APPENDIX 8.12A

Offsite Consequence Analysis

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Vernon Power Plant

PREPARED FOR: John Carrier/CH2M HILL

PREPARED BY: William Heung/CH2M HILL, Stephen O'Kane/CH2M HILL

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The City of Vernon proposes to develop a natural-gas-fired generating facility in the south-central portion of the City in Los Angeles County (County), California. The proposed Vernon Power Plant (VPP) will be a high-efficiency, combined-cycle facility that will be integrated into the City's plans to meet its growing native load, and provide other ancillary services and benefits to Vernon, Los Angeles County, and Southern California

VPP will consist of the following components:

- A 914-megawatt (MW) net (at 65 degrees Fahrenheit [°F] with duct burners and evaporative cooling) combined-cycle generating facility configured using three natural-gas-fired combustion turbine generators (CTGs) and one steam turbine generator (STG)
- A 230-kilovolt (kV) switchyard
- Approximately 4.4 to 4.8 miles of new 230-kV transmission line connecting to Southern California Edison's Laguna Bell Substation
- Approximately 2,300 feet of new 24-inch-diameter natural gas pipeline
- Approximately 2,400 feet of new sanitary sewer line

Emissions of nitrogen dioxides (NO_x) from the combustion turbines will be controlled using selective catalytic reduction. Aqueous ammonia (ammonium hydroxide at 19 percent nominal concentration by weight) will be injected into the flue gas stream from the turbines which is then passed through a catalyst bed. In the presence of the catalyst, the ammonia (NH_3) and NO_x react to form nitrogen (N_2) and water vapor (H_2O) thereby reducing the NO_x emissions. Two 17,500-gallon aqueous ammonia aboveground storage tanks (each holding 14,875 gallons of aqueous ammonia) will be installed to provide a 12-day supply of aqueous ammonia. Each ammonia tank will be 22 feet long and 12 feet in diameter. Each tank will be surrounded by a 60-foot by 20-foot by 3.5-foot secondary containment structure capable of holding the full contents of the tank, plus rainwater.

Aqueous ammonia will be delivered to the plant by truck transport. The ammonia delivery truck unloading station will include a bermed and sloped pad surface. The bermed truck drainage pad will be 60 feet long by 16 feet wide by 1 foot deep, sloping from the north end to a collection trough on the south end that will drain into the basin underlying the ammonia tank. The ammonia storage tank will also drain into the 60-foot long by 20-foot wide by 3.5-foot deep basin.

The ammonia tank will be equipped with a pressure relief valve set at 50 pounds per square inch gage (psig), a vapor equalization system, and a vacuum breaker system. The storage tank will be maintained at ambient temperature and atmospheric pressure.

Pumps will be used to dispense ammonia solution to the emission control equipment at a normal flow rate of 264 pounds per hour (lb/hr). The use of aqueous ammonia will require the vaporization of the ammonia solution. Aqueous ammonia will be vaporized before injection of the ammonia into the flue gas system. Ammonia will be diluted with air and injected into the gas stream through ammonia injection grid that is tuned to disperse the ammonia across the flue in proportion to the exhaust flow.

The amount of ammonia introduced into the system will vary depending upon the NO_x reduction requirements, but will be approximately a 1:1 molar ratio of ammonia to NO_x. The expected maximum use of aqueous ammonia will be 264 lb/hr for each SCR system, for a total of 102.5 gal/hr. At the maximum annual operation of the CTGs for 8,760 hours, the maximum annual aqueous ammonia use will be approximately 900,000 gallons.

Analysis

A dispersion analysis of a tank failure and subsequent release of aqueous ammonia was prepared using a numerical model. The analysis assumed the complete failure of a single tank and the formation of an evaporating pool of aqueous ammonia within the secondary containment structure. Evaporative emissions of ammonia would be subsequently released into the atmosphere. Meteorological conditions at the time of the release would control the dispersion and transport of ammonia released to the atmosphere. 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 19 CCR 2750.2.

The maximum temperature recorded near the VPP in the past 3 years was 105°F or 313.7 Kelvin (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca5790). Maximum temperatures combined with low wind speeds and stable atmospheric conditions would be expected to result in the highest 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)	313.7 (105)

One modeling run was conducted based on an evaporating pool release caused by the complete failure of a single tank, using the meteorological data presented 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. These data were used in modeling run 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 one hour after the initial release. 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 release scenario, a release of the entire contents of the storage tank (14,875 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 gas would result from evaporation.

Although the edge of the tank containment area is raised above ground level, the release heights used in the model were set at 0 m above ground level (AGL) to maintain the conservative nature of the analysis. Downwind concentrations of ammonia were calculated at heights of 10, 5, and 1.6 meters above ground level and at 0 meters above ground level. Reported distances to specified toxic endpoints are the maximum distances for concentrations at 0, 1.6, 5, or 10 meters above ground level. 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, four offsite "bench mark" exposure levels were evaluated, as follows: (1) the lowest concentration posing a risk of lethality, 2,000 ppm; (2) the Occupational Safety and

Health Administration's (OSHA) Immediately Dangerous to Life and Health (IDLH) level of 300 ppm; (3) the Emergency Response Planning Guideline (ERPG) level of 150 ppm, which is the American Industrial Hygiene Association's (AIHA) updated ERPG-2 for ammonia; and (4) 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 ERPG-2 value is based on a one-hour exposure or averaging time; therefore, the modeled distance to ERPG-2 concentrations are presented in terms of one-hour (or 60-minute) averaging time. The ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action. OSHA's IDLH for ammonia is based on a 30-minute exposure or averaging time; therefore, the IDLH modeling concentrations at all offsite receptors will be given in terms of a 30-minute averaging time.

Modeling Results

Table 2 shows the distance to the four benchmark criteria modeled: lowest concentration posing a risk of lethality, (2,000 ppm), 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	Distance in Meters to 2,000 ppm	Distance in Meters to IDHL (300 ppm)	Distance in Meters to AIHA's ERPG-2 (150 ppm)	Distance in Meters to CEC Significance Value (75 ppm)
0 m AGL	13.56	14.68	14.86	15.51
1.6 m AGL	14.45	15.85	16.06	16.72
5 m AGL	18.54	20.46	20.90	21.12
10 m AGL	27.72	30.50	31.14	31.47

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

At this concentration, the distance to the CEC's significance value of 75 ppm does not extend off the project site (see Figure 1, at the back of this memo).

Assessment of the Methodology Used

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

- Modeling & Meteorology
  - Worst case of a constant mass flow, at the higest possible initial evaporation rate for the modeled wind speed and temperature was used, 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 105°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 (all forms) averages 0.017 accidental releases per process per year, and 0.018 accidental releases per million pounds stored per year. Data derived from *The Center for Chemical Process Safety, 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 the probability of occurrence, population densities near the project site, meteorological conditions, and the process design. 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, maximum potential air temperatures and F class atmospheric stability, the risk posed to the public from the storage of aqueous ammonia at the VPP 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 the VPP and the predicted distances do not extend off the project site and pose no threat to public receptors. Therefore, it is concluded that the risk from exposure to aqueous ammonia due to the VPP is less than significant.

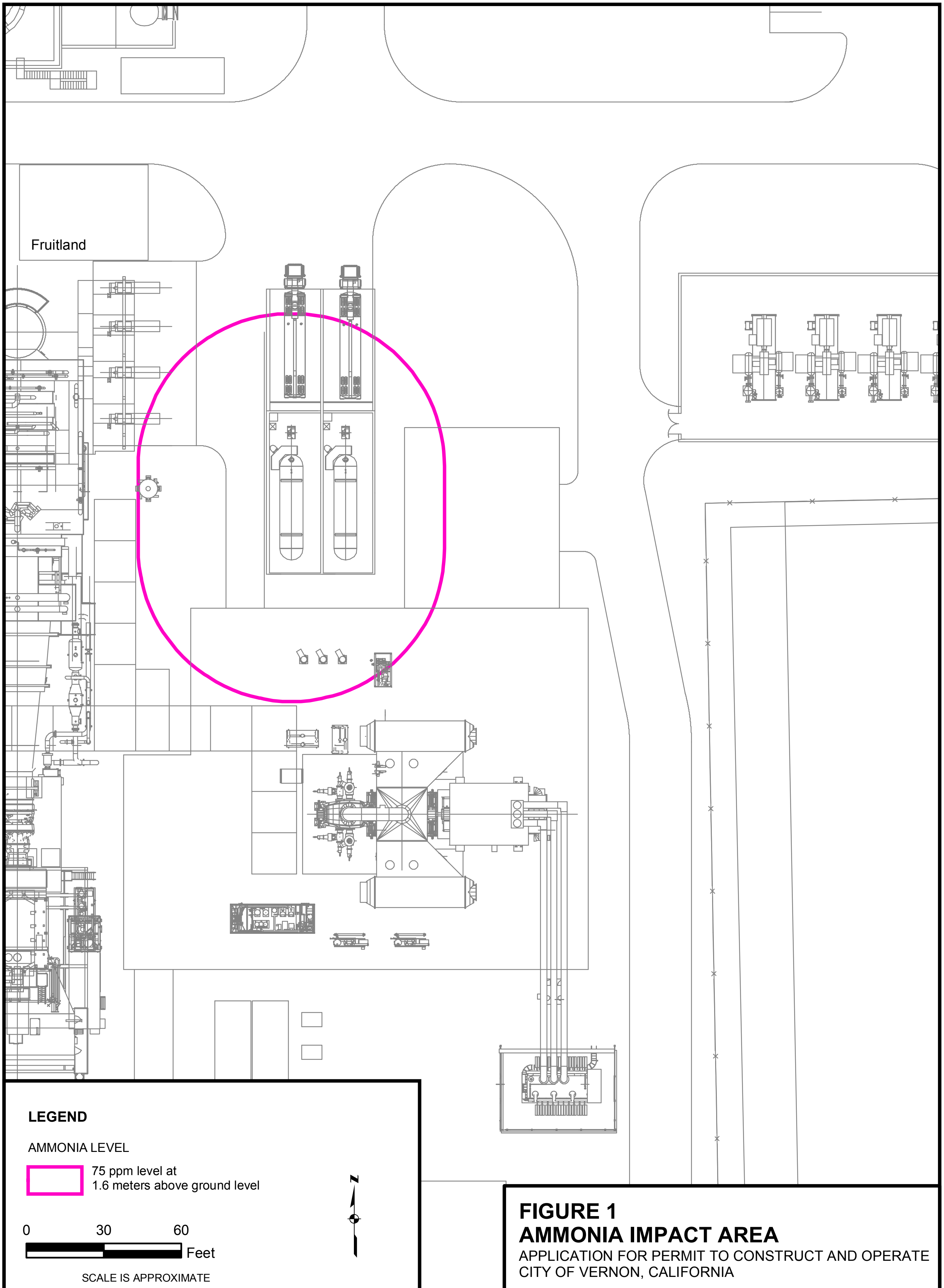

FIGURE 1
AMMONIA IMPACT AREA

APPLICATION FOR PERMIT TO CONSTRUCT AND OPERATE
CITY OF VERNON, CALIFORNIA

CH2MHILL

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