ANALYSIS FOR NEW SOURCES OF TOXIC EMISSIONS
OEPA Engineering Guide #70 Report
Middletown Cogeneration

Overview

Air Products and Chemicals, Inc. (Air Products) is proposing to construct and operate a combined-cycle power generation plant at the AK Steel Corporation's (AK Steel) Middletown Works in Middletown, Ohio. The plant would capture and process waste blast furnace gas to produce electricity and process steam for use at AK Steel's Middletown Works. This project would be the first deployment in North America using steel mill blast furnace gas to generate both electricity and process steam using a combined-cycle gas turbine technology. The project is referred to as the Middletown Cogeneration.

Air Products is making this application to the Ohio Environmental Protection Agency (OEPA) for a Permit-To-Install (PTI) for the air contaminant sources including a stationary combined cycle turbine that will be equipped with a selective catalytic reduction system (SCR) to reduce emissions of nitrogen oxides. As a result of the SCR system, the facility will have the potential to emit greater than 1 ton per year of ammonia. As required by the AToxic Air Contaminant Statute@, ORC 3704.03(F), and OAC rule 3745-114-01, an evaluation was performed to insure that new sources of emissions do not cause a significant environmental impact due to the release of any toxic air pollutant. An evaluation employing air quality dispersion modeling was performed for ammonia emissions (as ammonia is the only listed pollutant whose potential emission estimates exceeds 1 ton) to determine the ambient impact of ammonia emissions from this process. This evaluation follows the OEPA guidance described in their document entitled "Option A – Review of New Sources of Air Toxic Emissions" (also known as the "Air Toxic Policy") and OEPA Engineering Guide #70 (Draft). A description of the modeling evaluation and summary of results are provided herein. The air quality analysis documented in this section was performed in accordance with general EPA and OEPA modeling guidance and acceptable modeling techniques.

Model Selection

The SCREEN3 (version 96043) model was used to calculate the impact of ammonia emissions from the new gas turbine. This mathematical model simulates plume dispersion and estimates pollutant concentrations at receptor locations for the conservative assumptions and conditions used in the modeling analysis. The SCREEN3 model (EPA, 1995) was developed by EPA to provide an easy-to-use method of obtaining pollutant concentration estimates based on the document entitled "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources" (EPA, 1995a). Most of the techniques used in the SCREEN3 model are based on assumptions and methods common to other EPA dispersion models. Performing a screening analysis in this manner will yield a somewhat conservative first approximation of the source's maximum impact. The model was executed consistent with OEPA's Air Dispersion Modeling Guidance (Engineering Guide #69).

Meteorological conditions used in SCREEN3 include a full range of stability class/wind speed combinations. Receptors are assumed to be located directly downwind of the source. The model's automated distance array option was employed so that the model's iteration routine can locate the maximum concentration value over the range of downwind distances input to the model. (In this case, distances from 325 to 50,000 m were used to insure the model would return the absolute maximum concentration.)

SCREEN3 uses a Gaussian plume model that incorporates source-related factors and worst-case meteorological conditions to estimate pollutant concentrations from continuous sources. It is assumed that the pollutant does not undergo any chemical reactions, and that no other removal processes, such as wet or dry deposition, act on the plume during its transport form the source. SCREEN3 model results for simple terrain (terrain below stack top) are estimated maximum 1-hour concentrations.

Modeling Methodology

The maximum predicted 1-hour ambient ammonia impact calculated by SCREEN3 was compared to OEPA's Maximum Acceptable Ground-Level Concentration (MAGLC) to determine the acceptability of the impact. The maximum ambient concentration of ammonia was estimated using the maximum hourly emission rate of 11 lbs/hr of ammonia. Table 1 summarizes the stack and building parameters that define the new gas turbine. Typically, a screening analysis is initially performed to provide a conservative estimate of the air quality impacts. If screening modeling can demonstrate that the impacts from the project are acceptable, no further air quality analysis is typically required.

Initial dispersion modeling was performed using the SCREEN3 dispersion model in the flat terrain mode with rural dispersion coefficients. This modeling is based on release of the air emissions through a single stack with an emission rate representing the maximum short-term (peak) emission rate of the new source. The most dominant building structure influencing the stack serving the gas turbine may cause the plume emitted from the gas turbine stack to be entrained into the adjacent building wake. Thus, the dimensions of the building structure were input into the model to account for potential building downwash effects. The dimensions of the influencing structure considered in the model are shown in Table 1.

OEPA's MAGLC is derived by taking the threshold limit value (TLV) from the American Conference of Government Industrial Hygienists (ACGIH) and dividing it by 42 to account for source operation 7 days per week and 24 hours per day. The TLV for ammonia is 17 mg/m^3. Thus the MAGLC is 17 $mg/m^3/42 = 0.405$ mg/m^3 or 405 $\mu g/m^3$. The ACGIH TLV as reported by the Occupational Safety and Health Administration (OSHA) is shown on Attachment I

Terrain elevations at or near the facility fenceline where maximum impacts are expected is similar to the terrain onsite. Thus, the model was run in flat terrain mode where receptors are the same elevation as the base of the stack. The first receptor was placed at 325 m, which is the nearest distance to the fence line from the proposed gas turbine stack. Simple terrain receptors were located out to a distance of 50,000 m downwind. The full meteorology option of SCREEN3 was selected for each model run along with rural dispersion coefficients. The default

ambient temperature of 68ºF was used in the model along with the default anemometer height of 10m.

Modeling Results and Conclusions

The maximum one-hour concentration of ammonia predicted by SCREEN3 is 3.086 $\mu g/m^3$. This predicted concentration is well below the MAGLC for ammonia of 405 $\mu g/m^3$ indicating compliance with OEPA's Air Toxic Policy. A printout of the modeling results is included in Attachment II.

REFERENCES

USEPA 1995. SCREEN3 Model User's Guide. USEPA Document 454/B-95-004, Office of Air Quality Planning and Standards, Research Triangle Park, NC. September, 1995.

40 CFR 51 Appendix W Guideline on Air Quality Models (Revised).

OEPA. Engineering Guide #69, Air Dispersion Modeling Guidance

OEPA. Engineering Guide #70, (Draft)

OPEA. Option A - Review of New Sources of Air Toxic Emissions, (Draft)

OSHA. www.osha.gov/dts/chemicalsampling/data/CH_218300.html

TABLE 1
SOURCE PARAMETERS

Source Parameter	Value
Stack Height	125 ft.
Stack Diameter	16.5 ft.
Exit Gas Velocity	77.9 fps
Exit Gas Temperature	317 ºF
Volumetric Flow Rate	1,000,000 acfm
Building Height	63 ft.
Building Width	132.7 ft.
Building Length	86.2 ft.
NH3 emission rate	11 lb/hr (1.386 g/s)

ATTACHMENT I
ACGIH TLV for AMMONIA

Safety and Health Topics:

Ammonia

Safety and Health Topics
Ammonia
Refrigeration

Chemical Sampling Information
Ammonia
- General Description
- Exposure Limits
- Health Factors
- Monitoring

General Description

Synonym: Anhydrous ammonia

OSHA IMIS Code Number: 0170

Chemical Abstracts Service (CAS) Registry Number: 7664-41-7

NIOSH, Registry of Toxic Effects (RTECS) Identification Number: BO0875000

Department of Transportation Regulation Number (49 CFR 172.101): 1005 125 (anhydrous); 2672 154 (10-35% solution); 2073 125 (>35-50% solution); 1005 125 (>50% solution)

NIOSH Pocket Guide to Chemical Hazards, Ammonia: chemical description, physical properties, potentially hazardous incompatibilities, and more

Exposure Limits

OSHA Permissible Exposure Limit (PEL) for General Industry: 29 CFR 1910.1000 Z-1 Table -- 50 ppm, 35 mg/m^3 TWA

OSHA Permissible Exposure Limit (PEL) for Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 50 ppm, 35 mg/m^3 TWA

American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV): 25 ppm, 17 mg/m^3 TWA; 35 ppm, 24 mg/m^3 STEL

National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL): 25 ppm, 18 mg/m^3 TWA; 35 ppm, 27 mg/m^3 STEL

Health Factors

NIOSH Immediately Dangerous To Life or Health Concentration (IDLH): 300 ppm

Potential symptoms: Eye, nose, throat irritation; corneal burns, increased intraocular pressure; coughing; laryngeal edema; dyspnea, bronchospasm; chest pain; pulmonary edema or pneumonitis; pink frothy sputum; skin burns; vesiculation

Health Effects: Respiratory Effects---Acute lung damage/edema (HE11); Asthma, pulmonary fibrosis, bronchiolitis obliterans (HE9); Irritation-Eye, Nose, Throat, Bronchi, Skin---Marked (HE14); Blindness (HE14)

Affected organs: Respiratory system, eyes, skin

Date Last Revised: 02/25/2003

Literature Basis:

- (symptoms/health effects)
  Hung, O.L. and Shih, R.D.: Firefighters (Chapter 15), in *Occupational, Industrial, and Environmental Toxicology*, Greenburg, M.I., Hamilton, R.J. and Phillips, S.D., eds. St. Louis: Mosby, 1997, pp. 113-122.

Monitoring Methods used by OSHA

Laboratory Sampling/Analytical Method:

sampling media: Sulfuric Acid impregnated Carbon Bead (Supelco ORB0-77 tube or equivalent)
maximum volume: 24.0 Liters **maximum flow rate:** 0.1 L/min TWA
maximum volume: 7.5 Liters **maximum flow rate:** 0.5 L/min STEL
current analytical method: Ion Chromatography; IC/Conductivity
method reference: OSHA Manual of Analytical Methods (OSHA ID-188)
method classification: Fully Validated

ATTACHMENT II
MODEL OUPUT

03/03/11
15:05:00

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 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***

NH3 Air Products

SIMPLE TERRAIN INPUTS:
   SOURCE TYPE            =        POINT
   EMISSION RATE (G/S)    =      1.38600
   STACK HEIGHT (M)       =      38.1000
   STK INSIDE DIAM (M)    =       5.0292
   STK EXIT VELOCITY (M/S)=      23.7578
   STK GAS EXIT TEMP (K)  =     431.4833
   AMBIENT AIR TEMP (K)   =     293.1500
   RECEPTOR HEIGHT (M)    =       0.0000
   URBAN/RURAL OPTION     =        RURAL
   BUILDING HEIGHT (M)    =      19.2000
   MIN HORIZ BLDG DIM (M) =      26.2800
   MAX HORIZ BLDG DIM (M) =      40.4600

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.


BUOY. FLUX =  472.287 M**4/S**3;  MOM. FLUX = 2424.801 M**4/S**2.

*** FULL METEOROLOGY ***

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*** SCREEN AUTOMATED DISTANCES ***
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 *** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES
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DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
325.	3.086	4	20.0	24.4	6400.0	56.88	25.29	27.59	HS
400.	2.536	4	20.0	24.4	6400.0	60.46	30.50	29.80	HS
500.	2.063	4	20.0	24.4	6400.0	64.90	37.29	32.69	HS
600.	1.513	4	20.0	24.4	6400.0	69.05	43.96	33.84	HS
700.	1.284	4	20.0	24.4	6400.0	72.98	50.51	36.11	HS
800.	1.114	4	20.0	24.4	6400.0	76.72	56.97	38.32	HS
900.	0.9818	4	20.0	24.4	6400.0	80.31	63.35	40.46	HS
1000.	0.9456	1	2.0	2.2	748.1	747.11	264.26	481.93	NO
1100.	1.060	1	2.0	2.2	748.1	747.11	285.23	581.54	NO
1200.	1.068	1	2.0	2.2	748.1	747.11	305.87	692.22	NO
1300.	1.026	1	2.0	2.2	748.1	747.11	326.21	814.06	NO
1400.	0.9716	1	2.0	2.2	748.1	747.11	346.10	947.06	NO
1500.	0.9335	1	2.0	2.2	748.1	747.11	360.46	1089.60	NO
1600.	0.8975	1	2.0	2.2	748.1	747.11	374.95	1243.91	NO
1700.	0.8639	1	2.0	2.2	748.1	747.11	389.56	1409.97	NO
1800.	0.8325	1	2.0	2.2	748.1	747.11	404.25	1587.76	NO
1900.	0.8031	1	2.0	2.2	748.1	747.11	419.01	1777.30	NO
2000.	0.7757	1	2.0	2.2	748.1	747.11	433.82	1978.61	NO
2100.	0.7500	1	2.0	2.2	748.1	747.11	448.67	2191.72	NO
2200.	0.7260	1	2.0	2.2	748.1	747.11	463.55	2416.66	NO

2300.	0.7034	1	2.0	2.2	748.1	747.11	478.45	2653.47	NO
2400.	0.6821	1	2.0	2.2	748.1	747.11	493.35	2902.20	NO
2500.	0.6621	1	2.0	2.2	748.1	747.11	508.27	3162.90	NO
2600.	0.6432	1	2.0	2.2	748.1	747.11	523.18	3435.59	NO
2700.	0.6254	1	2.0	2.2	748.1	747.11	538.08	3720.33	NO
2800.	0.6086	1	2.0	2.2	748.1	747.11	552.97	4017.17	NO
2900.	0.5926	1	2.0	2.2	748.1	747.11	567.85	4326.14	NO
3000.	0.5775	1	2.0	2.2	748.1	747.11	582.71	4647.29	NO
3500.	0.5125	1	2.0	2.2	748.1	747.11	656.69	5000.00	NO
4000.	0.5044	2	2.0	2.2	748.1	747.11	564.89	539.66	NO
4500.	0.5002	2	2.0	2.2	748.1	747.11	618.92	604.17	NO
5000.	0.4812	2	2.0	2.2	748.1	747.11	672.70	670.28	NO
5500.	0.4558	2	2.0	2.2	748.1	747.11	726.16	737.73	NO
6000.	0.4290	2	2.0	2.2	748.1	747.11	779.29	806.29	NO
6500.	0.4035	2	2.0	2.2	748.1	747.11	832.05	875.80	NO
7000.	0.3802	2	2.0	2.2	748.1	747.11	884.44	946.16	NO
7500.	0.3593	2	2.0	2.2	748.1	747.11	936.47	1017.27	NO
8000.	0.3445	3	2.0	2.3	720.2	719.22	699.94	453.47	NO
8500.	0.3495	3	2.0	2.3	720.2	719.22	735.87	474.66	NO
9000.	0.3514	3	2.0	2.3	720.2	719.22	771.68	495.95	NO
9500.	0.3599	5	2.0	3.2	10000.0	195.30	391.33	89.18	NO
10000.	0.3714	5	1.5	2.4	10000.0	211.12	409.92	93.25	NO
15000.	0.4425	5	1.0	1.6	10000.0	236.15	586.12	111.06	NO
20000.	0.4721	5	1.0	1.6	10000.0	236.15	754.45	123.08	NO
25000.	0.4577	5	1.0	1.6	10000.0	236.15	917.41	131.65	NO
30000.	0.4381	5	1.0	1.6	10000.0	236.15	1076.03	139.32	NO
40000.	0.3958	5	1.0	1.6	10000.0	236.15	1382.88	152.73	NO
50000.	0.3505	5	1.0	1.6	10000.0	236.15	1678.67	161.76	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 325. M:

325.	3.086	4	20.0	24.4	6400.0	56.88	25.29	27.59	HS

DWASH= MEANS NO CALC MADE (CONC = 0.0)
DWASH=NO MEANS NO BUILDING DOWNWASH USED
DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

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     *** REGULATORY (Default) ***
    PERFORMING CAVITY CALCULATIONS
  WITH ORIGINAL SCREEN CAVITY MODEL
          (BRODE, 1988)
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*** CAVITY CALCULATION - 1 ***			*** CAVITY CALCULATION - 2 ***		
CONC (UG/M**3)	=	0.000	CONC (UG/M**3)	=	0.000
CRIT WS @10M (M/S)	=	99.99	CRIT WS @10M (M/S)	=	99.99
CRIT WS @ HS (M/S)	=	99.99	CRIT WS @ HS (M/S)	=	99.99
DILUTION WS (M/S)	=	99.99	DILUTION WS (M/S)	=	99.99
CAVITY HT (M)	=	24.38	CAVITY HT (M)	=	21.18
CAVITY LENGTH (M)	=	42.69	CAVITY LENGTH (M)	=	34.26
ALONGWIND DIM (M)	=	26.28	ALONGWIND DIM (M)	=	40.46

CAVITY CONC NOT CALCULATED FOR CRIT WS > 20.0 M/S. CONC SET = 0.0

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      END OF CAVITY CALCULATIONS
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 *** INVERSION BREAK-UP FUMIGATION CALC. ***
  CONC (UG/M**3)   =    1.324
  DIST TO MAX (M)  = 19569.05

     ***************************************
     *** SUMMARY OF SCREEN MODEL RESULTS ***
     ***************************************

 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
--------------    -----------   -------   -------
SIMPLE TERRAIN      3.086          325.        0.

INV BREAKUP FUMI    1.324        19569.       --
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