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DIVISION OF AIR QUALITY
TOXICS PROTECTION BRANCH

Risk Assessment for Reciprocating Internal Combustion Engines (RICE) Area Sources

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Final Report

Robin Barrows, MEM

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1 Executive Summary

This is a risk assessment for inhalation exposure to hazardous air pollutants (HAPs) emitted by sources detailed in the Reciprocating Internal Combustion Engine (RICE) area source category Federal rule. The objective of this risk assessment is to determine cancer and non-cancer risk associated with exposures to pollutants emitted from RICE sources. Inhalation exposure and risk were determined on a per facility basis using the Human Exposure Model (HEM-3) developed by the Environmental Protection Agency (EPA). The first part of the report contains a screening level risk assessment used to determine which sources are significant contributors to risk; the second part contains a refined risk assessment for those significant contributors.

Using the North Carolina 2007 emissions inventory, risk for cancer and non-cancer endpoints was estimated for inhalation exposure to pollutants[1] emitted from 56 facilities having 413 RICE sources. Emissions data for metal HAPs[2] were not included in the inventory; therefore risk estimates were not determined for inhalation exposures to those pollutants.

The results of the screening level inhalation risk assessment for the RICE source category include risk estimates for cancer and non-cancer endpoints. Also included are those pollutants, or risk drivers, that contributed significantly to the estimation of risk.

Of the 56 facilities screened, 6 facilities (ten percent) have cancer risk over the established health threshold of one in a million. The results indicate a range of excess cancer risk from one to 16 per million people. This means that there is likelihood of between one and 16 additional cases of cancer per million that may occur due to inhalation exposures to pollutants emitted from RICE sources.

Non-cancer risk estimates exceeded established threshold values at two facilities. The model predicted that the target organ system of interest was respiratory, with formaldehyde as the risk driver.

Uncertainties were evaluated for data gaps in the emissions inventory and modeling capabilities.

A refined risk assessment was conducted for those facilities exceeding benchmark levels of risk. To reduce uncertainty, the data gaps regarding specific locations of sources, metal HAP emissions, reported emissions for emergency generators, and inactive sources were further investigated.

Sources were relocated using refined information for those facilities where the cancer risk exceeded the threshold of one in a million. Metal HAP emissions were estimated based on fuel throughput and emission factors (EFs) for arsenic and cadmium compounds.

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[1] polycyclic aromatic hydrocarbons for seven compounds (7-PAH), benzene, formaldehyde, and acetaldehyde

[2] Arsenic, beryllium compounds, cadmium compounds

Overall, filling data gaps in the emissions inventory reduced uncertainties dramatically.

There does not appear to be any excessive risk associated with inhalation exposure to emissions from RICE sources (for the HAPs specified in Subpart ZZZZ) as determined by modeling.

Many of the data gaps in the screening assessment arose from incomplete data in the emissions inventory. Filling those data gaps reduced risk significantly, yet the collected data have not been updated in the emissions inventory therefore similar data gaps will continue to occur. Development of a more complete emissions inventory will benefit DAQ by increasing emissions reporting efficiency and accuracy, leading to improved ambient air quality throughout the state as regulators will have the data needed to enforce compliance.

2 Introduction

This is a risk assessment for inhalation exposure to hazardous air pollutants (HAPs) emitted by sources detailed in the Reciprocating Internal Combustion Engine (RICE) area source category. The objective of this risk assessment is to determine cancer, chronic and acute inhalation risk associated with exposures to pollutants emitted from RICE sources. These sources are regulated by EPA in the National Emission Standard for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines (40 CFR Part 60, 63, 85, 90, 1048, 1065, and 1068, Subpart ZZZZ)[3] final rule. Emergency generators included in the Federal rule are exempt from air quality permit procedures in NC Division of Air Quality rules (15A NCAC 02Q.0102 (C)(2)(b)(v)(III)).

Inhalation exposure and risk associated with that exposure were determined on a per facility basis using the Human Exposure Model (HEM-3) developed by the Environmental Protection Agency (EPA).[4] HEM-3 performs atmospheric dispersion modeling of source emissions, and then estimates human exposure and risk resulting from that exposure. These risk estimates are for chronic and acute inhalation exposures and include both cancer and non-cancer endpoints.

The first part of the report contains a screening level risk assessment used to determine which sources are significant contributors to risk; the second part contains a refined risk assessment for those significant contributors. This report summarizes the methods used to determine these risk estimates for RICE sources.

3 Screening Level Assessment

3.1 Planning and Scoping

3.1.1 Exposure Assessment

Background Information

The RICE final rule was published in the Federal Register on January 18, 2008. Compliance with this regulation for facilities was required by July 1, 2008.

The final rule applies to new or reconstructed engines that are less than or equal to 500 horsepower (hp) produced after June 12, 2006. The RICE rule regulates the following HAPs:

- polycyclic aromatic hydrocarbons for seven compounds (7-PAH),
    - comprised of: benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene
- arsenic,

[3] EPA 2008. Standards of Performance for Stationary Spark Ignition Internal Combustion Engines and National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule. http://www.epa.gov/ttn/atw/area/fr18ja08.pdf accessed August 2009.

[4] EPA. Risk Assessment and Modeling - Human Exposure Model (HEM). http://www.epa.gov/ttn/fera/human_hem.html accessed August 2009.

- benzene,
- beryllium compounds,
- cadmium compounds,
- formaldehyde, and
- acetaldehyde.

The fuels used in these engines are natural gas, or lean-burn liquefied petroleum gas (LPG) for non-emergency engines or any fuel for emergency generators (i.e. diesel, gasoline).

Facilities subject to this rule are not required to obtain a permit to control emissions from these sources; rather, they are subject to compliance demonstrations and reporting and recordkeeping as detailed in the rule.

Source Identification

Data for this study were obtained from the North Carolina emission inventory for 2007. Facilities with emission sources potentially subject to the RICE rule were identified using the North American Industry Classification System[5] (NAICS) and Source Classification Codes[6] (SCC) listed in the regulation.[7] Based on a preliminary evaluation using the NAICS codes, 325 facilities were identified having a total of 13,450 sources. Facilities were further eliminated from the initial database if engine horsepower rating was greater than 500[8], and the pollutants emitted and fuel used did not match those listed in the regulation. See the flow diagram in Figure 1.

The final dataset contained emissions for 56 facilities having 413 RICE sources. Table A1 in the Appendix summarizes the emissions from these sources.

Emission release point (ERP) parameters and annual emission rate data were then obtained for all sources in the final database Data for metal HAP emissions (arsenic, beryllium compounds and cadmium compounds) and were not reported in the inventory and, therefore, were not modeled for the screening level assessment.

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[5] U.S. Census Bureau. North American Industry Classification System (NAICS). http://www.census.gov/eos/www/naics/

[6] EPA. Airs Facility Subsystem. Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants Publication. #EPA-450/4-90-003. March 1990.

[7] NAICS codes: 2211, 622110, 335312, 333912, 333992, 48621, 211111, 211112, 92811.
SCC: 20100102, 20100105, 20100107, 20100202, 20200104, 20200104, 20200202, 20200301, 20200702, 20201001, 20201702, 20300101, 20300201, 20300301, 20300702, 20301001

[8] 40 CFR Part 60, 63, 85, 90, 1048, 1065, and 1068, Subpart ZZZZ includes engines with horsepower rating of ≤ 500.

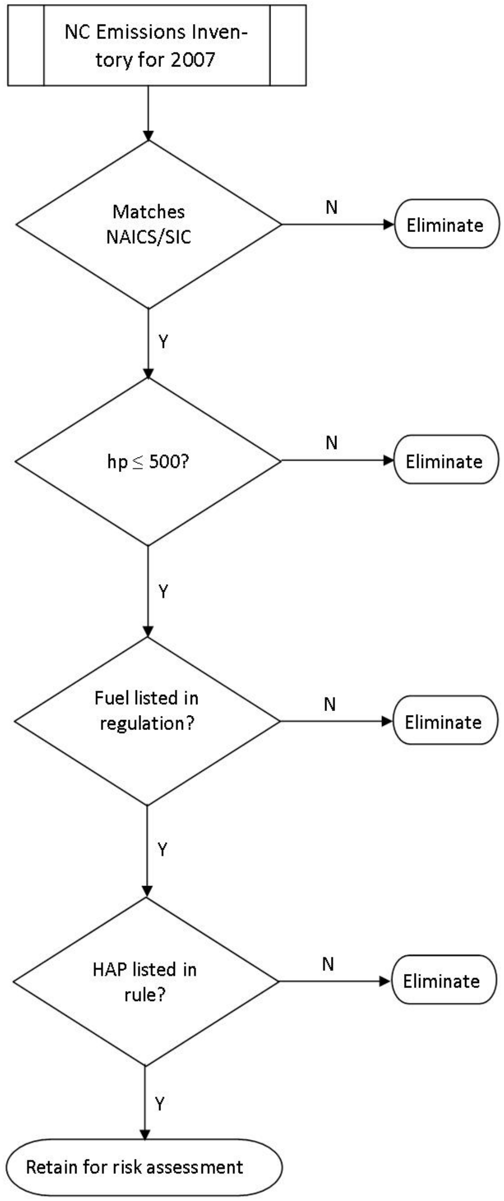

Figure 1. Flow Diagram for Source Exclusion from Inventory

Fate and Transport
A dispersion model is a computer simulation that predicts the movement of pollutants from a source. These models take into consideration the photochemistry (fate) and meteorology (transport) of air pollutants from a source. The atmospheric dispersion modeling function of HEM-3 (a computer program called AERMOD) predicts the ambient concentration of each modeled HAP at default and user-specified receptor locations. Required dispersion model inputs are:

- annual HAP emissions (in tons per year),
- ERP parameters (stack location coordinates, stack height, diameter, exhaust gas velocity and temperature), and
- meteorological data files, formatted for use with AERMOD, which include hourly data values spanning one calendar year.

Meteorological data from 1991, collected at National Weather Service (NWS) surface observation stations throughout the state, were obtained from EPA and used in modeling. The meteorological processor of AERMOD uses surface observations made prior to the introduction of the Automated Surface Observation System (ASOS). ASOS was installed in 1992; that is why data for 1991 were used in modeling. These are standard meteorological data inputs used by HEM-3.

Additionally, in cities and densely populated areas, urban heat island effects can significantly influence dispersion, especially at night. To account for these effects, HEM-3 requires the selection of a "Rural" or "Urban" dispersion environment, based on the population and land use near the modeled facility[9]. For this study, the rural dispersion environment was used for all modeling runs.

Finally, standard practice suggests that pollutant deposition/depletion parameters and photochemistry algorithms are not considered in a screening level assessment.

Airborne Concentrations
Ambient air concentrations were predicted by HEM-3 at default receptor locations for 7-PAH, benzene, formaldehyde, and acetaldehyde. Estimates of arsenic, beryllium compounds, and cadmium compounds ambient air concentrations could not be modeled because these were not included in the NC emissions inventory. Concentrations of these pollutants, considered metal HAPs, may have an effect on risk estimates.

Population
HEM-3 uses year 2000 US Census data. The model estimates cancer and chronic risk at Census block centroids[10]; therefore they were the primary receptor of interest in this study. Census blocks are geographic areas assigned to approximate similar populations in

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[9] Urban population choice is only used when more than 50% of the land within a 3 kM radius of the source is classified as urban or the population density within a 3 kM radius (1.86 mile radius) is greater than 750 people per square kM (approximately 1942 people per square mile).
[10] Centroid: an approximate center of a polygon. http://local.wasp.uwa.edu.au/~pbourke/geometry/polyarea/ accessed July 2010.

an area of a city block (roughly 40 people, or about 10 households). However, the actual population of a census block can vary from zero to over two thousand.

By default, HEM-3 predicts ambient concentrations at two types of receptor locations:

- polar grid points (located along 16 equally spaced radial directions at up to 13 radial distances from the emission release point),
- and centroids (geographic centers) of census blocks (based on the 2000 Census).

Measures of Exposure
HEM-3 dispersion modeling predicts the ambient concentration of a HAP at a census block centroid.

For cancer risk, exposure and risk are determined by multiplying the modeled ambient concentration by a unit risk estimate (URE) for cancer (see Equation 1). The model also predicts maximum individual risk (MIR). The MIR represents the highest estimated cancer risk to an exposed individual in a populated area.

Equation 1[11]: $CR_T = \sum_{i,k} AC_{i,k} \times URE_k$

where:
CR_T = total cancer risk at a given receptor (probability for one person)
$\sum_{i,k}$ = the sum over all sources i and pollutant types k (particulate or gas)
$AC_{i,k}$ = ambient concentration (µg/m) for pollutant k at the given receptor.
URE_k = cancer unit risk factor for pollutant k

To determine cancer risk for a census block population, HEM-3 assumes the entire population of a census block is located at the centroid of the census block and is exposed to the HAP concentration for a seventy-year lifetime. Benchmark levels for cancer risk are found in guidelines established by EPA[12] and use a risk level of one in a million to determine the potential for excess cancer if that population is exposed continuously (24 hrs/day) over 70 years. Human activity patterns (e.g., commuting to work or school, relocation) of the population residing within the census block are not accounted for in the model. The MIR and HI results for each facility are shown in the Appendix, Table A2.

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[11] HEM-3 Users Guide…
[12] Guidelines for Carcinogen Risk Assessment (2005). National Center for Environmental Assessment. US EPA. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=116283 accessed July 2009.

For non-cancer risk, the predicted ambient concentration of each HAP is divided by its reference concentration (RfC)[13] resulting in a hazard quotient (HQ). The sum of the HQ for each HAP results in a hazard index (HI) (see Equation 2).

Equation 2[11]: $HI_T = \sum_{i,k} AC_{i,k} / RC_k$

where:
HI_T = total organ-specific hazard index at a given receptor and for a given organ
$\sum_{i,k}$ = the sum over all sources i and pollutant types k (particulate or gas)
$AC_{i,k}$ = ambient concentration (µg/m) for pollutant k at the given receptor.
RC_k = noncancer health effect reference concentration for pollutant k

Chronic health effects are also estimated at census block centroids. Chronic health effects are based on an RfC. The RfC is an estimate of a continuous inhalation exposure to an individual that is likely to result in a non-cancer endpoint. Methodology for RfC development, definition and derivation are discussed in EPAs "Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry".[14] To assess non-cancer chronic effects, the model predicts a target-organ-specific hazard index (TOSHI) by summing the HQs for each HAP affecting the same target organ or organ system. The model estimates TOSHIs for the following organs or systems: respiratory, liver, neurological, developmental, reproductive, kidney, ocular, endocrine, hematological, immunological, skeletal, spleen, thyroid and whole body. HQs less than one are not likely to cause adverse health effects; those greater than one have a higher risk for adverse effects.

HEM-3 estimates a maximum acute exposure concentration based on annual emissions multiplied by a scaling factor of 10. The acute exposure concentration is divided by a short-term threshold value to determine an HQ. Short-term threshold values are defined in Section 3.2.1. Acute exposures are those that may occur from one second to two weeks. When the HQ is less than one, there is little potential for acute risk. Where the HQ is one or above, additional information is needed to determine if there is a potential for significant acute health risk.

[13] Reference concentration (RfC): An estimate of a continuous inhalation exposure for a given duration to the human population (including susceptible subgroups) that is likely to be without an appreciable risk of adverse health effects over a lifetime. USEPA. http://www.epa.gov/IRIS/gloss8_arch.htm#r accessed July 2010.

[14] U.S. EPA. Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry. U.S. Environmental Protection Agency, Office of Research and Development, Office of Health and Environmental Assessment, Washington, DC, EPA/600/8-90/066F.

3.2 Toxicity Assessment

3.2.1 Hazard Identification

The HAPs listed in the RICE rule (Table 1) are the identified hazards for the purpose of this study. These HAPs are emitted as a result of fuel combustion processes for example.

Table 1. Hazardous Air Pollutants with Human Health Endpoints

HAP	Human Health Endpoint(s)
Acetaldehyde	Cancer, chronic, acute
Arsenic and compounds	Cancer, chronic
Benzene	Cancer, chronic, acute
Beryllium and compounds	Cancer, chronic
Cadmium and compounds	Cancer, chronic
Formaldehyde	Cancer, chronic, acute
7-PAH	none

3.2.2 Comparative Risk Levels[15]

HEM-3 includes a library of toxicity data for HAPs. For each HAP, the library includes: UREs for cancer endpoints, RfCs for chronic non-cancer endpoints, RfCs for acute endpoints and the target organs or organ systems affected by the HAP. UREs and RfCs are based on data from several agencies and methodologies.[16] The toxicity data included in the HEM-3 library is equivalent or more conservative than the toxicity values used for Toxic Air Pollutant (TAP) regulations in NC. See Table 2 for the values used in the model.

[15] Smith, R. and D. Murphy. 2003. *Dose-Response Assessment for Assessing Health Risks Associated with Exposure to Hazardous Air Pollutants.* US Environmental Protection Agency, Research Triangle Park, NC. http://www.epa.gov/ttn/atw/toxsource/summary.html accessed June 2009.

[16] EPA Integrated Risk Information System (IRIS), Agency for Toxic Substances and Disease Registry (ATSDR), and California Environmental Protection Agency- Office of Environmental Health Hazard Assessment (Cal/EPA-OEHHA) data. Acute endpoints are based on data from: National Advisory Committee (NAC) - Acute Exposure Guideline Levels (AEGLs), American Industrial Hygiene Association (AIHA) – Emergency Response Planning Guidelines (ERPGs), Cal/EPA-OEHHA - Reference Exposure Levels (RELs), and National Oceanic and Atmospheric Administration's (NOAA) - Temporary Emergency Exposure Limits (TEELs)

Table 2. Reference Values used for Specific Pollutants in HEM-3

Pollutant	URE $(1/(\mu g/m^3))$	Source, Year	WOE†	RfC (mg/m^3)	AEGL-1 (1-hr) (mg/m^3)	AEGL-2 (1-hr) (mg/m^3)
7-PAH‡	0.0011	CAL	EPA, B2			
Acetaldehyde	2.2E-06	IRIS, 1991	EPA, B2	0.009	81	490
Arsenic compounds	0.0043	IRIS, 1998	EPA, A	0.00003		
Benzene	7.8E-06	IRIS, 2000	EPA, CH	0.03	170	2600
Beryllium compounds	0.0024	IRIS, 1998	EPA, LH	0.00002		
Cadmium compounds	0.0018	IRIS, 1992	EPA, B1	0.00002		
Formaldehyde	1.3E-05*	IRIS	EPA, B1	0.0098	1.1	17

†WOE - Weight of Evidence - 1986 guidelines: A - human carcinogen, B1 - probable carcinogen (limited human data), B2 - probable carcinogen (sufficient animal data), C - possible human carcinogen, D - not classifiable, E - evidence of noncarcinogenicity. 1999 guidelines: CH - carcinogenic to humans, LH -likely to be carcinogenic.
‡7-PAH - health effects are characterized by EPA in HEM-AERMOD as a group referred to as polycyclic aromatic hydrocarbons: benzo(a)pyrene toxic equivalent.
*Updated by EPA in HEM-3 toxicity input file 4/27/2010.

3.3 Risk Characterization

3.3.1 Results and Interpretations

The results of the screening level inhalation risk assessment for the RICE source category include the MIR (cancer), maximum HI (chronic), and maximum HQ (acute). Also included are those pollutants, or risk drivers, that contributed significantly to the estimation of risk.

Of the 56 facilities screened, 6 facilities (ten percent) have cancer risk predicted to be one in a million or greater. The results indicate a range of excess cancer risk from one to 16 per million people. This means that there is likelihood of between one and 16 additional cases of cancer per million that may occur due to inhalation exposures to pollutants emitted from RICE sources.

As discussed above, the model estimates the MIR at a Census block centroid for all facilities. The highest MIR was used except in two cases where it was estimated within the property boundaries of a facility. Since HEM-3 located the MIRs for Duke University and American Drew within the respective facility property boundaries, the highest modeled MIR (the secondary MIR) outside the facility property line was determined and reported in Table 3. These secondary MIRs were used because some people use their work or school address as their home address. The use of non-residential addresses when reporting to the Census Bureau results in incorrect location data.

Additionally, NC Division of Air Quality rules do not consider exposures within the property line for a facility. By placing the facility and MIR locations on a map, it can be determined visually whether the Census block centroid is located properly. There are exceptions, however, such as the Fort Bragg military base, where individuals live and work within the facility boundaries for extended periods of time.

Table 3. Maximum Cancer Risk for RICE Source Category

Facility ID	Facility Name	Estimated Cancer Risk MIR (in one million)	Cancer Risk Driver
6800043	UNC-CH	16	Benzene
7900131	Transcontinental Gas Pipeline Corp. Station 160	5	Acetaldehyde
4900225	Transcontinental Gas Pipeline Corp.	3	Acetaldehyde
2600102	HQ XVIII ABN Corps & Fort Bragg	2	Benzene
3200144	Duke University	2*	Benzene
9700005	American Drew, Inc.- Plant 13	1*	Benzene

* Secondary MIRs Used

Maximum chronic target-organ-specific hazard indices (TOSHIs) are presented in Table 4. TOSHIs are provided for those facilities where the HI exceeds one. The model predicted that the target organ system of interest was respiratory for these facilities, with formaldehyde as the chronic risk driver.

Table 4. Maximum Chronic Hazard Indices for RICE Source Category

Facility ID	Facility Name	Estimated Hazard Indices (HI) for Respiratory	Chronic Risk Driver
7900131	Transcontinental Gas Pipeline Corp. Station 160	2	Formaldehyde
4900225	Transcontinental Gas Pipeline Corp.	1	Formaldehyde

Acute effects were estimated for formaldehyde emissions from the Transcontinental Gas Pipeline Corp. Station #160. For this assessment a 1-hour exposure time was used. The acute exposure concentration was divided by a short-term threshold value to determine an HQ (Table 5). Mild effects are acute exposures to formaldehyde of less than 24 hours that cause irritation to the eyes, nose and throat. Exposure to higher levels emissions or longer exposure durations may cause coughing, wheezing, chest pains and bronchitis and are more serious effects.[17] Serious effects are considered to be irreversible, long-lasting, and impair one's ability to escape. The modeled results of acute exposure indicate that there is an enhanced likelihood of transient health effects in the general population and serious health effects in sensitive subpopulations.

Table 5. Acute Screening Results for RICE Source Category

Facility ID	Facility Name	HAP	Maximum Acute HQs	
			Mild Effects	Serious Effects
7900131	Transcontinental Gas Pipeline Corp. Station 160	Formaldehyde	11.2	0.7

3.3.2 Uncertainties

Emissions Inventory

HEM-3 requires emission release point (ERP) information. HEM-3 can provide a more precise prediction of risk if each ERP is identified by their specific latitude (lat) and longitude (lon). However, in the inventory, ERP location is generally based on the latitude and longitude for the front door of the facility. Using one location for all the ERPs in the model may overestimate risk because the model sums all the emissions together and assumes that they are emitted from one common stack.

Many sources in the inventory are emergency generators. While actual emissions are reported for these sources, operating time is not; an emergency generator will run for short periods of time during a power outage to provide power for required services and on some routine schedule, for maintenance. HEM-3 determines risk using annual emissions values which do not account for fluctuations throughout the year therefore estimations of risk may be underestimated.

Individual facilities are responsible for providing accurate estimates of emissions to the emissions inventory. An emissions factor[18] is an average emission rate that can be used to calculate pollutant emissions from a particular source type. The emission factors for this the RICE source category were developed between 1996 and 2000[19] and are based on

[17] EPA. Formaldehyde. Hazard Summary-Created in April 1992; Revised in January 2000. http://www.epa.gov/ttn/atw/hlthef/formalde.html

[18] EPA. Air Quality Emission Factor. http://www.epa.gov/air/aqmportal/management/emissions_inventory/emission_factor.htm. accessed March 2010.

[19] AP 42, Fifth Edition, Volume I Chapter 3: Stationary Internal Combustion Sources http://www.epa.gov/ttn/chief/ap42/ch03/index.html accessed August 2009.

standard emissions factors[20] developed by EPA. Given that the emission factors do not represent measured emissions, the risk predicted here may not be representative.

Plume depletion and deposition were not included in this estimate. In HEM-3, these modeling parameters are related to particulate matter only. Particulate matter emissions are comprised of metal HAPs such as arsenic, beryllium and cadmium compounds and 7-PAH. Emissions data regarding these pollutants were not available in the inventory. Moreover, data pertaining to particle size, mass, and density are not accurately included in the inventory regardless of pollutant. It was assumed that particles smaller than 2.5 µm in diameter will typically behave like a gas[21], therefore all emissions were modeled as gases. Risk associated with exposure to these emissions is unknown.

Engines subject to this rule are either reconstructed or new after June 12, 2006; all other engines are considered existing and are not subject to this rule. The assessment included both existing and new engines because the inventory used did not distinguish manufacture date. Including existing engines would tend to overestimate risk.

The rule is applicable to specific emissions of specific pollutants; other HAPs may be emitted from these sources. Not including these emissions may underestimate total risk.

HEM-3

Default modeling receptors and meteorology were used for this screening level risk assessment. Site specific modeling receptors and meteorology for the facilities were not used. Using site specific receptors and meteorology may or may not significantly change the risk results.

Building downwash data, which includes building heights and dimensions, were not used in this assessment because these data were not recorded in the inventory. EPA has noted, however, that risk estimated at census block centroids are typically beyond the influence of downwash[22]; therefore risk estimated in this assessment should not be significantly impacted by including building downwash data.

HEM-3 estimates inhalation exposures at Census block centroids. While Census blocks are small, about 10 households or 40 persons, few if any of those people live at the centroid. The model assumes that everyone living within the Census block will be exposed to the maximum concentration predicted at the centroid for a continuous duration. The model does not account for other exposures (i.e. occupational) to the pollutants modeled. Also, the model does not take into account human activity patterns or migration events. Risk based on a continuous exposure scenario may be overestimated.

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[20] US EPA. Technology Transfer Network Clearinghouse for Inventories & Emissions Factors. http://www.epa.gov/ttn/chief/ap42/index.html accessed July 2009.

[21] EPA. Characteristics of Particles - Particle Size Categories. http://www.epa.gov/apti/bces/module3/category/category.htm accessed March 2010.

[22] EPA. Office of Air and Radiation. Risk and Technology Review (RTR) Assessment Plan. http://www.epa.gov/ttn/atw/rrisk/rtrpg.html accessed July 2009.

HEM-3 is designed to overestimate acute health risk. Acute risk is determined by multiplying the annual emissions value by a factor of 10 to estimate a worst case scenario. The factor of 10 is intended to cover routinely variable emissions and startup, shutdown, and malfunction emissions. For this assessment a one hour exposure duration was used. Corresponding one hour acute reference concentrations were based on emergency response values (AEGLs). Hazard indices greater than one cannot be interpreted as posing any real potential for adverse health effects without further refinement of the analysis.

Cancer risk estimates are based on UREs and chronic risk estimates are based on RfCs developed by EPA and available from the Integrated Risk Information System (IRIS). UREs and RfCs tend to be conservative; therefore estimated risk may be overestimated.

4 Refined Assessment

4.1 Introduction

The results of the screening level risk assessment indicated that cancer, chronic and acute risk exceeded benchmark levels for ten percent of the 56 facilities modeled. MIR cancer risk ranged from one in a million to 16 in a million for six facilities. Hazard indices greater than one for chronic effects were exceeded at two facilities. Acute effects exceeded the threshold at one facility.

A refined risk assessment was then conducted for those facilities exceeding benchmark levels of risk. To reduce uncertainty, the data gaps regarding specific locations of ERPs, metal HAP emissions, reported emissions for emergency generators, and inactive sources were further investigated.

4.2 Source Identification

ERP information used for the screening level risk assessment was collected from the North Carolina Emissions Inventory for inventory year 2007. To identify specific ERP locations the emission unit description in the emissions inventory was queried. These descriptions were investigated for building name or other descriptive location information. The building names for sources located at UNC-CH and Duke Universities were present, but no additional information was available for the other four facilities. Using university campus maps, georeference tools (i.e. Google Earth), and best engineering judgment, the ERPs were relocated to a specific latitude and longitude (see Figure 2 for the original vs. relocated ERPs for RICE sources at Duke University). The Facility ID pin (green) is the original ERP location, and the individually named balloons (blue) are the new ERP locations.

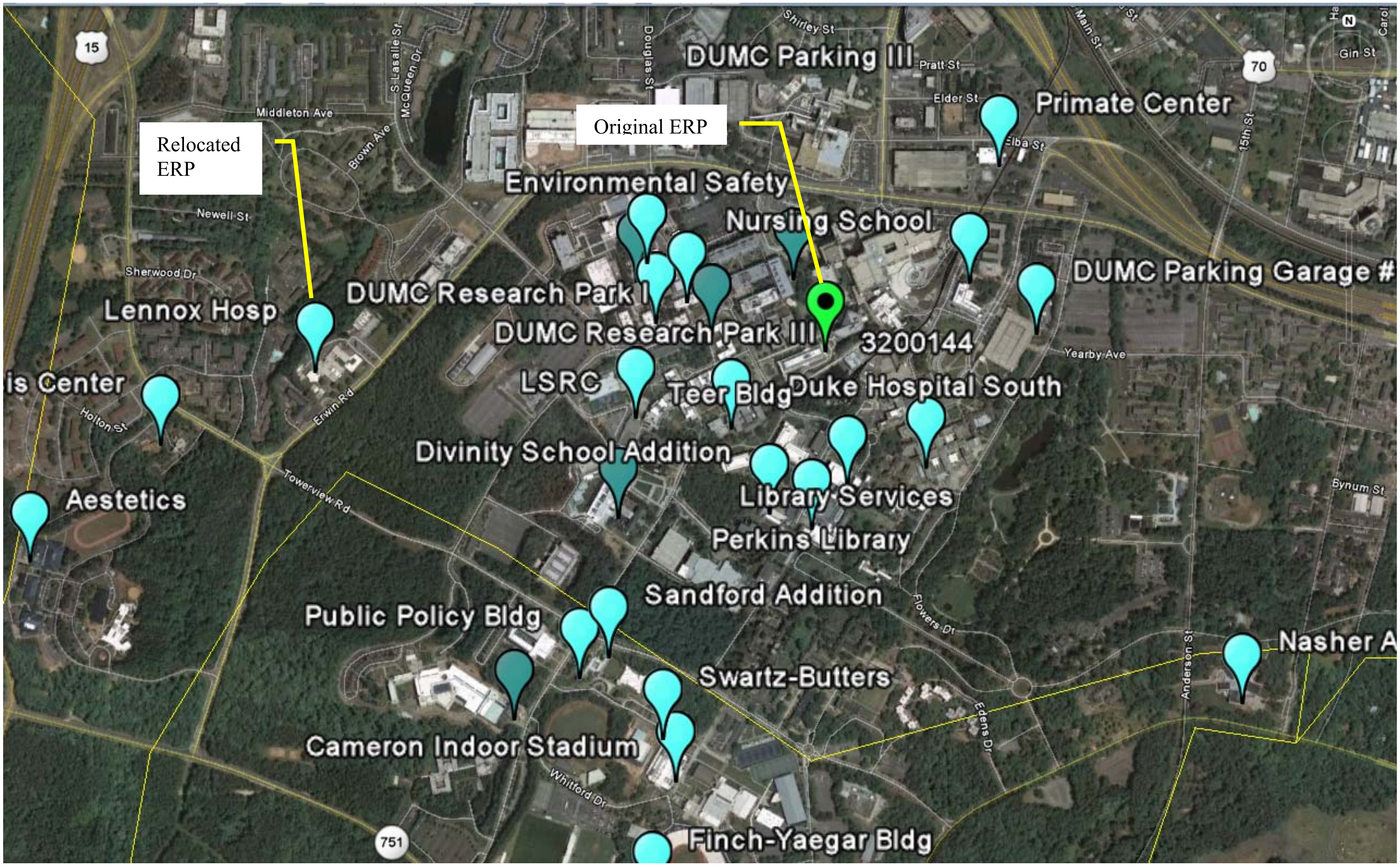

Figure 2. Original ERP Location vs. Relocated Emission Release Points for Duke University, Facility ID 3200144

4.3 Emissions Data

Metal HAP emissions, a component of diesel fuel, were not included in the emissions inventory. Emissions can be calculated if the fuel throughput and corresponding emission factors are known. Fuel throughput was present in the inventory for UNC-CH but not the other five facilities. Emission factors for the RICE sources with hp $\leq$ 500 have not been developed by EPA and are not included in AP-42.[18] Default emission factors for internal combustion engines were developed by Ventura County Air Pollution Control District in 2001.[23] In 2006 the California's Air Resources Board compiled emission factors from all the Local Air Pollution Control Districts, updating some of the data from Ventura County.[24] Emission factors for arsenic and cadmium from internal combustion engines with hp > 100, uncontrolled emissions using diesel fuel are shown in Table 6 below.

Table 6. Emission Factors for Metal HAPs from Diesel Fuel for RICE sources

Pollutant	Emission Factor (lb/1000 gallons)
Arsenic	7.8×10^{-3}
Cadmium	1.5×10^{-3}

Emission factors for beryllium are not available for these sources. The Ventura County Air Pollution Control District report[23] indicates that beryllium was not detected in any of the fuel analyses reviewed. Additionally, in a separate study regarding trace metal components of crude oil, McMillen *et.al.* (2001)[25] report that beryllium was not detected in 28 samples taken from crude oils across the world. Emissions were not calculated for beryllium.

HEM-3 requires individual emissions per source, however; the emissions inventory often combines small sources, like emergency generators, for permitting purposes. In this inventory, the majority of small sources were grouped at three facilities (UNC-CH, Duke, Ft. Bragg). Distinguishing grouped sources from individual sources was accomplished by reviewing current air permit applications. For three facilities emission rates used in the screening level assessment were from 29 to 62 times greater than those reported in the inventory because the sources were grouped. For instance, if there were 29 sources at one facility and each source was associated with an emissions rate of 1 tpy then the total emissions reported were 29 tpy.

Erroneous emissions data was modeled for two facilities. In the current inventory there were emissions data present where no data should have existed because those sources were classed as inactive. To determine whether a source is inactive the source must

[23] Ventura County Air Pollution Control District. AB 2588 Combustion Emission Factors. www.aqmd.gov/prdas/pdf/combem2001.pdf Accessed May 2010.
[24] www.avaqmd.ca.gov/Modules/ShowDocument.aspx?documentid=1362 Accessed May 2010.
[25] McMillen SJ, Magaw RI, Carovillano RL, Editors. Risk-Based Decision-Making for Assessing Petroleum Impacts at Exploration and Production Sites. Published in Cooperation with The Petroleum Environmental Research Forum & The United States Department Of Energy. October 2001.

contain an end date. If no date was found, it was assumed that the source was still active. For the two facilities there were inactive sources that did not have end dates. This error was remedied by screening prior inventory years.

4.4 Risk Characterization

4.4.1 Results and Interpretations

A refined risk assessment was conducted given the results of the screening level risk assessment. To reduce uncertainty, the data gaps regarding specific locations of ERPs, reported emissions for emergency generators, and inactive sources were investigated more thoroughly.

The results of the refined risk assessment for all six facilities indicate that the maximum individual lifetime cancer risk is less than one in a million. There appear to be no excessive risk associated with chronic or acute exposures from RICE sources based on the refinements to the modeling inputs. Tables 7 - 9 show the results of the refined assessment for cancer, chronic and acute endpoints.

Table 7. Refined Analysis Maximum Individual Cancer Risk

Facility ID	Facility Name	Revised MIR (per million)
6800043	UNC-CH	0.01
7900131	Transcontinental Gas Pipeline Corp. Station 160	0.06
4900225	Transcontinental Gas Pipeline Corp.	0.06
2600102	HQ XVIII ABN Corps & Fort Bragg	0.0007
3200144	Duke University	0.008
9700005	American Drew, Inc.- Plant 13	0.003

Table 8. Refined Maximum Chronic Hazard Indices

Facility ID	Facility Name	Estimated Hazard Indices (HI) for Respiratory Effects
7900131	Transcontinental Gas Pipeline Corp. Station 160	0.0004
4900225	Transcontinental Gas Pipeline Corp.	0.0005

Table 9. Refined Acute Results

Facility ID	Facility Name	Maximum Acute HQs	
		Mild Effects	Serious Effects
7900131	Transcontinental Gas Pipeline Corp. Station 160	0.0014	0.0001

4.4.2 Uncertainties

Emissions

Metal HAPs were not part of the 2007 emissions inventory for these sources. Arsenic, beryllium, and cadmium compounds have both cancer and chronic endpoints. Estimating emissions for arsenic and cadmium was based on emission factor (EF) data from CalEPA. The derived EFs were based on testing studies that are more recent and relevant than EFs derived by EPA. Risk estimates calculated using these data are more conservative and depict a more accurate estimate of risk for cancer and chronic inhalation exposures to arsenic and cadmium.

Beryllium EFs were not available for sources using diesel fuel therefore risk estimates for cancer and chronic inhalation exposures to this compound are unknown. There are several studies that indicate beryllium is not detected in diesel fuels, and that may be because of its very high melting point and it does not oxidize or corrode readily.

Engines subject to this rule are either reconstructed or new after June 12, 2006; all other engines are considered existing and are not subject to this rule. The assessment included both existing and new engines because the inventory used did not contain enough information to distinguish manufacture date. Including existing engines would tend to overestimate risk.

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The original population estimates did not change from the screening level assessment, therefore risk based on census block data may be overestimated. The risk may be overestimated because the model assumes that everyone living within the census block will be exposed to the concentration predicted at the centroid for a continuous duration. The model does not account for other exposures (i.e. occupational) to the pollutants modeled. Also, the model does not take into account human activity patterns or migration events that may also result. Risk based on a continuous exposure scenario may be overestimated.

The rule regulates specific emissions of specific pollutants, it should be recognized that other HAPs are emitted from these sources. Not including these emissions may underestimate total risk.

Worst case risk estimates were determined in the screening level assessment. The results showed there were maximum individual cancer risk for six facilities, chronic risk for two facilities, and acute risk for one facility. The refined results showed that the risk decreased by several orders of magnitude below all established human health benchmarks (Table 10).

Table 10. Comparison of Worst and Best Case Maximum Individual Cancer Risk for RICE Source Category

Facility ID	Facility Name	Estimated Cancer Risk	
		Original MIR (per million)	Updated MIR (per million)
6800043	UNC-CH	16	0.01
7900131	Transcontinental Gas Pipeline Corp. Station 160	5	0.06
4900225	Transcontinental Gas Pipeline Corp.	3	0.06
2600102	HQ XVIII ABN Corps & Fort Bragg	2	0.0007
3200144	Duke University	2	0.008
9700005	American Drew, Inc.- Plant 13	1	0.003

5 Conclusions and Recommendations

There does not appear to be any excessive risk associated with inhalation exposure to emissions from RICE sources (for the HAPs specified in Subpart ZZZZ) as determined by modeling.

Many of the data gaps in the screening assessment arose from incomplete data in the emissions inventory. Filling those data gaps reduced risk significantly, yet the collected data have not been updated in the emissions inventory therefore similar data gaps will continue to occur. Development of a more complete emissions inventory will benefit DAQ by increasing emissions reporting efficiency and accuracy, leading to improved ambient air quality throughout the state as regulators will have the data needed to enforce compliance.

Based on the findings of the risk assessment it is recommended that rule information (e.g. Compliance Demonstration and Reporting and Recordkeeping sections) be posted on the DAQ website. Facilities that operate an engine subject to Subpart ZZZZ must have documentation from the engine manufacturer certifying that the engine meets emission standards of the rule. Furthermore, notification letters are not required by DAQ.

Appendix

Table A1: Summary of Annual Emissions (tpy) for Each Facility by HAP for 2007 Inventory Year

Facility ID	Facility Name	HAP	Emissions (tpy)
9700005	American Drew, Inc. - Plant 13	Acetaldehyde	2.15E-04
9700005	American Drew, Inc. - Plant 13	Benzene	2.60E-05
9700005	American Drew, Inc. - Plant 13	Formaldehyde	3.25E-04
9700005	American Drew, Inc. - Plant 13	PAH	4.65E-05
1900015	ATC Panels, Inc.	Acetaldehyde	1.67E-04
1900015	ATC Panels, Inc.	Benzene	2.03E-04
1900015	ATC Panels, Inc.	Formaldehyde	2.58E-04
1900015	ATC Panels, Inc.	PAH	1.82E-05
9200504	Austin Quality Foods, Inc.	Acetaldehyde	9.45E-06
9200504	Austin Quality Foods, Inc.	Benzene	1.15E-05
9200504	Austin Quality Foods, Inc.	Formaldehyde	1.46E-05
1200008	Broughton Hospital	Acetaldehyde	6.81E-04
1200008	Broughton Hospital	Benzene	1.44E-03
1200008	Broughton Hospital	Formaldehyde	1.03E-03
1200008	Broughton Hospital	PAH	3.12E-04
6700011	Camp Lejeune	Acetaldehyde	5.61E-01
6700011	Camp Lejeune	Benzene	8.17E-01
6700011	Camp Lejeune	Formaldehyde	1.32E+00
6700011	Camp Lejeune	PAH	1.64E-01
2600014	Cape Fear Valley Med Center	Formaldehyde	2.27E-04
1800031	Carpenter Company Conover	Formaldehyde	5.76E-03
5400023	Caswell Center	Acetaldehyde	1.31E-04
5400023	Caswell Center	Benzene	1.97E-04
5400023	Caswell Center	Formaldehyde	2.94E-04
5400023	Caswell Center	PAH	6.86E-06
9600023	Cherry Hospital	Acetaldehyde	6.15E-05
9600023	Cherry Hospital	Benzene	1.92E-03
9600023	Cherry Hospital	Formaldehyde	1.98E-04
9600023	Cherry Hospital	PAH	
0100238	City of Burlington - South Burlington WWTP	Acetaldehyde	4.79E-04
0100238	City of Burlington - South Burlington WWTP	Benzene	2.70E-04
0100238	City of Burlington - South Burlington WWTP	Formaldehyde	3.51E-03
0100238	City of Burlington - South Burlington WWTP	PAH	2.42E-05

Facility ID	Facility Name	HAP	Emissions (tpy)
1300005	CMC - Northeast, Inc.	Acetaldehyde	9.74E-04
1300005	CMC - Northeast, Inc.	Benzene	2.68E-02
1300005	CMC - Northeast, Inc.	Formaldehyde	4.32E-03
3100116	Coastal Carolina Clean Power LLC	Benzene	2.89E-03
3100116	Coastal Carolina Clean Power LLC	Formaldehyde	3.65E-03
4100863	Cone Denim LLC - White Oak Plant	Benzene	5.10E-05
9200599	CP&L - Harris Nuclear Plant	PAH	1.99E-02
9200333	Dorothea Dix Campus	Acetaldehyde	3.08E-03
3200144	Duke University	Acetaldehyde	2.47E-02
3200144	Duke University	Benzene	3.04E-02
3200144	Duke University	Formaldehyde	3.99E-02
3200144	Duke University	PAH	5.51E-03
7400242	ECU School of Medicine	Acetaldehyde	2.93E-05
7400242	ECU School of Medicine	Benzene	8.89E-04
7400242	ECU School of Medicine	Formaldehyde	9.01E-05
3200041	G E Aviation - Durham Engine Facility	Acetaldehyde	1.45E-03
3200041	G E Aviation - Durham Engine Facility	Benzene	3.51E-03
3200041	G E Aviation - Durham Engine Facility	Formaldehyde	2.33E-03
3200041	G E Aviation - Durham Engine Facility	PAH	7.94E-04
6600016	Georgia-Pacific Chemicals, LLC - Conway	Acetaldehyde	8.10E-06
6600016	Georgia-Pacific Chemicals, LLC - Conway	Benzene	2.50E-04
6600016	Georgia-Pacific Chemicals, LLC - Conway	Formaldehyde	2.54E-05
6600016	Georgia-Pacific Chemicals, LLC - Conway	PAH	6.82E-05
4100433	Gilbarco, Inc.	Acetaldehyde	1.20E-05
4100433	Gilbarco, Inc.	Benzene	1.50E-05
4100433	Gilbarco, Inc.	Formaldehyde	1.80E-05
4900077	Gulistan Carpet	Acetaldehyde	2.40E-04
4900077	Gulistan Carpet	Benzene	3.00E-04
4900077	Gulistan Carpet	Formaldehyde	3.80E-04
2600009	Hexion Specialty Chemicals, Inc.	Formaldehyde	6.44E-05
6400003	Hospira, Inc.	Acetaldehyde	1.72E-03
6400003	Hospira, Inc.	Benzene	4.27E-03
6400003	Hospira, Inc.	Formaldehyde	2.75E-03
6400003	Hospira, Inc.	PAH	9.83E-04
2600102	HQ XVIII ABN Corps & Fort Bragg	Acetaldehyde	8.19E-01
2600102	HQ XVIII ABN Corps & Fort Bragg	Benzene	8.29E+00

Facility ID	Facility Name	HAP	Emissions (tpy)
2600102	HQ XVIII ABN Corps & Fort Bragg	Formaldehyde	1.63E+00
2600102	HQ XVIII ABN Corps & Fort Bragg	PAH	1.04E-01
3200055	IBM Corporation	Acetaldehyde	2.34E-01
3200055	IBM Corporation	Benzene	1.53E+00
3200055	IBM Corporation	Formaldehyde	4.68E-01
3200055	IBM Corporation	PAH	3.12E-01
8600006	InterfaceFABRIC Elkin, Inc.	Acetaldehyde	4.56E-05
8600006	InterfaceFABRIC Elkin, Inc.	Benzene	1.75E-04
8600006	InterfaceFABRIC Elkin, Inc.	Formaldehyde	7.66E-05
8600006	InterfaceFABRIC Elkin, Inc.	PAH	4.30E-05
4100619	Jefferson-Pilot Life Insurance Company	Formaldehyde	4.20E-04
4100619	Jefferson-Pilot Life Insurance Company	PAH	1.62E-04
4100019	Kay Chemical Company	Acetaldehyde	1.32E-06
4100019	Kay Chemical Company	Benzene	5.16E-05
4100019	Kay Chemical Company	Formaldehyde	4.54E-04
4100019	Kay Chemical Company	PAH	1.11E-05
8500028	KobeWieland Copper Products, LLC	Acetaldehyde	2.35E-04
8500028	KobeWieland Copper Products, LLC	Benzene	2.89E-04
8500028	KobeWieland Copper Products, LLC	Formaldehyde	5.03E-04
4100198	Lorillard Tobacco Company	Acetaldehyde	1.24E-03
4100198	Lorillard Tobacco Company	Benzene	1.08E-03
4100198	Lorillard Tobacco Company	Formaldehyde	2.28E-03
4100198	Lorillard Tobacco Company	PAH	2.00E-04
9200349	Mallinckrodt Inc	Acetaldehyde	2.22E-06
9200349	Mallinckrodt Inc	Benzene	2.70E-06
9200349	Mallinckrodt Inc	Formaldehyde	3.41E-06
9200349	Mallinckrodt Inc	PAH	4.85E-07
0300074	Martin Marietta Composites Inc.	Benzene	5.40E-05
7400288	Metallix, Inc.	Benzene	5.00E-09
7400288	Metallix, Inc.	Formaldehyde	1.50E-07
1200049	NC DOC Western Youth Institution	Acetaldehyde	2.15E-05
1200049	NC DOC Western Youth Institution	Benzene	2.60E-05
1200049	NC DOC Western Youth Institution	Formaldehyde	3.30E-05
1200049	NC DOC Western Youth Institution	PAH	4.70E-06
2800021	NC Electric Membership Corporation - Buxton	Acetaldehyde	4.11E-04
2800021	NC Electric Membership Corporation - Buxton	Benzene	1.18E-02

Facility ID	Facility Name	HAP	Emissions (tpy)
2800021	NC Electric Membership Corporation - Buxton	Formaldehyde	1.24E-03
2800021	NC Electric Membership Corporation - Buxton	PAH	3.23E-03
4800028	NC Electric Membership Corporation - Ocracoke	Acetaldehyde	4.07E-04
4800028	NC Electric Membership Corporation - Ocracoke	Benzene	4.14E-03
4800028	NC Electric Membership Corporation - Ocracoke	Formaldehyde	8.22E-04
4800028	NC Electric Membership Corporation - Ocracoke	PAH	1.10E-03
3200251	NCCU	Acetaldehyde	3.36E-02
3200251	NCCU	Benzene	4.08E-02
3200251	NCCU	Formaldehyde	5.17E-02
3200251	NCCU	PAH	7.35E-03
3200253	North Durham Water Reclamation Facility	Acetaldehyde	6.76E-04
3200253	North Durham Water Reclamation Facility	Benzene	9.85E-03
3200253	North Durham Water Reclamation Facility	Formaldehyde	1.48E+00
5100160	Novo Nordisk Pharmaceutical	Formaldehyde	7.00E-06
1900002	Performance Fibers, Inc.	Acetaldehyde	1.32E-04
1900002	Performance Fibers, Inc.	Benzene	1.61E-04
1900002	Performance Fibers, Inc.	Formaldehyde	2.03E-04
1900002	Performance Fibers, Inc.	PAH	1.45E-05
6600074	Pleasant Hill Compressor Station	Formaldehyde	1.38E-01
1000067	Primary Energy of North Carolina LLC - Southport Plant	Acetaldehyde	2.38E-05
1000067	Primary Energy of North Carolina LLC - Southport Plant	Benzene	2.89E-05
1000067	Primary Energy of North Carolina LLC - Southport Plant	Formaldehyde	3.65E-05
1000067	Primary Energy of North Carolina LLC - Southport Plant	PAH	5.20E-06
7300045	Progress Energy - Mayo Facility	Acetaldehyde	5.00E-05
7300045	Progress Energy - Mayo Facility	Benzene	2.36E-04
7300045	Progress Energy - Mayo Facility	Formaldehyde	9.84E-05
7300045	Progress Energy - Mayo Facility	PAH	6.04E-05
7300029	Progress Energy - Roxboro Plant	Acetaldehyde	4.54E-04
7300029	Progress Energy - Roxboro Plant	Benzene	5.50E-04
7300029	Progress Energy - Roxboro Plant	Formaldehyde	6.93E-04
7300029	Progress Energy - Roxboro Plant	PAH	1.25E-04
1000051	Progress Energy Carolinas - Brunswick Plant	Acetaldehyde	1.28E-05
1000051	Progress Energy Carolinas - Brunswick Plant	Benzene	1.56E-05

Facility ID	Facility Name	HAP	Emissions (tpy)
1000051	Progress Energy Carolinas - Brunswick Plant	Formaldehyde	1.97E-05
1000051	Progress Energy Carolinas - Brunswick Plant	PAH	2.81E-06
3300150	Sara Lee Bakery	Acetaldehyde	2.43E-04
3300150	Sara Lee Bakery	Benzene	3.77E-03
3300150	Sara Lee Bakery	Formaldehyde	3.01E-03
3300150	Sara Lee Bakery	PAH	3.06E-04
8400053	Stanly Regional Medical Center	Acetaldehyde	2.70E-04
8400053	Stanly Regional Medical Center	Benzene	3.40E-04
8400053	Stanly Regional Medical Center	Formaldehyde	4.20E-04
8400053	Stanly Regional Medical Center	PAH	6.00E-05
4100031	Syngenta Crop Protection Inc	Benzene	8.00E-07
4100031	Syngenta Crop Protection Inc	Formaldehyde	2.68E-05
5100103	Talecris Biotherapeutics, Inc.	Formaldehyde	3.00E-08
7900131	Transcontinental Gas Pipeline Corp. - Compressor Station 160	Acetaldehyde	5.31E+01
7900131	Transcontinental Gas Pipeline Corp. - Compressor Station 160	Benzene	1.34E+01
7900131	Transcontinental Gas Pipeline Corp. - Compressor Station 160	Formaldehyde	3.79E+02
4900225	Transcontinental Gas Pipeline Corporation	Acetaldehyde	1.75E+03
4900225	Transcontinental Gas Pipeline Corporation	Formaldehyde	1.25E+04
9000023	Tyson Foods, Inc., Monroe Processing Plant and Feed Mill	Acetaldehyde	1.50E-02
9000023	Tyson Foods, Inc., Monroe Processing Plant and Feed Mill	Benzene	2.26E-03
9000023	Tyson Foods, Inc., Monroe Processing Plant and Feed Mill	Formaldehyde	4.94E-02
6800043	UNC-CH	Acetaldehyde	1.47E+00
6800043	UNC-CH	Benzene	1.79E+00
6800043	UNC-CH	Formaldehyde	2.28E+00
6800043	UNC-CH	PAH	3.23E-01
4101148	UNC-G	Benzene	3.64E-02
4101148	UNC-G	Formaldehyde	4.68E-02
9500077	Watauga Medical Center	Benzene	1.03E-02
9500077	Watauga Medical Center	Formaldehyde	9.73E-03
4400815	Waynesville WWTP	Acetaldehyde	5.50E-05
4400815	Waynesville WWTP	Benzene	7.00E-06

Facility ID	Facility Name	HAP	Emissions (tpy)
4400815	Waynesville WWTP	Formaldehyde	8.50E-05
5000085	Western Carolina University	Acetaldehyde	1.81E-05
5000085	Western Carolina University	Benzene	5.61E-04
5000085	Western Carolina University	Formaldehyde	5.61E-05
8600108	Weyerhaeuser Company - Elkin Plant	Acetaldehyde	8.00E-05
8600108	Weyerhaeuser Company - Elkin Plant	Benzene	7.75E-04
8600108	Weyerhaeuser Company - Elkin Plant	Formaldehyde	1.60E-04
8600108	Weyerhaeuser Company - Elkin Plant	PAH	1.90E-04

Table A2: Maximum Individual Risk (MIR) and HI (chronic) for all HAPs Combined for Each Facility (Screening Level Assessment)

Facility ID	Facility Name	MIR	HI-Chronic
9700005	American Drew, Inc.- Plant 13	1.00E-06	0.0
1900015	ATC Panels, Inc.	2.00E-07	0.1
9200504	Austin Quality Foods, Inc	1.00E-10	0.0
1200008	Broughton Hospital	3.80E-09	0.0
6700011	Camp Lejeune	1.70E-07	0.0
2600014	Cape Fear Valley Med Center	5.80E-11	0.0
1800031	Carpenter Company Conover	1.80E-10	0.0
5400023	Caswell Center	3.90E-10	0.0
9600023	Cherry Hospital	3.80E-09	0.0
0100238	City of Burlington - South Burlington WWTP	1.30E-10	0.0
1300005	CMC - Northeast, Inc.	2.00E-08	0.0
3100116	Coastal Carolina Clean Power LLC	9.90E-08	0.0
4100863	Cone Denim LLC - White Oak Plant	8.60E-10	0.0
9200599	CP&L- Harris nuclear Plant	0.00E+00	0.0
3200144	Duke University	2.00E-06	0.0
7400242	ECU School of Medicine	3.80E-09	0.0
3200041	GE Aviation - Durham Engine Facility	9.60E-10	0.0
6600016	Georgia-Pacific Chemicals,LLC - Conway	3.40E-09	0.1
4100433	Gilbarco, Inc.	2.40E-11	0.0
4900077	Gulistan Carpet	7.20E-12	0.0
2600009	Hexion Specialty Chemicals, Inc.	6.10E-09	0.1
6400003	Hospira	2.40E-09	0.0
2600102	HQ XVIII ABN Corps & Fort Bragg	2.30E-06	0.0
3200055	IBM Corporation	2.30E-08	0.0
8600006	InterfaceFABRIC Elkin, Inc	2.90E-08	0.0
4100619	Jefferson -Pilot Life Insurance Company	7.40E-13	0.0
4100019	Kay Chemical Company	1.50E-09	0.0
0850028	KobeWieland Copper Products, LLC	3.10E-08	0.0
4100198	Lorillard Tobacco Company	2.00E-10	0.0
9200349	Mallinckrodt Inc.	9.30E-07	0.0
0300074	Martin Marietta Composites Inc.	4.90E-10	0.0
7400288	Metallix	1.30E-11	0.0
1200049	NC DOC Western Youth Institution	1.10E-11	0.0
2800021	NC Electric Membership Corporation-Buxton	1.70E-07	0.0
4800028	NC Electric Membership Corporation-Ocracoke	2.70E-08	0.0
3200251	NCCU	4.60E-08	0.0
3200253	North Durham Water Reclamation Facility	1.70E-09	0.0
5100160	Novo Nordisk Pharmaceutical	1.40E-12	0.0
5600179	Old Fort WWTP	1.30E-11	0.0
1900002	Performance Fibers, Inc	8.70E-07	0.0
6600074	Pleasant Hill Compressor Station	2.00E-11	0.0

Facility ID	Facility Name	MIR	HI-Chronic
1000067	Primary Energy of North Carolina LLC - Southport Plant	1.50E-07	0.0
7300045	Progress Energy - Mayo Facility	1.20E-08	0.0
1000051	Progress Energy Carolinas - Brunswick Plant	1.10E-09	0.0
3300150	Sara Lee Bakery	4.10E-10	0.0
8400053	Stanly Regional medical Center	1.60E-09	0.0
4100031	Syngenta Crop Protection Inc	4.40E-11	0.0
4900225	Transcontinental Gas Pipeline Corp.	3.23E-06	0.7
7900131	Transcontinental Gas Pipeline Corp. Station 160	4.86E-06	1.8
9000023	Tyson Food Inc. Monroe Plant	9.00E-10	0.0
6800043	UNC-CH	1.64E-05	0.2
4101148	UNC-G	1.91E-07	0.0
9500077	Watauga Med Cntr	6.30E-09	0.0
4400815	Waynesville WWTP	4.30E-11	0.0
5000085	Western Carolina University	1.10E-07	0.1
8600108	Weyerhaeuser Company - Elkin Plan	3.10E-07	0.1