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January 9, 2017

Mike Monasmith, Project Manager
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Subject: Mission Rock Energy Center (15-AFC-02) Offsite Consequences Analysis in Response to CEC Staff Data Request No. 109

Dear Mike:

Per direction from CEC Staff, Mission Rock Energy Center, LLC is docketing the attached Offsite Consequence Analysis (OCA) for the Mission Rock Energy (15-AFC-02) as Attachment DR109-1 to Data Request Response Set 1. A courtesy copy of the OCA was previously provided to CEC Staff on November 11, 2016.

Sincerely,

Douglas M. Davy, Ph.D.
Project Manager

Attachment

ATTACHMENT DR 109-1

Offsite Consequence Analysis for Ammonia

An offsite consequence analysis (OCA) for ammonia was conducted for the proposed Mission Rock Energy Center (MREC). The MREC selective catalytic reduction (SCR) control system utilizes aqueous ammonia as the reduction reagent in the presence of a catalyst. MREC will use a 19.5-percent aqueous ammonia solution, stored in an aboveground storage tank located near the power block with a capacity of 10,200 gallons (12,000 gallon tank filled to 85% of capacity).

The storage area for the ammonia storage tank will be carefully designed to minimize the potential impact of an accidental release of ammonia. The storage area will include a secondary containment basin, measuring 40 feet by 20 feet, and fitted with an underground vault capable of holding 150 percent of the tank contents. The secondary containment area will drain to the vault via a 2-foot diameter piping. The ammonia storage tank will be equipped with a pressure relief valve, a vapor equalization system, and a vacuum breaker system. The ammonia storage tank will be constructed to meet the safety standards of the most current building and fire codes and will be maintained at ambient temperature and atmospheric pressure.

Aqueous ammonia will be delivered to the plant by truck transport. The ammonia delivery truck unloading area will include a bermed and sloped pad surface. The bermed truck drainage pad will slope to a collection trough that will drain into the same secondary containment basin used for the ammonia storage tank.

Analysis

This assessment of worst-case and alternative scenarios of an accidental ammonia release is considered pursuant to the guidance given in *RMP Offsite Consequence Analysis Guidance, USEPA, April 1999*. The purpose of this analysis is to assist emergency planners by providing a maximum possible distance downwind for specified concentrations of ammonia. An alternative scenario is included because of the low probability of the worst-case scenario. The alternative scenario is also unlikely to occur, but has a slightly higher probability of occurrence than the worst case scenario.

The worst-case analysis is the hypothetical instantaneous release of a full storage tank induced by some improbable catastrophic event. The storage tank is assumed to instantaneously release its full contents of aqueous ammonia into the tank's secondary containment area. The worst case analysis uses a number of conservative assumptions including the following:

- Worst-case of a constant mass flow, at the highest possible initial evaporation rate for the modeled wind speed and temperature is used, whereas in reality the evaporation rate would decrease with time as the concentration in the solution decreases.
- Worst-case stability class is used with the maximum ambient temperature of 99.0 degrees Fahrenheit (°F).

The worst-case meteorology stability class corresponds to nighttime hours, whereas the maximum ambient temperature most likely occur during daytime hours.

Additionally, the worst-case modeling does not take into account the low risk probability associated with such a catastrophic release, which is discussed separately.

The purpose of an alternative release scenario is to assess the risk associated with a more probable, non-catastrophic scenario. The MREC alternative scenario assumed an uncoupling of the ammonia transfer hose during tank filling. The hose is assumed to have an inside diameter of 4 inches, and a length of 20 feet, resulting in a release of 13.1 gallons of aqueous ammonia into the secondary containment area.

The assessment of the worst-case and alternative release scenarios were prepared using the USEPA's Area Locations of Hazardous Atmospheres (ALOHA) model[1], and assuming a dense gas release. Each analysis assumed the immediate release of ammonia, and the formation of an evaporating pool of aqueous ammonia within the underground vault. Evaporative emissions of ammonia would be subsequently released into the atmosphere. Meteorological conditions at the time of the release would control the evaporation rate, dispersion, and transport of ammonia released to the atmosphere. Meteorological data for the worst-case and alternative scenarios were pursuant to USEPA guidance and supplemented by the requirements of 19 California Code of Regulations (CCR) 2750.2.

Worst-Case Release Scenario

For purposes of worst-case release scenario, the maximum temperature recorded at the Oxnard station, which is near the MREC, in the past three years was 99.0 °F or 310 Kelvin[2]. Maximum temperatures combined with worst-case meteorological conditions result in the highest ammonia concentrations at the farthest distance downwind of the release site. Table 1 displays the meteorological data values used in the worst-case modeling analysis.

TABLE 1
Worst-Case Release Scenario 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)	310 (99.0)
Surface Roughness Length, meters (based on open country land cover)	0.03

Release rates for ammonia vapor from an evaporating 19.5-percent aqueous ammonia solution were calculated assuming mass transfer of ammonia across the liquid surface occurs according to principles of heat transfer by natural convection. The ammonia release rates for the worst-case scenario were calculated using ALOHA, meteorological data displayed in Table 1, and the dimensions of vault opening (based on the cross section of the 2-foot diameter conveyance pipe) assuming that the maximum contents of the storage tank (10,200 gallons) would be released instantaneously into the underground vault. No other passive controls were assumed for the worst-case scenario.

An initial ammonia evaporation rate was calculated and conservatively assumed to occur for 1 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.

Alternative Release Scenario

For purposes of the alternative release scenario, average daily high temperature at the Oxnard station, which is near the MREC, is 71.0 °F or 295 Kelvin. An average wind speed of 3.2 meters per second and was assumed based on meteorological data collected at Oxnard Airport station[3]. Atmospheric stability class C

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[1] http://www2.epa.gov/cameo/aloha-software.

[2] Accessible at http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca6572

[3] Accessible at http://www.wrcc.dri.edu/climatedata/climtables/westwind/#CALIFORNIA

was based on ALOHA default. Table 2 displays the meteorological data values used in the alternative modeling analysis.

TABLE 2
Alternative Release Scenario Meteorological Input Parameters

Parameter	Alternative-Case Meteorological Data
Wind Speed, meters/second	3.2
Stability Class	C
Relative Humidity, Percent	50
Ambient Temperature, Kelvin (°F)	295 (71.0)
Surface Roughness Length, meters (based on open country land cover)	0.03

Release rates for ammonia vapor from an evaporating 19.5-percent aqueous ammonia solution were calculated assuming mass transfer of ammonia across the liquid surface occurs according to principles of heat transfer by natural convection. The ammonia release rates for the alternative-case scenario were calculated using ALOHA and meteorological data displayed in Table 2. For the alternative release scenario, it is assumed that 13.1 gallons of ammonia escapes from the transfer hose and drains into the underground vault.

An initial ammonia evaporation rate was calculated and assumed to occur for a maximum of 10 minutes after the initial release as the any remaining ammonia in the solution after that time would be more dilute than it was initially and will evaporate much less rapidly.

The release height used in the modeling was set at 0 meters above ground level (AGL) to maintain the conservative nature of the analysis.

Exposure Levels

For the purpose of this assessment, the maximum release distances were estimated for four exposure levels: (1) 75 parts per million (ppm), the level presumed by the California Energy Commission (CEC) staff to be without serious adverse effects on the public for a one-time exposure of (*Preliminary Staff Assessment-Otay Mesa Generating Project, 99-AFC-5, May 2000)*[4], (2) 150 ppm, the American Industrial Hygiene Association's (AIHA) updated Emergency Response Planning Guideline (ERPG)-2 for ammonia, (3) 300 ppm, the Occupational Safety and Health Administration's (OSHA) Immediately Dangerous to Life and Health (IDLH) level, and (4) 2,000 ppm, the lowest concentration posing a risk of lethality.

The ERPG-2 value of 150 ppm is based on a 1-hour exposure or 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.

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,

[4] As the Staff explained in the Otay Mesa PSA, "If the exposure associated with a potential release would exceed 75 ppm at any public receptor, Staff will presume that the potential release poses a risk of significant impact." But this is only a presumption, and may be rebutted based upon "the probability of occurrence of the release and/or the nature of the potentially exposed population. Staff may, based on such analysis, determine that the likelihood and extent of potential exposure are not sufficient to support a finding of potentially significant impact."

September 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, as 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

As shown in Table 3, the probability of a catastrophic failure of the ammonia storage tank is very remote. Given the consequences of a release due to the catastrophic failure of the ammonia storage tank, it should be evaluated to determine if a significant public health impact could occur.

Modeling Results

Table 4 shows the modeled distance for the worst-case and alternative release scenarios to the four benchmark criteria concentrations: 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). Please note that the distances shown represent the distance to the instantaneous downwind concentration from the edge of the ammonia tank secondary containment basin, and do not take into account the exposure or averaging time associated with the exposure criteria.

TABLE 4
Downwind Distance to USEPA and CEC Exposure Levels (Ammonia) for the Worst-Case and Alternative Release Scenarios

Scenario	Distance to 2,000 ppm	Distance to IDLH (300 ppm)	Distance to AIHA's ERPG-2 (150 ppm)	Distance to CEC Significance Value (75 ppm)
Worst-Case Release	75 feet	198 feet	279 feet	396 feet
Alternative Release	< 33 feet	< 33 feet	42 feet	60 feet

Note:

The model input and output files are available upon request.

The closest point on the MREC boundary to the ammonia tank secondary containment basin extends approximately 120 feet to the southeast. The distance to the closest residence is approximately 1,160 feet to the northeast, as measured from the secondary containment area.

The results for the alternative release scenario show that all benchmark exposure levels would remain within the project boundary and not extend offsite.

The results of the offsite consequence analysis for the worst-case release scenario of ammonia indicate that the 2,000 ppm benchmark would not extend beyond the project boundary and the distances to the other three exposure benchmarks above would extend beyond the project boundary, but would not extend as far as the nearest residence:

- Concentrations exceeding 300 ppm could extend up to approximately 80 feet beyond the nearest fenceline, but no sensitive receptors, residences, or emergency response facilities are located within the area potentially affected by a worst case release.
- Concentrations exceeding 150 ppm could extend up to approximately 200 feet beyond the nearest fenceline, but no sensitive receptors, residences, or emergency response facilities are located within the area potentially affected by a worst case release.
- Concentrations exceeding 75 ppm (the CEC value) could extend up to approximately 280 feet beyond the nearest fenceline, but no sensitive receptors, residences, or emergency response facilities are located within the area affected by a worst case release.
- Assuming the worst-case scenario modeling assumptions and also a specific wind direction (NE), the modeled ammonia concentration at the nearest residence (approximately 1,160 feet NE from the secondary containment basin) is approximately 10 ppm. The odor threshold of ammonia is approximately 5 ppm, and minor irritation of the nose and throat will occur at 30 to 50 ppm.

Although the catastrophic tank failure would result in offsite ammonia concentrations exceeding some of the benchmark exposure levels, the area affected by a MREC catastrophic ammonia storage tank failure is sparsely populated with no residences directly impacted by the potential release. Furthermore, the probability of a catastrophic ammonia tank failure is further mitigated by the fact that MREC is required to comply with the state and federal Risk Management Programs (RMP). These programs require MREC to prepare and submit Risk Management Plans, including measures/procedures to prevent accidental releases and to conduct periodic inspections of covered components. Compliance with RMP, coupled with the low probability of the MREC ammonia tank catastrophic failure further reduces the potential impact of an accidental ammonia release.

The alternative release scenario shows that all benchmark exposure levels would remain within the project boundary. As noted above, compliance with the RMP will require the preparation of measures to reduce the potential for accidental ammonia releases. These measure will include procedures for unloading ammonia to ensure that releases associated with the alternative scenario are minimized.

Conclusions

Considering the results of the above analysis, in the very unlikely event of either an accidental or catastrophic release of ammonia at the MREC site, the release would not pose a significant risk to any sensitive receptor, residence, or emergency response facility.

The results of the alternative release analysis show that none of the benchmark exposure levels would extend beyond the project boundary.

The results of the worst-case analysis, indicate that even the very low probability of a complete storage tank failure in combination with the conservatively modeled worst-case meteorological conditions, no sensitive receptor, residence, or emergency response facility would be significantly impacted by such a release. The conservative modeling analysis shows that ammonia concentrations at the nearest residence would be well below the most stringent exposure threshold considered by CEC Staff, and would not result in effects beyond a potential odor.

As described above, numerous conservative assumptions have been made at each step in this analysis. The conservative nature of these assumptions has resulted in a significant overestimation of the impacts of an ammonia release at the MREC site, and the predicted distances to the benchmark exposure levels do not pose a threat to the public. Therefore, the risk from exposure to aqueous ammonia due to the MREC is not significant.

Attachment 1
ALOHA Model Output

```
SITE DATA:
  Location: SANTA PAULA, CALIFORNIA
  Building Air Exchanges Per Hour: 0.46 (unsheltered single storied)
  Time: July 1, 2016  1200 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AQUEOUS AMMONIA
  Solution Strength: 19.5% (by weight)
  Ambient Boiling Point: 118.9° F
  Partial Pressure at Ambient Temperature: 0.59 atm
  Ambient Saturation Concentration: 600,653 ppm or 60.1%
  Hazardous Component: AMMONIA          Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 1.5 meters/second from W at 10 meters
  Ground Roughness: 3.0 centimeters      Cloud Cover: 5 tenths
  Air Temperature: 99.0° F
  Stability Class: F (user override)
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Evaporating Puddle (Note: chemical is flammable)
  Puddle Diameter: 2 feet                Puddle Volume: 10200 gallons
  Ground Type: Concrete                  Ground Temperature: 99.0° F
  Initial Puddle Temperature: Ground temperature
  Release Duration: ALOHA limited the duration to 1 hour
  Max Average Sustained Release Rate: 0.174 pounds/min
     (averaged over a minute or more)
  Total Amount Hazardous Component Released: 10.4 pounds

THREAT ZONE:
  Model Run: Gaussian
  Red   : 25 yards --- (2000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
  Orange: 66 yards --- (300 ppm = IDLH)
  Yellow: 93 yards --- (150 ppm = ERPG-2)
```

```
SITE DATA:
  Location: SANTA PAULA, CALIFORNIA
  Building Air Exchanges Per Hour: 0.46 (unsheltered single storied)
  Time: July 1, 2016  1200 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AQUEOUS AMMONIA
  Solution Strength: 19.5% (by weight)
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  Hazardous Component: AMMONIA           Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 1.5 meters/second from W at 10 meters
  Ground Roughness: 3.0 centimeters      Cloud Cover: 5 tenths
  Air Temperature: 99.0° F
  Stability Class: F (user override)
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Evaporating Puddle (Note: chemical is flammable)
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  Initial Puddle Temperature: Ground temperature
  Release Duration: ALOHA limited the duration to 1 hour
  Max Average Sustained Release Rate: 0.174 pounds/min
     (averaged over a minute or more)
  Total Amount Hazardous Component Released: 10.4 pounds

THREAT ZONE:
  Model Run: Gaussian
  Red   : 66 yards --- (300 ppm = IDLH)
  Orange: 93 yards --- (150 ppm = ERPG-2)
  Yellow: 132 yards --- (75 ppm)
```

```
SITE DATA:
  Location: SANTA PAULA, CALIFORNIA
  Building Air Exchanges Per Hour: 0.57 (unsheltered single storied)
  Time: July 1, 2016  1200 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AQUEOUS AMMONIA
  Solution Strength: 19.5% (by weight)
  Ambient Boiling Point: 118.9° F
  Partial Pressure at Ambient Temperature: 0.31 atm
  Ambient Saturation Concentration: 313,654 ppm or 31.4%
  Hazardous Component: AMMONIA          Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3.2 meters/second from W at 10 meters
  Ground Roughness: 3.0 centimeters      Cloud Cover: 5 tenths
  Air Temperature: 71.0° F               Stability Class: C
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Evaporating Puddle (Note: chemical is flammable)
  Puddle Diameter: 2 feet                Puddle Volume: 10200 gallons
  Ground Type: Concrete                  Ground Temperature: 71.0° F
  Initial Puddle Temperature: Ground temperature
  Release Duration: ALOHA limited the duration to 1 hour
  Max Average Sustained Release Rate: 0.167 pounds/min
     (averaged over a minute or more)
  Total Amount Hazardous Component Released: 10.0 pounds

THREAT ZONE:
  Model Run: Gaussian
  Red   : less than 10 meters(10.9 yards) --- (2000 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
  Orange: less than 10 meters(10.9 yards) --- (300 ppm = IDLH)
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
  Yellow: 14 yards --- (150 ppm = ERPG-2)
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
```

```
SITE DATA:
  Location: SANTA PAULA, CALIFORNIA
  Building Air Exchanges Per Hour: 0.57 (unsheltered single storied)
  Time: July 1, 2016  1200 hours PDT (user specified)

CHEMICAL DATA:
  Chemical Name: AQUEOUS AMMONIA
  Solution Strength: 19.5% (by weight)
  Ambient Boiling Point: 118.9° F
  Partial Pressure at Ambient Temperature: 0.31 atm
  Ambient Saturation Concentration: 313,654 ppm or 31.4%
  Hazardous Component: AMMONIA           Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3.2 meters/second from W at 10 meters
  Ground Roughness: 3.0 centimeters      Cloud Cover: 5 tenths
  Air Temperature: 71.0° F               Stability Class: C
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Evaporating Puddle (Note: chemical is flammable)
  Puddle Diameter: 2 feet                Puddle Volume: 10200 gallons
  Ground Type: Concrete                  Ground Temperature: 71.0° F
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  Release Duration: ALOHA limited the duration to 1 hour
  Max Average Sustained Release Rate: 0.167 pounds/min
     (averaged over a minute or more)
  Total Amount Hazardous Component Released: 10.0 pounds

THREAT ZONE:
  Model Run: Gaussian
  Red   : less than 10 meters(10.9 yards) --- (300 ppm = IDLH)
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
  Orange: 14 yards --- (150 ppm = ERPG-2)
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
  Yellow: 20 yards --- (75 ppm)
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
```