrafluoride.

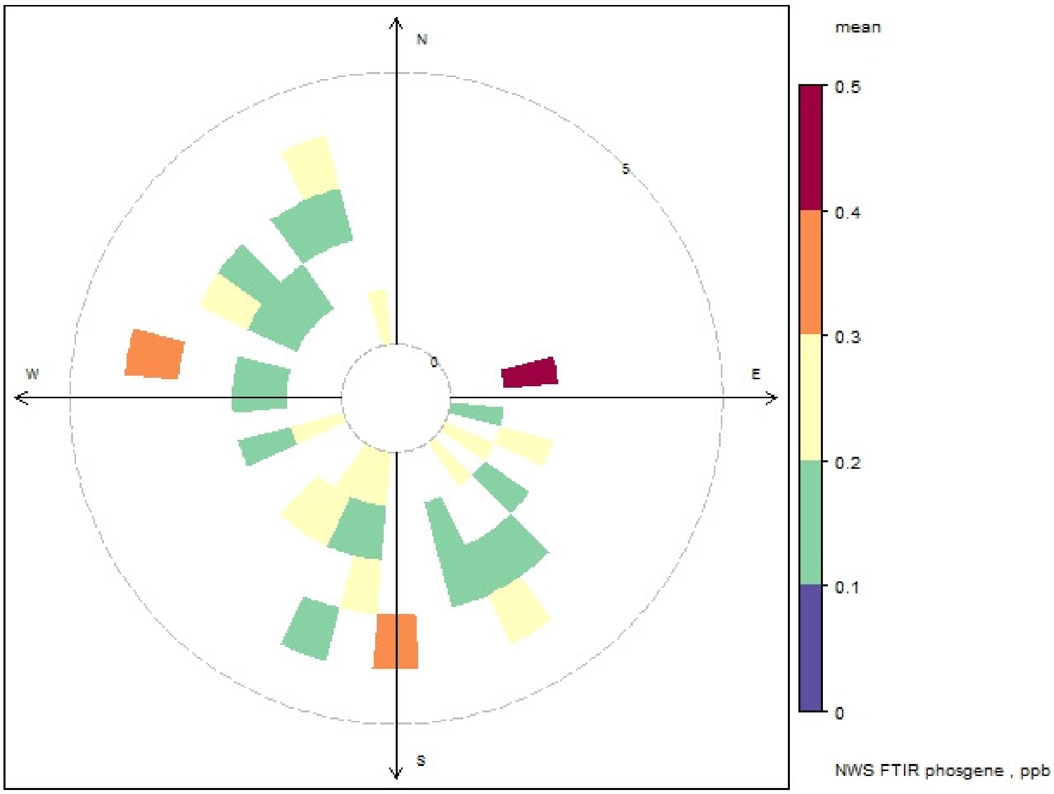
Figure J – 3. Hexafluoroethane levels (in parts per billion) by wind direction (from) and hour of day for the period August 21 - September 7, 2003



The highest levels were detected when the wind was blowing from the north-northeast and northeast between 8 PM and midnight and around 6 PM, respectively. The monitor was located on the southeast fence line of the facility (Figure 3). Intel-New Mexico's Central Utilities Building (CUB), Rio Rancho wastewater plant, and the crematory were north and northeast of the monitor during this period. ATSDR and EPA have not established comparison values for hexafluoroethane. Hexafluoroethane was detected 0.2 percent of the monitoring period (45 of 22,308 data frames).

Appendix K Polar Frequency Plots - Phosgene

Figure K – 1 Phosgene Levels by the wind direction (from) for the period August 1 – 9, 2003



This polar frequency graph depicts the wind direction (from) when phosgene was measured by the FTIR (in parts per billion). The Intel- New Mexico plant was located southeast of the monitor during this period (August 1-9, 2003). Phosgene was detected when winds were blowing towards and away from the Intel-New Mexico Plant. The phosgene levels measured were below the EPA health-based reference concentration of 74 parts per billion. Phosgene was detected in 40 of 9,747 frames, 0.4 percent of the monitoring period. Each frame consists of a 70 second period.

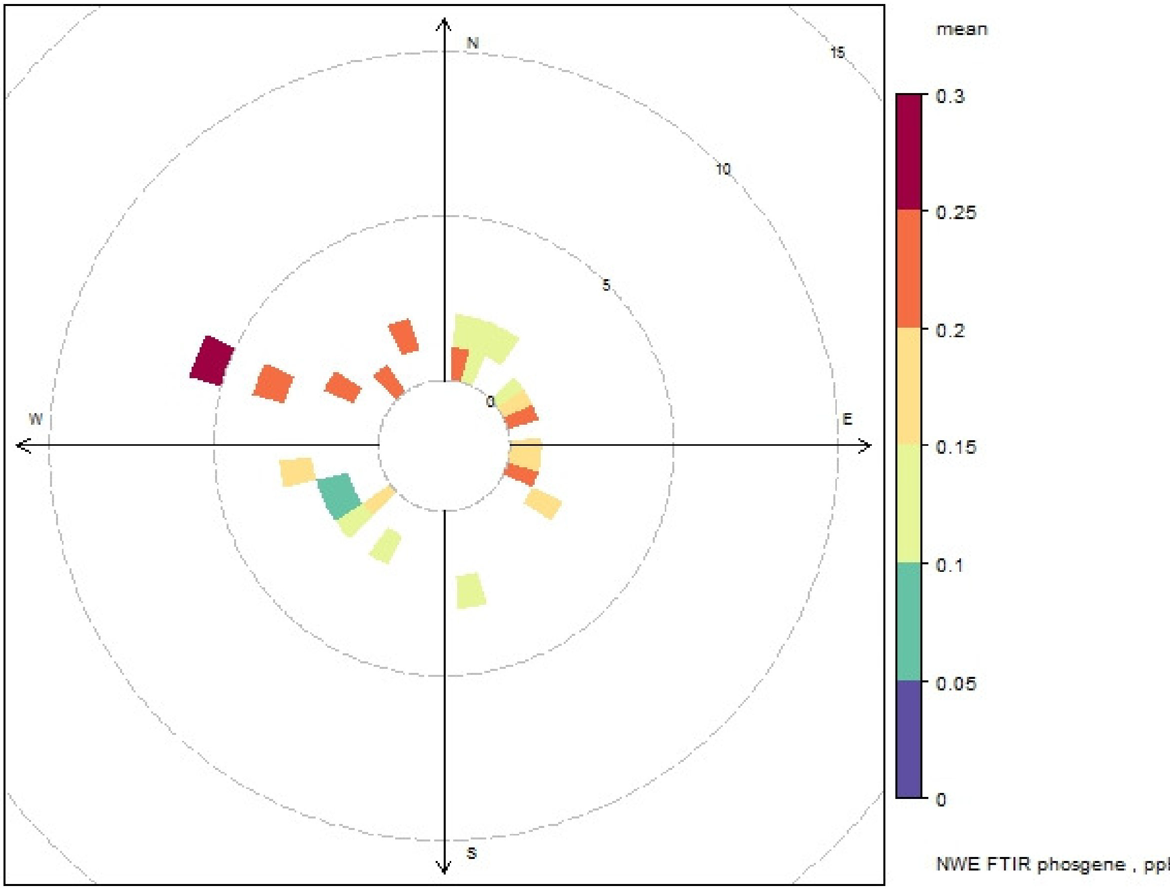
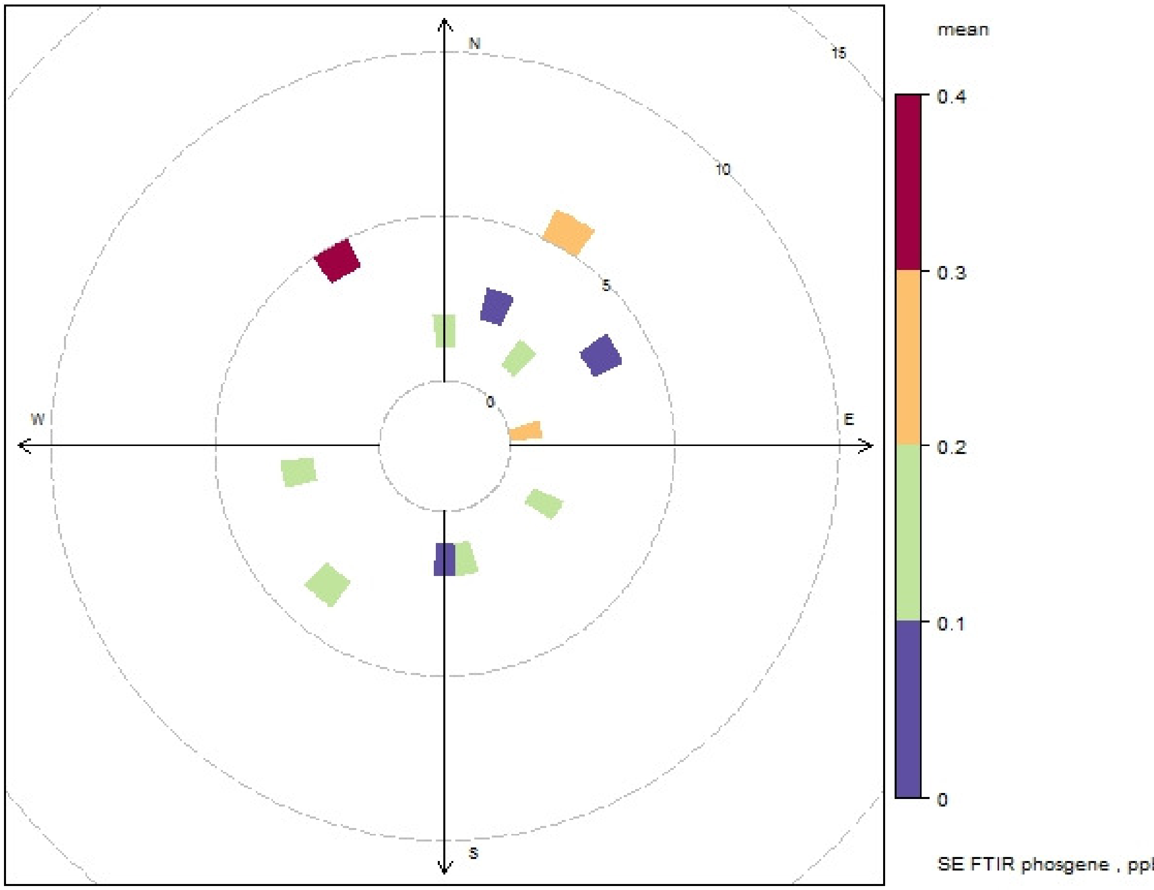


Figure K 2 Phosgene Levels by the wind direction (from) for the period Aug 12 - 21, 2003

This polar frequency graph depicts the wind direction (from) when phosgene was measured by the FTIR (in parts per billion) during Aug 12 - 21, 2003. The Intel- New Mexico plant was south of the monitor during this period. Phosgene was detected when winds were blowing toward and away from the Intel-New Mexico Plant. The phosgene levels measured were below the EPA health-based reference concentration for phosgene of 74 parts per billion. Phosgene was detected in 31 of 10,986 frames, 0.3 percent of the monitoring period. Each frame consists of a 70 second period.

Figure K-3 Phosgene Levels by the wind direction (from) for the period during August 21 – September 7, 2003



This polar frequency graph depicts the wind direction (from) when phosgene was measured by the FTIR (in parts per billion) during August 21 – September 7, 2003. The Intel-New Mexico plant was northwest of the monitor during this period. Phosgene was detected when winds were blowing toward and away from the Intel-New Mexico Plant. The phosgene levels measured were below the EPA health-based reference concentration for phosgene of 74 parts per billion. Phosgene was detected in 12 of 22,309 frames, 0.1 percent of the monitoring period. Each frame consists of a 70 second period.

Appendix L Silica Testing Task Force Report Summary

Note:

The Silica Testing Task Force appendices are not included in Appendix L but they can be viewed at Community Environmental Working Group website link http://www.cewg.org/silicon-dioxide/.

SILICA TESTING TASK FORCE REPORT

Community Environmental Working Group

April 20, 2011

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List of Acronyms

ACFM	Unit of flow; Actual Cubic Feet Per Minute
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
°C	Unit of Temperature; degrees Celsius
CEWG	Community Environmental Working Group
CDC	Centers for Disease Control
CFR	Code of Federal Register
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Conc.	Concentration
DHAC	Division of Health Assessment and Consultation
DSCFM	Unit of Flow; Dry Std. Cubic Feet Per Minute (corr. To 29.92" Hg & 25°C)
EPA	Environmental Protection Agency
F11X-F-side	Fab 11X Fab Side location designation
F11X B-side	Fab 11X Bridge Side location designation
°F	Unit of Temperature; degrees Fahrenheit
HMDS	hexamethyldisilazane
Lbs/hr	Unit of emissions; pounds per hour
LOD	Limit of detection
LOQ	Limit of Quantitation
MW	Molecular Weight
NA	Not Applicable
ND	Non-Detected (value below the analytical/instrument limit of detection)
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
TPY	Unit of emissions; Tons per Year
ppm	Unit of concentration; parts per million
RM	Reference Method
RCTO	Recuperative Thermal Oxidizer
-RO	Rotor Outlet, synonymous with Wheel Exhaust of the Munters Systems Exhaust measurement point prior to common wheel exhaust manifold and stacks
SCFM	Unit of Flow; Std. Cubic Feet Per Minute (corr. To 29.92" Hg & 25°C)
SOP	Standard Operating Procedure
SS	Stainless Steel
STTF	Silica Testing Task Force
-TO	Thermal Oxidizer (separate stack designation on MUNTERS systems)
TFE	Teflon
µg	microgram
$\mu g/m^3$	microgram per cubic meter
QA	Quality Assurance
QC	Quality Control
VOC	Volatile Organic Compound (synonymous with Total Hydrocarbon)
WHEEL	Represents the exhaust of the Concentrator of the Munters System Further identified as the Rotor Outlet and also the fresh air exhaust
XRD	X-Ray Diffraction Analysis

1.0 Executive Summary

Intel's potential to emit crystalline silica to the air has concerned diverse interests, including Intel, for years. By varied means, the concerns are voiced repeatedly – to Intel, in newspapers, in a published book, to the N.M. Air Quality Bureau, to the U.S. Agency for Toxic Substances and Disease Registry (ATSDR), and repeatedly at public meetings of the Community Environmental Working Group (CEWG). The public concerns voiced to the ATSDR led that agency to recommend more testing of crystalline silica from the stacks at Intel.

To address these concerns, the CEWG appointed a Silica Testing Task Force (STTF) to design and carry out a program which would test the emissions from the Intel thermal oxidizers emissions for crystalline silica. The primary objective of the testing was to determine whether crystalline silica concentration at-the-fence were above a CEWG provisional level. If the concentrations were above the provisional level, further studies would be conducted to identify the validity of the provisional study and other factors that influence the health risks that might be posed by the emissions.

STTF developed a sampling program that was carried out with the assistance of an Intel contractor Environmental Resources Management (ERM) and the National Institute for Occupational Safety and Health (NIOSH). ERM used standard stack sampling techniques to collect filter samples from Intel recuperative thermal oxidizers (RCTO) stacks while being observed by citizen volunteers. Because the sampled gas temperatures are too high to permit the use of the filters normally used for samples for X-Ray Diffraction Analysi*s (*XRD) analysis of crystalline silica, a modified approach to insure field sampling compatibility with silica specific analyses was developed by ATSDR[1], ERM, and NIOSH[2] crystalline silica expert Rosa Key-Schwartz. The stack sampling was carried out using Environmental Protection Agency (EPA) stack-sampling techniques and measurements that were closely observed. All five RCTO stacks were sampled simultaneously four times (test runs) for an extended period to include representative periods of the day.

The collected filters were sent to NIOSH with careful chain of custody procedures. Measureable crystalline silica concentrations were found on only one of the filters and the measured level was far below the CEWG provisional level. The highest estimate of emissions estimates of the crystalline silica consistent with the data were very low so that very much higher levels of hexamethyldisilazane (HMDS) could be used without approaching the CEWG provisional level. Even the highest estimate of emissions consistent with the measured data in this silica testing program would have to be 15,000 times higher to approach the CEWG provisional level. As a further check at-the-fence concentrations with the use of previously developed dispersion models

[1] See www.atsdr.cdc.gov
[2] See www.cdc.gov/NIOSH

were estimated under the assumption that all of the particulate matter was crystalline silica. The result was still quite low compared to CEWG provisional level.

Crystalline Silica was found in only 1 of the 20 collected stack samples from the five (5) Intel RCTO's;

- 310 µg found on one sample = 103 µg/m^3 volume in stack
- The detected value equates to 0.0000177 µg/m^3 at fence line (55,000 times less than the CEWG's provisional level)
- If all other non-detect samples @ level of detection added together = 0.0000634µg/m^3 at fence line (15,000 times less than the CEWG provisional level)
- CEWG Provisional level = 1.0 µg/m^3 at fence line

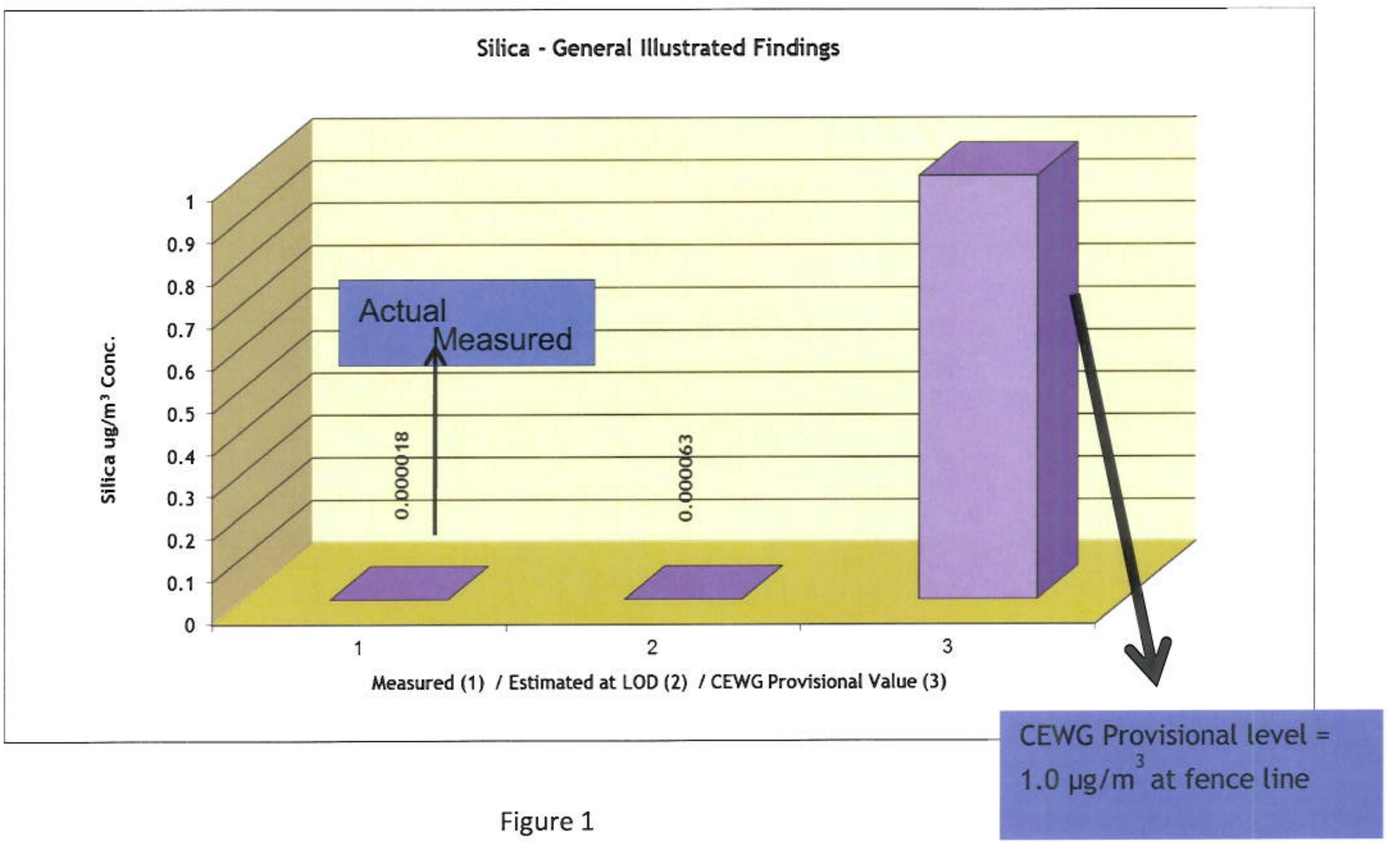

Figure 1

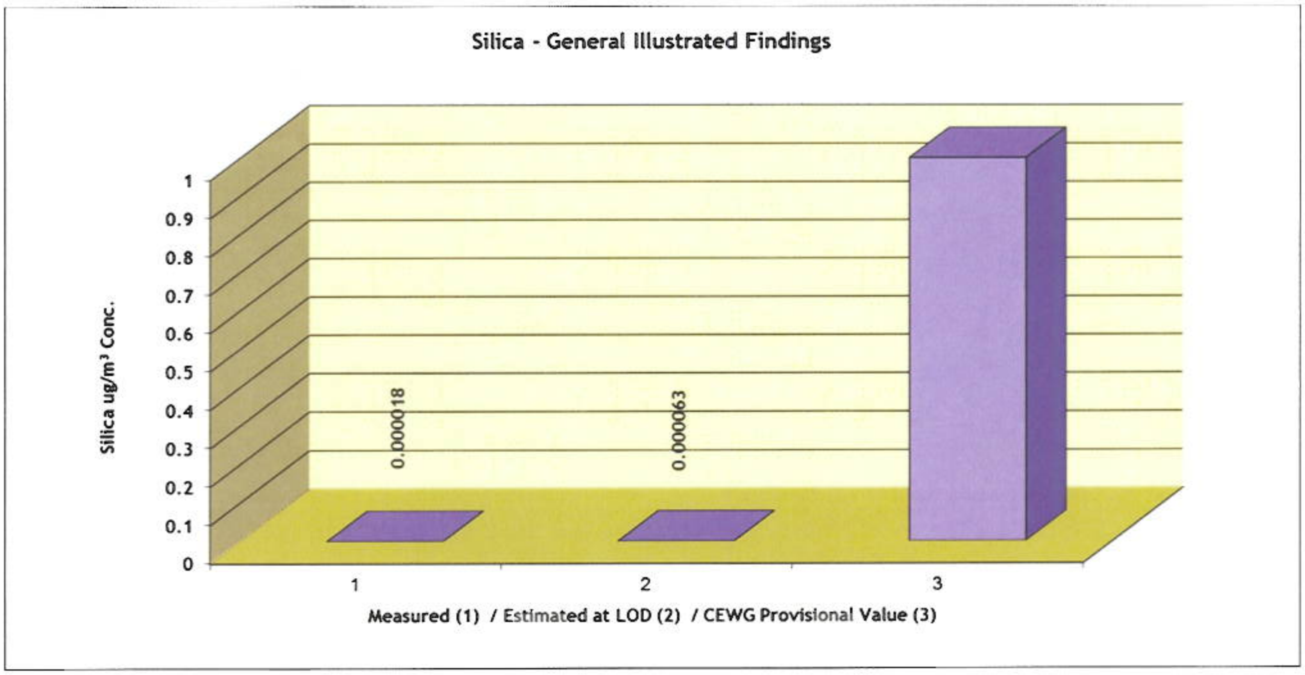
Silica - General Illustrated Findings
Silica ug/m³ Conc.
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.000018
0.000063
1
2
3
Measured (1) / Estimated at LOD (2) / CEWG Provisional Value (3)

Figure 2

2.0 Background

The Intel plant at which this testing occurred is located in Rio Rancho, New Mexico, adjacent to the Village of Corrales and near Albuquerque. The potential to emit crystalline silica from the VOC control systems (thermal oxidizers) at this plant has concerned diverse interest groups from these areas and elsewhere, and the topic of increased discussion in the past years. The public concerns voiced to the ATSDR led that agency to recommend additional testing of crystalline silica from the stacks of the Munters and Durr thermal oxidizers at Intel (Public Health Consultation, Intel New Mexico Facility, Public Comment Release, Feb. 2, 2009, p. 42, Recommendations). The ATSDR suggested measuring crystalline silica collected (deposited) in the units. CEWG proposed testing for the presence of crystalline silica concentration in the emissions of the thermal oxidizers to determine if there was detectable levels of crystalline silica emitted as part of Intel's particulate matter, and if silica was found at quantifiable levels, to accurately quantify the silica concentration and relative mass in the emissions sources that could be used for further modeling studies to assess potential fence line concentrations of the material.

An initial test plan, or citizen protocol, was discussed and drafted by the CEWG in support of this proposed sampling effort. The proposed program was discussed by the CEWG, STTF and its consultants, ERM, ATSDR, and NIOSH.[3] All of these groups were very active in the design of the process. ERM, ATSDR, and NIOSH were in communication and agreement in the type of filter media and NIOSH analytical methods.

An initial test plan or citizens protocol was discussed and drafted by CEWG and Intel in support of this proposed sampling effort. The proposed program was discussed between ERM, ATSDR, and NIOSH in defining an appropriate sampling method that would meet the objectives of the CEWG draft plan, with communication and agreement on the type of filter media, and duration of sampling in support of the silica assessment.

The field program was conducted by ERM, with direct interaction with CEWG in observing the execution of the sampling, recovery and packaging of the samples, completing the chain-of-custody forms, and observing daily sample shipments to the NIOSH approved third party laboratory to express mailing drop-offs.

Once laboratory data has been compiled by NIOSH, the lab data and supporting documentation is to be disseminated through appropriate representatives of CEWG, whom will incorporate the lab data with the source test information, provided herein, and conduct an independent and/or

[3] (NIOSH is described in Wikipedia in part as follows: "The National Institute for Occupational Safety and Health (or NIOSH) is the United States federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH is part of the Centers for Disease Control and Prevention (CDC) within the U.S. Department of Health and Human Services.... NIOSH is a professionally diverse organization with a staff of over 1,400 people representing a wide range of disciplines including epidemiology, medicine, industrial hygiene, safety, psychology, engineering, chemistry, and statistics. The director of NIOSH is John Howard.")

parallel calculation of PM/silica concentrations and emissions in support of the program assessment reporting.

Concerns have been voiced to Intel, in newspapers, in a published book,[4] to the N.M. Air Quality Bureau, to the U.S. Agency for Toxic Substances and Disease Registry (ATSDR), and repeatedly at public meetings of the Community Environmental Working Group (CEWG). The public concerns voiced to the ATSDR led that agency to recommend more testing of crystalline silica from the stacks at Intel. The CEWG proposes testing the crystalline silica emissions from both the Durr and Munters thermal oxidizers.

The ATSDR suggested measuring crystalline silica collected (deposited) in the units. The CEWG proposal differs slightly from this suggestion. The CEWG proposes measuring crystalline silica concentrations in the emissions to: 1) determine if there are detectable concentrations of crystalline silica emitted as part of Intel's particulate matter and 2) ascertain if further size distribution measurements of any crystalline silica are required to understand the possible health consequences of the emissions. The sampling and testing documented herein address specifically whether or not crystalline silica is present and emitted from the RCTO stacks at a provisional significant level adopted by the CEWG as $1 \mu g/m^3$ annual average at the Intel fence line.[5] The original questions posed by the ATSDR Follow up Committee are below and the entire documentation including answers to the questions are included in Appendix C.

[4] "Boiling Frogs: Intel vs. The Village," by Barbara Rockwell, iUniverse, Inc., 2009, chapter "The First Body Down the River." pp. 199-203

[5] The reference used for the provisional "safe level" is: U.S. Environmental Protection Agency, "Ambient Levels and Non-Cancer Health Effects of Inhaled Crystalline and Amorphous Silica: Health Issue Assessment," EPA/600/R-95/115, November 1996, pp 5-17 through 5-21 and Appendix B-6.

3.0 Planning, Sampling, Testing, and Analysis Overview

3.1 Planning

Innovative Process of Community Involvement. The crystalline silica testing project was planned and carried out using an unusual community-centered process and uncommon resources. Distinctive features of the process, taken together, create a model for fresh approaches to environmental issues in communities generally. Unique features of community participation include:

1. The testing project was planned by a specially-formed, self-governing community committee -- the Silica Testing Task Force.

- The STTF had six members: two non-Intel members of the CEWG, one Intel member of the CEWG, and three task force members nominated by Mayor Phil Gasteyer of the Village of Corrales. Two of the mayor's nominees are currently elected village councilors and the third was elected to be chair of the STTF by its members.
- All aspects of the project were planned by the STTF in open public meetings. Minutes of the meetings are available.

2. The sampling of stacks at Intel was witnessed by eight community volunteers.

- Three of the volunteers were the mayor's nominees on the STTF.
- Each volunteer, two at a time, worked one of the four sampling shifts -- two day shifts and two night shifts completed over four days. The Intel STTF member attended all four sampling events.

3. The sample testing was done by a subcontracted analytical laboratory (Bureau Veritas) of the National Institute for Occupational Safety and Health (NIOSH), affiliated with the U.S. Centers for Disease Control and Prevention. Access to this non-commercial national testing resource was extremely valuable and greatly appreciated.

- The test results were sent only to the chair of the STTF. Intel did not see the results before the community did.

4. The specific computations that tell the meaning of the test results in context with local air quality were established and agreed on before the sampling began.

- A strict, provisional level of crystalline silica was established to guide further work. "Strict" means having a large margin of safety compared to existing standards in the nation and other states and the latest knowledge base for effects of silica. "Provisional" means the CEWG work to follow depends on whether test results are lower, higher or much higher than the provisional level.

- The specific computations, provisional level, and follow-up actions were laid out at a community meeting and remained subject to scrutiny and revision for six months before sampling began.
- The project found that planned actions and follow-up are easier to agree on before the test results are known.

All together, this array of procedures and resources represents a fresh approach to a long-standing community concern. The procedures were designed in public to deal with specific doubts about Intel's prior testing routine, as well as to utilize the unique history of the community itself.

3.2 Sampling Overview

The primary focus of the sampling program was to support testing of crystalline silica from the stacks of the Munters and Durr thermal oxidizers at the Intel facility. As there are no direct prescribed methods for silica sampling from stationary sources, a sampling approach was designed and executed that supported the proper methods for sample collection, sampling handling, and sample analyses to meet the program objectives. The program was designed around the quantitative and representative collection of particulate from all the site's thermal oxidizer exhaust stacks with appropriate handling and subsequent analyses for both total particulate and silica (a subset of the collected particulate) to assess the silica emissions from all the Intel facility thermal oxidizer systems.

As overall approach was to conduct particulate sampling and take the exposed filters from the qualified test runs and analyze the filters for total particulate with further analyses for presence of silica, it was important to insure that overall approach supported compatible methods, representative processes, and defensible results.

This required the collaborative effort of (1) designing the field method (for quantifying the TO exhaust characteristics) that was compatible with the analytical methods (for taking the collected samples and analyzing for silica); (2) defining the method requirements that would support sufficient sample collection, (3) developing a test schedule that would test all units concurrently (refer to previous planning discussion); (4) insure that the testing was unbiased, qualified, and representative of the expected total source emissions; (5) collect a minimum number of samples from the program to support statistical significance and meet the objectives of the program.

The basic approach for the measurement program was to establish, from each exhaust stack, the physical measurements of exhaust gas temperature (in Farenheit), velocity and volumetric flow rate as well as the concentration of particulate (and silica) for each sampling period (test run) based on the samples collected. These data and measurements were then used to determine the mass rate per unit time of particulate and silica from each exhaust and further used in supporting data to compare to the CEWG provisional level developed as part of the program approach.

Information regarding HMDS usage and production levels before, during, and after the test can be found in Appendix G. Observers were briefed on this information at a training session. This information was also given to those who asked on site.

The sampling approach supported in this document assists in further defining the methods, steps and process undertaken in developing this full program to support quantifying representative emissions from all the Intel facility's thermal oxidizer stacks. The design and development of this program was the result of a collaborative effort between the STTF, its consultants, and individuals with considerable experience and understanding of source testing, analytical methods, facility operations, and program management and coordination. The CEWG delegated the specifics of this work to the STTF. Both groups were very active in the design of the process. ERM, NIOSH, and ATSDR consultants confirmed the substrate compatibility with elevated stack temperature and NIOSH analytical methods. NIOSH tested and endorsed this procedure.

3.2.1 Sampling Approach

Defining measurement methods for silica for the program focused on a number of key issues. Most predominantly, the thermal oxidizer stacks to be tested were stationary source exhaust streams (stacks) of high flow and elevated temperature. Existing silica sampling methods are based on industrial hygiene and worker exposure assessments that support using sampling equipment and collection materials under ambient conditions.[6] The introduction of high flow, temperature and moisture, required a different approach to the sampling method, equipment, and technique to meet these challenging source conditions. Further, it was necessary to support a measurement approach that would yield a sample, on a suitable substrate (filter) that would allow direct analyses for silica, with minimal handling using approved analytical procedures.

As silica would be in the form of a solid, or particulate fraction in the exhaust stream of the thermal oxidizers, the measurement method selected was an approved stationary source sampling method for particulate, with additional focus of collecting particulate on a suitable filter media (e.g. NIOSH suitable substrate). This would insure that the method and approach not only be compatible with the source environment for collection, but the subsequent silica lab method, for analyses. By collecting the particulate mass on a compatible substrate, the presence and quantity of silica in the collected sample could be easily determined.

Two (2) primary approved stationary source sample methods for particulate collection are available. EPA Reference Method 5 (RM5) "Determination of Particulate Matter Emissions

[6] U.S. Environmental Protection Agency, "Ambient Levels and Non-Cancer Health Effects of Inhaled Crystalline and Amorphous Silica: Health Issue Assessment," EPA/600/R-95/115, November 1996, p. 7-2.

from Stationary Sources," and EPA Reference Method 17 (RM17), "In-Stack Particulate." In RM5, 120°C (248°F) is established as a nominal reference temperature and in order to maintain this collection temperature the method employs a heated glass sample probe and a heated filter holder. Further, with this method, to quantitatively collect all particulate, the method results in two particulate fractions, one the exposed filter, and (2) the quantitative rinse of particulate that deposited along the extended length of the sample probe and filter holder (typically acetone is used as the rinse solvent).

RM17, employs the use of in-stack filtration where typically the filter holder is placed in-stack and the sample is directly impacted on a filter media contained within the filter holder (exposed to the gas effluent). Similar to RM5, the exhaust gas is drawn through the sampling system under a controlled sampling approach. In the RM17 approach, the PM concentrations (over the expected temperature range of the thermal oxidizer systems) is independent of temperature, and it was much more desirable to eliminate the glass probe and the heating systems, and to sample at stack temperature to provide a single sample that would be compatible with subsequent analyses.

EPA RM17 (in-stack) was chosen over EPA RM5 (1) to maximize the particulate collection on the filter media and not minimize the impact of the collected sample on the internal surfaces of the sample train prior to collection of PM on the filter, and (2) further to allow quantitative collection of PM at the elevated exhaust gas temperatures exhibited by the individual Munters thermal oxidizer stacks. A very basic illustration of the EPA RM17 sampling train is illustrated in Figure 1.

Once the most suitable particulate sampling method was selected, the focus was directed on identifying a compatible substrate to support the elevated source temperatures and meet the needs of the analytical methods for silica. The Durr exhaust stacks have the thermal oxidizer and fresh air exhaust from the concentrator wheel comingled into one stack that significantly reduces the exhaust temperature, minimizing sample system conflicts with elevated temperatures. However the Munters systems have separate wheel and thermal oxidizer exhausts that result in isolated TO stacks of lower flow but much higher temperatures. Previous exhaust measurements for these thermal units had demonstrated Munters TO stack temperatures in the 650°F-670°F range, while the comingled Durr exhaust stack temperatures were measured in the 120°F-125°F range.

As the focus of the program was to collect exhaust stack samples of particulate matter (PM) on a NIOSH approved substrate to allow subsequent silica analyses, care was taken in the final sample system design to insure that the elevated exhaust gas temperatures would not affect the integrity of the filter media used. The Munters elevated exhaust temperatures posed the greatest hurdle in the substrate selection for source method and analytical compatibility. The media selection was critical in insuring sample integrity for the subsequent silica analyses. Based on historical information and previous stack exhaust tests for similar source exhaust characteristics, Teflon™ (TFE) coated glass fiber filters had been used in the collection system. However, in detailed review, it was defined by the manufacturer that this media has an upper temperature tolerance of approximately 550°F, that would be challenged in the Munters TO exhaust gas stream and was requested by NIOSH to investigate other media.

Review of other media type that had better temperature suitability (higher tolerance range) were found to have a significant "dirty" background (e.g. binders and weave), that would essentially blind silica analyzes due to the background. Therefore, to accommodate the use of the Teflon™ (TFE) coated glass fiber filter identified as an appropriate media for silica analyses based on it higher temperature tolerance and clean background, a review on modifying the method sample train was undertaken to support the use of the filter without affecting the integrity of the sampling system.

To accommodate these elevated Munters TO temperatures using the RM17 in-stack method, a modification was employed to ensure (1) the actual temperature at the filter surface was reduced to not affect the integrity of the TFE coating on the media; (2) the length of the nozzle and filter holder (with extension) was minimized to support quantitative collection of the solid PM fractions, (3) that the modified system was compatible with the physical limitations at the individual stack locations in relation to clearance of sample system(s) to outside obstructions, and (4) placement of the nozzle in the exhaust stream at the appropriate sample positions was achievable. Based on the acceptable temperature range of the comingled exhaust stacks for the Durr systems, nozzle extensions were not required and the in-stack sample approach followed that of EPA RM17 without modification to the sample system and configuration.

Moreover, this approach improves the ability to perform a complete quantitative recovery of particulate deposited in the components prior to the filter (sample nozzle and front half of filter holder). It was specifically requested by the NIOSH laboratory to have a filter (solid) sample only from the test runs to support the silica analyses and lab equipment compatibility.

A prescreen assessment was conducted on site using the modified sampling assembly that extended the sample nozzle from the filter holder. The extension was of sufficient length to reduce the temperature of the gas impacting the filter but have as short a length possible to eliminate deposition prior to the filter. With this configuration, two individual tests were conducted on site with the nozzle extension under a full system test mock-up of sampling at the appropriate extraction rate for a period of four (4) hours (target sample times for the full test series). The exposed filters were sent to NIOSH to confirm that the integrity of the filter was maintained, assess adequacy of the media for silica screening, and further ensure the target sample times and extraction rates did not overload the filters for the required analyses. Indication from NIOSH supported that the substrates were not compromised for the intended analyses nor the filter loadings were inadequate for the intended program objective.

3.2.2 Field Sampling Execution

With the method, equipment configuration, suitable substrate, sample volumes, and target analyses confirmed, the field program coordination was developed and scheduled. To support facility wide assessment of the potential total silica emissions from all five RCTO stacks (3-Munters and 2-Durr control systems), it was requested that the sampling be conducted simultaneously from each of the five units (exhaust stacks). This concurrent approach was supported to eliminate any concern of process shift between units by capturing emissions from all thermal abatement systems at the same time. Under this configuration five (5) independent sampling systems were setup and operated to support the concurrent testing at each of the five individual VOC abatement systems.

Further, to support the program objectives, testing was not conducted at the same period for each series. The testing was designed to support a series of two morning (~0800-1200) and two evening (~ midnight – 0400) test cycles for extended sample periods of 4 hours per test run for the five units over an entire operational week. Testing was supported at the beginning and end of a typical work week for a total of twenty (20) individual test runs.

Table 1 provides the testing chronology for the field program defining the dates of each test and associated start and stop times of the test runs. Field coordination between test teams was provided to attempt to support exact start and stop times for all runs.

Table 1
Field Program Testing Chronology

Date	S/S	Munters TO-1	Munters TO-2	Munters TO-3	DURR F11XB	DURR F11xF
12/07/10	START	08:17	08:17	08:19	08:15	08:15
	STOP	12:17	12:17	12:19	12:15	12:41
12/08/10	START	00:16	00:17	00:18	00:15	00:15
	STOP	04:16	04:17	04:18	04:15	04:15
12/09/10	START	09:06	09:07	09:08	09:05	09:05
	STOP	13:06	13:07	13:08	13:05	13:05
12/10/10	START	00:16	00:17	00:18	00:15	00:15
	STOP	04:16	04:17	04:18	04:15	04:15

As the Durr and Munters system and exhaust stacks had been subjected to prior emissions testing, adequate sample ports and platforms were already in place to support the extended sampling program at each exhaust (stack) location. All test locations were verified as representative sampling locations for flow rate and particulate measurements following EPA Reference Method 1 "Selection of Traverse Points".

The field methods used were guided by EPA's Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, and 40CFR60 Appendix A Reference Methods 1-4 and EPA RM17 (for in-stack PM), and modified where necessary to be directly compatible with the silica objectives of this program. The subsequent analyses of the exposed filters from the field measurements were supported by a third party NIOSH approved laboratory and the specifics of the analytical process is further detailed in Section 2.2.3 of this report. A list of the field primary methods applied in this program follows:

EPA RM1	"Selection of Traverse Points"
EPA RM2	"Determination of Duct Gas Velocity and Volumetric Flow Rate"
EPA RM4	"Determination of Moisture Content in Stack Gas"
EPA RM17	"Determination of Particulate Matter Emissions from Stationary Sources"

A brief description of the primary methods is provided below.

EPA Reference Method 1. This method is designed to aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source. A measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. Traverse points are then located within each of these equal areas.

EPA Reference Method 2. This is conducted to determine the average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type S (Stausscheibe or reverse type) pitot tube. The velocity measurement points were guided by EPA RM1 and ensured that a representative data set was obtained at the cross section of the measurement location. Concurrent with the measurement of velocity, pressure and gas temperature were also recorded. Gas temperatures were measured using a Type-K thermocouple attached to the Pitot, oriented in the same measurement plane as the velocity measurements. The Type-K thermocouple was connected to a calibrated digital pyrometer for documenting temperature. Data derived from the stack pressure and temperature records were used in the determination of the exhaust gas velocity and flow rate.

EPA Reference Method 4. The reference method is used for accurate determinations of moisture content from the stack gas and is used is support of correcting stack exhaust volumes and sampled gas volumes to standard conditions. The reference method is conducted simultaneously with a pollutant emission measurement test run, and in this case integrated into EPA Reference Method 17, the primary method used for particulate collection in this program.

EPA Reference Method 17. This method is applied for the determination of PM emissions, where PM concentrations are known to be independent of temperature over the normal range of temperatures characteristic of emissions from a specified source category. Following this method, PM is withdrawn isokinetically from the source stack and collected on a pre-weighed filter. The PM mass, which includes any material that condenses at or above the filtration (stack) temperature, is determined gravimetrically after the removal of uncombined water. All results are corrected to standard conditions as part of the normal calculations of the method. Concurrent with the PM sample collection, stack gas velocity and temperature were measured (as defined in EPA RM2) and the resultant stack flow rate measurements used to support reporting of the emissions by combining the PM (or silica) concentration and exhaust gas flow rate.

EPA RM17 (in-stack) was chosen over EPA RM5 (Determination of Particulate Matter Emissions from Stationary Sources) to minimize the impact of the collected sample on the internal surfaces of the sample train prior to collection of PM on the filter, and further to allow quantitative collection of PM at the elevated exhaust gas temperatures exhibited by the individual Munters thermal oxidizer stacks. A very basic illustration of the EPA RM17 sampling train is illustrated in Figure 1.

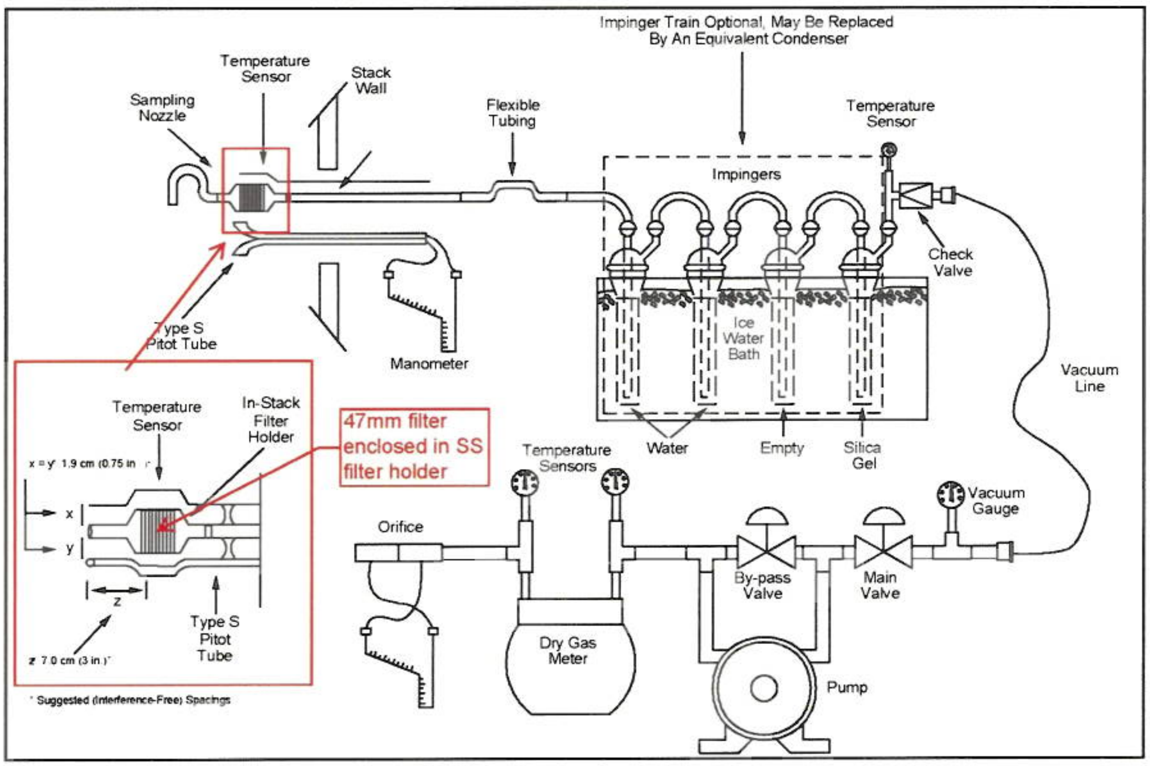

Figure 3 - EPA RM17 Sample Train

For this sampling application, a Teflon™ coated glass fiber filter was used in order to provide a media that was robust to support the elevated exhaust gas temperatures while providing a very low stable silica background for analysis.

In conducting the field measurements, initial velocity traverses were conducted at all stacks to initially align the selection of the appropriate sample nozzles with the measured exhaust gas parameters to support PM isokinetic sampling. Prior to the initiation of each test cycle (the five units are tested for each cycle), a full stack traverse was conducted to identify the probe and nozzle placement in each stack.

Once traverses were completed and sample points determined, the filter holder was loaded with a pre-numbered and pre-weighed TFE coated filter, the filter holder assembled into the complete sample system, and full system leak check completed. Once all sample systems were confirmed to meet the leak check acceptance criteria, the probes with filter holders were placed in-stack at the designated sample point, allowed to equilibrate, and sampling was executed.

Sampling was executed for four (4) hours for each test run. During the 4 hour test, at 19 minute intervals, the stack gas velocity and temperature were recorded along with the reading from the extractive gas meter (sample volume), the meter temperature, meter pressure, system extraction vacuum, and the temperature of the sample gas leaving the moisture train.

At the completion of the four hour test run, the sample pump was turned off, the probe removed from the stack, and a post leak check of the sampling system was initiated at the highest vacuum recorded during the test run. After test confirmations, the filter assemblies were detached from the sampling system and directed to the site trailer for filter recovery. During Run 1 at VOC-16-lt2-1s (11X-F Durr RCTO), the sampling was paused between 08:27 and 08:53 to replace a failed pump in the sampling system. The total sample run time was four hours and the sample volume unaffected.

Each filter holder (Figure 2) was taken apart, and the filter media removed from the filter holder and support screen and transferred to its prescribed numbered filter Petri slide holder. The front half of the filter holder support (nozzle, extension, and filter holder assembly), was carefully and thoroughly brushed to capture any loose material that may have adhered to the inside of the system components. This loose material was quantitatively transferred to the filter surface and slide holder, then capped, taped, and secured to eliminate sample loss.

Figure 4 - Filter Holder with Filter Support Screen

The recovered filter information was entered into the daily field chain of custody form documenting; (1) NIOSH filter ID, (2) Field sample ID, (3) Source location, (4) run #, (5) sample date, and (6) analytical requirements, and (7) any specific comments/remarks related to the specific sample and recovery process. Processed samples were placed in a shipping container with corresponding chain-of-custody, sealed and transferred to Federal Express for direct shipping to the NIOSH designated laboratory.

For filters Intel-7 (VOC-138-1-120-2s Run 2), Intel-10 (VOC-138-3-120-2s Run 2), and Intel-17 (VOC-138-3-120-2s Run 3) graphite fragments from outside of sample probe deposited onto the filter during recovery. These graphite fragments were left on the filter, and are assumed to potentially bias the particulate results high and have no effect on the silica analysis.

3.2.3 Laboratory Analyses

Laboratory analyses procedures in support of this program effort are provided in the following section. The narrative is taken directly from the 14 March 2011 "Analytical Results for Feasibility Study and Field Survey for Crystalline Silica" memorandum (*ATSDR.Intel.Sequence 11239.cover memo.pdf*) provided as part of the laboratory data submittal by NIOSH.

A collaborative project between CDC / NIOSH and ATSDR / DHAC was initiated September, 2010, in order to provide analytical support services for an ATSDR community health project. The issue of concern was the possible presence of crystalline silica in stack emissions at a production facility. The NIOSH industrial hygiene laboratory is housed within the Division of Applied Research and Technology (DART) with an associated contract laboratory for which DART provides direct oversight. Both the DART in house laboratory and the NIOSH contract laboratory (Bureau Veritas North America) are currently accredited via the American Industrial Hygiene Association (AIHA) accreditation program.

A formal request for analytical support services was submitted by the NIOSH / DART QA Manager to the NIOSH / DART Laboratory Coordinator, with a Laboratory Control Number assigned (Sequence 11239). This request is attached, *"ATSDR.Intel.Sequence 11239.pdf."* All information concerning this collaboration has been filed under Sequence 11239. All samples associated with this collaboration have been retained in the DART XRD laboratory which is a limited access (secured) laboratory. For the purposes of transparency, all reports attached are the actual Quality Assurance version of the reports, which include all information associated with the analyses, not just laboratory results. In addition, all XRD chromatograms are included.

All analyses were accomplished via X-ray diffraction (XRD) using NIOSH Manual of Analytical Methods (NMAM) 7500, "Silica, Crystalline, by XRD." NMAM 7500 can be downloaded from the NIOSH NMAM website, www.cdc.gov/niosh/docs/2003-154.

This collaboration was accomplished in two phases which are described below.

1. Feasibility study. *Laboratory Control Number, Sequence 11239-CA*. The field study involved stack sampling which needed to be performed via US EPA Reference Method (RM) 17, "Determination of Particulate Matter Emissions from Stationary Sources." The filters employed for the sampling were Emfab™ filters, 47-mm. Because these filters are borosilicate microfibers reinforced with woven glass cloth and bonded with PTFE, it was necessary to determine the feasibility of use for crystalline silica analysis. A protocol was developed for a feasibility study, which is included in the feasibility study report and described in the attachment,

"ATSDR.Intel.Sequence 11239- CA.QA protocol.feasibility study.pdf." The crystalline silica feasibility study included both quartz and cristobalite since cristobalite is a polymorph of crystalline silica which may be formed at high temperatures.

In order to ensure that the Emfab™ sampling filters would yield quantitative recovery of crystalline silica with no interferences from the filter material, a set of 20 blank filters were sent for a feasibility study. All blank filters were analyzed for possible XRD detection of crystalline silica. No crystalline silica XRD peaks were detected, indicating that the sampling filters would not be a source of interference in the field survey samples. The analytical report documenting the investigation of possible crystalline silica interferences is attached, *"ATSDR.Intel.Sequence 11239-CA.blank filter study.narrative and XRD chromatograms.pdf."*

The next step in the feasibility study was to determine if quantitative recovery could be obtained from direct-on-filter measurement of crystalline silica from the Emfab™ filters. Sample preparation / redeposition is not possible for Emfab™ filters, necessitating direct-on-filter measurement of crystalline silica. It was essential to investigate if the sampling constraints would affect the analytical results. Since the OSHA Permissible Exposure Limit (PEL) for quartz can be equated to 100 micrograms per filter for analytical purposes, a level close to this amount (120 micrograms) was deposited on 10 blank Emfab™ filters for quartz and 10 blank Emfab™ filters for cristobalite. The results showed quantitative recovery for both crystalline silica polymorphs, indicating the feasibility of using Emfab™ filters for sample collection and subsequent analysis via XRD. The narrative analytical report documenting the recovery studies for crystalline silica is the same as the attachment above. The XRD chromatograms for the recovery study are attached, with quartz documented on pages 10-59 and cristobalite documented on pages 66-96 of the attachment, *"ATSDR.Intel.11239-CA XRD charts.recovery.Emfab filters.pdf"*

The two sets of XRD chromatograms associated with the blank filter interference study and the crystalline silica recovery study are sent exactly as received from the laboratory, with no data manipulation. With the feasibility study completed, yielding results which indicated the suitability of use of Emfab™ sampling filters for possible presence of crystalline silica in the facility emissions stacks, the field study was cleared to proceed.

2. Field study. *Laboratory Control Numbers, Sequence 11239-CB (gravimetric) and 11239-CC (silica via XRD).*

A set of 40 blank Emfab™ filters were sent to the laboratory, where they were pre-weighed in preparation for the gravimetric study, via NMAM 0600, "Particulates, N.O.R., Respirable." For quality assurance purposes, 16 filters were retained at the laboratory for media blanks and 4 filters were designated as field blanks. The 20 field sample filters and 4 field blank filters were then Fed-Exed directly from the laboratory to the survey site prior to the sampling dates of December 6-10, 2010.

Upon completion of the sampling, the filters were submitted directly to the laboratory for analysis. The first analysis was for particulates (gravimetric). The analytical report is attached, *"ATSDR.Intel.11239-CB.gravimetric.pdf."* The results show high loadings of particulates on the filters[7]. Subsequent to the gravimetric analysis, the filters were analyzed for crystalline silica, quartz, cristobalite and tridymite. Since the samples were required to be measured direct-on-filter, with no sample preparation and no sample redeposition, accommodation for the XRD sample holder had to be made. Due to the fact that the XRD can only accept samples on 25-mm size samples, upon careful inspection of the sample filters for homogeneous distribution of particulates, it was decided to take a center punch from each sample for XRD analysis. The final results were extrapolated back to an effective sampling area based on the actual surface area of the filter exposed in the sampling stream.

Further details on this procedure are given in the attached narrative and data report, *"ATSDR.Intel.11239-CC.silica narrative and data.pdf."* It should be noted that the filters were heavily loaded with particulates, relative to ambient breathing samples, indicating sufficient sample to detect the presence of crystalline silica. All but one sample exhibited no XRD peaks for crystalline silica, yielding an ND (none detected) for these samples. One sample exhibited a large peak at the primary diffraction angle for quartz, Intel-10. Quartz was not confirmed since there was no secondary quartz peak detected. Quartz has a known ratio for the primary to secondary peak; the high intensity of the primary peak for this sample would have given rise to a substantial secondary peak had quartz been present. The client's paperwork noted that there were pieces of the graphite ferrules used in the equipment present on this sample. All XRD chromatograms for the field survey samples are attached, *"ATSDR.Intel.11239-CC.XRD chromatograms.pdf."*

Due to the fact that the sampling filters were borosilicate microfibers reinforced with woven glass cloth and bonded with PTFE, there was no sample preparation via NMAM 7500 (low temperature asher, muffle furnace, tetrahydrofuran) which would fully digest the sample for further analysis (amorphous silica). Therefore, only gravimetric and crystalline silica results are reported.

It should be noted that these data were reviewed by a NIOSH silica expert, the author of the 4th edition NMAM 7500, Rosa Key-Schwartz. In order to avoid any conflict of interest (the DART Quality Assurance Manager was also the silica expert), the entire set of reports was also reviewed in detail for QA purposes by a member of the DART Quality Assurance activity, Paula Fey O'Connor. The reports reflect this by the initials for sign-off on each of the 3 Sequences at the top right of the cover pages, "PFO for RK-S." The entire set of reports was also reviewed by the NIOSH Laboratory Coordinator, Charles Neumeister, reflected by the initials for sign-off, "CEN."

[7] Filter loading reference is based on typical ambient filters and not that of filters exposed for particulate emission testing purposes from stationary sources.

3.2.4 Quality Assurance / Quality Control Activities

Verification of the proper operation of the field equipment and instrumentation was performed prior to the field sampling effort, supported by on site verifications of extractive meters and pumps, followed by post test calibration checks, specifically with gas sampling consoles. Calibrations were performed as described in the EPA publications "Quality Assurance Handbook for Air Pollution Measurement Systems; Volume III - Stationary Source Specific Methods" (EPA-600/4-77-027b) and EPA 40 CFR Part 60 Appendix A. QC measures were used to ensure the generation of reliable data from sampling activities. Proper collection and organization of source information followed by clear and concise reporting of the data was the primary goal in the project. The data input from the field data to the computer spreadsheets were cross-checked to ensure that the data has been transferred accurately.

All data is reported in standard units, where applicable, depending on the measurement and the ultimate use of the data. Field spreadsheets and summary data (provided Appendix F-1) will be used with the completed laboratory data to support reporting PM and silica concentrations and emissions.

Coupled with the source specific testing data, RCTO process data for all systems was continually documented to demonstrate appropriate operation by documenting thermal oxidizer chamber temperatures and desorb temperatures. These data are provided with the summary information and further provided in full in Appendix F-3 *RCTO Documented Process Data* of the report.

4.0 Discussion of Results

Table 2 provides results developed for the key measured or calculated parameters derived from each of the five (5) unit test series for the thermal oxidizer systems. Each column in the table represents the average stack parameters of the four individual runs for each abatement system test series. The discussion of results provided herein, as well as the field documentation provided in the Appendices of this report. Further detail of all recorded and calculated parameters for each separate test run of the individual system test series can be referenced from this data.

Data developed from the test series, coupled with the mass PM and silica data derived from a third party laboratory, supports the reporting basis of PM/silica concentration and emissions by individual test, by RCTO abatement unit and collectively for the facility.

Table 2
Results Summary of Source Test Series

Parameter / Source Series	Munters TO1 Series	Munters TO2 Series	Munters TO3 Series	Durr F11x-B Series	Durr F11X-F Series
Total Sampling Time (min)	240	240	240	240	240
Stack Temp (°F)[8]	644.6	677.8	649	125	128.9
Gas Exhaust Velocity (FPS)	33.12	35.78	34.13	42.31	38.75
Exhaust Flow Rate (ACFM)	3,415	3,689	3,519	23,846	21,839
Exhaust Flow Rate (SCFM)	1,298	1,355	1,326	17,568	15,991
TO Oxidizer Avg. Temp (°F)	1385	1384.9	1385	1369.9	1369.9
Desorb Avg. Temp (°F)	359.8	360	360.2	350	349.9
PM Concentration (μg /m^3)	880.84	703.69	823.7	744.86	79
PM Emissions (lbs/hr)	4.28E-03	3.58E-03	4.09E-03	4.89E-02	4.72E-03
Silica Concentration (μg /m^3)	ND	ND	ND	ND	ND[1]
Silica Emissions (lbs/hr)	ND	ND	ND	ND	ND[1]

[1] Run #1 (Intel-3 substrate) supported a reported laboratory value of 310 μg quartz (within the analytical range). This mass value equates to 103.1 μg/m^3 for the individual run. The remaining

[8] Average sampling temperatures. The average "sampling temperatures" = average stack temperature at the sampling point are in the table ....values are represented in the second line in the table for each system...for each series the average value identified is drawn from the average of the 4 tests for each series in Tables 3, 4, 5, 6, and 7.

3 runs of the test series, for VOC-16-lt2-1s, were reported as non-detect (ND); refer to Table 5 for individual test runs and results)

Table 3 through Table 7 provides the detailed source data derived from each test run of the each control unit test series. These data were used is the development of PM/silica concentration and emission for each of the five (5) RCTO emission stacks supporting the combustion process. The purpose of this data is to report the results for each run of the test series (4 total runs for each test series) and provide comparative data for reviewing changes, variability, and consistency from test to test for each run series.

Table 3
Summary of Munters TO-1 (VOC138-1-120-2s) Test Series

Run Number		1	2	3	4	Average
Filter #		INTEL-1	INTEL-7	INTEL-15	INTEL-20	
Run Start Time		08:17	00:16	09:06	0:16	
Run Stop Time		12:17	04:16	13:06	04:16	
Average Stack Temp	(˚F)	645.6	646.1	641.9	644.7	
Standard Meter Volume	dscf	105.539	111.637	107.054	104.757	107.247
Average Stack Gas Velocity	ft/sec	32.77	33.99	32.80	32.91	33.12
Actual Stack Flow Rate	acfm	3,379	3,505	3,382	3,393	3,415
Dry Standard Stack Flow Rate	dscfm	1,279	1,334	1,287	1,293	1,298
Percent of Isokinetic Rate	%	100.4	100.4	99.9	98.9	99.9
Mass of Particulate	µg	3200	2900	2100	2500	2675
Stack PM Concentration	µg/dscf	30.32	25.98	19.62	23.86	24.94
Stack PM Concentration	$\mu g/m^3$	1070.76	917.37	692.74	842.77	880.84
Particulate Emission Rate	lbs/hr	5.13E-03	4.58E-03	3.34E-03	4.08E-03	4.28E-03
Mass of Silica	µg	ND	ND	ND	ND	ND
Stack Silica Concentration	µg/dscf	ND	ND	ND	ND	ND
Stack Silica Concentration	$\mu g/m^3$	ND	ND	ND	ND	ND
Silica Emission Rate	lbs/hr	ND	ND	ND	ND	ND

Table 4
Summary of Munters TO-2 (VOC138-2-120-2s) Test Series

Run Number		1	2	3	4	Average
Filter #		INTEL-2	INTEL-8	Intel-16	INTEL-MB1	
Run Start Time		08:17	00:17	09:07	08:17	
Run Stop Time		12:17	04:17	13:07	12:17	
Average Stack Temp	(˚F)	679.8	679.9	673.5	677.8	
Standard Meter Volume	dscf	107.973	111.065	109.635	107.938	109.152
Average Stack Gas Velocity	ft/sec	36.35	36.10	35.21	35.46	35.78
Actual Stack Flow Rate	acfm	3,748	3,722	3,630	3,656	3,689
Dry Standard Stack Flow Rate	dscfm	1,372	1,370	1,339	1,341	1,355
Percent of Isokinetic Rate	%	99.7	99.8	99.6	99.6	99.7
Mass of Particulate	µg	2700	2200	1900	1900	2175
Stack PM Concentration	µg/dscf	25.01	19.81	17.33	17.60	19.94
Stack PM Concentration	µg/m^3	883.09	699.52	612.01	621.63	703.69
Particulate Emission Rate	lbs/hr	4.54E-03	3.59E-03	3.07E-03	3.12E-03	3.58E-03
Mass of Silica	µg	ND	ND	ND	ND	ND
Stack Silica Concentration	µg/dscf	ND	ND	ND	ND	ND
Stack Silica Concentration	µg/m^3	ND	ND	ND	ND	ND
Silica Emission Rate	lbs/hr	ND	ND	ND	ND	ND

Table 5
Summary of Munters TO-3 (VOC138-3-120-2s) Test Series

Run Number		1	2	3	4	Average
Filter #		INTEL-3	intel-10	Intel-17	INTEL-MB-2	
Run Start Time		08:19	00:18	09:08	08:18	
Run Stop Time		12:19	04:18	13:08	12:18	
Average Stack Temp	(˚F)	651.9	649.5	647.4	646.9	
Standard Meter Volume	dscf	106.202	108.278	107.78	110.761	108.255
Average Stack Gas Velocity	ft/sec	33.72	34.31	34.15	34.33	34.13
Actual Stack Flow Rate	acfm	3,477	3,538	3,521	3,540	3,519
Dry Standard Stack Flow Rate	dscfm	1,306	1,337	1,329	1,332	1,326
Percent of Isokinetic Rate	%	99.5	99.6	99.4	99.7	99.5
Mass of Particulate	µg	2,800	2,800	2,100	2,400	2,525
Stack PM Concentration	µg/dscf	26.36	25.86	19.48	21.67	23.34
Stack PM Concentration	$\mu g/m^3$	931.07	913.22	688.07	765.21	823.7
Particulate Emission Rate	lbs/hr	4.55E-03	4.57E-03	3.42E-03	3.82E-03	4.09E-03
Mass of Silica	µg	310	ND	ND	ND	-
Stack Silica Concentration	µg/dscf	2.9	ND	ND	ND	-
Stack Silica Concentration	$\mu g/m^3$	103.1	ND	ND	ND	-
Silica Emission Rate	lbs/hr	5.04E-04	ND	ND	ND	-

Table 6
Summary of DURR F11x-(VOC-np2-1s) Bridge Test Series

Run Number		1	2	3	4	Average
Filter #		Intel-5	INTEL-11	Intel-14	INTEL-19	
Run Start Time		08:15	00:15	09:05	00:15	
Run Stop Time		12:15	04:15	13:05	04:15	
Average Stack Temp	(°F)	123.9	123.8	125.1	127.3	
Standard Meter Volume	dscf	109.158	114.043	110.849	111.614	111.416
Average Stack Gas Velocity	ft/sec	42.75	42.99	42.28	41.21	42.31
Actual Stack Flow Rate	acfm	24,096	24,229	23,831	23,229	23,846
Dry Standard Stack Flow Rate	dscfm	17,758	17,960	17,559	16,992	17,568
Percent of Isokinetic Rate	%	98.6	100.4	99.8	99.8	99.6
Mass of Particulate	µg	1500	2800	2800	2300	2350
Stack PM Concentration	µg/dscf	13.74	24.55	25.26	20.61	21.04
Stack PM Concentration	µg/m^3	485.28	867.05	892.03	727.72	744.86
Particulate Emission Rate	lbs/hr	3.23E-02	5.83E-02	5.87E-02	4.63E-02	4.89E-02
Mass of Silica	µg	ND	ND	ND	ND	ND
Stack Silica Concentration	µg/dscf	ND	ND	ND	ND	ND
Stack Silica Concentration	µg/m^3	ND	ND	ND	ND	ND
Silica Emission Rate	lbs/hr	ND	ND	ND	ND	ND

Table 7
Summary of DURR F11x-Fab (VOC-16-lt2-1s) Test Series

Run Number		1	2	3	4	Average
Filter #		Intel-6	Intel-12	Intel-13	INTEL-18	
Run Start Time		08:15	00:15	09:05	00:15	
Run Stop Time		12:41	04:15	13:05	04:15	
Average Stack Temp	(˚F)	128.8	122.1	130.4	134.3	
Standard Meter Volume	dscf	102.273	154.717	150.433	151.387	139.702
Average Stack Gas Velocity	ft/sec	38.66	39.27	38.67	38.39	38.75
Actual Stack Flow Rate	acfm	21,787	22,133	21,796	21,639	21,839
Dry Standard Stack Flow Rate	dscfm	15,938	16,434	15,932	15,658	15,991
Percent of Isokinetic Rate	%	90.8	100.9	99.4	100.6	97.9
Mass of Particulate	µg	220	350	320	360	313
Stack PM Concentration	µg/dscf	2.15	2.26	2.13	2.38	2.23
Stack PM Concentration	µg/m^3	75.97	79.89	75.12	83.98	79.00
Particulate Emission Rate	lbs/hr	4.54E-03	4.92E-03	4.48E-03	4.93E-03	4.72E-03
Mass of Silica	µg	ND	ND	ND	ND	ND
Stack Silica Concentration	µg/dscf	ND	ND	ND	ND	ND
Stack Silica Concentration	µg/m^3	ND	ND	ND	ND	ND
Silica Emission Rate	lbs/hr	ND	ND	ND	ND	ND

Stack sampling of RCTO stacks at Intel's Rio Rancho, New Mexico site was performed to show whether or not the interaction of hexamethyldisilazane (HMDS) with the RCTO treatment process would form crystalline silica above the provisional levels promulgated by the CEWG. The data collected and discussed in this report answer several key questions: (1) what was the volume of gases that passed through the collection filters for the Durr and Munters stacks, (2) what quantities of crystalline silica were found on the filters from the Durr and Munters stacks and (3) is the quantity of the crystalline silica at or above the CEWG's proposed provisional level, 1µg/m^3 annual average concentration. Discussion and derivation of the provisional level is provided in Appendix K-5.

The sampling was conducted by Intel's consultant ERM. The sampling was witnessed by Intel employees and selected citizens from the community. Everyone who volunteered to observe was accepted by the STTF. A log of these individuals is presented in Appendix E. The data derived during collection is summarized in Table 2 through Table 7. The methods and overview of the sampling procedures have provided in Section 2.2 with further detail of the method provided in Appendix K-5.

The exposed field samples were submitted to NIOSH to determine particulate mass gain and analyze for the presence of crystalline silica. The NIOSH analytical approach involved center-punching a 25.4 mm section from the individual 47 mm diameter filter, to support direct compatibility with the substrate holder of the XRD analytical unit, and therefore, only a portion of the filter was actually analyzed. With the effective collection diameter reduced to 40 mm based on the placement of the Teflon "O-ring" in the supporting filter holder, the exposed filter surface was reduced. The XRD analyses for this test application were based on the assumed even distribution of material across the filter. Therefore the final results reported for the silica analyses were proportioned from the analyzed 25.4 mm filter size to that of the 40 mm exposed filter actual size. The post-gravimetric analysis of the filter substrates, for determination of the total mass PM gain, was conducted before the center-push process and XRD analyses.

Only one filter, Intel 3, had any measured crystalline silica. A second exposed filter provided material that indicated a large peak at the primary diffraction angle for the quartz (a crystalline form of silica) but could not be confirmed as there was no secondary peak (which, given the level of the primary peak should have been visible) and consequently was not quartz. This filter, Intel 10 (TO-3, Run #2), was addressed by assigning it as a non-detect, but setting the level of detection to 300 micrograms instead of a level of detection of 50 micrograms as used for the other filters. This filter was one in which the sampling notes indicated that there were pieces of graphite carried over on the filter from the field recovery. It was also one of three filters that NIOSH investigators reported loose material visible on the filter. For Intel 3, 310 micrograms of quartz were reported (Allen Schinsky, Bureau Veritas –ATSDR.Intel.11239-CC.narrativeanddata.pdf).

The primary question is: was there enough measured crystalline silica collected in the sampling to produce levels at the fence line above the CEWG provisional level (Appendix K-5 describes the basis for the provisional level). To take a very conservative approach to the question by using the highest estimate consistent with the measurement, one assumes that all samples are treated as detectable at the limit of detection (LOD); therefore, ten of the twelve Munters samples are assigned a quartz level of 50 micrograms, one is assigned a level of 300 micrograms and one at the reported measured level of 310 micrograms. Under this assumption, the average mass collected for the Munters test series was 92.5 micrograms for the twelve samples.

The modeling was done for the proposed Munters stacks in the context of the selection of the appropriate stack height to use for the new Munters units. This modeling did not address the Durr units and we don't have an appropriate dilution factor for the Durrs stacks. Accordingly, we estimate the fence-line concentrations from the Munters units alone and compare them to the CEWG provisional level. Other particulate modeling did not break out the RCTO stacks separately and thus, is not appropriate for the estimation of concentrations associated with the RCTO stacks that are the potential sources of crystalline silica.

The most accurate analysis of the Durr data required different modeling of dispersion from the Durr stacks, which have different flows and temperatures from the Munters stacks. Extra, detailed modeling for the Durr units was not justified in light of the very small, if any, level of crystalline silica detected in any stack, compared with what corresponds to the CEWG provisional level. In addition, all the Durr units are being replaced with Munters units.

A more approximate analysis of the Durr data indicates the highest possible emissions from the Durr stacks consistent with the measurements would be about five times higher than the highest possible emissions from the Munters. The fence line concentrations would scale approximately with the emissions, so that the estimated level would be about one three thousandth of the CEWG provisional level. The lowest level consistent with the measurements would be zero. The analysis for the Durr units is more sensitive to the level of detection, because the flows through the stacks are much greater and there were no measurements above the level of detection.

Particulate modeling done for RCTO stacks supported that an estimated emissions of one pound per hour (1 lb/hr) would produce concentrations of about 1 microgram per cubic meter outside the plant boundary on an annual average. This would correspond to a dilution of the stack gases by 178,000 parts of background air for every part of stack gas. The dilution factor was based on the actual stack gas flows which is the area of the stack times the stack gas velocity.

The average volume of gases that passed through the filter through one four-hour sampling period was 289 cubic feet under actual conditions. Note that the flow through the filters is described in tables 3, 4, and 5 in terms of standard meter volume expressed in dry standard cubic feet. In order to be consistent with the modeling procedure we must convert standard flows to actual flows. Tables 3, 4, and 5 describe the average actual stack flows and the dry standard stack flows. On average the actual flows are 2.68 times the dry standard stack flows, because the stack gases are at a much higher temperature and lower pressure than those of standard conditions. We found that the average standard meter volume was 108 standard cubic feet. Consequently, the actual volume of gases passing through the filter in cubic feet is:

$$V_{ft^3} = 2.68x108sft^3 = 289ft^3.$$

The actual flow in cubic meters is:

$$V_{m^3} = \frac{V_{ft^3}}{35.3ft^3 / m^3} = 8.19m^3.$$

The sampled gas concentration is:

$$\chi_{sampled} = \frac{92.5 micrograms}{8.19 m^3} = 11.29 micrograms / m^3 .$$

After dilution from the stack, based on modeling, the concentration outside the boundary will be:

$$\chi_{outside} = \frac{\chi_{sampled}}{178000} = 0.0000634 micrograms / m^3 .$$

The answer is clearly "NO" since even assumptions based on the highest estimate of emissions consistent with the data produce concentrations about one fifteen thousandth of the CEWG provisional level of 1 microgram per cubic meter outside the plant boundary.

If we were less conservative and treated all the non detects as zero; 310 micrograms averaged with eleven zeros gives 25.8 micrograms per average Munters filter which corresponds to 0.0000177 micrograms per cubic meter, or 56000 times less than the CEWG level.

Since the analysis procedure is a little out of the ordinary, we might want to examine if errors in the procedure could change the primary conclusion that the crystalline silica concentrations will not exceed the CEWG provisional level.

An extreme assumption is that all of the particulate matter collected on the filter was actually crystalline silica. The material on the filters was weighed using standard techniques and the average weight on the Munters stack filters was 2333 micrograms (Allen Schinsky – Bureau Veritas ATSDR.Intel.11239-CB.gravimetric.pdf); and average sample volume 289 acf (8.19 m^3) for the same Munters tests (summary tables 2-7). The average does not include filters Intel 3, Intel 7, and Intel 10 where investigators observed "an uneven distribution of visible loose particulate matter present on the filter surface." In this case we estimate at-the-fence concentrations of 0.0016 micrograms per cubic meter, one six hundred twenty-fifth (1/625) of the CEWG level. Consequently, we conclude based on the extreme assumption case, that there wouldn't be enough silica emitted by the Munters stacks to produce at-the-fence concentrations anywhere near the CEWG provisional level even if all the particulates were silica in the crystalline form.

We should also note that EPA investigators estimate crystalline silica levels in major metropolitan areas average about 3 micrograms per cubic meter, and they may be significantly higher in agricultural areas.[9]

[9] (U.S. Environmental Protection Agency, "Ambient Levels and Non-Cancer Health Effects of Inhaled Crystalline and Amorphous Silica: Health Issue Assessment," EPA/600/R-95/115, November 1996, pp. 3-30.

5.0 Conclusions

The field results of the facility wide PM/silica emissions assessments, developed through concurrent testing of all five thermal control systems at the Intel Rio Rancho facility, are provided in this report document. The assessment program was successfully completed over a four day period during the week of December 07, 2010 testing each of the five emission units four (4) separate times. The twenty (20) qualified exposed filter substrate samples collected were sent via controlled chain-of-custody to a NIOSH directed laboratory that supported the analyses of total particulate (PM) and silica. The data developed from the third party analyses was used with the qualified field measurement data in defining the emissions from the VOC abatement systems, individually and collectively.

From the field assessment PM emissions from all RCTO exhausts were determined to be 0.066 lbs/hr. Individual source emissions for each test series ranged from 0.0046 lbs/hr for Munters-2 exhaust to 0.0489 lbs/hr for the Fab 11X Bridge site Durr system (VOC-np2-1s). PM emissions for each run series average, for each RCTO exhaust, can be compared directly to the facility permitted PM limits of 1.0 lbs/hr.

Based on the laboratory results of the exposed filters collected from the entire field test series, 19 of the 20 exposed filters were found to be non-detect (ND) for silica. The initial run of the first test series from the Munters TO-3 (VOC138-3-120-2s) resulted in the detection of quartz within the stated analytical limit of quantification (LOQ) of the analyses. Crystalline silica concentration and emissions for this test run resulted in a calculated value of 103.1 µg/m3 or 5.04E-04 (0.00050) lbs/hr, respectively. Crystalline silica source emissions are not regulated under federal, state or local limitations or site specific permit limits.

In support of the program to assist in further assessing silica concentrations, the sampling program was carried out using standard stack sampling techniques to collect filter samples from Intel RTO stacks. However, because the sampled gas temperatures from the Munters TO stacks were too high to permit the use of the filters normally used for samples for XRD analysis of crystalline silica, a modified system was developed collectively by ERM, ATSDR, and NIOSH crystalline silica expert Rosa Key-Schwartz to allow compatible source methods and compatible substrates required for silica assessment. The stack sampling was carried out using developed sampling techniques and measurements were closely observed by citizen observers. All five stacks were sampled simultaneously four times to include representative portions of the day throughout a typical operational week at the facility.

The collected filters were sent to NIOSH with careful chain of custody procedures. Measureable particulate matter was found on all exposed substrates and only one of these samples was positive for crystalline silica. The calculated crystalline silica concentration for this one sample was far below the CEWG provisional level.

Even the highest estimates of the crystalline silica consistent with the data were very low. As a further check, we estimated of at-the-fence concentrations, based on the assumption that all particulate matter collected on the filters consisted of crystalline silica with the use of previously developed dispersion models (AERMOD) and again found exposure levels well below the CEWG provisional level.

Appendix M New Mexico Department of Health Case Finding Investigation

Investigation of Pulmonary Fibrosis in Corrales, New Mexico: 2010 - 2011

Background

In August 2010, a New Mexico resident contacted the New Mexico Department of Health (NMDOH) with concerns about "a cluster of cases of pulmonary fibrosis in Corrales" with an unknown cause. What follows is a description of the condition as well as a summary of the investigation.

Pulmonary fibrosis is a serious disease that causes progressive scarring of the lung tissue. Pulmonary fibrosis of unknown cause, also known as idiopathic pulmonary fibrosis (IPF), is the most common type of interstitial lung disease (ILD). ILD is the generic term used to describe a number of conditions which primarily affect the lung parenchyma in a diffuse manner. They are characterized by chronic inflammation and/or progressive interstitial fibrosis, and share a number of clinical and radiological features such as dyspnea on exertion, non-productive paroxysmal cough, abnormal breath sounds, abnormal high resolution CT scan, and restrictive pulmonary spirometry with impaired gas exchange.

The ILDs can be broadly grouped into three categories (Longmore et al. 2007):

1) Conditions with a known etiology (e.g. asbestosis, silicosis, tuberculosis, allergic alveolitis)
2) Conditions with systemic disorders (e.g. lupus, ulcerative colitis, rheumatoid arthritis)
3) Conditions with an unknown cause (e.g. IPF, cryptogenic organizing pneumonia)

IPF has a median survival of less than 3-5 years following diagnosis (Harari & Caminati, 2010). It is the most common of the idiopathic interstitial pneumonias, with a prevalence of 13-20 per 100,000 people in the general population. Males are affected more often than females, and approximately 75% of patients are older than 60 years of age at presentation. It should be emphasized that IPF is very similar to other well-defined diseases, such as asbestosis, the connective tissue diseases, and a number of other conditions. Therefore, known causes must be ruled out before the term/label of "idiopathic" is used (Brashers, 2006).

Based on a population-based registry of patients with ILDs[1] that was established in 1988 in Bernalillo County, New Mexico, the overall prevalence of ILDs for the period of 10/01/1988 to 09/30/1990 was 80.9 per 100,000 in males and 67.2 per 100,000 in females (Coultas et al., 1994). The annual incidence rate (rate of new cases diagnosed) was 31.5 per 100,000 in males and 26.1 per 100,000 in females. The prevalence of IPF, a subset of ILD, was 20.2 per 100,000 for males and for females it was 13.2 per 100,000.

The diagnosis of IPF requires clinical, radiographic, and histopathological evaluations. Secondary causes of pulmonary fibrosis, including collagen-vascular disease, chronic hypersensitivity pneumonitis, adverse drug reactions, granulomatous diseases, and pneumoconiosis must be excluded.

[1] Coultas et al. (1994) define IDLs as "a heterogeneous group of disorders that comprise more than 130 entities with some diagnoses commonly encountered by pulmonary physicians in the United States."

Methods

In August 2010, the Epidemiology and Response Division of the NMDOH began investigating idiopathic pulmonary fibrosis cases in Corrales through the development of a case definition, collection of medical records, analysis of medical records against the case definition, and the calculation of an idiopathic pulmonary fibrosis prevalence rate in Corrales.

First, NMDOH created a case definition for idiopathic pulmonary fibrosis. This definition was based on the American Thoracic Society/European Respiratory Society's criteria for diagnosis of idiopathic pulmonary fibrosis (Appendix). This definition was used to categorize the IPF status of each case as confirmed, probable, suspected, or not IPF.

Next, a list was gathered of current or former residents of Corrales who either self-identified as having pulmonary fibrosis or were previously identified through the *Corrales Comment* as having pulmonary fibrosis. A request for medical records was made for each of these residents. This process took several months since some residents had died or moved out of state, making record acquisition more laborious.

Finally, data were analyzed and the prevalence of IPF in Corrales was calculated.

Results/Discussion

A total of ten potential cases of IPF were identified. The age range of the cases was 47-76; six were females and four were males; four were deceased. Of these, all had some type of lung disease. However, only one case was confirmed as having IPF. Of the remaining nine potential cases, six were classified as not IPF based on the identification of an alternate diagnosis such as chronic obstructive pulmonary disease (COPD), sarcoidosis, and hypersensitivity pneumonitis. One case was excluded because the person had developed pulmonary fibrosis before moving to New Mexico. NMDOH did not have enough information to confirm the IPF case status for two potential cases, both of which were deceased. Therefore, these two cases were classified as suspected IPF.

Based on data from the 1990 and 2000 censuses, the Corrales population is 6,394 (www.census.gov). With one confirmed IPF case, the rate is 15.6 per 100,000 population. This is within the range of IPF prevalence found by Coultas et al. (1994) for Bernalillo County from 10/01/1988 to 09/30/1990 (20.2 per 100,000 for males and 13.2 per 100,000 for females.)

Conclusions

NMDOH identified a heterogeneous group of lung disease in Corrales due to various causes. An IPF cluster was not identified.

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3. Coultas DB, Zumwalt RE, Black WC, Sobonya, RE. 1994. The epidemiology of interstitial lung diseases. American Journal of Respiratory and Critical Care Medicine 150: 967-972.
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Appendix: Case Definition for Idiopathic Pulmonary Fibrosis (IPF)

1. **Does Case Have an Interstitial Lung Disease (ILD)?** Each case was first evaluated to determine if it met the clinical and pathological features of ILD. If it did not, it was excluded from analysis.

   Interstitial Lung Disease Definition: A number of conditions that primarily affect the lung parenchyma in a diffuse manner.

   A. Clinical Features**:**
   Dyspnea on exertion, non-productive paroxysmal cough, abnormal breath sounds, abnormal CXR or high resolution CT scan, restrictive pulmonary spirometry with reduced DLCO.

   B. Pathological Features**:**
   Fibrosis and remodeling of the intersitium, chronic inflammation, hyperplasia of type II epithelial cells or type II pneumocytes

   C. Classification Categories:
      i. *Conditions with a known etiology:*
         -Occupational/Environmental e.g. asbestosis, berylliosis, silicosis
         -Drugs: nitrofurantoin, bleomycin, amiodarone, sulfasalazine, busulfan
         -Hypersensitivity reactions e.g. extrinsic allergic alveolitis
         -Infections e.g. TB, fungi, viral
      ii. *Conditions associated with systemic disorders:*
         -Sarcoidosis
         -Rheumatoid Arthritis, SLE, Systemic Sclerosis, MCTD, Sjogren's syndrome
         -Ulcerative Colitis, RTA, Autoimmune Thyroid Disease
      iii. *Conditions with an unknown cause*:
         -IPF/CFA
         -Cryptogenic Organizing Pneumonia
         -Lymphocytic Interstitial Pneumonia

2. **If Case has ILD, Does It Meet Idiopathic Pulmonary Fibrosis (IPF) Definition?** Once a case was defined as having an ILD, it could be evaluated to determine if it met the criteria for idiopathic pulmonary fibrosis (IPF). The definition for IPF is based on the American Thoracic Society/European Respiratory Society criteria for diagnosis of IPF in absence of surgical lung biopsy.

   IPF diagnosis requires clinical findings compatible with ILD in combination with either characteristic radiologic findings (probable) or a pathologic diagnosis of usual interstitial pneumonia (UIP) on surgical lung biopsy (confirmed).

   A. Major Criteria
      i. Exclusion of other known causes of ILD such as certain drug toxicities, environmental exposures, and connective tissue diseases
      ii. Abnormal pulmonary function studies that include evidence of restriction (reduced VC[2], often with an increased FEV1/FVC ratio) and impaired gas exchange [increased P (A–a) O2[3], decreased PaO2 with rest or exercise or decreased DLCO[4]]

[2] VC= vital capacity.

iii. Bibasilar reticular abnormalities with minimal ground glass opacities on HRCT[5] scans
iv. Transbronchial lung biopsy or BAL[6] showing **no** features to support an alternative diagnosis

B. <u>Minor Criteria</u>
i. Age > 50 yr
ii. Insidious onset of otherwise unexplained dyspnea on exertion
iii. Duration of illness > 3 mo
iv. Bibasilar, inspiratory crackles (dry or "Velcro"-type in quality)

C. <u>Case Classification</u>
In the immunocompetent adult, the presence of **all** of the major diagnostic criteria as well as at least **three** of the four minor criteria increases the likelihood of a correct clinical diagnosis of IPF. Potential cases are classified in the following manner:
i. *Confirmed:* Clinically compatible with ILD and has a surgical lung biopsy (such as through video-assisted thoracoscopic surgery) consistent with usual interstitial pneumonitis.
ii. *Probable:* Meets all of the major diagnostic criteria (including typical HRCT for IPF) and at least three of the four minor criteria, but does not have a surgical lung biopsy.
iii. *Suspected:* Meets at least three of the major criteria (but no HRCT or the HRCT is inconclusive for IPF) and meets at least three minor criteria, but has no surgical lung biopsy.
iv. *Not IPF:* If none of the above applies, the condition is not IPF.

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[3] P (A–a) O2= alveolar–arterial pressure difference for O2

[4] DLCO = diffusing capacity of the lung for CO

[5] HRCT= high-resolution computerized tomography

[6] BAL = bronchoalveolar lavage

References:

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Appendix N Peer Reviewer Comments – Crystalline Silica and ATSDR Response

Appendix N – External Peer Review Intel-New Mexico Health Consultation - Silica Task Force Report

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Guidance Provided to Reviewers:

The objective of peer review conducted by the Office of Science is to ensure the highest quality of science for NCEH/ATSDR studies and results of research; therefore, your comments should be provided with this goal in mind. Unlike other peer review processes in which you may have participated, the questions to be addressed for NCEH/ATSDR are broadly based so that each reviewer may have a wide latitude in providing his/her comments. Any remarks you wish to make that have not been specifically covered by the General Questions Section may be included under question # 2 in the Additional Questions Section. Please note that your unaltered comments will be sent to the investigator for a response. You should receive a copy of the response to the peer review comments when they are available.

Intel-New Mexico Health Consultation - Silica Task Force Report – Reviewer #1

April 2015

General Questions:

1. Does the public health assessment adequately describe the nature and extent of contamination?

The public health report describes the nature and extent of environmental contamination coming from the Intel Corporation facility in Rio Rancho, New Mexico which may pose a public health concern to residents living near the facility. The report describes potential exposures to volatile organic hydrocarbons (VOCs) and acid aerosols, carbon monoxide, crystalline silica, particulate matter, odors, idiopathic pulmonary fibrosis, and amytrophic lateral sclerosis (ALS). The report adequately describes the nature and extent of contamination within the limitations of the data available. The VOCs and acid aerosol exposures could not be adequately evaluated based on available FTIR data. The report accurately states that residents are not exposed to levels of carbon monoxide and crystalline silica that will harm their health.

2. Does the public health assessment adequately describe the existence of potential pathways of human exposure?

The pathway for human exposure to emission from the Intel Corporation facility are through inhalation of gases and particulates. The report describes the characteristics of the plant and the surrounding community, noting geographic and climatic features that would lead to potential exposures to residents living near the facility. The conditions that may lead to human environmental exposures are thoroughly discussed in the report.

3. Are all relevant environmental, toxicological, and radiological data (i.e., hazard identification, exposure assessment) being appropriately used?

Based on review of Intel Corporation facility emissions and toxic release data, the reported permitted emissions (Table 1), and contaminant environmental exposure measurements it appears that the relevant hazards have been evaluated. The report describes evaluation of diseases such as idiopathic pulmonary fibrosis and ALS which have not been reported as being increased in association with occupational exposures among semiconductor populations.

4. Does the public health assessment accurately and clearly communicate the health threat posed by the site?

The report indicates that there are very little if any health effects posed by environmental emissions from the Intel facility. The concentrations of carbon monoxide and crystalline silica emitted from the plant to which residents could potentially be exposed are well below levels that pose health risks. The elevated particulate levels that have been measured near the plant in recent times are most likely due to other environmental sources with very little contribution from Intel facility emissions. Emitted levels of VOCs are not adequately characterized. Low levels of some VOCs may result in detectable odors and some of the chemicals used at the plant may illicit a “burnt” odor. While annoying, odor thresholds for most VOCs are well below levels that may cause health effects. The association between odors and health effects are not well known, but odors may increase anxiety among local residents. There is no evidence of a cluster of idiopathic pulmonary fibrosis and increased rates of ALS could not be evaluated because comparison rates are not available. This assessment is accurate and clearly communicated.

5. Are the conclusions and recommendations appropriate in view of the site’s condition as described in the public health assessment?

The conclusions and recommendations offered in the report on pages 38 through 41 are appropriate and adequately supported by data provided in the report and the appendices.

6. Were the Silica Task Force testing methods appropriate for answering the following questions:

Does Intel-New Mexico emit crystalline silica?

A rather thorough investigation of the potential for the plant to release crystalline silica through its exhaust stacks was conducted. The sampling and analytical procedures were very carefully conducted. The typical stack sampling technique was modified to use a Teflon coated filter—appropriate for crystalline silica analysis—and the potential effects from elevated temperatures on these filters were thoroughly evaluated. Quality control on the crystalline silica sampling and analysis methods were carefully conducted. An abundance of blank samples were collected and no crystalline silica detected on any of them, indicating no background levels of silica on the sampling media. The analysis of samples spiked with known concentrations of crystalline silica showed that the technique used to analyze the samples was highly accurate. The field samples were analyzed by the top experts on crystalline silica analysis in the U.S. All of the emission stacks were sampled four times using approved EPA sampling methods. Only one sample out of 20 had detectable concentrations of crystalline silica (310 µg). Nineteen of the samples were below 50 µg, the lower limit of detection for the analytical methods employed for quartz, the most likely form of crystalline silica. This data indicates that crystalline silica may occasionally be produced during the Intel facility production process and emitted into the environment.

b. If so, are the emissions a potential public health concern to the community?

However, the concentrations of crystalline to which residents near the plant would be exposed due to these emissions would be well below background environmental levels that may result from roadway dusts, agricultural and construction activities, and windblown aerosols. The potential exposures to residents as described in the Silica Testing Task Force Report are below any levels known to cause disease, even after making extreme assumptions on the potential exposures. The potential crystalline silica emissions do not pose a potential public health concern to the community.

7. Are ATSDR's summary and conclusions appropriate regarding crystalline silica?

ATSDR concludes that the crystalline silica emissions from the Intel New Mexico facility are not expected to harm people's health. This conclusion is appropriate and well supported by Appendix L-the Silica Testing Task Force Report.

8. Do you have recommendations to improve this portion of the ATSDR's Health Consultation?

No. I believe the ATSDR has done an extremely careful and thorough job of evaluating the potential for residents living near the Intel facility to be exposed to crystalline silica. The sampling and analytical plan were very well executed.

9. Are there any other comments about the public health assessment that you would like to make?

I am concerned about the VOC analyses. The FTIR data was not adequate to evaluate resident exposures to VOCs. While it is my belief that the residents are not exposed to VOC levels that will cause health effects, I do believe they are experiencing unusual odors, and the presence of these odors may be causing anxiety and concern in the community. The low odor threshold concentrations of VOCs may be difficult to detect with existing sampling and analytical technology. The Response to Public Comments was appropriate in addressing the crystalline silica concerns (pages 2 – 6). I did read the rest of Appendix O and the public comments indicate, to some extent, unreasonable concerns about environmental hazards coming from the Intel facility. I wonder if "strange odors" is the source of some of those concerns.

Additional Questions:

1. Are there any comments on ATSDR's peer review process?

No. I was pleased to assist with this review and would be happy to help ATSDR in any way I can in the future. ATSDR provides valuable service to our citizens and I cite their work frequently and use in my course instruction.

Are there any other comments?

I think it important that someone—Dr. Key-Schwartz or someone else—take the lead on publishing the results of the crystalline silica stack sampling and analysis. This was a complex problem which was addressed quite thoroughly. I suspect this question has or will arise again. It is good to know that the process used by Intel does not result in creation and emission of significant environmental concentrations of crystalline silica.

ATSDR Response to Peer Review #1 Comments

Comment (Question 9)

"I am concerned about the VOC analyses. The FTIR data was not adequate to evaluate resident exposures to VOCs. While it is my belief that the residents are not exposed to VOC levels that will cause health effects, I do believe they are experiencing unusual odors, and the presence of these odors may be causing anxiety and concern in the community. The low odor threshold concentrations of VOCs may be difficult to detect with existing sampling and analytical technology." ". I wonder if "strange odors" is the source of some of those concerns."

ATSDR Response

Thank you for these comments. ATSDR agrees that odors are difficult to detect using standard VOCs methods and odors may be one source of community concern.

Comment (additional comment section)

I think it important that someone—Dr. Key-Schwartz or someone else—take the lead on publishing the results of the crystalline silica stack sampling and analysis. This was a complex problem which was addressed quite thoroughly. I suspect this question has or will arise again. It is good to know that the process used by Intel does not result in creation and emission of significant environmental concentrations of crystalline silica.

ATSDR Response

ATSDR will provide this comment to Dr. Key-Schwartz and the CEWG.

Intel-New Mexico Health Consultation - Silica Task Force Report – Reviewer #2

General Questions:

1. Does the public health assessment adequately describe the nature and extent of contamination?

The document is voluminous and provides a detailed description of the Intel facility, historical evolution, as well as extensive description of legal information about environmental release of pollutant (TRI, EPA permits). It is well stated in the document that following the exact nature and quantity of released pollutants is very difficult. However the final recommendations focus on rather well defined agents: silica, VOCs, Particles, carbon monoxide. I believe the report might benefit from small section that clearly presents the rational for the choice of the agents that end up being the focus of the recommendation. I believe the information is already present, but in a scattered fashion across the document.

2. Does the public health assessment adequately describe the existence of potential pathways of human exposure?

The document extensively delves into concerns related to air quality using air monitoring and emission modelling. It seems indeed pretty obvious that the main exposure pathway of concern would be ambient air. Maybe a small focused section might clearly state that this is the case, and that ingestion (of contaminated soil or water) or skin contact were not a concern for this assessment.

3. Are all relevant environmental, toxicological, and radiological data (i.e., hazard identification, exposure assessment) being appropriately used?

The report contains extensive documentation reported in the main text or in appendices. To the best of my knowledge the presented data is adequately presented and interpreted.

4. Does the public health assessment accurately and clearly communicate the health threat posed by the site?

The recommendations provided in the document are clearly stated.

5. Are the conclusions and recommendations appropriate in view of the site's condition as described in the public health assessment?

I think the recommendations stated in the abstract and the discussion are appropriate. As already stated, I would recommend a clearer rational for the selection the agents for which a recommendation was made (availability of data, public concern, high emission volume from the facility).

6. Were the Silica Task Force testing methods appropriate for answering the following questions:

a. Does Intel-New Mexico emit crystalline silica?
b. If so, are the emissions a potential public health concern to the community?

Potential emission of silica may have seemed a concern as presented in the first health consultation report. Indeed the mechanisms by which it could be formed seemed to cause some debate with concerned citizens. However The Silica task force report (appendix L) provides ample demonstration that, even if emitted, silica levels at the stacks pose no health threat to the community

7. Are ATSDR's summary and conclusions appropriate regarding crystalline silica?

I agree with the ATSDR's conclusions that crystalline silica emissions from the Intel New-Mexico facility are not expected to harm people's health

8. Do you have recommendations to improve this portion of the ATSDR's Health Consultation?

Paragraph 2 and 3 p4 of Appendix L are repetitions, and the two last paragraphs p5 should be made consistent to what is said before. This feels like sections of previous reports or letters were copy-pasted without proof reading. Table 2-6 of Appendix L: I would replace the "ND" by the more informative "<X".

9. Are there any other comments about the public health assessment that you would like to make?

I have a general comment about the structure of the health consultation report. As I already stated, the report provides adequate answers (at least the best that can be provided) about the major areas of concern for community health. However I found it was presented in a narrative way that does not follow a very clear path from section to section, which does not facilitate the digestion of such quantity of information. As a first step towards a "tighter" version I would number the sections and have a separate section that provides an overview of the full report and all its subsections and their content. I also wanted to point out that I found the recommendation section very clear and concise.

Additional Questions:

1. Are there any comments on ATSDR's peer review process?

No additional comment

Are there any other comments?

No additional comment

ATSDR Response to Peer Review #2 Comments

Comment (Question 2 Response)

"The document extensively delves into concerns related to air quality using air monitoring and emission modelling. It seems indeed pretty obvious that the main exposure pathway of concern would be ambient air. Maybe a small focused section might clearly state that this is the case, and that ingestion (of contaminated soil or water) or skin contact were not a concern for this assessment."

ATSDR Response

ATSDR added the following statement in the "Statement of Issues" section of the health consultation.

"ATSDR did not evaluate ingestion or skin contact (dermal) exposure pathways in this public health consultation."

Comment (Question 5 Response)

"I believe the report might benefit from small section that clearly presents the rational for the choice of the agents that end up being the focus of the recommendation. I believe the information is already present, but in a scattered fashion across the document."

ATSDR Response

ATSDR conclusions and recommendations were revised as follows based of the above comment:

"Volatile Organic Compound (VOC) and acid aerosol air emissions

> ATSDR cannot accurately evaluate volatile organic compounds (VOCs) and acid aerosols near the Intel-New Mexico facility. Therefore, ATSDR cannot determine whether these compounds could harm people's health.
>
> > The open path FTIR data were not sufficiently sensitive and reliable to draw health conclusions. Additional air monitoring data are not available to make this health determination.
> >
> > The principal public health protection from Intel-New Mexico air emission resides with effective administration and compliance of a valid air permit. NMED has issued an air permit to the Intel-New Mexico facility that allows for the release of specific quantities of, carbon monoxide, Hazardous Air Pollutants (HAPs), nitrogen oxides, total suspended particulate and VOCs calculated on a rolling 12-month average system. Effective administration and enforcement of the

Intel-New Mexico facility air permit is essential to maintaining air quality, i.e., preventing harmful exposure (including short-term exposures) to the plant's air emissions particularly to community members directly downwind of the facility.

Recommendations

As the result of its 2009 compliance inspection, EPA has noted several areas of concern and one area of non-compliance. Follow-up of these areas of concern noted in the EPA inspection are necessary to confirm the adequacy of the air permit's public health protections and improve the community's overall confidence in the air permit.

ATSDR encourages NMED, CEWG and Intel-New Mexico to evaluate the need to conduct additional air modeling, and possibly air monitoring for validation, following the results of any additional Intel-New Mexico air pollution control equipment stack testing i.e., acid scrubbers and RTOs, required in follow-up to EPA's 2009 compliance inspection. Particular attention should be given to acid aerosols and VOCs that may result in health effects from short-term exposure.

Comment (Question 8 Response)

"Paragraph 2 and 3 p4 of appendix L (Silica Testing Task Force Report) are repetitions, and the two last paragraphs p5 should be made consistent to what is said before. This feels like sections of previous reports or letters were copy-pasted without proof reading. Table 2-6 of appendix L: I would replace the "ND" by the more informative "<X"."

ATSDR Response

Thank you for these comments. Appendix L contains the Silica Testing Task Force Report. This report was developed and published by the Community Environment Working Group (CEWG), a separate organization. Therefore, ATSDR cannot revise CEWG document but will provide these comments to the CEWG.

Comment (Question 9 Response)

"I have a general comment about the structure of the health consultation report. As I already stated, the report provides adequate answers (at least the best that can be provided) about the major areas of concern for community health. However I found it was presented in a narrative way that does not follow a very clear path from section to section, which does not facilitate the digestion of such quantity of information. As a first step towards a "tighter" version I would number the sections and have a separate section that provides an overview of the full report and all its subsections and their content. I also wanted to point out that I found the recommendation section very clear and concise."

ATSDR Response

ATSDR appreciates these comments. The Intel-New Mexico Health Consultation's format follows ATSDR's standard format for public health consultations. To some extent the sections are in response to the community concerns e.g. idiopathic pulmonary fibrosis, amyotrophic lateral sclerosis.

Intel-New Mexico Health Consultation - Silica Task Force Report – Reviewer #3

General Questions:

1. Does the public health assessment adequately describe the nature and extent of contamination?

The results of testing show no significant emissions of crystalline silica.

2. Does the public health assessment adequately describe the existence of potential pathways of human exposure?

This is not specifically addressed in the report for crystalline silica, however inhalation is presumed to be the main route of exposure. Hence the stack emission testing and estimation of fence line air level exposures are the appropriate assessment methods.

3. Are all relevant environmental, toxicological, and radiological data (i.e., hazard identification, exposure assessment) being appropriately used?

Data on the sampling and analysis method, validation of method adjustments and field forms were all supplied. On pages 26-27 of the report the calculation of the concentration outside the boundary of the plant is described. This could use some clarification: 1) on page 26 the last paragraph states that the average volume of gases passing through the filter through one four hour sampling period was 289 cubic feet under actual conditions…and that ….actual flows are 2.68 times the dry standard stack flows. It is not clear where these values came from. The Sampling Data sheets in the Appendix (titled RM17 Sampling Data) show Standard Meter Volumes (dscf) in the range of the reported 108 standard cubic feet (page 26) but the Total Meter Volumes listed are more in the range of 124 cfm so clarification would be helpful. Likewise, for the dilution denominator of 178000 on page 27, an explanation of source of this number and how it was derived (presumably from the AEROMOD model) would be helpful (along with a reference to the larger report that describes the model). Information on the stack heights used in the model should be clearly described given the Public Comment discussions about stack height recommendations and changes (Appendix O page 6).

It appears that the analysis of this data was simplified by using a single average value for silica mass and air volume across the Munters stacks. Since there are 12 samples, it would be useful to calculate 12 levels and use the median and range of those values for the summary (given most air concentrations are lognormally distributed).

On page 26 it says that the “Durr data indicates the highest possible emissions from the Durr stacks consistent with the measurements would be about five times higher than the highest possible emissions from the Munters”. Yet fence line estimates for the Durr stacks are not included in the summary graphs or discussion because the report states different modeling of dispersion is needed due to the different flows and temperatures of these units. Modeling was not done because of the low crystalline silica levels and the report that “all the Durr units are being replaced with Munters units” (page 26). For clearer communications with the public, some bounding of possible fence line levels should be included given the higher emissions from these units.

On page 25 3rd paragraph there is discussion of the use of the “very conservative approach” of using the LOD in the emission calculations. Explanation is needed for why the LOD of 50 ug was used in the emission calculations for quartz, rather than more typical NIOSH approach of using the LOQ (170 ug) and why the LOD for Intel10 sample was set at 300 ug (large primary peak on XRD but no secondary peak so likely interference by graphite, but no rationale for LOD of 300ug).

Discussion of the provisional level of 1 ug/m3 for evaluation of crystalline silica exposure levels at the fence line was in Appendix K which was not provided. However, this toxicological/risk assessment derivation is not within my expertise for review.

4. Does the public health assessment accurately and clearly communicate the health threat posed by the site?

On page 2 of the report there is a graph that shows the estimated fence line exposure levels compared to the CEWG provisional level. The fence line estimates are labeled “actual measured”, which implies these were fence line sampling results. This should be clarified. These are estimated concentrations based on emission modeling and that (if true) the estimated concentrations were based on dispersion models from lower stack heights than are now in place (40 meters?) (Appendix O page 6) and that higher stacks are expected to produce even lower maximum emissions levels. It would also be useful to stress that the worst case modeling scenario (all particulate emissions = crystalline silica) also produced very low fence line concentration estimates relative to the CEWG provisional level.

Inclusion of the Durr stack data with bounded estimates of fence line levels (see comment #3) along with the report that “all the Durr units are being replaced with Munters units” (page 26) would be useful to the public.

5. Are the conclusions and recommendations appropriate in view of the site’s condition as described in the public health assessment?

The conclusion of the report that “even the highest estimates of the crystalline silica consistent with the data were very low” and that even assuming that all the particulate matter collected on the filters was crystalline silica “found exposure levels well below the CEWG provisional level” appears justified. No specific recommendations are made.

6. Were the Silica Task Force testing methods appropriate for answering the following questions:

Does Intel-New Mexico emit crystalline silica?

Use of stack emission testing was an appropriate method. The validation of the adaptations of the stack sampling method were well described and justified. A discussion should be included of several possibly relevant limitations in the XRD method: a) the use of respirable crystalline silica fraction for standards can result in over or underestimate of levels if particle sizes of the sample are significantly larger or smaller than the standards used and b) XRD can be impacted by heavy particulate loading of filters.

Graphs showing the median and range of maximum possible emissions (lbs/hr) of crystalline silica (using LOD or LOQ values) as well as for particulates from each of the 5 stacks tested would be helpful for explaining to the public. This can be compared with the estimated emission rate needed to reach the CEWG provisional level at the original and currently (?) higher stack heights would be useful for public communication. In addition, reporting the % of the particulate emissions estimated to be crystalline silica in the worst case scenario (using LOD or LOQ) may also provide some useful context.

b. If so, are the emissions a potential public health concern to the community?

As described in #3 clarification of the calculations used in the estimation of fence line levels is needed.

7. Are ATSDR's summary and conclusions appropriate regarding crystalline silica?

The results suggest minimal emissions from the plant's recuperative thermal oxidizer stacks.

8. Do you have recommendations to improve this portion of the ATSDR's Health Consultation?

Page 4 last paragraph discusses future actions rather than completed ones.

Page 4 footnote 3 uses Wikipedia to describe NIOSH. The NIOSH web site would be a better source http://www.cdc.gov/niosh/about.html

Page 6 describes Bureau Veritas lab as a non-commercial national testing resource. They are a commercial contract lab used by NIOSH

Page 25 3rd paragraph says the primary question is….but it is not answered until page 27 when the paragraph says "the answer is clearly NO". Suggest this be restated.

Page 178 of report shows levels of factory capacity and relative HMDS usage reported by the company during 10/2-12/18/10, which covers the sampling period. It is not clear if these are actual results reported by the company or a model of what they could report. If actual data, this should be included in the summary and conclusion to highlight that conditions during sampling were not unusual (80% factory capacity which is both higher and lower than some periods in October and relative HMDS usage at the higher end of the period reported).

9. Are there any other comments about the public health assessment that you would like to make?

No

Additional Questions:

1. Are there any comments on ATSDR's peer review process?

No

Are there any other comments?

No

ATSDR Response to Peer Review #3 Comments

Comments (Response to Questions 3, 4, 6 and 8)

Peer reviewer #3 provides several comments and suggestions about the CEWG report Silica Testing Task Force Report. This report was developed and published by the Community Environment Working Group (CEWG), a separate organization. Therefore, ATSDR cannot revise CEWG document but will provide these comments to the CEWG.

ATSDR does not find any comments from Peer Reviewer #3 that would require changing the conclusion “that crystalline silica emissions from the Intel New-Mexico facility are not expected to harm people’s health.”

Appendix O ATSDR Responses to Public Comments on the 2009 Health Consultation

Appendix O - Response to Public Comments

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Crystalline Silica

Public Comment

ATSDR's 2009 Health Consultation (page 35) indicates the high temperature and slow cooling time needed to convert amorphous (non-crystalline) silica to crystalline silica. However, the conditions for conversion of amorphous silica have no bearing on Intel's silica formation process, which can produce crystalline silica directly.

Organo-silicon compounds are present at very low concentration in the gaseous waste streams entering Intel's RTOs. Thus, the conversion of organo-silicates to silica occurs on an almost individual molecule basis. Such widely dispersed molecules of newly formed silica tend to coalesce in crystalline patterns. In fact, such a process strongly favors the formation of crystalline silica.

The conditions in Intel's thermal oxidizers are nearly ideal for directly producing crystalline silica when Intel's organo-silicon compounds are burned. So the recent discussion about the temperature at which amorphous silica is converted to crystalline silica is irrelevant.

ATSDR Response

ATSDR cannot find any evidence of crystalline silica exposure (occupational or environmental resulting) from semiconductor manufacturing nor do any regulatory agencies specifically regulate crystalline emissions, (Burgess 1995, Baldwin et al, 2011, Fischman 2001, and Wald PH and Williams ME 1997).

In semiconductor manufacturing, the preparation of amorphous silicon films uses chemical vapor deposition (CVD) or excessive heat exposure results in deposition of silicon. Other parameters play a role including pressure, silicon sources, carrier gases and gas flow, and heating sources (Baldwin et al, 2011).

Hexamethyldisilazane (HMDS) is an organo-silicon compound with chemical formula $[(CH_3)_3Si]_2NH$. HMDS reacts with the oxide surface in a process called silylation to form a strong bond to the surface. At the same time, free bonds are left which readily react with the photoresist, enhancing the photoresist adhesion. The process works not only with silicon dioxide, but other oxides (e.g., Al_20_3), as well as native oxide present on bare silicon wafers. HMDS is applied in the gas phase on heated substrate material (amorphous SiO_2). It reacts immediately with the substrate material removing absorbed water and reducing surface energy, which in turn promotes photoresist adhesion to the substrate (Seguin et al., 2008; Dagget et al., 2003).

HMDS used by Intel– New Mexico is commonly used as a wafer treatment to improve photoresist adhesion onto wafers. Any presence of humid air reacts with HMDS through a process called hydrolysis to produce trimethylsilanol (TMS) and ammonia (NH_3). TMS can combine with another TMS molecule (dimerization) in the presence of oxygen, or on specific types of adsorption media, to form hexamethyldisiloxane (HMDSO). The chemical reaction equations of HMDS hydrolyze in aqueous solutions to form trimethylsilanol (TMS) plus ammonia and a direct conversion of HMDS to hexamethyldisiloxane (HMDSO) and ammonia are shown below:

$$[(CH_3)Si]_2NH + 2H_2O \longrightarrow 2(CH_3)_3SiOH + NH_3 \quad (1)$$

$$[(CH_3)_3Si]_2NH + H_2O \longrightarrow [(CH_3)_3Si)_2O + NH_3 \quad (2)$$

TMS also undergoes acid catalyzed condensation into HMDSO as shown in reaction (3) below

$$2(CH_3)_3SiOH \xrightarrow{H+} [(CH_3)_3Si]_2O + H_2O \quad (3)$$

It is unlikely that high concentrations of respirable crystalline silica are released to the environment from the Intel's RTOs because of its high reactivity with oxide surfaces as previously noted.

Emissions of TMS, NH_3 and HMDSO may be released to the environment but can be controlled with available emission controls at the semiconductor manufacturer facility. (Seguin et al, 2008; Dagget et al, 2003).

This above explanation is consistent with the results of crystalline silica exposure assessment of the Intel – New Mexico thermal oxidizers. Nineteen out of 20 samples showed non-detectable levels of crystalline silica and low concentrations of $PM_{2.5}/PM_{10}$ in nearby ambient monitors.

Public Comment

"While I was a member of the Task Force, Intel's Mindy Koch, claimed to have proof that Intel released only amorphous silica. When I asked to see that proof, she sent me an analysis report for silica that had been scraped from an RTO burner nine years earlier. I told Ms. Koch that silica deposited on an RTO burner in no way represented what was released into the air. I then asked Ms. Koch to have particulates collected from the gas exiting their RTOs and have it analyzed by X-ray diffraction, but she never responded to my request. As a Task Force member I also repeatedly asked NMED to collect samples from the RTO exit for silica analysis, but NMED never did so. If they had, we could have actual evidence of the silica form, one way or another. Perhaps NMED preferred Intel's unsupported claims of amorphous silica, to evidence that might prove otherwise."

ATSDR Response

ATSDR agrees that the previous bulk sampling by Intel-New Mexico is not representative of current conditions. The results from the CEWG appointed STTF did not find silica emissions that would result in silica exposure at levels of health concern. The nearby $PM_{2.5}/PM_{10}$ air monitors indicate that particulate levels have been less than EPA National Ambient Air Quality Standards for particulate matter. Silica comprises approximately 10 percent of PM_{10} (EPA, 1996).

Public Comment

The potential risks of fine-particle emissions are discussed only in the context of crystalline silica, while fine-particle concentrations are a health concern with or without the presence of crystalline silica. The modeled (Attachment K, Intel Rio Rancho Facility, RTO Relocation, Technical Permit Revision, Air Dispersion Modeling, Class One Technical Services, November 2007) fine-particle concentrations are close to the standard set to protect human health. Furthermore, the World Health Organization (WHO) advocates a more restrictive adverse health level than our standards set by the EPA, even though both the WHO and the EPA relied upon the same data. The data included several levels of fine-particle concentrations and impaired health in US cities. There is a simple explanation for the discrepancy between the two adverse levels, the studies showed that increasing fine-particle concentrations produced health effects throughout the levels found in the study areas. EPA chose to pick a level next to the lowest concentrations as a standard where they could show health deterioration between that level and the lowest level, while WHO chose to pick the lowest level studied since no safe level had been found."

ATSDR Response

ATSDR has added a discussion of the risks of fine-particle emissions and includes $PM_{2.5}/PM_{10}$ data. Elevated levels of PM_{10} may pose a public health hazard to the Rio Rancho and Corrales communities (and greater Albuquerque) during high wind conditions that are associated with lower pressure trough weather patterns. These patterns occur infrequently.

Public Comment

We believe that the discussion of the formation of crystalline silica is a little misleading. The literature does note that crystalline silica forms above 800 degrees Celsius, but the literature also suggests crystalline silica begins to form at lower temperatures (750 degrees Celsius, which corresponds to the Durr's RTO operating temperature of 1360 degrees F and even more closely to the Munter's RTO operating temperature of 1385, which started operating during January 2009), so that some formation might be expected at temperatures near those in the Intel facility. Specifically, the following statement, "Combustion of rice husks, typically stoker fired boilers, where the ash experiences sustained temperature above 750ºC leads to a significant quantity of crystalline silica in the residual ash," appears in the report Rabovsky, J., "Estimated health risk associated with the exposure to Silica from Wadham Energy Co, Williams, CA": final report California Environmental Protection Agency, Office of Environment Health Hazard Assessment, 1992 page 44. It is also important to note that even a very small conversion on the order of 1% would be sufficient to produce more of a hazard associated with crystalline silica than associated with amorphous silica.

ATSDR Response

ATSDR has revised the text. This health consultation recognizes that amorphous chemical vapor deposition silicon films crystallize over wide range of temperatures between 450°C and 825°C.

This conversion cannot be attributed solely to temperature increase. Based on Bettermann and Liebau, (1975) and Wahl et al (1961), the transformation behavior of different amorphous silica via cristobalite and keatite to quartz depends mainly on parameters including pressure, temperature, run duration, kind and concentration of mineralizers (such as alkalies) and state of the starting material. Based on the results of the Silica Task Force's testing and follow-up modeling of the Intel-New Mexico RTO stacks, the estimated concentrations were less than the State of California's Chronic Inhalation Reference Exposure Level for respirable crystalline silica (3 $\mu g/m^3$).

Public Comment

Please explain ATSDR's recommendation for "bulk analysis of RTO build-up for crystalline silica?"

ATSDR Response

In the 2009 public comment health consultation, ATSDR recommended that "Intel-New Mexico should conduct additional (bulk) analysis of thermal oxidizer build-up for crystalline silica (ATSDR, 2009) in order to obtain additional information about this community concern. The CEWG's Silica Task Force's investigation addresses this recommendation by conducting stack air sampling for crystalline silica.

Public Comment

Given the relatively large quantities of silica particulate already being produced, why did ATSDR not give any cautions about amorphous silica? Based on Intel's anticipated production increase, or expanded capacity due to recent re-tooling, how much silica, crystalline or amorphous, is expected to be released to the air, and what are the health implications of that?

Why did ATSDR not accept CEWG panelist Mike Williams' conclusion that Intel probably does release crystalline silica? What does ATSDR's data bank on silica exposure indicate should be anticipated as a result of 365 day, 7 day – 24 hour per inhalation of silica particulate at levels in the 14 ton per year range.

ATSDR Response

The scientific literature does not indicate that the use of HMDS promoter results in environmental release of crystalline silica (Seguin et al. 2012). Additionally, the results of the CEWG Silica Task Force investigation did not find crystalline silica emissions that would result in exposure at levels of health concern.

No stack testing data were available for the ATSDR's 2009 Health Consultation. In this health consultation, ATSDR reviewed the Silica Task Force effort and $PM_{2.5}/PM_{10}$ monitoring data from nearby monitors. The PM_{10} monitoring would contain amorphous silica that is less than 10 micrometers in diameter.

Public Comment

What conclusions, if any, did ATSDR reach regarding silica particulates delivery of Intel HAPs and TAPs to lung tissue? Refer to University of New Mexico's Bill Buss on silica's role in delivering toxic molecules to lung tissue.

ATSDR Response

ATSDR did not draw any conclusions about this statement. However, new evidence suggests that volatile organic compounds may modify the biological effect of some particulate matter. (Ebersville et al, 2012). This topic requires additional research.

Public Comment

There are reasons to believe that some of the assumptions in the fine-particle modeling were unduly conservative, so that actual, as opposed to modeled, concentrations may be somewhat less. Furthermore, Intel and CEWG have worked to make modifications (the removal of rain caps on boiler stacks, which raises effective plume height) that further reduce ground-level concentrations. The CEWG also recommended that the stack heights of the new thermal oxidizers be increased from the original design level of 23 meters to 38-40 meters. However, Intel chose a level of 30 meters. The initial fine particle modeling used the design value of 23 meters, so that some additional reduction in the modeled, fine particle concentrations has been realized. It is also worth noting that the modeled fine particle concentrations included significant contributions from sources other than Intel facility emissions.

ATSDR Response

Comment noted. ATSDR appreciates the work of the CEWG to reduce community exposures from air emission including its air modeling, oxidizers, and efforts to raise the stack heights. Intel-New Mexico has raised their thermal oxidizer stacks to 40 meters, as recommended by the CEWG.

Health Specific Comments

Public Comment

Information was provided to ATSDR which showed a level of methyl tertiary butyl ether (better known as MTBE) in a resident's blood at 10 times the population average. To my knowledge, these test results were never provided to an ATSDR toxicologist for review and opinion.

ATSDR Response

Methyl *tert*-butyl ether (MTBE) was added to gasoline to boost octane and to reduce carbon monoxide exhaust emissions in the United States in the 1980s. MTBE was phased-out of use in the mid-2000s due to its adverse impact on groundwater.

Most people were exposed to MTBE from auto exhaust when driving or from gasoline while fueling their cars (ATSDR, 1996). CDC reported that commuters in urban areas with high vehicular traffic had median blood MTBE blood levels that were more than tenfold higher than those in the U.S. general population (CDC, 2013). People can also be exposed to MTBE from groundwater pollution (ATSDR, 1996). ATSDR found no evidence of MTBE use in the semiconductor manufacturing industry.

Public Comment

Please provide autopsy results from 'Ellie the dog' to an ATSDR veterinarian for her/his review and opinion and the information included in your final report. (A Concerned Citizen asked ATSDR to review the necropsy results of her 17 year old pet dog.)

ATSDR Response

An ATSDR veterinary pathologist reviewed the pathology report provided by the concerned citizen. This report was consistent with necropsy findings for an elderly canine. Pulmonary adenocarcinoma, reported on the necropsy, is not the most common tumors found in dogs but it is not considered unusual. Cancer is the most common cause of death in domestic dogs (near 40%), and primary lung tumors account for approximately 1% of these cancers, with adenocarcinoma accounting for 70-80% of primary lung tumor in dogs. As with humans, the probability of cancer in dogs increases with age.

ATSDR cannot draw any conclusions about the levels of toluene (50 parts per billion (ppb), n-hexane (18 ppb), and ethyl benzene (14 ppb) reported for the dog's lung tissue, or link this information to the cause of pulmonary adenocarcinoma detected in this elderly dog. Toluene and n-hexane are not considered to cause cancer in either animals or humans. Ethyl benzene is not classified as to human carcinogenicity because of lack of animal bioassays and human studies, though some laboratory animal studies suggest that ethyl benzene may be a carcinogen. The meaning of the levels reported from the dog's lung tissue is unclear. ATSDR cannot completely rule out a causal link between exposure to environmental contaminants and the pulmonary adenocarcinoma noted in the necropsy report, but there is not sufficient information to establish a causal link.

Public Comment

ATSDR should obtain and provide current Tumor Registry Data to Corrales Residents for Clean Air and Water (CRCAW) this year and every year for a minimum of 10 years so that if a trend *is* developed, it can be identified as soon as possible.

ATSDR Response

In the public comment Health Consultation ATSDR indicated that it would complete a health consultation on cancer rates for the Rio Rancho – Corrales community. After further review with an ATSDR medical epidemiologist, it was determined that all of following (below) criteria were not met in order to complete a health outcome data (HOD) review for a specific site.

1) Current (or past) potential or completed exposure pathway?
2) Duration and extent of exposure can be determined?
3) Population that was (or is) being exposed can be identified?
4) Estimated doses and duration of exposure sufficient for plausible, reasonable expectation of health effects?
5) HOD available at geographic level to allow correlation with the exposed population?
6) Accessible validated data sources have info on health outcomes of interest likely to occur from exposure?

Specifically, ATSDR does not have sufficient information to estimate duration and extent of exposure.

The New Mexico county-level cancers rates (by cancer site) are available online for the period 1990 through 2007 at the following link http://www.cancer-rates.info/nm/index.php.

Public comment

A former seven-year resident of western Rio Rancho New Mexico reported that she was diagnosed with Pulmonary Fibrosis, Nonspecific Interstitial Pneumonitis (NSIP), and Emphysema, with Lymphoid hyperplasia of Bronchus Associated Lymphoid Tissue and Multiple Bilateral pulmonary infiltrates. The *Corrales Comment* has reported several possible cases of pulmonary fibrosis among Rio Rancho – Corrales residents.

ATSDR Response

Pulmonary fibrosis and Nonspecific Interstitial Pneumonitis (NSIP) are two of over 100 types of interstitial lung disease. Certain types of pulmonary fibrosis are caused by exposure to environmental dust including crystalline silica. The causes of other types of pulmonary fibrosis or are Nonspecific Interstitial Pneumonitis are not known. However the risk of idiopathic pulmonary fibrosis increases with age. Other risk factors may include genetics, exposure to viruses, gastro-reflux disease and certain medications [Kottmann RM, Hogan CM, Simei PJ, 2009].

Emphysema is the fourth leading cause of death in the United States. Emphysema is chronic obstructive pulmonary disease (COPD) that is strongly linked to smoking. Exposure to air pollution or dust from the environment or workplace also can contribute to COPD. In rare cases, a genetic condition called *alpha-1 antitrypsin deficiency* may play a role in causing Emphysema. ATSDR's Public Health Assessments typically cannot determine whether specific illnesses noted by community members, on an individual basis are associated with environmental exposures being evaluated. This is the case with pulmonary fibrosis.

Public Comment

A resident voiced concern about experiencing throat irritation i.e. having their "larynx shut" without observing odor.

ATSDR Response

Some chemicals do not have good warning properties i.e. they may cause symptoms before you can smell the odors. Exposure to acids aerosols such as hydrochloric acid, hydrofluoric acid, and sulfuric acids are capable of resulting in throat irritation. Hydrochloric acid has poor warning properties (ATSDR, 2014). Persons who experience throat irritation should report this information and other pertinent information (location, time, date) to Intel-NM and NMED and seek medical attention if necessary.

Public Comment

When community members report a complaint to Intel New Mexico operation centers – they hear back from Intel-New-Mexico that the plant is operating "normally".

ATSDR Response

ATSDR encourages residents to continue to report any air quality complaints to Intel-New Mexico for tracking and analyses purposes. ATSDR recommends that the issue of continued air quality/odor concerns be addressed through CEWG.

Air Permitting

Public Comment

Why were the permitting issues not highlighted more prominently in ATSDR's Health Consultation?

ATSDR should explain why Intel-New Mexico, nearly 100 tons of Hazardous Air Pollutants and VOCs per year, could be allowed to operate under a minor source permit.

ATSDR should provide the names and addresses of other facilities in the United States that possess Minor Source Permits and that are allowed to emit more than 5 tons of Phosgene per year and all facilities in the United States who possesses a Minor Source Permit and who also has the legal ability to discharge 96.5 tons of Hazardous Air Pollutants and use more than 250 Volatile Organic Compounds

ATSDR Response

Air permitting is an environmental regulatory compliance issue. Compliance and enforcement of the Clean Air Act is the specific domain of the EPA and its delegated authorities, NMED and City of Albuquerque (in New Mexico). ATSDR reviewed the Intel-NM air permit information as background for preparing the health consultation and provided its observations to NMED (ATSDR, 2009). ATSDR does not maintain a listing of facilities with air permits.

Public Comment

What are opportunities for additional insights into Intel-New Mexico facility emissions noted in the ATSDR letter to NMED? How would this be funded?

ATSDR Response:

ATSDR suggested supplemental testing of thermal oxidizers and scrubbers, and testing to verify the control efficiencies (ATSDR, 2009). Companies that hold air permits are required to obtain the necessary information for their air permit e.g., any required stack testing.

Public Comment

Intel-New Mexico substitutes zeros for no-detect measurements for several chemicals when calculating their air emissions from stack emission testing.

ATSDR Response

Air emission calculations for compliance with Clean Air Act requirements come under the authority for NMED and EPA. From a health assessment standpoint, substituting zeros for less than detection limit observations could underestimate exposures.

Public Comment

Intel-New Mexico does not use phosgene but its permit allows it. The phosgene issue should have been looked into much more detail.

ATSDR Response

ATSDR does not know the rationale for having phosgene listed on the air permit. ATSDR is not aware of semiconductor manufacturing facilities listings phosgene on their air permits. EPA did not include semiconductor manufacturing in its document “Locating and estimating air emissions from sources of phosgene (USEPA, 1985). This question should be directed to Intel New-Mexico and NMED.

Public Comment

ATSDR should add the following statement “Intel’s air operating permit current at the time of the Public Comment version of this Health Consultation seems to be consistent with past Intel permits which require specific pollution control equipment operation, emissions testing and reporting, and numerous other on-site recordkeeping and monitoring requirements.”

ATSDR Response

ATSDR added the following on page 11 “Intel-New Mexico’s 2009 and current air operating permit appears to be consistent with past Intel permits which require specific pollution control equipment operation, air emissions testing and reporting, and other on-site recordkeeping and monitoring requirements”

Air Modeling

Public Comment

Corrales Residents for Clean Air and Water (CRCAW) is very concerned about ATSDR's response to Dr. Koracin's modeling study which provided evidence and scientific data that Intel was the culpable source of odors and illnesses. Although ATSDR did not discount any other evidence or studies in their report, ATSDR took the time and effort to discount Dr. Koracin's modeling study. CRCAW requests ATSDR address the fact that no other studies or conclusions were questioned except those of Dr. Koracin.

ATSDR Response

In the health consultation ATSDR states, in the Dispersion Modeling section, the following of the Koracin report: "the description of the meteorological modeling approach and results appear reasonable and consistent with standard modeling practice." The limitations noted about the Koracin report are inherent limitations of all air modeling. In general, ATSDR does not draw health conclusions based on modeling information alone.

Public Comment

Did ATSDR corroborate the findings of the Koracin modeling report?

ATSDR Response

ATSDR concurs with the wind flow patterns described in the Koracin report. Similar to the Koracin report, ATSDR has received "burnt coffee" odor complaints from residents occurring during the evening or early morning southeast of the Intel-New Mexico Plant.

Public Comment

ATSDR should include the Koracin modeling report in an appendix.

ATSDR Response

ATSDR cites key references considered in our evaluations, rather than including entire documents as appendixes. In this public health consultation, ATSDR cited Darko Koracin's report ("Koracin and Watson 2003") in the text but we failed to include it among the references at the end of the report. We have revised the Health Consultation to include that citation in the references.

Public Comment

ATSDR should have made better use of the available modeling data. We were a little disappointed that more use of modeling results was not made. It has been our experience that the best understanding of air quality issues is made when emissions (estimated or measured), models, and measurements are considered together. Models can help put limited measurements in context and they can be used to assess the significance of emission information.

ATSDR Response

ATSDR obtained and evaluated a wide range of environmental data, including information on emissions, fate and transport, and ambient air monitoring to draw public health conclusions. In particular, ATSDR considered the results of multiple modeling studies when developing this document. While we agree conceptually that modeling could have helped provide additional insights to the monitoring that was done, the available modeling studies had some important limitations. ATSDR recognizes that monitoring data had limitations as well. ATSDR added additional information about the uses and benefits of air modeling in the Methodology section of this health consultation and included CEWG's recent modeling of hydrogen fluoride.

General Comments

Public Comment

Has ATSDR anything to say about the synergistic exposure to toxins? Did ATSDR perform analysis of toxic exposure to nearby resident factor in the toxicity multiple effects of acetone and isopropyl alcohol?

ATSDR Response

ATSDR did not perform interaction analysis because of the lack of exposure information in the community. Isopropyl alcohol is metabolized to acetone. Therefore exposure to acetone and isopropyl alcohol would have a combined effect. Acetone has a synergistic effect in combination with pyridine (ATSDR, 2011). Pyridine gas is used as a catalyst silica atomic layer deposition in semiconductor manufacturing**.** ATSDR expects that pyridine would be routed to typical exhausts if Intel-New Mexico were using pyridine for this purpose**.**

Public Comment

Is ATSDR convinced that phosgene has not been released by Intel-New Mexico? Why does ATSDR not recommend monitoring for phosgene? The 2009 report cites Intel's assurances that measures are always in place to prevent formation of phosgene. Have those measures always been in place? When were they instituted?

ATSDR Response

ATSDR does not know when Intel-New Mexico implemented exhaust ventilation controls to prevent chlorine-containing gases from being vented through the thermal oxidizers.

ATSDR found no evidence, i.e. pattern of detections, indicating Intel-New Mexico that phosgene is being released from the Intel-New Mexico facility. Therefore ATSDR is not recommending phosgene monitoring.

ATSDR requires a rationale for making recommendations for air monitoring of phosgene. ATSDR is not aware of any releases of phosgene from semiconductors manufacturing facilities that have resulted in community exposure.

Semiconductor facilities and other industrial facilities, have the potential to release phosgene if they are using chlorinated solvents in the presence of high temperature or flames. For example, the use of carbon tetrachloride as a feed gas during the plasma etch process would result in the formation of phosgene and hydrochloride acid during oxidative decomposition by flame (Bolmen, 1998).

Public Comment

ATSDR did not mention Intel's "consultant shopping" to get a finding of no phosgene after it was detected multiple times by other monitoring devices. Does ATSDR take the position on the polluters' ability to discard as "false positive" readings they find inconvenient, substituting instead more acceptable findings produced after "consultant shopping"?

ATSDR Response

ATSDR did not evaluate the rationale for Intel-New Mexico's selection of environmental consultants. With the exception of the carbon monoxide readings, the quality of the open path FTIR, including the phosgene data, is not sufficient to make a public health determination, i.e., phosgene was detected very infrequently.

Public Comment

Are data available regarding phosgene in ambient air near other Intel plants, near other computer chip plants, and/or in other locations, including typical urban areas?

ATSDR Response

Phosgene levels have been measured in ambient air in the United States at levels from 22 (rural) to 32 (urban) parts per trillion (USEPA, 2005). These data were collected in California. ATSDR could not find any air monitoring specifically collected near semiconductor manufacturing facilities.

Public Comment

Intel-New Mexico is constantly striving to improve its operations.

ATSDR Response

Comment noted. ATSDR noted several air pollution control improvements at the Intel-New Mexico facility e.g. raising the stack height, adding redundancy to its thermal oxidizers, and installing of ammonia waste water systems, in this health consultation.

Public Comment

Change…approximately 15 miles north of Albuquerque to "….approximately 15 miles north of downtown Albuquerque".

ATSDR Response

ATSDR has added "downtown".

Public Comment

CEWG would like to have a source-apportionment for aldehydes and benzene so that we could separate out any Intel contribution from other sources in the urban area. In the context of source-apportionment it would be helpful to have precise measurements at many locations over a year or more of the pollutants of concern in addition to potential Intel tracers such as hydrogen fluoride, PGME (Propylene Glycol Monomethyl Ether Acetate), carbon tetrafluoride and isopropyl alcohol.

ATSDR Response

ATSDR does not typically conduct a source-apportionment evaluation for health evaluations. EPA National Emissions Inventory (NEI) may provide useful information to CEWG. For example, EPA's 2011 NEI fusion maps lists ammonia as a source from Intel-NM (EPA, 2014). http://www.epa.gov/ttn/chief/net/2011inventory.html

Public Comment

We would like to know what studies in the vicinities of other chip manufacturing plants have shown.

ATSDR Response

ATSDR completed a health consultation that estimated historical outdoor air emissions in Endicott, NY (ATSDR, 2006). ATSDR could not conclude that semiconductor emissions from the Endicott NY facility were harming the health of people residing near the facility because of insufficient data.

Chiu et al 2005 measured VOCs at a semiconductor industrial park in northwestern Taiwan from 2000 to 2003. The highest VOC levels measured were for isopropyl alcohol (29-135 ppbv) and acetone (12-164 ppbv). Researchers also note that low-wind conditions restricted large-scale dispersion of VOCs and increased the ground level build-up of VOCs within the industrial park.

Chein and Chen (2003) estimated VOC emission factors and examined VOC emission profiles at 9 semiconductor manufacturing processes (fabs). Overall, isopropyl alcohol accounted for highest emissions from individual chemicals. The authors noted that "care should be taken to apply the emission factor in many situations, such as in ambient dispersion modeling and analysis, control strategy development, and screening sources for compliance investigation. The emission factor represents the average value from limited fab source data without consideration of any control equipment".

Chein et al (2004) conducted a study to estimate the emission factors of inorganic acids from the nine semiconductor manufacturing fabs. The coefficient of variation for emission rates for each fab was up to 20 percent. The authors noted that sulfuric acid aerosol, fluorine, and chlorine were the main emission species, depending on the type of chemicals used in the particular fab.

Public Comment

Are there regulations regarding storage of large quantities of chemicals close to restricted areas? Was this addressed in the health consultation?

ATSDR Response

This issue was not addressed in the 2009 Health Consultation. EPA's Emergency Planning and Community Right-to-Know Act (EPCRA) requires that facilities storing certain hazardous chemicals above specific thresholds submit an emergency and hazardous chemical inventory to the Local Emergency Response Coordinator (LEPC), the State Emergency Response Coordinator (SERC) and the local fire department annually. Intel-New Mexico is also subject to requirements of the Resource Conservation and Recovery Act (RCRA) for the storage of hazardous waste.

Public Comment

Intel-New Mexico thermal oxidizer stack heights were originally 23.2 meters in height. New thermal oxidizer will be raised to 30 meters. Good engineering practices call for raising the height to 38.2 meters. Intel is choosing to ignore good engineering practices regarding stack heights.

ATSDR Comment

Intel-New Mexico raised its thermal oxidizers stacks to 40 meters in 2010-2011 (CEWG, 2013).

Public Comment

ATSDR did not adequately address emission from mobile and fixed sources in the area and the extent which Intel-New Mexico is a minor contributor.

ATSDR Response

The total amount of emissions in the Corrales area is influenced by Intel-New Mexico and other sources. ATSDR recognizes that motor vehicles are responsible for close to one-half of volatile organic compounds (VOCs) emissions, and about half of the toxic air pollutant emissions in the United States (EPA, 2007). Motor vehicles account for 75 percent of carbon monoxide emissions nationwide. However, for other pollutants, e.g., fluorinated gases, emissions from Intel-New Mexico may account for nearly all of the local releases. ATSDR added other sources of air contaminants e.g. wildland fires, motor vehicles and wind-blown dust in this health consultation.

Public Comment

ATSDR asserts that any pollution found near Intel-New Mexico Plant will be the result from other sources and not from Intel-New Mexico. While that may be true for certain pollutants, this assertion is not valid for all pollutants in the area.

ATSDR Response

ATSDR recognizes that Intel-New Mexico is the main point source of air pollution in the community. Other important air pollution sources include non-point sources such as motor vehicles traffic and wind-blown dust.

Public Comment

The ATSDR report was completed in a fragmentary manner without stepping back and grasping the big picture.

ATSDR Response

ATSDR integrated additional information into this health consultation to provide a more complete picture of air pollutants.

Public Comment

Why did ATSDR not mention "whistle blower" statements in the Health Consultation and why ATSDR did not contact the "whistle blowers"?

ATSDR Response

ATSDR reviewed a large amount of information, including information from two former Intel -NM employees and a retired state of New Mexico employee. This information was helpful in providing background information about community concerns.

Public Comment

ATSDR should change its report to reflect there are not active dry cleaner facilities in the Rio Rancho area. In the 2009 ATSDR report, it indicates a dry cleaner may be a likely source of odors and pollution. This is a false statement and needs to be removed.

ATSDR Response

ATSDR has removed the statement about dry cleaners from this health consultation. However, EPA's Enviromapper website (http://www.epa.gov/emefdata/em4ef.html) indicates that a dry cleaner is located on NM Highway 528 just north of the Intel-New Mexico facility. There are activities and operations capable of producing community odors including a crematorium northeast of the plant and farming in the valley to the east. EPA does not currently regulate crematoriums but some state agencies have issued air quality regulations regarding crematorium operations (BAAQMD, 2012).

Public Comment

After ATSDR's meeting with EPA Region 6 and after nearly five years of being told by ATSDR that CRCAW would receive two comprehensive evaluations (a health consultation and an air quality consultation), ATSDR suddenly decided to combine both consultations into one report.

ATSDR Response

ATSDR initially reported to the petitioner that it would release two health consultations, one on air emissions and a second one on air quality data. After additional internal discussion ATSDR decided to complete one health consultation and provide a separate letter to NMED Air Quality Bureau about ATSDR's observation regarding Intel-NM air emissions (ATSDR, 2009.) This letter was made available to the public in 2009.

Public Comment

A comprehensive emissions inventory was developed by Henderson Consulting for all mobile and area sources within 5 km and all point sources within 10 km of Intel-New Mexico. This was a critical part of the NMED project. Intel-New Mexico's maximum emissions (93.2 pounds/day) were less than 5% of the total air pollution emissions. The major source of emissions in the vicinity of Intel-New Mexico was mobile sources (1148.1 pounds/day) and area sources (618.9 pounds/day).

ATSDR Response

Emission inventory data provides useful background information. ATSDR recognizes that mobile sources are a significant source of air pollution in the community.

Public Comment

The ATSDR report should clearly reflect the community stakeholder process that led to the use of the FTIR-OP methods.

ATSDR Response

ATSDR added the following sentence to the methodology section: "This method was selected by NMED and the citizens group because of its ability to measure relatively low concentrations of many chemicals of concern."

Public Comment

ATSDR should add ozone monitoring results to the table. Ozone represents one of several substances showing significantly greater daytime detection activity; such behavior generally implicates sources other than Intel-New Mexico. ATSDR should add the information on ozone monitoring, including information on the time-of-day detection patterns.

ATSDR Response

Ozone is a regional air pollutant formed from VOCs, oxides of nitrogen and sunlight. The Albuquerque area is maintaining compliance with EPA National Ambient Air Quality Standards (NAAQs) for Ozone of 75 parts per billion (ppb) (City of Albuquerque, 2014).

Public Comment

Regarding the symptom and prevalence survey the sentence should read "These organizations have not released a formal report or description of methodologies on their efforts."

ATSDR Response

This sentence, in the Community Health Concerns section, has been changed to "These organizations have not released a formal report on their efforts including methods and conclusions."

Public Comment

Because OP-FTIR's generate real-time results with varying detection limits for each frame, it has often been the topic of discussion. However, experts and the equipment manufacturers have generally accepted data handling methods. ATSDR should mention that more detailed data are available for analysis that would take advantage of the results obtained for shorter periods of time, such as frame by frame spectral co-added scans, daily summaries supporting minimum, maximum, and average concentrations and companioned MDL's that would avoid the shortfalls ATSDR encountered by using summarized average ranges for MDL values for each monitoring period evaluated.

ATSDR Response

For more detailed analysis, ATSDR used polar annulus plots to evaluate daily pollutant concentration and wind patterns for select contaminants. These plots are included in Appendices G – K.

Public Comment

Page 21 of ATSDR's 2009 Health Consultation says "fence line monitoring may underestimate exposure to residents living next to plant's eastern border". Replace with "…..fence line monitoring may underestimate or overestimate exposure to residents living next to plant's eastern border". The physics of trace chemical compounds in the air and the increased distance make decreasing concentrations with distance not only possible, but much more likely.

ATSDR Response

ATSDR removed the word “underestimate”. The sentence has been changed to: “Because of the close proximity of the plant to the residential area and because of the higher elevation of the plant relative to the residential area, fence line monitoring may not accurately estimate exposure to residents living next to the plant’s eastern border.”

Public Comment

In the 2009 Health Consultation ATSDR noted “The primary limitation of the technology is its inability to measure low levels of multiple air contaminants over time.” This refers to OP-FTIR monitoring; however the method was actually chosen by NMED and the Citizens group because of its ability to measure low concentrations of many chemicals of concern (see attachment 4 and attachment 6) for extended periods of time (18 days). ATSDR should add a statement that says something to the effect of: “However, OP-FTIR was state of the art and valid methodology for the purpose of the NMED study which had other elements that assisted with the characterization of airborne chemicals in the community (i.e. emissions inventory, modeling, canister sampling, and facility stack test results).”

ATSDR Response

ATSDR added the following to page 23 “This method was selected by NMED and the Citizens group because of its ability to measure relatively low concentrations of many chemicals of concern.”

Public Comment

ATSDR should provide the name of the “…commercial software program used to plot the pollution rose in graphical depiction” referenced in first paragraph of page 31 of the 2009 Health Consultation.

ATSDR Response

ATSDR removed graphs that were presented in the 2009 Health Consultation. ATSDR used *R* and openair package to complete graphs in this Health Consultation (Carslaw and Ropkins 2012).

Public Comment

On page 35 of the 2009 Health Consultation ATSDR should add the following: “for Munters units and 1360 degrees F for Durr units.”

ATSDR Response

ATSDR has revised this section to include additional details on silica deposition and the results of the silica stack testing. Reference to thermal oxidizer operating temperatures are contained in the Silica Task Force report.

Public Comment

There is no discussion about the fact that the FTIR measurements are path measurements rather than point measurements. Modeling can be used to assess how much higher concentrations might be expected at individual points than the average over the path length.

ATSDR Response

The following was added to the text: "Open Path FTIR monitoring provides contaminant concentrations averaged over the beam length (around 100 meters). It does not provide maximum concentrations within that distance."

Public Comment

Discussion of aldehydes and combustion related chemicals detected at monitoring site on NW corner of Intel property less than 100 feet from Sara Road and Highway 528 intersection makes no mention of possibility of vehicles as source of combustion related chemicals even though the southern section of Highway 528 is also upwind of the monitor during the peak 1 hour measurement. Wind direction is listed in the text as southwest. This would make the monitor location more upwind or crosswind from Intel. More extensive review of the monitoring results for acetaldehyde and formaldehyde would show the relationship to mobile sources due to time of detection and wind directions. (For example, the detection activity of acetaldehyde during the 1.5 hours prior to the 19:00 - 20:00 interval reported in table 3; when the FTIR monitoring was generally upwind of the site and at a similar concentration (784 ppb versus 813 ppb). The same is seen when reviewing the detection activity of formaldehyde during the one hour prior to the 19:00 - 20:00 interval reported in table 3; the FTIR monitoring was generally upwind of the site and at a similar concentration (27 ppb versus 46 ppb).

ATSDR Response

ATSDR acknowledges that motor vehicles could be the source of the acetaldehyde peaks on August 2, 2002 and re-plotted this data using *R* and openair package. These plots are presented in Appendix G of the Health Consultation.

Public Comment

The 2009 Health Consultation Appendices 1-1, 1-2, 1-3, 1-4, and 1-5 are labeled "Intel Pollution Rose" suggest the Intel-New Mexico Plant as the source of the chemicals presented on the 20 graphs.

ATSDR Comment

These appendices have been replaced with appendices G – K and are labeled according to the graph type and chemical e.g., Polar Annulus Plots - Ammonia.

Tables 2 and 3 (FTIR Data)

Public Comment

The source of the "MDL Data Set Range" values presented in Table 2 of the 2009 Health consultation appear to be the minimum and maximum of the three or five "Mean MDL" values listed in the TRC summary tables for the OP-FTIR monitoring at the five locations . The TRC values in the original data report are in units of ppb whereas the ATSDR values are in units of $\mu g/m^3$. When comparing ATSDR's listed values against TRC's values a sizeable number of what appear to be transcription and/or calculation errors for the ug/m^3 values are listed. Intel has prepared a spreadsheet with the apparently incorrect numbers highlighted in yellow for many of the substances. Please review and correct these numbers. Also note, if ATSDR confirms our calculations as being correct, it appears nitric acid should no longer be listed as exceeding the CV.

ATSDR Response

In its 2009 Health Consultation ATSDR reported a summary of FTIR monitoring at all locations based on TRC data (TRC, 2003). ATSDR removed this table from this Health Consultation. Calculating average concentrations using zeros for non-detections underestimates the true average levels. Similarly, reporting average concentrations based on limited detected values overestimates the average concentrations. The table did not add any useful information to the overall evaluation.

Public Comment

Regarding Tables 2 and 3 (2009 Health Consultation), please add explanation in the document on the derivation and/or on the rationale and the limitations for the use of the values listed in Tables 2 and 3. For Table 3, there is no explanation or definition of the wind directions that are considered to be upwind or downwind of Intel site for the three OP-FTIR monitoring locations. This applies by extension, for the evaluation of the pollution roses in the appendices. ATSDR is encouraged to explain and define the wind directions that it considers to be upwind or downwind of Intel site for the three OP-FTIR monitoring locations. Table 3: Acetaldehyde concentration actually was 813 ppb (instead of the 81 ppb listed). Table 3: Correct the typographical errors on the dates for the three substances (n-butyl alcohol, n-hexane, and PGME) in Table 3 that are listed as 2007 instead of 2003. Table 3: For ethanol FTIR location is classified as “downwind” and “crosswind”. Change the classification to “upwind” since both of the listed wind directions (i.e., 202 & 142 degrees) actually are consistent with the monitor (SE location) being upwind of the Intel site. Table 3: For methanol FTIR location is classified as “upwind”. Change the classification to “downwind” since both of the listed wind directions (i.e., 223 & 195 degrees) actually are consistent with the monitor (SE location) being downwind of the Intel site. Table 3: Detection activity in 2nd column (# of detections per number of frames) should be 37/56 for carbon tetrafluoride versus the 53/56 listed, and 48/55 for n-butyl alcohol versus the 55/55 listed.

ATSDR Response

ATSDR removed the 2009 Health Consultation Table 2 from this Health Consultation as noted in the previous response. ATSDR also removed the 2009 Health Consultation Table 3 – "Select 1 hour Maximum Levels from Intel-New Mexico Open Path FTIR" from this Health Consultation. ATSDR replaced the previous Table 3 with polar annulus plots to visualize select contaminant levels by time of day and wind direction (Appendices G through K).

Public Comment

The phosgene values are of interest, because they are close to the California Acute Recommended Exposure Limit (REL). We know that NMED concluded that their measurements for phosgene were false positives, but Table 2 (2009 Health Consultation) reports Intel's values which apparently used a different analysis technique.

ATSDR Response

Phosgene was detected in 0.5 percent of the measurements (TRC, 2003). ATSDR cannot draw health conclusions based on this information.

In ATSDR's 2009 public comment Health Consultation ATSDR summarized selected 1-hour peaks levels for those chemical having an average detection limit below the corresponding health-based MRLs for acute exposure. ATSDR has removed Tables 2 and 3 from this Health Consultation because the high rate of censored data do not allow for accurate calculation of mean and peak concentrations.

Public Comment

We found the tables of concentrations measured by the Intel FTIR interesting. However, we found the entry for one hour and 24 hours concentrations for nitrogen dioxide on page 28 incomprehensible. Clearly, the maximum 1 hour cannot be five times lower than the maximum 24 hour average. Is there a leading digit missing in the 1 hour average? There are several cases where the mean over all measurements above threshold is significantly above the maximum one hour value (for example for phosphine the mean of the detected values is 12 while the maximum one hour value is 0.4593 $\mu g/m^3$). Are we to interpret this to mean that there was a very short time value of 12 or greater with the remainder of the 2 hour being below detection so that the measured value plus the zeros for the remainder of the hour gave an average of 0.4593 for the entire hour? If so, this certainly underscores the report's conclusions about the poor detection thresholds.

ATSDR Response

The nitrogen dioxide values contained a transcription error in the 2009 Health Consultation tables. Phosphine was detected in three of approximately 40,000 data frames 70 second data frames. As noted previously reporting average values for highly censored data does not provide meaningful information. Therefore ATSDR elected to remove the table from this document.

Public Comment

The nitric acid 1-hour concentrations appear to be above the California acute Recommended Exposure Limit (REL). Could you describe the averaging time on which this Acute REL is based?

ATSDR Response

The California Recommended Exposure Limit (REL) for nitric acid is 86 micrograms per cubic meter (33 ppb) for a 1-hour exposure duration. This is based on a human study of nitric acid resulting with mild respiratory irritation (OEHHA, 1999). California used a study of 9 adolescent asthmatics who were exposed to 129 micrograms per cubic meter (50 ppb) for a 40 minute period exhibited a 4 percent decrease in lung function measured as forced expiratory volume.

Public Comment

Benzene concentrations seem to be well above the ATSDR MRL but we are not aware of benzene emissions from the Intel facility. Do you have any information to suggest that these values are related to Intel-New Mexico or are these to be interpreted as probably produced by other sources?

ATSDR Response

Benzene is not associated with semiconductor manufacturing emissions (ATSDR, 2007, Baldwin et al 2011, Burgess 1995). Benzene levels cannot be accurately evaluated because of high level of censoring and highly variable detection limits which exceeded the ATSDR's Minimal Risk Level (MRL) of 9 parts per billion for acute exposure. The mean Minimum Detection Limit (MDL) ranged 70 to 112 ppb for benzene in 2003 TRC FTIR datasets (TRC, 2003). Benzene was detected less than 1 percent of the monitoring periods.

Public Comment

The average of the detected values for hydrogen fluoride is above the ATSDR acute MRL level and is also above the odor threshold of 33 micrograms per cubic meter.

The 1-hour average is not above the ATSDR acute MRL level of 16.7 $\mu g/m^3$ meter. However the average detected value of 46 $\mu g/m^3$ is similar to the risk assessment's modeled, maximum 1 hour average of 41 $\mu g/m^3$. Since the odor threshold is 33 $\mu g/m^3$, the measurements also suggest that HF odors would he expected. Since the FTIR measurements represent path length averages, higher concentrations must have occurred at points within the path.

ATSDR Response

Hydrogen fluoride was detected in only 28 of approximately 40,000 data frames. It is not possible to calculate an accurate average concentration of hydrogen fluoride because the data were highly censored data, i.e., had a high percentage of non-detections. Hydrogen fluoride has an odor threshold of 33 $\mu g/m^3$. A maximum 70-second hydrogen fluoride concentration of 132 $\mu g/m^3$ (162 ppb), above the odor threshold, was measured by the SE FTIR (TRC, 2003).

As noted in the 2009 public comment health consultation, minimum detection limits for many chemicals exceeded their health screening values.

Public Comment

Bromoform appears to illustrate the concerns about the inadequate thresholds. The average value of the detections was 392 $\mu g/m^3$ while the EPA Region 3 Risk-Based Concentration value is 1.6 $\mu g/m^3$. However if the non-detects are taken as zeros and averaged in with the detected values, the resulting average is 0.294 μ/m^3.

ATSDR Response

ATSDR agrees with comment. Bromoform was detected in 32 of 40,000 data frames. Therefore, it is not possible to interpret and draw public health conclusions from this data.

Public Comment

The data we do haves suggests that nitric acid levels are of concern and that hydrogen fluoride levels present odor concerns. There are also relatively high levels of benzene and various aldehydes which might involve some contributions from Intel sources. In order to fully understand the potential for health effects from Intel New-Mexico emissions we need to have a more complete picture of the concentrations of various contaminants that occur in the vicinity of the Intel-New Mexico plant. Ideally we would like to have sufficient measurements that the time-concentration profiles of species such as fine-particles, hydrogen fluoride, and nitric acid could be well described.

ATSDR Response

ATSDR has included $PM_{2.5}$ and PM_{10} monitoring data in this health consultation. ATSDR is recommending that NMED, CEWG and Intel-New Mexico evaluate the need to conduct additional air modeling and air monitoring, following the results of any additional Intel-New Mexico air pollution control equipment stack testing i.e., acid scrubbers and RTOs, required in follow-up to EPA's 2009 compliance inspection.

Corrales Air Quality Task Force Reports and Related Efforts

Public Comment

The findings and conclusions of the Gradient report are questionable.

ATSDR Response

ATSDR included the main findings from the Corrales Air Quality Task Force because it was a major effort to study local air quality. ATSDR included the main findings from that effort as background. However, ATSDR evaluated several sources of information to draw conclusions for this health consultation.

Public Comment

The Corrales Air Quality Task Force's air modeling was performed well. ATSDR should more prominently acknowledge the air quality assessments that have been completed.

ATSDR Response

ATSDR appreciates the efforts of the Corrales Air Quality Task Force. ATSDR considered the previous air quality and risk assessment as useful background information. The Health Consultation includes an overview of the modeling as well as the health interpretations that Gradient Corporation made from the air modeling.

Public Comment

The draft ATSDR report does not adequately convey the nature of the Intel-Rio Rancho operations, the continuing attention given to responsible operation of the facility to avoid environmental and public health impacts, the attention given to involving the local community and the emphasis given to continuous improvement. Micro-electronic product production facilities are very sophisticated and complex operations. The Intel-Rio Rancho facility was designed and constructed to meet all applicable federal and state emissions regulations and standards including a voluntary commitment to operate as a minor source of air emissions as defined under the US EPA Clean Air Act.

The Intel-Rio Rancho facility recognized from the beginning that it is important to conduct periodic risk assessments as a way to acquire, integrate and synthesize information on plant emissions during normal operations and anticipate the potential health consequences of accidents. Such periodic assessments help in evaluating the adequacy of operating procedures and provide a basis for continual improvement. The initial assessment included specifications and controls to guide construction of the facility and its operation. A second assessment was conducted by an external contractor (Radian Corporation) in 1997. That assessment evaluated overall short- and long-term health and safety risks to the community from the facility. The assessment was revised and updated, also by an external contractor (ERM), as a third assessment during 2003. (Both assessment reports are and have been available at the Rio Rancho and Corrales Public Libraries.) The fourth assessment, coordinated by the NMED, was begun in 2002 and completed in 2004**.**

NMED initiated in 2002 a comprehensive health risk assessment to identify and analyze potential air quality health risks due to air pollution in the Village of Corrales. The NMED used a stakeholder-based health risk assessment process conducted in accordance with EPA guidelines (see www.epa.gov/oar/oaqps/air_risc/3_90_024.html). This involved numerous facilitated public meetings and forums to provide community input for the direction and focus of the work plan. Intel actively participated in the process as a key stakeholder; however, the project was managed by NMED with data collection completed by highly qualified professional scientists and external experts. Results were shared with the public through open meetings and all reports and data from this study continue to be posted on the NMED web site
(see www.nmenv.state.nm.us/aqb/projects/Corrales/).

The project involved: 1) Initial air quality monitoring to help focus the scope of the inventory, identifying potential hot spots and specific air toxics of concern 2) The development of an emissions inventory including air toxics emissions for the area 3) A modeling analysis 4) a refined monitoring study to estimate exposure levels and 5) toxicological risk characterization considering the monitored and modeled results and dose-response assessment

We believe that ATSDR should describe the NMED study more thoroughly in this report and rely on its results as a basis for the ATSDR evaluation of the Intel-Rio Rancho facility and its potential health impacts.

ATSDR Response:

ATSDR agrees that the Corrales Air Quality Task Force Study was an important contribution to the understanding of local air quality issues near the Intel facility. The Health Consultation includes a review of the findings from the study, including direct quotations about the study's main findings as well as some important limitations. A summary of certain aspects of the risk characterization and the emissions assessment is provided in the health consultation.

ATSDR was petitioned to conduct its own evaluation of the Intel-New Mexico air quality issues. Accordingly, we gathered as much site-specific information as possible, much of which was generated for the Task Force study. ATSDR evaluated and interpreted those data, as well as information from other sources (e.g., the risk assessments prepared for Intel). The findings in the Health Consultation reflect ATSDR's analysis of the outdoor air data, modeling and related information.

Public Comment

ATSDR's Health Consultation does not acknowledge Intel's "tracer study".

ATSDR Response

ATSDR's acknowledges the tracer study in dispersion modeling section of this health consultation. The highest concentrations were found onsite and close to the property boundary. The air modeling results both under and over-predicted the FTIR concentrations of sulfur hexafluoride (ERM, 2005).

Public Comment

ATSDR should include a statement that says modeling is a legitimate recommended way to estimate facility-specific ground level concentrations of chemicals that can also come from multiple sources. The ATSDR report should state that a high degree of correlation was reported between Intel specific chemical modeling done by Koracin and Watson and FTIR monitoring for SF6, CF4, C2F6, and HF in the NMED study. This cross validation strengthens the characterization of ambient chemicals and subsequent interpretation of health risks in the study.

ATSDR Response

The cross validation was an excellent effort but the level of censoring of the FTIR data preclude a useful comparison of the modeling and monitoring data.

Public Comment

To aid in interpreting the air monitoring data, Intel, at the request of NMED, conducted a tracer gas study in which measured quantities of sulfur hexafluoride were purposefully released from the Intel site when the wind was blowing toward the monitoring site. Knowledge of the quantities of sulfur hexafluoride released and the concentrations measured in ambient air were used to calculate dilution coefficients and for comparison to modeled concentrations of Intel's emissions.

In our review of ATSDR Health Consultations, we did not identify any air quality evaluations that used similar tracer gas methodology to help validate the air monitoring data and relate it to a specific facility. This added data is significant and should be included in ATSDR's report since ATSDR's own guidance for evaluating modeled data recommends this type of validation (see www.atsdr.cdc.gov/HAC/PHAmanual/ch5.html).

As part of the NMED study, Darko Koracin and John Watson, scientists associated with Desert Research Institute, conducted air dispersion modeling of Intel's emissions. Because of resource constraints, the air dispersion modeling was not conducted for emissions from non-Intel sources even though Intel's emission represented less than 5% of the pollution emissions in this local area (according to the NMED Source Inventory). It is necessary to have modeled air concentration if there are any potential sources other than Intel contributing to what is monitored.

Three chemicals (sulfur hexafluoride, tetrafluoromethane, and hexofluoroethane) emitted from the Intel-New Mexico facility, unlikely to be emitted from other sources, were detected in the

FTIR-OP ambient monitoring. This provided the opportunity to compare the maximum 1-hour modeled concentrations and the maximum 1-hour monitored concentrations.

The results are shown below (Intel, 2004). The agreement between the modeled and monitored concentrations (7 of 8 comparisons) is remarkably good. In our review of other ATSDR Health Consultations we could not identify any similar rigorous comparison of monitored versus modeled air concentrations.

Comparison of Modeled (Koracin and Watson) and Monitored (TRC) Ambient Concentrations of Four Intel-Specific Fluorine-Containing Chemicals Compound

	Modeled* 1-hour Maximum Concentration (ppb)	Monitored NMED/TRC 1-hour Maximum Concentration (ppb)	Modeled* Maximum Annual Concentration (ppb)	Monitored Average 18-Day Concentration (ppb)
Sulfur Hexafluoride	0.26	0.39	0.004	0.007
Tetrafluoromethane	1.30	1.62	0.020	0.037
Hexafluoroethane	6.00	1.73	0.092	0.003
Hydrogen Fluoride	3.30	4.56	0.051	0.038

*Modeled data from Koracin and Watson Report corrected for revised emission rates per memo from Intel-New Mexico to NMED, May 28, 2004.

ATSDR Response

ATSDR strongly supports using air monitoring to validate dispersion modeling. The compounds selected for this effort are reflective of semiconductor manufacturing sources. From a public health perspective, ideally the modeled concentrations should be consistently higher than measured ones. Also, the monitored 1-hour maximum and 18-day concentration noted in the table above are influenced by censored data (non-detects). The frequency of detection for the four compounds was 10 percent or less for each chemical in the datasets used in the tracer gas study (TRC, 2003), as noted in the table below. The actual average concentrations of these compounds cannot be accurately determined because data are highly censored i.e., greater than 70 percent non-detections (Helsel, 2012). Since it is not possible to accurately estimate the true average concentrations any comparisons of maximum annual concentrations to average 18-day concentrations are spurious. This is also the case for comparing the modeled and measured 1-hour maximum concentrations of hydrogen fluoride. The maximum 1-hour average concentration reported of hydrogen fluoride (4.56 ppb) occurred on August 30, 2003 during the period 12:34 to 1:33 PM (TRC, 2003). This reported average is based on only 3 detections (103.7, 88.1 and 58.9 ppb) in 55 data frames. The remaining 52 data frames were reported as zeros (TRC, 2003). Yet TRC reported an average minimum detection limit for hydrogen fluoride of 40.3 ppb for this data set.

Frequency of FTIR Detections for NWE and SE FTIRs

	NWE – FTIR (Aug 9 – Aug 21, 2003)			SE – FTIR (Aug 21, 2003 – Sept 07 2003)		
	Percent detections (%)	Mean MDL (ppb)	Maximum MDL (ppb)	Percent detections (%)	Mean MDL (ppb)	Maximum MDL (ppb)
Sulfur Hexa Fluoride	NR	NR	NR	2.9	0.1	9.3
Tetrafluoro-methane	10	0.2	3.5	5.3	0.2	4.2
Hexafluoro -ethane	0.4	2	16.1	0.2	3.1	15.4
Hydrogen Fluoride	0.0	0.0	771.0	0.1	40.3	463.7

MDL = minimum detection limit
NR = not reported
Data Source (TRC, 2003)

Public Comment

On page 41 of the 2009 Health Consultation, ATSDR states that "several opportunities are available to gather additional data…" Given that there are 201 documents posted in the Technical Report & Data section and 289 documents posted in the Background Information section18 of the NMED Corrales Air Quality Study web page (www.nmenv.state.nm.us/aqb/projects/Corrales/), this ATSDR report should state that more extensive review of existing data could also be done. Intel and NMED have reviewed that extensive body of data as a basis of the comments made elsewhere in this Intel review.

ATSDR Response

ATSDR acknowledges the volume of work performed by the Corrales Air Quality Task Force and it members. ATSDR identified and evaluated relevant information for its public health assessment rather than publish an extensive history of the previous Corrales Air Quality Task Force work.

Conclusions and Recommendations

Public Comment

The ATSDR Health Consultation should not include unsupported recommendations for additional air monitoring. ATSDR's recommends "…..public health and environmental agencies explore the possibility of conducting additional sampling or monitoring to characterize residential exposures, specifically in the community and particularly immediately southeast of Intel- New Mexico." This recommendation is not supported by the data available from the NMED Corrales Air Quality Study web page. The NMED data for sampling and monitoring shows: 1) a lack of significant Intel specific directional gradient or health effect concerns based on SE perimeter FTIR monitoring, 2) no correlation with odor complaints and rapid capture Summa canister sampling results, and 3) no acute health effects associated with 18 day continuous Summa canister monitoring levels during Intel warm down and ramp up periods. The NMED data also shows that the modeling conducted by Desert Research Institute for the project supported the monitoring results and did not identify health risks associated with Intel as a point source or Intel specific chemical emissions.

ATSDR Response:

The ATSDR Health Consultation summarizes the history of ambient air monitoring in the vicinity of Intel-New Mexico and notes several important limitations that prevented the Agency from making public health conclusions for this site. In ATSDR's professional judgment, appropriate data monitoring is a means to increase the communities' confidence in its air quality. For example, $PM_{2.5}$ and PM_{10} air monitoring data provide valuable information about airborne particulate levels in the community. Intel Corporation has recently committed to conducting air monitoring in communities near two of its manufacturing plants in Oregon (The Oregonian, 2014). Air monitoring may be useful in refining the accuracy of air modeling as well.

Public Comment

It is Intel's view that within the ATSDR Categories of Public Health Hazard, the Intel-Rio Rancho facility should be placed in Category D: No Apparent Public Health Hazard. This categorization is based on substantial scientific and technical documentation including the comprehensive risk assessment conducted by the New Mexico Environment Department (NMED) and completed in June 2004. Voluntary continuous improvement actions taken by Intel since 2004 to reduce air emissions and engage with the community through monthly working group meetings serve to reinforce the position that current Intel-Rio Rancho operations do not pose a public health hazard.

ATSDR Response

ATSDR recognizes Intel-New Mexico's continuous improvements it has made to reduce air emissions. ATSDR concludes that crystalline silica does not pose a public health hazard to the residential community adjacent to the Intel-New Mexico plant. ATSDR cannot make this conclusion for VOCs and acid aerosols because of lack of evidence. The Intel-New Mexico health risk assessments are based primarily on air modeling. In general, ATSDR does not draw public health conclusions based on modeling particularly when emissions sources are dynamic and frequently changing as is often the case with the semiconductor industry.

Public Comment

CEWG believes that the conclusion that the available data are not adequate to show conclusively that emissions are safe or that they are unsafe is accurate. The logical response to this conclusion is to make the emissions safer by reducing them and to gather appropriate data to make stronger conclusions possible.

ATSDR Response

ATSDR concurs with efforts to reduce emissions.

Public Comment

CEWG continues to strive for measures that reduce emissions or ground-level concentrations associated with the Intel plant. We welcome any suggestions that you might have to help us in that regard. We would appreciate suggestions on measurement techniques and other chemical species of interest. Follow-up modeling of additional air pollution control testing.

ATSDR Response

The need for follow-up monitoring should be based on pertinent testing of scrubbers and thermal oxidizers and associated air modelling. Also, monitoring should be considered to validate air modeling as appropriate.

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