APPENDIX 8.12A

Offsite Consequence Analysis

TECHNICAL MEMORANDUM

CH2MHILL

Off-site Consequence Analysis

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DATE: May 19, 2006

AES Corporation (AES) is proposing to construct and operate a simple-cycle power plant, known as AES Highgrove. The project site is located in the city of Grand Terrace, San Bernardino County on the site of the former Southern California Edison oil-fired generating plant. Highgrove will be located on the portion of the site formerly used for liquid fuel storage.

AES Highgrove will consist of a nominal 300-megawatt (MW) simple-cycle plant, using three natural gas-fired GE LMS 100 gas turbines and associated infrastructure. The project will include a tie-in to the existing 115-kV substation adjacent to the site. A natural gas pipeline tie-in will be made to a new Southern California natural gas metering station, on the southern boundary of the project site. Process water for the project would be delivered from onsite wells.

AES Highgrove is required by both the Clean Air Act and the South Coast Air Quality Management District (SCAQMD) to install Best Available Control Technology (BACT) to control emissions of criteria air pollutants from the combustion turbines. The project's turbines will incorporate water injection to reduce emissions of oxides of nitrogen (NO_X). Carbon monoxide (CO) and volatile organic compounds (VOC) emissions will be controlled using an oxidation catalyst system. In addition, emissions of NO_X from the turbines will be further reduced through the use of selective catalytic reduction (SCR). The SCR control system uses ammonia as the reduction reagent in the presence of a catalyst. Two forms of ammonia may be used in currently designed SCR systems; i.e., aqueous ammonia or anhydrous ammonia. AES is proposing to use the less toxic form, aqueous ammonia.

AES will store a 19-percent aqueous ammonia solution in a single stationary storage tank. The capacity of the tank will be approximately 16,000 gallons, but will be limited by regulation to storing a maximum amount of 13,600 gallons (85 percent capacity). The tank will be surrounded by a secondary containment structure approximately 1,100 square feet (22 feet by 50 feet) that is capable of holding the full contents of the tank. The containment area will be filled with polyballs to reduce the surface area in the event of a spill. The polyballs were assumed to line edge-to-edge across the containment area such that for each square inch of containment area, a 1-inch diameter polyball would cover most of the surface. For the 1,100-square-foot containment area, the area exposed using the polyballs is approximately 236 square feet.

Aqueous ammonia will be delivered to the plant by truck transport. The truck loading area will be located within a bermed area adjacent to the storage tank. The bermed area will be sufficient to contain the contents of the truck in the event of a spill.

Analysis

An analysis of a tank failure and subsequent release of aqueous ammonia was prepared. The analysis assumes the complete failure of the tank and the formation of an evaporating pool of aqueous ammonia within the secondary containment structure. For purposes of this analysis, the following meteorological data were used:

- U.S. Environmental Protection Agency (USEPA) default (worst case) meteorological data, supplemented by daily temperature data as required by CCR Title 19, Section 2750.2.

AES Highgrove will be located in the City of Grand Terrace, San Bernardino County, California. The maximum temperature recorded near the proposed site in the past 75 years was 116 °F or 319.82 Kelvin (http://www.wrcc.dri.edu/cgi-bin/cliGCStT.pl?carvrf). Maximum temperatures combined with low wind speeds and stable atmospheric conditions are expected to result in the highest modeled ammonia concentrations at the furthest distance downwind of the project site.

Table 1 displays the meteorological data values used in the modeling analysis.

TABLE 1
Meteorological Input Parameters

Parameter	Worst Case Meteorological Data
Wind Speed, meters/second	1.5
Stability Class	F
Relative Humidity, Percent	50
Ambient Temperature, Kelvin (°F)	319.82 (116)

One modeling run was conducted for an evaporating pool release caused by a single tank failure leaking into the entire bermed area, for corresponding meteorological scenario listed in Table 1. Modeling was conducted using the SLAB numerical dispersion model. A complete description of the SLAB model is available in *User's Manual for SLAB: An Atmospheric Dispersion Model for Denser-Than-Air Releases, D. E. Ermak, Lawrence Livermore National Laboratory, June 1990*. The SLAB user manual contains a substance database, which includes chemical-specific data for ammonia. This data was used in all modeling runs without exception or modification.

Emissions of aqueous ammonia were calculated pursuant to the guidance given in *RMP Offsite Consequence Analysis Guidance, EPA, April 1999* and using the "evaporation calculator" provided by the National Oceanic and Atmospheric Administration (http://archive.orr.noaa.gov/cameo/evapcalc/evap.html). Release rates for ammonia vapor from an evaporating 19-percent solution of aqueous ammonia were calculated assuming mass transfer of ammonia across the liquid surface occurs according to principles of heat transfer by natural convection. The ammonia release rate was calculated using the evaporation calculator, meteorological data displayed in Table 1, and the dimensions of the secondary containment area.

An initial ammonia evaporation rate was calculated and assumed to occur for at least one hour. For concentrated solutions, the initial evaporation rate is substantially higher than the rate averaged over time periods of a few minutes or more, since the concentration of the solution immediately begins to decrease as evaporation begins.

For the main storage tank scenarios, the complete release of the storage tank contents (13,600 gallons of 19-percent aqueous ammonia) was assumed to be the worst case scenario. The failure of the tank would cause the aqueous ammonia to leak into the containment area and the release of ammonia would result from evaporation.

Although the edge of the tank containment area is raised above ground level, the release heights used in the modeling were set at 0 meters above ground level (AGL) to maintain the conservative nature of the analysis. Downwind concentrations of ammonia were calculated at heights of 0, 1.6, 5 and 10meters AGL. Reported distances to specified toxic endpoints are the maximum distances for concentrations at 0, 1.6, 5 or 10 meters AGL. The California Office of Environmental Health Hazard Assessment (OEHHA) has designated 1.6 meters as the breathing zone height for individuals. Five and 10 meters correspond to the heights of a 2- and 3-story building, respectively.

An analysis of the tank loading hose failure with a leak below the excess flow valves activation set-point and the subsequent impacts was considered. This analysis would normally be completed under typical or average meteorological conditions for the area. However, after review of the possible failure modes, it was determined that the impact of this leak would be bracketed by the complete tank failure as a worst-case for the hose failure.

Toxic Effects of Ammonia

With respect to the assessment of potential impacts associated with an accidental release of ammonia, three offsite "bench mark" exposure levels are typically evaluated, as follows: (1) the Occupational Safety and Health Administration's (OSHA) Immediately Dangerous to Life and Health (IDLH) level of 300 ppm; (2) the Emergency Response Planning Guideline (ERPG) level of 200 ppm, which is also the RMP level 1 criterion used by the USEPA and California [Note: in the year 2005 the American Industrial Hygiene Association (AIHA) updated the ERPG-2 for ammonia to 150 ppm]; and (3) the level considered by CEC staff to be without serious adverse effects on the public for a one-time exposure of 75 ppm (*Preliminary Staff Assessment-Otay Mesa Generating Project, 99-AFC-5, May 2000).*

The odor threshold of ammonia is about 5 ppm, and minor irritation of the nose and throat will occur at 30 to 50 ppm. Concentrations greater than 140 ppm will cause detectable effects on lung function even for short-term exposures (0.5 to 2 hours). At higher concentrations of 700 to 1,700 ppm, ammonia gas will cause severe effects; death occurs at concentrations of 2,500 to 7,000 ppm.

The specified toxic endpoint (TE) value for ammonia is 0.105 mg/L, which is approximately equal to 150 ppm. The TE value is based on a one-hour exposure or averaging time; therefore, the modeling concentrations at all offsite receptors will be given in terms of one-hour (or 60-minute) averaging time.

Modeling Results

Table 2 shows the distance to the three benchmark criteria modeled: OSHA's IDLH (300 ppm), AIHA's ERPG-2 (150 ppm), and the CEC significance value (75 ppm).

TABLE 2
Distance to EPA/CalARP and CEC Toxic Endpoints: Scenario 1 – Release into entire bermed area

Scenario	Distance in Meters to IDHL (300 ppm)	Distance in Meters to AIHA's ERPG (150 ppm)	Distance in Meters to CEC Significance Value (75 ppm)
0 m AGL	10.1	10.4	10.5
1.6 m AGL	11.9	12.1	12.2
5 m AGL	19.2	20.0	20.4
10 m AGL	37.4	38	38.3

The model input file and the output files are available upon request.

The distance to the CEC's extremely protective 75 ppm ammonia concentration does not extend off the project site under the very conservative release scenario (see Figure 8.12A-1).

Assessment of the Methodology Used

Numerous conservative assumptions were used in the above analysis of the tank failure. These include the following:

- Modeling & Meteorology
  - Worse case of a constant mass flow, initial evaporation rate was modeled; whereas, in reality the evaporation rate would decrease with time as the concentration in the solution decreases.
  - Worst case stability class was used, which almost exclusively occurs during nighttime hours, but the maximum ambient temperature of 116°F was used, which would occur during daylight hours.
  - Again worst-case meteorology corresponds to nighttime hours, whereas the worst-case release of a tank failure would most likely occur during daytime activities at the power plant. At night, activity at a power plant is typically minimal.

Risk Probability

Accidental releases of aqueous ammonia in industrial use situations are rare. Statistics compiled on the normalized accident rates for RMP chemicals for the years 1994-1999 from *Chemical Accident Risks in U.S. Industry-A Preliminary Analysis of Accident Risk Data from U.S. Hazardous Chemical Facilities, J.C. Belke, Sept 2000*, indicates that ammonia (aqueous) averages 0.017 accidental releases per process per year, and 0.018 accidental releases per million pounds stored per year. Data derived from *Guidelines for Technical Management of Chemical Process Safety,* AIChE, *1989*, indicates the accidental release scenarios and probabilities for ammonia in general shown in Table 3.

TABLE 3
General Accidental Release Scenarios and Probabilities for Ammonia

Accident Scenario	Failure Probability
Onsite Truck Release	0.0000022
Loading Line Failure	0.005
Storage Tank Failure	0. 000095
Process Line Failure	0.00053
Evaporator Failure	0.00015

Conclusions

Several factors need to be considered when determining the potential risk from the use and storage of hazardous materials. These factors include population densities near the project site, meteorological conditions, the process design, and the probability of occurrence. Considering the results of this analysis, the probability of a catastrophic storage tank failure resulting in the modeled ammonia concentrations, and the probability of a tank failure occurring under low wind speeds and F class atmospheric stability, the risk posed to the local community from the storage of aqueous ammonia at the AES Highgrove site is insignificant.

As described above, numerous conservative assumptions have been made at each step in the analysis. This compounding of conservative assumptions has resulted in a significant overestimation of the probability of an ammonia release at AES Highgrove. Even if it were to happen, the predicted distances to toxic endpoints do not pose a threat to public receptors. Therefore, it is concluded that the risk from exposure to aqueous ammonia due to the AES Highgrove facility is less than significant.

References

American Industrial Hygiene Association (AIHA) 2005 Emergency Respond Planning Guidelines

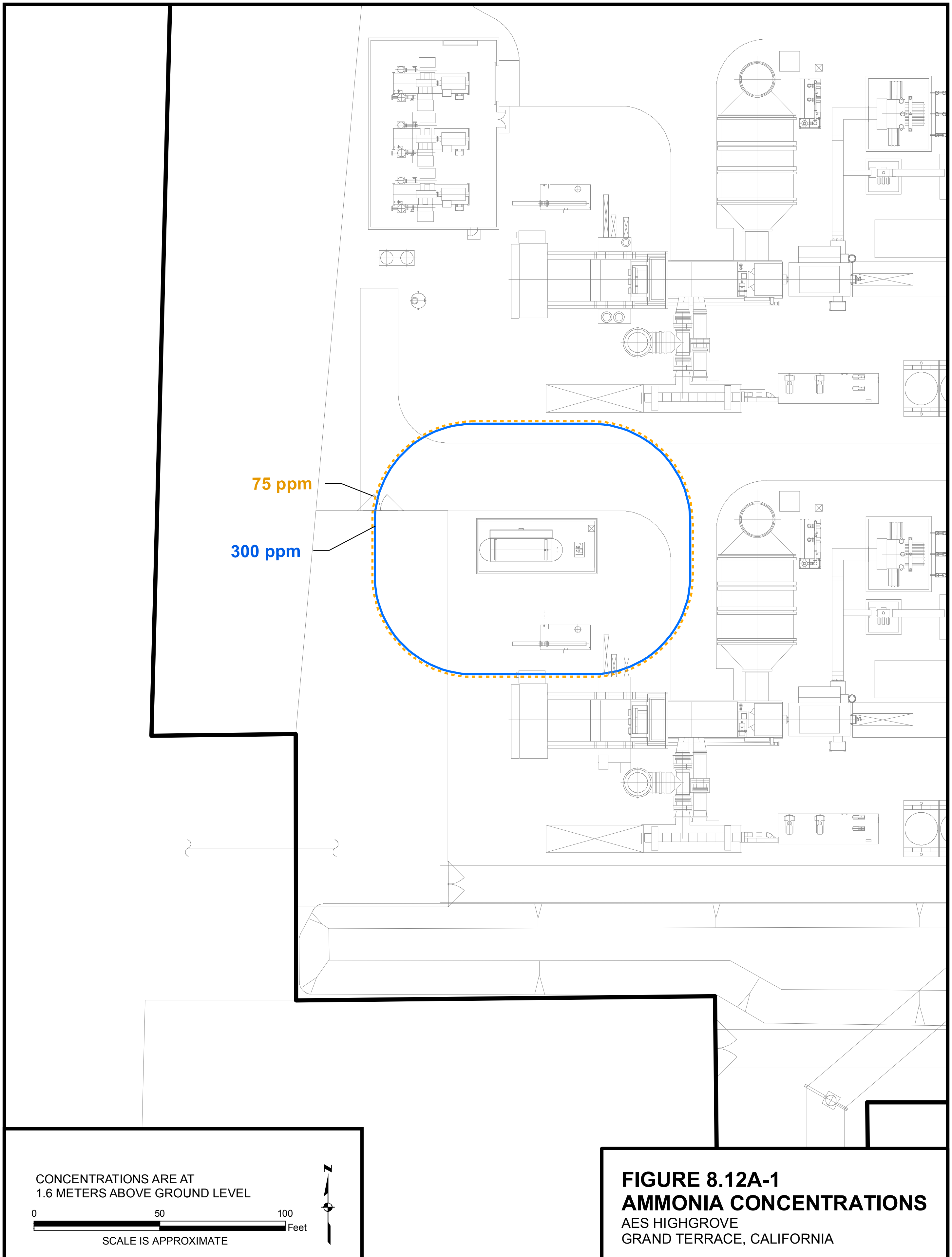
Chemical Accident Risks in U.S. Industry-A Preliminary Analysis of Accident Risk Data from U.S. Hazardous Chemical Facilities, J.C. Belke, Sept 2000

Guidelines for Technical Management of Chemical Process Safety, AIChE, 1989

Preliminary Staff Assessment-Otay Mesa Generating Project, 99-AFC-5, May 2000

RMP Offsite Consequence Analysis Guidance, EPA, April 1999

User's Manual for SLAB: An Atmospheric Dispersion Model for Denser-Than-Air Releases, D. E. Ermak, Lawrence Livermore National Laboratory, June 1990


75 ppm
300 ppm
CONCENTRATIONS ARE AT
1.6 METERS ABOVE GROUND LEVEL
0
50
100
Feet
SCALE IS APPROXIMATE
N
FIGURE 8.12A-1
AMMONIA CONCENTRATIONS
AES HIGHGROVE
GRAND TERRACE, CALIFORNIA
CH2MHILL