APPENDIX 8.12A

Offsite Consequence Analysis

Off-Site Consequence Analysis

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The San Francisco Public Utility Commission (SFPUC) is proposing to construct and operate a simple-cycle power plant, the San Francisco Electric Reliability Project (SFERP). The project site is located adjacent to the San Francisco Bay in the Potrero District of the City and County of San Francisco (CCSF) within the existing Potrero Power Plant (formerly owned by PG&E and now owned and operated by Mirant California). The SFERP will be located on a portion of the Unit 7 site.

The SFERP project will consist of a nominal 145-megawatt (MW) simple-cycle plant, using three natural gas-fired LM 6000 gas turbines and associated infrastructure. The project will include the construction of a new air insulated 115-kV switchyard on the west side of the site. A natural gas pipeline tie-in will be made to an existing PG&E-owned, natural gas, Gas Load Center, approximately 275 feet west of the project site. Water for the project would be delivered via a wastewater supply pipeline and treated on-site.

The SFPUC is required by both the Clean Air Act and the Bay Area Air Quality Management District (BAAQMD) 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. SFPUC is proposing to use the less toxic form, aqueous ammonia.

SFPUC will store a 29-percent aqueous ammonia solution in a single stationary storage tank. The capacity of the tank will be approximately 12,000 gallons. The tank will be surrounded by a secondary containment structure capable of holding the full contents of the tank, approximately 665 square feet (38 feet by 17.5 feet). On the floor of the detention basin, is a drain line (24-inch diameter) that leads to a spill vault (6 feet by 14 feet by 18 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 floor of the loading area will be sloped that will drain into the spill vault for the tank through a 4-inch drain line.

Additional Analysis

An additional 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 19 CCR 2750.2.

The SFERP will be located in the Potrero District, San Francisco, California. The maximum temperature recorded near the Potrero District (San Francisco International Airport) in the past 3 years was 97 °F or 309.26 Kelvin (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?casfoa+sfo). 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)	309.26 (97)

One modeling run was conducted, an evaporating pool release caused by a single tank failure, for the 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://response.restoration.noaa.gov/cameo/evapcalc/evap.html#). Release rates for ammonia vapor from an evaporating 29-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 scenario, the complete release of the storage tank contents (10,000 gallons of 29-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 will 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 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. Reported distances to specified toxic endpoints are the maximum distances for concentrations at 0, 1.6, 5 or 10 meters above ground. The California Office of Environmental Health Hazard Assessment (OEHHA) has designated 1.6 meters as the breathing zone height for individuals. 5 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 are typically 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 200 ppm, which is also the RMP level 1 criterion used by the USEPA and California [Note: in the year 2000 the American Industrial Hygiene Association (AIHA) updated the ERPG-2 for ammonia to 150 ppm]; 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 specified toxic endpoint (TE) value for ammonia is 0.14 mg/l, which is approximately equal to 200 ppm (*RMP Offsite Consequence Analysis Guidance, EPA, April 1999*). 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 lowest concentration posing a risk of lethality, (2,000 ppm), OSHA's IDLH (300 ppm), the EPA/CalARP toxic endpoint (200 ppm) and the CEC significance value (75 ppm) for the modeled release scenario. Figure 1 shows the facility and the distance to the 75 ppm, 200 ppm, 300 ppm, and 2,000 ppm modeled concentrations.

TABLE 2
Distance to EPA/CalARP and CEC Toxic Endpoints

Scenario	Distance in Meters to 2,000 ppm	Distance in Meters to IDHL of 300 ppm	Distance in Meters to EPA/CalARP TE of 200 ppm	Distance in Meters to CEC Significance Value, 75 ppm
0 m AGL	22.18	25.75	26.19	27.22
1.6 m AGL	25.79	29.72	30.13	31.13
5 m AGL	35.54	40.02	40.29	41.07
10 m AGL	51.72	54.01	54.15	58.77

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

As shown by Figure 1, the distance to the CEC's extremely protective 75 ppm ammonia concentration extends just off the project site's eastern boundary, which is on the Mirant Potrero Power Plant site. Additionally, ammonia concentrations expected to occur to the north, south, and west boundaries would be significantly lower than 75 ppm due to the ammonia storage tanks location at the eastern side of the project site (further away from public and residential receptors) and the SFPUC's selection of the safer form of ammonia.

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 97°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 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 and F class atmospheric stability, the risk posed to the local community from the storage of aqueous ammonia at the SFPUC 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 SFERP and 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 SFERP is less than significant.

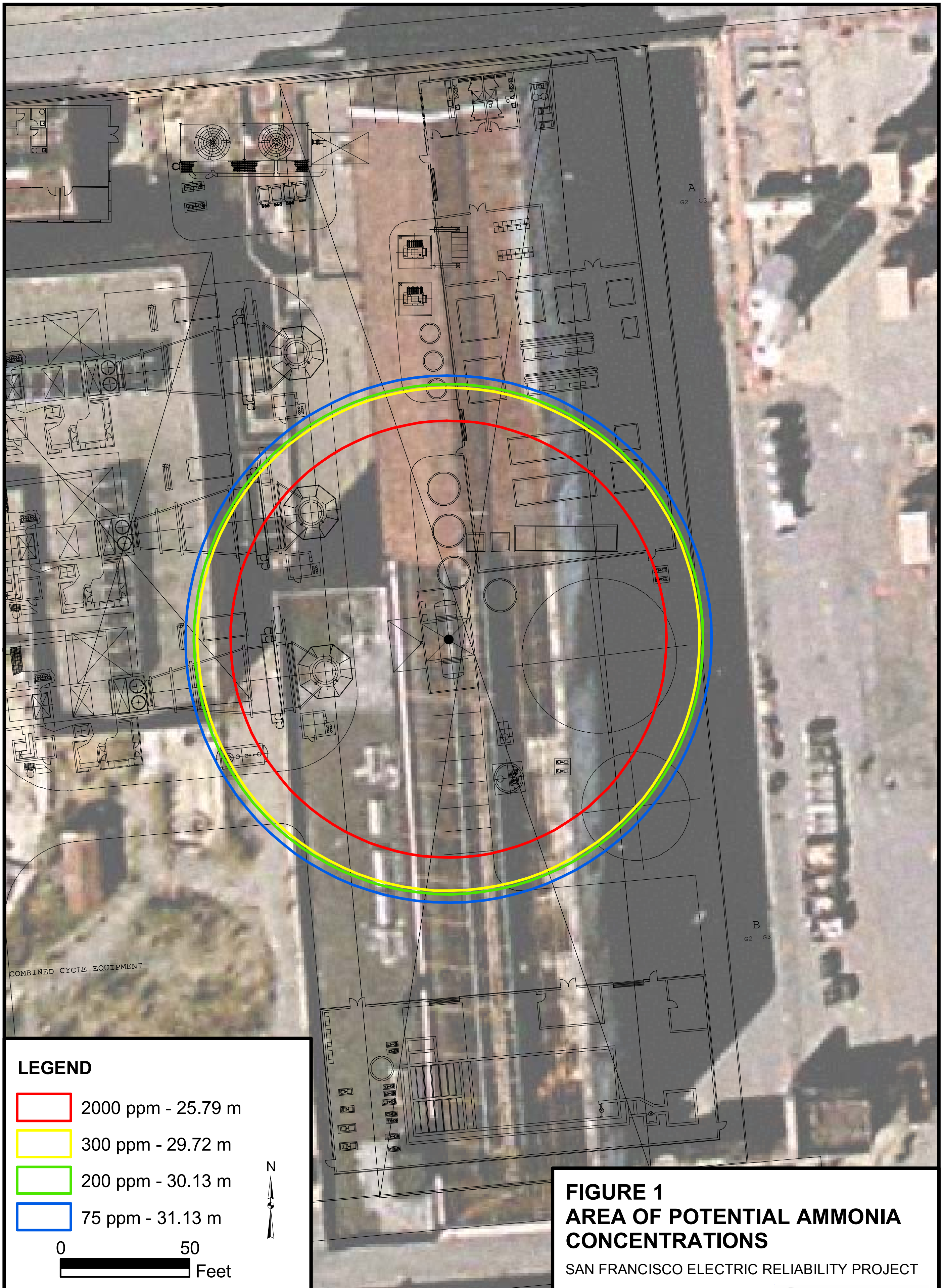

FIGURE 1
AREA OF POTENTIAL AMMONIA CONCENTRATIONS

SAN FRANCISCO ELECTRIC RELIABILITY PROJECT