Technical Support Document
Yahoo Data Center Complex
Quincy, Washington
February 7, 2008

1. Executive Summary

Proposed nitric oxide (NO) emissions from the Yahoo Data Center complex in Quincy, Washington exceed a regulatory trigger level called an Acceptable Source Impact Level (ASIL).

Based on the Second Tier analysis described here and the modeled NO concentrations, the Washington State Department of Ecology's Headquarters Office (Ecology) has determined that the health risks are within the range Ecology may approve for proposed new sources of TAPs under Chapter 173-460 Washington Administrative Code (WAC).

Below is the technical analysis performed by Ecology.

2. The Process

2.1 The Regulatory Process

The requirements for performing a toxics screening are established in Chapter 173-460 WAC. These rules require a review of any increase in toxic emissions for all new or modified stationary sources in the State of Washington.

2.2 The Three Tiers of Toxic Air Pollutant Permitting

There are three levels of review when processing a new or modified emissions unit emitting Toxic Air Pollutants (TAPs): (1) Tier One (toxic screening), (2) Tier Two (health impacts assessment), and (3) Tier Three (risk management decision).

All projects are required to undergo a toxic screening (Tier One analysis) as required by WAC 173-460-040. The objective of the toxic screening is to establish the systematic control of new sources emitting toxic air pollutants in order to prevent air pollution, reduce emissions to the extent reasonably possible, and maintain such levels of air quality as will protect human health and safety. If modeled emissions exceed the trigger levels called ASILs, a Second Tier analysis is performed.

A Second Tier analysis, promulgated in WAC 173-460-090, is a site-specific health impacts assessment. The objective of a Second Tier analysis is to quantify the increase in lifetime cancer risk for persons exposed to the increased concentration of any Class A TAP and to quantify the increased health hazard from any Class B TAP in ambient air that would result from the proposed project. Once quantified, the cancer risk is compared to the maximum risk allowed by a Second Tier analysis, which is one in one hundred thousand, and the concentration of any Class B TAP that would result from the proposed project is compared to its effect threshold concentration.

If the emissions of a toxic pollutant result in a cancer risk of greater than one in one hundred thousand then an applicant may request that Ecology perform a Tier Three analysis. A Tier Three is basically a risk management decision in which the Director of of Ecology makes a decision that the risk of the project is acceptable based on determination that emissions will be maximally reduced through available preventive measures, assessment of environmental benefit, disclosure of risk at a public hearing and related factors associated with the facility and the surrounding community.

2.3 Processing Requirements

Ecology shall evaluate a source's Second Tier analysis only if:

- The authority has advised Ecology that other conditions for processing the notice of construction have been met,
- Emission controls contained in the conditional notice of construction represent at least Best Available Control Technology for Toxics (T-BACT), and
- Ambient concentrations exceed acceptable source impact levels after using more refined emission quantification and air dispersion modeling techniques.

Ecology's Eastern Regional Office (ERO) submitted the three items listed above to Ecology on November 26, 2007.

2.3.1 Authority's Activities

ERO received the original Buildings 1 and 2, 31-generator application on November 14, 2007. ERO provided a draft Notice of Construction (NOC) permit to Ecology on November 26, 2007 as required initiating the Second Tier analysis by HQ.

2.3.2 T-BACT Verification

T-BACT is required for any new or modified emission unit that has an increase in emissions of toxic air pollutants. ERO agreed that on-road specification diesel fuel with a sulfur content of 0.0015 weight percent or less, and compliance with the Environmental Protection Agency (EPA) Tier II standards (40 CFR 89) for non-road engines, represents T-BACT for the emergency generators. HQ concurs with the T-BACT determination made by ERO.

2.3.3 Ambient Concentrations of Toxic Air Pollutants

Ecology reviewed the application and verified the emission estimates. Emissions of NO exceed the ASIL and a Second Tier analysis must be performed.

2.4 The Project

2.4.1 Permitting History

On November 13, 2007, ERO approved Order 07AQ-E241, which allowed for the construction and operation of a data center facility that included a 150,000 square foot building, 13 emergency diesel powered generators, and cooling towers. Construction of the project was to be phased over several years and expected to be complete in 2009. The data center will house banks of servers to track user internet activity including Yahoo search, e-mail, and business delivery services. It will also be equipped with a stable electrical power delivery system, an air-cooling and cleaning system, and backup diesel power capacity. The backup diesel power will come from thirteen 2.28 megawatt (MW) diesel-powered emergency generators. The first five generators have been installed with the next four in February of 2008 and the remaining four in April 2009.

Operation of each of the 13 generators was limited to no more than 400 hours per year to account for reliability and maintenance testing and possible power outages.

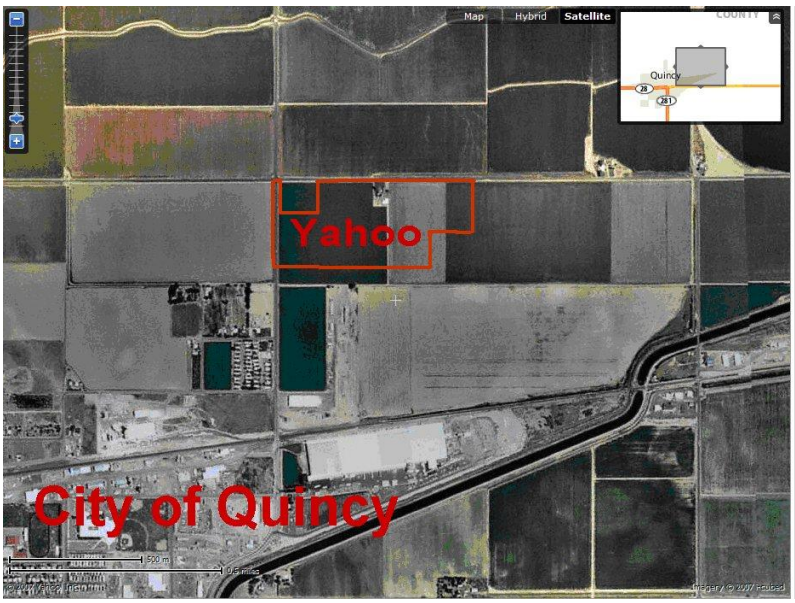
2.4.2 The Proposed Project

The proposed project is for the construction of a new 150,000 square-foot building (Building 2) an additional eighteen 2.28 MW diesel-powered emergency generators. Startup testing for the first six generators expected in January 2009, with the next six being installed in March 2009 and the final six are scheduled to be installed in September 2009.

ERO determined that the two projects would constitute a single stationary source and New Source Review must be conducted for both buildings as a single project to avoid circumvention of New Source Review. The approval order for the entire project (Buildings 1 and 2, and the 31 generators) will rescind and replace the November 13 approval order. In addition, each of the 31 generators will be limited to 200 hours of operation per year.

2.4.3 Site Description

The data center will be located on Grant County parcel # 312823000, southeast of the intersection of County Road P NW and County Road 11 NW. The proposed facility's physical address will be 1115 Industrial Road, Quincy, WA 98848 in Grant County, Washington. Its coordinates are 47° 14' 46"N, 119° 49' 40"W. An aerial photo from Yahoo's search engine results in the following:



2.4.4 Emissions

Yahoo has estimated its emissions of NO from the 31 emergency generators to be 52 tons per year[1] or 522 pounds per hour. These emissions were based upon a conversion from NO_X to NO using a factor of 62% by weight. The NO_X emissions were derived by an AP-42 emission factor of 5.4 g/kWh. In addition, there are five other TAPs emitted. Those TAPs are Arsenic, Benzene, Cadmium, Lead, and Total PAHs. The table below compares the TAPs to the Small Quantity Emission Rate Tables:

Pollutant	ASIL Type	Averaging period	Max concentration $\mu g/m^3$	ASIL $\mu g/m^3$	Emissions above ASIL Yes or No
NO	B	24-hour	1924.7	100	Yes
Arsenic	A	Annual Average	$< 1 \times 10^{-5}$	0.00023	No
Benzene	A	Annual Average	0.0044	0.12	No
Cadmium	A	Annual Average	$< 1 \times 10^{-5}$	0.00056	No
Lead	A	24-hour	$< 1 \times 10^{-5}$	0.5	No
Total PAH's	A	Annual Average	$< 1 \times 10^{-5}$	0.00048	No

[1] (5.4 g/kWh)*(2280 kW)/(1 lb/453.6 g)*(200 hr/yr)*(31 generators)*(0.62)* (1 lb/2000lb) = 52 tons per year NO.

2.4.5 Point of Compliance

Assessment of potential health risks from the project were based on the maximum modeled concentration of NO at an assumed point of public exposure (nearest point of ambient air), the point of maximum concentration, at the closest residence, and at three industrial receptors.

2.4.6 Emission Concentrations

Pollutant	Closest Point of Ambient Air (164 ft) ($\mu g/m^3$)	Highest Concentration ($\mu g/m^3$)		Residence (1,214 ft) ($\mu g/m^3$)		ASIL (24-hr Ave.) ($\mu g/m^3$)
		1-hr ave. (656 ft)	24-hr ave. (656 ft)	1-hr ave.	24-hr ave.	
NO	1,311	8,372	1,940	3,499	854	100

2.4.7 Pollutants Subject to Second Tier Analysis

Emissions of NO are above the ASIL after being modeled for all three points (closest, highest concentration, and closest residence) and therefore are subject to review under this Second Tier analysis.

2.4.8 Background Emissions

NO is produced during combustion and has been found in urban atmospheres, as well as indoor environments. Although it normally converts to the more toxic nitrogen dioxide (NO_2) readily in the presence of ozone, high levels of NO are found immediately downwind of combustion sources, especially during stagnant conditions, and near heavy traffic.

Within two miles of the proposed facility there are two other data farms being constructed. MSN located to the Southwest has twenty-four 2.5 MW generators, and Intuit to the northeast has nine 2,500 KW diesel powered electric generators. In the event of a system-wide power failure, the emissions of nearby emergency generator diesel emissions will contribute to background concentrations of nitric oxide and other pollutants. When wind direction causes an overlap of either of these facility's emissions with Yahoo's emissions, there will be a greater chance of exceeding the adverse effects threshold in downwind areas. All three facilities have requested limits on the hours of operation. In their application, Intuit states, "According to Mr. William Coe of Grant County Public Utility district, Grant County's electrical system has a system reliability of 99.9990 percent. The 115 kilovolt line that currently serves Quincy has had only one outage in the past 5-years that lasted approximately 90-minutes." Each of these companies has agreed to test only one to two generators at a time for maintenance

purposes for a period of one hour per month. Therefore, Ecology concluded that background emissions of NO are near zero in the project area.

2.5 T-BACT

T-BACT is required for any new or modified emission unit that has an increase in emissions of toxic air pollutants. ERO has determined that T-BACT for controlling emissions of NO from the 31 emergency generators is on-road specification diesel fuel with a sulfur content of 0.0015 weight percent or less, and compliance with EPA Tier II standards (40 CFR 89) for non-road engines.

2.5.1 Air Dispersion Modeling

The applicant used ISC-AERMOD version 5.4.0. Three types of meteorological data were used. They were:

- National Weather Service hourly surface observations from Grant County International Airport in Moses Lake. This source is approximately 24 miles from the Yahoo Data Center. The data was for a 5-year period from January 2001 through December 2005.
- National Weather Service twice-daily upper air soundings from Spokane, Washington. The data was for a 5-year period from January 2001 through December 2005.
- Site-specific data including Albedo, Bowen ratio, and surface roughness.

2.6 Health Impacts Assessment

A health impacts assessment was prepared by the applicant and was reviewed and approved by Ecology. A team was assigned to this project consisting of an engineer, a toxicologist, and a modeler.

Mr. Clint Bowman, Senior Modeler for the Washington State Department of Ecology evaluated the information submitted by the applicant.

Dr. Matt Kadlec, Senior Toxicologist for the Washington State Department of Ecology evaluated the information submitted by the applicant.

Below are descriptions of the content of each part of the Health Impacts Assessment.

2.6.1 Hazard Identification

Hazard identification involves gathering and evaluating toxicity data on the types of health injury or disease that may be produced by a chemical and on the conditions of

exposure under which injury or disease is produced. It may also involve characterization of the behavior of a chemical within the body and the interactions it undergoes with organs, cells, or even parts of cells. This information may be of value in determining whether the forms of toxicity known to be produced by a chemical agent in one population group or in experimental settings are also likely to be produced in human population groups of interest. Note: Risk is not assessed at this stage; hazard identification is conducted to determine whether, and to what degree, it is scientifically correct to infer that toxic effects observed in one setting will occur in other settings (i.e., are chemicals found to be carcinogenic or teratogenic in experimental animals also likely to be so in adequately exposed humans?).

2.6.2 Identification of Potentially Exposed Populations

This step involves describing the nature and size of the various populations exposed to a chemical agent in the vicinity of the proposed project.

2.6.3 Discussion of TAP Concentrations

This step involves the identification of the toxicological profiles of all toxic air pollutants that exceed the ASIL. It includes a discussion of the toxicological effects of hazardous substances, chemicals, and compounds. Each profile includes an examination, summary, and interpretation of available toxicological and epidemiological data evaluations on the hazardous substance.

2.6.4 Exposure Assessment

This step includes characterization of exposure pathways, and total daily intake based on the magnitude and duration of exposure to toxic air pollutants that exceed the ASIL from these pathways. The evaluation could include past exposures, current exposures, or exposures expected in the future.

2.6.5 Risk/Hazard Assessment

This step involves the integration of data analyses from each step of the risk assessment to determine the likelihood that the human population of interest will experience any of the various forms of toxicity associated with a chemical under its known or anticipated conditions of exposure.

3. HEALTH IMPACTS ASSESSMENT

3.1 Introduction

The Second Tier analysis described below was conducted according to the requirements in Chapter 173-460 WAC. It addressed the public health risk associated with exposure to

the NO emissions from operating diesel powered emergency generators in the health effects assessment prepared by the consultant (Landau Associates) for Yahoo.

3.2 Hazard Identification

NO is a colorless gas with a sharp, sweet odor. It turns brown in the air at high concentrations. Its molecular weight is 30 g/mole and its vapor pressure is 26,000 millimeters of mercury. NO's boiling point is -241^0F and it is not combustible. NO is an off-gas produced from the use of diesel powered emergency generators. NO emissions from this facility are not expected to have any impacts on the soil or water.

3.2.1 Acute and Chronic Effects

Most of the toxic effects of NO have been attributed to its reaction with O_2^-, with a rate constant of about 7×10^9 $M^{-1} \cdot sec^{-1}$ to form $ONOO^-$. The protonated form of $ONOO^-$, peroxynitrous acid (ONOOH), forms nitrogen dioxide (NO_2) and an intermediate with reactivity equivalent to the $^{\cdot}OH$ derived from the trans-isomerization of ONOOH, as shown in the equation:

$$O_2^- + NO \rightarrow ONOO^- + H^+ \rightarrow ONOO \rightarrow [OH \cdot \cdot \cdot \cdot NO_2]$$

$ONOO^-$ initiates iron-independent lipid peroxidation and oxidizes thiols at rates at least 1000-fold greater than that of H_2O_2 at pH 7, damages the mitochondria electron transport chain, and causes lipid peroxidation of human low density lipoproteins. $ONOO^-$-mediated thiol oxidation occurs at physiologic pH and in some cases may be irreversible (i.e., oxidized sulfhydryl groups cannot be reduced by physiologic reductants). In addition, $ONOO^-$ nitrates phenolics, including tyrosine and tryptophan residues in several proteins.

Results of a recent literature review suggest that ambient levels of NO may be sufficient to induce health effects, especially in asthmatics and people with platelet dysfunction. It may also alter the body's response to infection. Recent epidemiological studies suggest a link between exposure and childhood respiratory infection, lung cell damage, asthma, bronchitis, croup, and adverse changes in immune system functions.

3.2.2 Reproductive/Developmental Effects

A literature search identified a 1998 study[2] that presented evidence that $ONOO^-$ has been identified in a number of organs, including lungs of infants who died with respiratory failure.

[2] http://www.ehponline.org/members/1998/Suppl-5/1157-1163zhu/zhu-full.html

3.2.3 Terrestrial Fate

NO is a gas not a solid or liquid, its terrestrial deposition and fate are therefore not significant.

3.2.4 Aquatic Fate

Nitric oxide is relatively insoluble in water. Its transport and fate in environmental media are predominantly within the atmospheric medium.

3.3 Identification of Exposed Populations

Potentially exposed populations were identified based upon zoning classifications for Grant County and the City of Quincy. Within 1 kilometer of the proposed facility there is industrial, agricultural, medium-density residential, and high-density residential land zoning within Grant County. Within the City Of Quincy (which is within one kilometer of the proposed site), there is light industrial and low-density residentially zoned land within the City of Quincy. The table below identifies the distances to the nearest buildings:

Distance from Receptors to Yahoo Property Boundary		
Receptor	Kilometers	Miles
Nearest residential building (R-1)	0.37	0.23
Nearest industrial building to the south (I-2)	0.12	0.08
Nearest industrial building to the northeast (I-3)	1.07	0.67
Nearest industrial building to the north (I-4)	1.07	0.66
Closest point of ambient air (C-5)	0.05	0.03
Point of maximum concentration (24-hr average)	0.2	0.12
Point of maximum concentration (1-hr average)	0.2	0.12

3.4 Discussion of TAP Concentrations

The table below is based upon all 31 units running at full operation:

NO at Exposed Receptors						
Averaging Time Exposure Duration	R-1: Nearest residential building	I-2 Nearest industrial building to the south	I-3: Nearest industrial building to the northeast	I-4: Nearest industrial building to the north	C-5: Closest point of ambient air	Point of maximum concentration
24-Hr Concentration (ug/m^3)	854	1,017	418	399	1,311	1,940
1-Hr Concentration (ug/m^3)	3,499	2,989	2,828	3,644	2,807	8,372

3.5 Exposure Assessment (daily intake and risk)

The Risk-Based Concentration (RBC) levels used in Second Tier analysis are based on existing data. Ecology evaluated these data and developed the following exposure limits:

RBC ($\mu g/m^3$)	Hours	Basis
2350	1	1-h Reference exposure limit for NO_2 (470-$\mu g/m^3$) x 5:1[3]
1030	24	ASIL without a non-recovery factor[4]

3.6 Risk/Hazard Assessment

A comparison of the modeled concentration at select receptors is compared to the exposure limit in the table below. The calculation is referred to as the Hazard Quotient (HQ). The definition of a HQ was taken from the EPA NATA glossary.[5]

Hazard Quotient:

> The ratio of the potential exposure to the substance and the level at which no adverse effects are expected. If the HQ is calculated to be less than one, then no adverse health effects are expected as a result of exposure. If the HQ is greater than one, then adverse health effects are possible. The HQ cannot be translated to a probability that adverse health effects will occur, and is unlikely to be proportional to risk. It is especially important to note that a HQ exceeding one does not necessarily mean that adverse effects will occur.

[3] The 1-hr. reference exposure limit (REL)-equivalent for nitric oxide derived from the 5:1 ratio based on the NIOSH Immediately Dangerous to Life or Health values of 20-ppm for NO_2 and 100-ppm for nitric oxide.
[4] The nitric oxide ASIL multiplied by a factor of 10 to remove the non-recovery factor to obtain a 24-hr. risk-based concentration (RBC) = 3100-$\mu g/m^3$ x (8/24) / 10 [for healthy worker to sensitive populations.
[5] http://www.epa.gov/ttn/atw/nata/gloss.html

NO Hazard Quotients at Exposed Receptors						
Averaging Time Exposure Duration	R-1: Nearest residential building	I-2 Nearest industrial building to the south	I-3: Nearest industrial building to the northeast	I-4: Nearest industrial building to the north	C-5: Closest point of ambient air	Point of maximum concentration
24-Hr Concentration (ug/m^3)	854	1,017	418	399	1,311	1,940
24-Hr Exposure Limit (ug/m^3)	1030	1030	1030	1030	1030	1030
24-Hr HQ	0.83	0.99	0.41	0.39	1.27	1.88
1-Hr Concentration (ug/m^3)	3,499	2,989	2,828	3,644	2,807	8,372
1-Hr Exposure Limit (ug/m^3)	2350	2350	2350	2350	2350	2350
1-Hr HQ	1.49	1.27	1.20	1.55	1.19	3.56

Chapter 173-460 WAC lists NO as a Class B TAP with a 24-hour averaging period. As you can see from the table above, the hazard quotient at the point of maximum concentration is 188. What that means is that there is an increased chance that emissions from this facility could cause an acute health impact especially to people with asthma. Dr. Kadlec has expressed concern that the real risk is actually from the 1-hour exposure, which has a hazard quotient of 3.56 at the point of maximum concentration.

Ecology does not have the legal authority to regulate NO emissions on a 1-hour average. However, we believe it is important to identify this potential risk. Ecology recommends that Yahoo find a mechanism to notify the public of this potential risk when emergency conditions dictate that all generators operate.

4. CONCLUSION

This project is expected to result in a hazard quotient of 1.88 for NO at the point of maximum concentration for the 24-hour averaging period. Ecology has determined the health risks are within the range that Ecology may approve for proposed new sources of TAPs under Chapter 173-460 WAC. Ecology finds the applicant, Yahoo, has satisfied all requirements for Second Tier analysis. However, this project is also expected to result in a hazard quotient of 3.56 for NO at the point of maximum concentration for the 1-hour averaging period. Although Ecology has no regulatory basis for denying the proposal for

this potential risk, we are suggesting that the public be made aware of this risk. This could be fulfilled by either a public notice of some sort, when Yahoo knows there is going to be an extended power outage and that the generators will be operating or some sort of emergency management plan that has yet to be developed for the Quincy area.

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5. LIST OF ABBREVIATIONS

ASIL	Acceptable Source Impact Level
BACT	Best Available Control Technology
BTU	British Thermal Unit
CFR	Code of Federal Regulations
Ecology	Washington State Department of Ecology, Headquarters Office
ERO	Washington State Department of Ecology, Eastern Regional Office
EPA	United States Environmental Protection Agency
HAP	Hazardous Air Pollutant
HQ	Hazard Quotient
hr	Hour
KW	Kilowatt
MBtu/hr	Thousand British Thermal Units per Hour
MMBtu/hr	Million British Thermal Units per Hour
MW	Megawatt
NATA	National-scale Air Toxic Assessments
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NOC	Notice of Construction
NO_X	Nitrogen Oxides
PAH	Polyaromatic hydrocarbon
PTE	Potential to Emit
SQER	Small Quantity Emission Rate Table
TAP	Toxic Air Pollutant
T-BACT	Best Available Control Technology for Toxics
tpy	Tons per Year
VOC	Volatile Organic Compounds
WAC	Washington Administrative Code
yr	Year