

**Appendix L**  
**Hazardous Materials Technical Analysis**



**APPENDIX L**  
**HAZARDOUS MATERIALS TECHNICAL ANALYSIS**  
**TABLE OF CONTENTS**

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1.0	Introduction.....	1
2.0	Applicable Regulatory Requirements.....	1
3.0	Off-site Consequence Analysis.....	3
3.1	Modeling Parameters .....	5
3.2	Results of Modeling.....	13
3.3	Modeling Outputs .....	18

# **APPENDIX L**

## **HAZARDOUS MATERIALS TECHNICAL ANALYSIS**

### **TABLE OF CONTENTS**

---

#### **Tables**

Table L-1 Regulatory Program Applicability

Table L-2 Hydrogen Modeling Input Parameters

#### **Figures**

Figure L-1 Aqueous Ammonia Area of Potential Impact From a Worst Case Scenario

# APPENDIX L

## HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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### 1.0 INTRODUCTION

Hazardous materials are often a necessary part of industrial operations. Hazardous materials present potential risks based upon their specific chemical properties and characteristics. A hazard risk analysis evaluates a system or unit using hazardous chemicals by examining the process, hazardous properties of substances involved with the process, potential deviations that may affect the process, the potential consequences of a worst-case release scenario, and the appropriate controls and mitigations. Accordingly, this analysis was performed for the Project to address such potential risks.

Various hazardous materials will be used in connection with operation of the Project. See Table 5.12-3, Ammonia Dispersion Model Parameters, and Table 5.12-4, Ammonia Dispersion Model Results, of Section 5.12, Hazardous Materials Handling, of this document. This Appendix addresses aqueous ammonia, hydrogen, acid gas (hydrogen sulfide), methanol, and syngas (carbon monoxide), for the reasons discussed below.

### 2.0 APPLICABLE REGULATORY REQUIREMENTS

The Project will comply with applicable laws, ordinances, regulations, and standards (LORS) pertaining to the storage and use of hazardous materials. The hazardous materials evaluated in this Appendix (aqueous ammonia, hydrogen, syngas, and acid gas) are regulated hazardous materials under the California Accidental Release Prevention (CalARP) program and the federal Clean Air Act (CAA) Risk Management Program (RMP). Although methanol is not regulated under CalARP and RMP, it is regulated as a hazardous material under various federal and state regulations.

The CalARP and RMP programs set regulatory thresholds for the aforementioned hazardous materials, with the exception of methanol. The use or storage of any of these substances in excess of their specific regulatory thresholds triggers specific CalARP and RMP program requirements. The specific threshold requirements and regulatory program applicability for the hazardous materials analyzed are provided in Table L-1, Regulatory Program Applicability.

**Table L-1  
Regulatory Program Applicability**

Hazardous Chemical	Federal RMP Threshold (lbs)	State CalARP Threshold (lbs)	Regulatory Program Applicability
Aqueous Ammonia	20,000 <sup>(1)</sup>	500	Project will store 20,000-gallons (approximately 28,348 lbs) of 19% aqueous ammonia for turbine emissions control (Selective Catalytic Reduction). The aqueous ammonia will be subject to state CalARP program requirements, but will not be subject to federal RMP program requirements based on the concentration of the aqueous ammonia solution ( <i>see Note <sup>(1)</sup></i> ).

# APPENDIX L

## HAZARDOUS MATERIALS TECHNICAL ANALYSIS

**Table L-1**  
**Regulatory Program Applicability**

Hazardous Chemical	Federal RMP Threshold (lbs)	State CalARP Threshold (lbs)	Regulatory Program Applicability
Hydrogen	10,000	10,000	The Project will store 29,000-scf (approximately 150.8 lbs) of hydrogen for electrical generator cooling. The hydrogen will not be subject to either state CalARP or federal RMP program enforcement.
Syngas (Hydrogen, Carbon Monoxide, Hydrogen sulfide, Methane)	Hydrogen: 10,000 Hydrogen Sulfide: 10,000 Methane 10,000	Hydrogen: 10,000 Hydrogen Sulfide: 500 Methane 10,000	The Project will generate syngas in the gasification block of the facility. The syngas will not be subject to either state CalARP or federal RMP program enforcement ( <i>see Note<sup>(2)</sup></i> ).
Acid Gas (Hydrogen Sulfide)	10,000	500	The Project will generate acid gas from the Acid Gas Removal unit of the facility. The quantities of acid gas (hydrogen sulfide) do not trigger regulatory requirements under the state CalARP or federal RMP program enforcement ( <i>see Note<sup>(3)</sup></i> ).
Methanol	N/A	N/A	The Project will store 600,000 gallons methanol for use in the Acid Gas Removal unit. The methanol is not regulated under the state CalARP or federal RMP program enforcement. The methanol is regulated under 29 CFR § 1910, 40 CFR §§ 116, 117, 355, 372, 302.

Notes:

- (1) Federal RMP requirements apply only to aqueous ammonia solutions that are of a concentration of 20% or greater by weight.
- (2) Only hydrogen, hydrogen sulfide, and methane in the syngas mixture are regulated chemicals. Carbon monoxide is a hazardous substance, but is not regulated by either the Federal RMP or State CalARP regulations. The quantities of regulated substances in syngas do not trigger regulatory requirements for the following two reasons: a) syngas is not stored on site but consumed within the operation as it is produced and, therefore, is not a stationary source, and b) quantities are below regulatory thresholds.
- (3) Acid gas is primarily composed of hydrogen sulfide which is a regulated substance. However, the Project will not be subject to these regulations for the two following reasons: a) hydrogen sulfide is not stored on site but converted to elemental sulfur within the operation as it is produced and, therefore, is not a stationary source, and b) quantities are below regulatory thresholds.

% = percent  
 CalARP = California Accidental Release Prevention  
 CFR = Code of Federal Regulations  
 lbs = pounds  
 N/A = not applicable  
 RMP = Risk Management Plan  
 scf = standard cubic foot

## APPENDIX L

# HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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The following sections provide the analysis that was performed for each of these five hazardous materials.

### 3.0 OFF-SITE CONSEQUENCE ANALYSIS

Off-site consequence analysis (OCA) modeling was performed to address the potential off-site impacts from a worst-case release scenario for each substance. The models provide an examination of separate hazards: (1) the dispersion of the substances in the form of a vapor cloud, (2) the ignition of the released substance, and/or (3) pool fire. The modeling assumptions for a worst-case release scenario are that the total contents from the largest inventory (e.g., tank or pipe) are accidentally released into the atmosphere.

For dispersion modeling, the calculations also assumed the worst-case atmospheric conditions during such a release, when applicable. These conditions provide conservative results, because these extreme and unlikely climatic conditions maximize the vaporization to create the vapor cloud and minimize its dispersion. The specific atmospheric parameters under which a worst-case release scenario is examined are provided by the California Code of Regulations (CCR) Title 19 § 2750.2 and consist of the following:

- Temperature – The highest temperature recorded for the area in the past 3 years. An increased temperature accelerates the vaporization rate of ammonia from an accumulated pool, thereby providing worst-case conditions.
- Average Humidity – A 50 percent atmospheric humidity is used when performing the worst-case scenario evaluation.
- Wind Speed – A 1.5 meter per second (m/s) wind speed is used when performing the worst-case scenario evaluation. A low-wind speed prevents the quick dispersion of vapor clouds.
- Atmospheric Stability – An atmospheric stability level of F is applied for the worst-case scenario OCA. The F atmospheric stability provides the most stable atmospheric environment where the tendency of the atmosphere is to resist or enhance vertical motion and/or turbulence – this also contributes to minimum dissipation of the vapor cloud.

The U.S. Environmental Agency (USEPA) approved ALOHA<sup>®</sup> software version 5.4.1 to be used to examine the impacts from the hypothetical accidental spill. ALOHA is a Gaussian plume model that incorporates continuous source and meteorological parameters

For vapor cloud explosion calculations, USEPA's RMP OCA guidance was used. The endpoint selected by the USEPA as a significance criterion is an overpressure of 1.0 pound per square inch (psi) for vapor cloud explosion. An overpressure of 1.0 psi may cause partial demolition of houses, which can result in serious injuries to people and shattering of glass windows, which may cause skin laceration from flying glass. Blast impacts are also of concern wherever flammable materials and ignition sources are present, or where processes operate under high temperatures and pressures.

The potential impact distance from a worst-case release scenario for a vapor cloud explosion was determined through the following equation:

## APPENDIX L

### HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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$$X = 0.0081 \left( 0.1 W_f \frac{H_{Cf}}{H_{CTNT}} \right)^{\frac{1}{3}} \quad (\text{L-1})$$

where:

- X = distance to overpressure of 1 psi (miles)
- $W_f$  = weight of flammable substance (pounds [lbs])
- $H_{Cf}$  = heat of combustion of flammable substance (kilojoules/kilogram [kg])
- $H_{CTNT}$  = heat of combustion of trinitrotoluene (4,680 kilojoule/kg)

In some cases (e.g., hydrogen), the RMP Comp software developed by USEPA and the National Oceanic and Atmospheric Administration (NOAA) was used as an additional tool to determine the 1 psi overpressure impact distance.

For pool fire scenarios, the analysis was conducted in accordance with the appropriate regulatory guidance as follows. The modeling basis for a pool fire estimates the distance from the center of a pool fire to the heat radiation endpoint as 5 kilowatts per square meter ( $\text{kW}/\text{m}^2$ ). The worst-case release that is assumed for the model is as follows: the entire contents of the vessel are released forming a pool of fire of approximately 1 inch in liquid thickness.

The following equation was used to estimate the possible impact distance from the pool fire:

$$X = H_c \sqrt{\frac{0.0001 A}{5000 \pi (H_v + C_p (T_B - T_A))}} \quad (\text{L-2})$$

where:

- X = distance to the 5 kilowatt per square meter endpoint (meters)
- $H_c$  = heat of combustion of the flammable liquid (joules/kg)
- $H_v$  = heat of vaporization of the flammable liquid (joules/kg)
- A = pool area (meters squared [ $\text{m}^2$ ])
- $C_p$  = liquid heat capacity (joules/kg  $^\circ\text{Kelvin}$  [K])
- $T_B$  = boiling temperature of the liquid ( $^\circ\text{K}$ )
- $T_A$  = ambient temperature ( $^\circ\text{K}$ )

Models considering the ignition of a material (such as hydrogen, syngas, methanol, and acid gas) do not take into consideration climate conditions. These models examine the impact from a vapor cloud explosion of the flammable material or the heat or radiation derived from the ignition of the material. As stated above, the OCA for these scenarios use the maximum quantity of the materials and the specific combustion characteristics of the material to conservatively assess the potential impact distance from either an explosion or a pool of fire.

The following sections provide the specific modeling criteria, programs, and procedures applied for each of the materials.

### 3.1 Modeling Parameters

#### **Aqueous Ammonia (19%)**

The Project will store approximately 20,000 gallons (28,348 lbs) of aqueous ammonia (19% concentration by weight) in a pressurized horizontal aboveground storage tank (AST) with secondary containment. Aqueous ammonia is a reducing agent used for control of nitrogen oxide (NO<sub>x</sub>) emissions from the combustion turbine generators (CTGs). Aqueous ammonia is a colorless liquid with strong pungent odor. Ammonia, in particular, is a potentially toxic chemical that will vaporize upon release into a vapor cloud.

Due to its hazardous characteristics, ammonia is regulated by state and federal regulations. As presented in Section 5.12, Hazardous Materials Handling, of this Application for Certification (AFC), the use and/or storage of ammonia is regulated by the federal CAA RMP and the CalARP program. The regulations are found in the Code of Federal Regulations (CFR) Title 40 Part 68, California Health and Safety Code §§ 25531 to 25543.3, and CCR Title 19, §§ 2735.1 to 2785.1. These regulations governing the use and storage of ammonia require facilities utilizing the substance in quantities exceeding the imposed threshold to develop and implement an RMP. As indicated in Section 5.12 of the AFC, a CalARP RMP is required and will be submitted to the Kern County Environmental Health and Safety Department.

A component of the RMP involves the evaluation of potential off-site consequences derived from the accidental worst-case release of ammonia. Following the regulatory guidance for OCAs, an OCA was conducted for a worst-case accidental release under worst-case atmospheric conditions for the Project Site. The worst-case release scenario evaluated consisted of a release scenario in which the entire contents from the aqueous ammonia tank is released instantaneously. Under the scenario, all 20,000 gallons of aqueous ammonia are assumed to flow instantaneously into the secondary containment. In addition, the secondary containment surface area is assumed to be covered with floating balls, which reduces the available surface area for vaporization. The exposed ammonia is then vaporized over a 10-minute period, as per regulatory guidelines. The model examines the results of the subsequent dispersion over a 1-hour period. It should be noted that based upon the physical properties of aqueous ammonia, this scenario is very unlikely to occur.

The analysis also assumes the worst-case climate conditions consisting of an ambient temperature of 115 degrees Fahrenheit (°F) (the highest average temperature within the Project area), a 50 percent average humidity, a 1.5-meters per second wind speed, and a level F atmospheric stability.

During the hypothetical worst-case spill scenario, the aqueous ammonia spill is assumed to evaporate in the form of gas via laminar mass transfer. The ALOHA model examined the effects of the designated wind speed and atmospheric turbulence force that move the molecules released as gas through the air. The examination of the affecting atmospheric parameters allow for an evaluation of the total area impacted.

Three levels of concern were used to evaluate the potential impacts associated with the hypothetical worst-case aqueous ammonia release:

## APPENDIX L

### HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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- Lethal – The lethal concentration of ammonia is 2,000 parts per million volume (ppmv) averaged over 30 minutes.
- Immediately Dangerous to Life and Health (IDLH) – The IDLH concentration from ammonia is 300 ppmv, average over 30 minutes (National Institute of Occupational Safety and Health [NIOSH] 1997). This concentration was chosen by NIOSH to ensure that workers can escape without injury or irreversible health effects from an IDLH exposure. Exposure to ammonia at or above the IDLH poses a threat of death or immediate or delayed permanent adverse health effects or prevents escape from the impacted environment.
- USEPA/CalARP Toxic Endpoint (the “Endpoint”) – The CalARP for ammonia concentration, based on USEPA 40 CFR 68, is 200 ppmv (0.14 milligrams per liter [mg/L]) average over 1 hour. This concentration is the maximum airborne concentration below which it is believed 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.

The aqueous ammonia modeling results are presented in Section 3.2 of this Appendix.

#### Hydrogen

The unique properties of hydrogen – low density, high specific heat and thermal conductivity – make it an ideal coolant for electricity generators and it is now being widely used as a coolant for power plants. In a hydrogen-cooled generator, the hydrogen gas is circulated in a closed loop within the generator to remove heat from its active parts; then it is cooled by gas-to-water heat exchangers that are part of the stator frame. The Project will use a hydrogen-cooled generator and store 29,000 standard cubic feet (scf) of compressed hydrogen gas in a pressurized multi-tube trailer as make-up for the loss within the generator.

While hydrogen gas is not toxic, it is a highly flammable material. The potential risk posed by a hydrogen leak is mainly considered to be fire and explosion. Due to its low ignition energy, an impact of a hydrogen-oxygen fire is usually localized. A hydrogen release may also pose an explosion risk, which is generally localized with small-source volumes.

To determine the behavior of hydrogen under a worst-case release scenario, we have examined its properties and also examined the historical data to evaluate the potential impacts in this section.

Although the storage amount of hydrogen at the Project Site is far below the federal or state regulatory threshold, a worst-case OCA evaluation was performed in order to assess the potential consequences of a worst-case release scenario, and the need for appropriate controls and mitigations.

The examination was performed following instruction from USEPA’s RMP OCA guidance (April 1999) document (USEPA RMP OCA guidance). In addition, the USEPA-approved RMP\*Comp software for hazardous chemical release modeling was also used to confirm the result. These results are presented in Section 3.3.

The purpose of the modeling was to estimate the consequences from potential releases of hydrogen gas from the storage vessel. Due to the property of hydrogen, and also according to the

## APPENDIX L

# HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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historical hydrogen incidents information, the hazard caused by explosion is considered to be the most significant impact for accidental hydrogen releases. The USEPA vapor cloud explosion method will be used for the evaluation (see Section 3.0 Equation L-1). The OCA modeling performed for the worst-case scenario was based on USEPA's RMP criteria:

The worst-case scenario assumes that the contents of the entire hydrogen tube trailer (29,000 scf) are accidentally released into the atmosphere. For vapor cloud explosions, the total quantity of hydrogen is assumed to form a vapor cloud (Note: vapor cloud explosions generally are considered unlikely events). The entire cloud is assumed to be within the flammability limits, and the cloud is assumed to explode. Ten percent of the flammable vapor in the cloud is assumed to participate in the explosion. The impact is measured as the distance to the 1 psi overpressure level. This is determined using Equation L-1 (from USEPA's RMP OCA guidance). According to USEPA's RMP OCA guidance Exhibit C-1,  $H_c$  for hydrogen is 119,950 kilojoules/kilogram (kg). Other input parameters used in Equation L-1 are given in Table L-2, Hydrogen Modeling Input Parameters.

**Table L-2**  
**Hydrogen Modeling Input Parameters**

Chemical	Storage Type	Volume (scf)	Weight (lbs)	Hc[4] (kJ/kg)	Density[5] (lb/ft <sup>3</sup> )
Hydrogen	Compressed gas	29,000	150.8	119,950	0.0052

Notes:

ft <sup>3</sup>	=	cubic foot
kJ/kg	=	kilojoules per kilogram
lbs	=	pounds
Scf	=	standard cubic foot

The weight of the flammable substances, in this case hydrogen, is calculated using the equation below:

$$W_h = V\rho$$

where:

$W_h$	=	weight of hydrogen (lbs)
$V$	=	volume of hydrogen (ft <sup>3</sup> )
$\rho$	=	density of hydrogen gas

Since the amount of hydrogen to be stored on site is 29,000 scf, and the density of hydrogen gas at 70°F, 1 atmosphere (atm) is 0.0052 lb/ft<sup>3</sup>,

$$W_h = 29,000 \text{ ft}^3 \times 0.0052 \text{ lb/ft}^3 = 150.2 \text{ lbs}$$

The hydrogen modeling results are presented in Section 3.2 of this Appendix.

# APPENDIX L

## HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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### Acid Gas (45% Hydrogen Sulfide)

The Rectisol process will remove acid gas to significantly reduce sulfur dioxide emissions to the atmosphere. Acid gas is removed from shifted syngas to produce low-sulfur hydrogen-rich fuel for low-carbon electrical generation. The acid gas will consist of a 45 percent hydrogen sulfide and 55 percent carbon dioxide mixture. Hydrogen sulfide presents a potential hazard due to its toxic and flammable characteristics.

Hydrogen sulfide is classified as a regulated hazardous substance by federal CAA § 112(r) RMP regulations and by CalARP regulations. The regulatory threshold for hydrogen sulfide is 10,000 pounds under CAA RMP regulations and 500 pounds under CalARP regulations. The toxicity concentration level set by the CAA RMP/CalARP for hydrogen sulfide is 30 parts per million (ppm) (0.042 mg/L). However, the quantities of hydrogen sulfide do not trigger regulatory requirements under CalARP and the federal CAA RMP for worst-case modeling because (1) hydrogen sulfide is not stored on site but converted to elemental sulfur within the operation as it is produced, thus, there is no stationary source, and (2) quantities are below regulatory thresholds.

Nonetheless, the Project performed an OCA for the worst-case release scenario to investigate the potential impact from the explosion and toxicity of a hydrogen sulfide vapor cloud.

The worst-case release scenario for hydrogen sulfide was studied using the USEPA-approved ALOHA 5.4.1 air dispersion modeling program and with worst-case atmospheric and environmental conditions as provided by CalARP regulations. Worst-case atmospheric conditions under which the hypothetical release was examined were set as follows: wind speed of 1.5 meters per second; an F atmospheric stability level (most stable); atmospheric temperature of 77°F; and atmospheric humidity of 50 percent. These conditions are default settings on the RMP\*Comp modeling program per regulatory protocols established by CalARP.

The ALOHA 5.4.1 model requires calculation of the weight of the regulated chemical. The model assumes the total quantity of hydrogen sulfide released to be identical to the volume of hydrogen sulfide found within the pipe. In order to obtain the weight of the hydrogen sulfide found in the acid gas mixture, the ideal gas law was applied for the hydrogen sulfide component of the total acid gas within the transfer pipe (i.e., 45% of total pipe volume).

The process pipeline between the acid gas removal (AGR) and sulfur recovery unit (SRU) was examined through this analysis. The hydrogen sulfide volume in the process pipeline is shown below:

Diameter (inches)	Length (feet)	H <sub>2</sub> S Volume (cubic feet)	H <sub>2</sub> S Volume (cubic meters)
12	500	176.7	5.00

The ideal gas law was used to determine the total amount of moles found for hydrogen sulfide for the various pipeline conditions (as shown below).

$$PV = nRT$$

$$n = PV/RT$$

## APPENDIX L

# HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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$$\text{Weight of Gas} = n \times \text{Molecular Weight of H}_2\text{S (34g/mol)}$$

A process pressure of 30 pounds per square inch absolute (psia) and process temperature of 120°F (48.8° Celsius [C]) were selected for the equation based on operational conditions that will be found at the power plant. Additionally, the Ideal Gas Constant (R), which is equivalent to 8.314 Pascal (Pa) m<sup>3</sup>/mol K, was also applied to the equation. After calculating the moles of hydrogen sulfide, the weight of hydrogen sulfide in the pipeline was calculated by multiplying the molecular weight of hydrogen sulfide with the moles. The total weight for the hydrogen sulfide gas for the pipeline is shown below:

Pipe Dimensions (diameter x length)	Moles of H <sub>2</sub> S in Pipeline (mol)	Weight of H <sub>2</sub> S in Pipeline (pounds)
12-inch x 500 feet	0.85	28.98

As previously explained, the weight shown in the table above was input into the ALOHA 5.4.1 modeling program, under worst-case scenario conditions, to determine the distance to the Endpoint from the complete release of the pipe contents. ALOHA 5.4.1 was used to determine the distance to the Endpoint concentration of 0.042 mg/L, as required by CAA § 112 (r) RMP and CalARP regulations. A 10-minute time of release was also selected for the scenario, following CAA § 112 (r) RMP and CalARP regulatory requirements.

Although not regulated as a flammable substance, hydrogen sulfide may present a hazard of producing a flammable vapor cloud upon an accidental release. In order to determine the most significant impact that could be developed from a worst-case release scenario for a flammable hydrogen sulfide vapor cloud, USEPA's RMP OCA guidance document was used for determining the distance to 1 psi overpressure for vapor cloud explosions. The pipeline diameter was the key input parameter for the vapor cloud explosion analysis.

Equation L-1 was then used to calculate the impact distance as a result of the worst-case vapor cloud explosion. Results of the hydrogen sulfide modeling are presented in Section 3.2 of this Appendix.

### Syngas

The feedstock will be gasified to produce a synthesis gas (syngas) that will be processed and purified to produce a hydrogen-rich gas, which will be used to fuel the combustion turbine for low-carbon baseload power generation. Syngas consists primarily of hydrogen, carbon monoxide, carbon dioxide, and water, with trace amounts of methane, hydrogen sulfide, carbonyl sulfide, nitrogen, argon, ammonia, and hydrogen cyanide. Of these substances, only hydrogen, carbon monoxide, hydrogen sulfide, and methane are regulated chemicals under federal and state regulations. Hydrogen, carbon monoxide, and methane are regulated as flammable substances, and hydrogen sulfide is regulated as a toxic substance (see 40 CFR 68.130 and 19 CCR 2770.5). However, the quantities of these constituents in the syngas do not trigger regulatory requirements under CalARP and the federal CAA RMP for worst-case modeling because (1) syngas is not stored on site but consumed within the operation as it is produced, thus, there is no stationary source, and (2) quantities are below regulatory thresholds.

## APPENDIX L

### HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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Nonetheless, the Project performed an OCA for the worst-case release scenario to investigate the potential impact from the explosion, combustion, and toxicity levels of a syngas vapor cloud.

In order to evaluate the worst-case release scenario for a syngas vapor cloud explosion, the volume released was 10,000 cubic feet based on the volume of the gasifier and downstream equipment up to the closest isolation valve and the maximum concentrations of each flammable component found in the syngas mixture. These maximum concentrations consist of 40 percent hydrogen, 50 percent carbon monoxide, 2 percent hydrogen sulfide and 4 percent methane. The probability that these substances would be present in the syngas in the aforementioned high level concentrations, is very low because the total syngas volume that could be released actually contains a substantial amount of water vapor. In addition, the large amount of water present prevents the formation of an explosive mixture. However, in order to assess the worst-case scenario, this parameter was excluded from the modeling. Other non-flammable substances in the syngas mixture were excluded in the analysis for the same reason.

The syngas vapor cloud explosion evaluation was conducted following USEPA's RMP OCA guidance document (see Section 3.0 above, Equation L-1). The purpose of the modeling was to estimate the consequences from a hypothetical worst-case release of syngas at the Project Site. The scenario analyzed consisted of a catastrophic release of 10,000 cubic feet of syngas from equipment and process piping at the site. To calculate the heat of combustion of the syngas, the following equation was used:

$$H_{\text{Syngas}} = \frac{W_{\text{H}_2}}{W_{\text{CO}+\text{H}_2+\text{CH}_4+\text{H}_2\text{S}}} \times HC_{\text{H}_2} + \frac{W_{\text{CO}}}{W_{\text{CO}+\text{H}_2+\text{CH}_4+\text{H}_2\text{S}}} \times HC_{\text{CO}} + \frac{W_{\text{CH}_4}}{W_{\text{CO}+\text{H}_2+\text{CH}_4+\text{H}_2\text{S}}} \times HC_{\text{CH}_4} + \frac{W_{\text{H}_2\text{S}}}{W_{\text{CO}+\text{H}_2+\text{CH}_4+\text{H}_2\text{S}}} \times HC_{\text{H}_2\text{S}} \quad (\text{L-3})$$

where:

$W_{\text{H}_2}$	=	weight of flammable substance (lbs)
$W_{\text{CO}}$	=	weight of flammable substance (lbs)
$W_{\text{CH}_4}$	=	weight of flammable substance (lbs)
$H_{\text{H}_2}$	=	heat of combustion of flammable substance (joules/kg)
$H_{\text{CO}}$	=	heat of combustion of flammable substance (joules/kg)
$H_{\text{CH}_4}$	=	heat of combustion of flammable substance (joules/kg)
$H_{\text{H}_2\text{S}}$	=	heat of combustion of flammable substance (joules/kg)
$H_{\text{Syngas}}$	=	heat of combustion of flammable substance (joules/kg)

Hydrogen sulfide is the only regulated toxic substance found in the syngas. However, at a maximum potential concentration of 4 percent, hydrogen sulfide in the syngas does not present a significant hazard in the event of a syngas release.

## APPENDIX L

# HAZARDOUS MATERIALS TECHNICAL ANALYSIS

---

The primary component found in syngas is carbon monoxide (CO). Carbon monoxide is hazardous material with toxic and ignitable characteristics. However, carbon monoxide is not classified as a regulated hazardous substance by federal CAA § 112(r) RMP regulations or by CalARP regulations. Nevertheless, in order to evaluate the potential health hazards that could be attributed to the carbon monoxide component of the syngas, an OCA was conducted. The OCA focused on the carbon monoxide component and the vapor cloud that might develop from a worst-case syngas release. The table below provides some regulatory concentration level thresholds that have been established for carbon monoxide.

Regulatory Enforcement	Concentrations
NIOSH REL (ceiling @ 10 min)	35 ppm
OSHA PEL (ceiling)	35 ppm
OSHA PEL (maximum peak @ 10 min)	50 ppm
ACGIH TLV TWA	25 ppm
IDLH	1,500 ppm
LCLO (human @ 30 min)	400 ppm

Notes:

NIOSH REL (ceiling @ 10 min)	National Institute for Occupation Safety and Health Recommended Exposure Limit.
OSHA PEL (ceiling)	Occupation Safety and Health Administration Permissible Exposure Limit
OSHA PEL (maximum peak @ 10 min)	Occupation Safety and Health Administration Permissible Exposure Limit
ACGIH TLV TWA	American Conference of Governmental Industrial Hygienists Threshold Limit Value Time Weighted Average
IDLH	Immediately Dangerous to Life and Health
LCLO (human @ 30 min)	Lethal Concentration Low

The vapor cloud dispersion that may occur from the accidental worst-case release scenario for syngas was examined using the USEPA-approved ALOHA5.4.1 air dispersion modeling program. The program was used to examine hypothetical scenarios under which the entire volume of the pipe would be released into the atmosphere under worst-case scenario conditions as provided by CalARP regulations. Worst-case climate conditions were assumed as follows: wind speed of 1.5 meters per second, an F atmospheric stability level (most stable), an atmospheric temperature 25°C, and an atmospheric humidity of 50 percent, per regulatory protocols established by CalARP.

In order to apply the ALOHA 5.4.1 model, the weight of the regulated chemical must be calculated and input into the model. The model assumes the total quantity of carbon monoxide released to be equal to the volume of carbon monoxide found within the pipe. In order to obtain the weight of the carbon monoxide found in the acid gas mixture, the ideal gas law was applied for the carbon monoxide component of the total acid gas within the transfer pipe (i.e., 50% of total pipe volume ~ 5,000 ft<sup>3</sup>).

# APPENDIX L

## HAZARDOUS MATERIALS TECHNICAL ANALYSIS

---

### Methanol

The Project will use methanol in the process unit and will be stored in two 300,000-gallon ASTs with secondary containment. Each tank will have its own independent berm to contain any potential release.

Methanol is considered to be a hazardous substance due to its flammable and moderately toxic chemical properties. Methanol is listed in the following federal regulations:

- 29 CFR 1910.1200 (OSHA)
- 40 CFR 116 and 40 CFR 117 (USEPA)
- 40 CFR 355, Appendices A and B (USEPA)
- 40 CFR 372 (Superfund Amendments and Reauthorization Act [SARA] Title III)
- 40 CFR 302 (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA])

Although it is a listed substance, federal regulations do not require an OCA for the use of methanol. Additionally, methanol is not regulated under applicable state regulations. Nonetheless, an OCA was conducted to evaluate the potential impact area associated with a worst-case methanol release at the Project Site. Since methanol is a flammable substance, the most severe hazardous consequence that could be derived from an accidental release would consist of a vapor cloud explosion. Two potential worst-case release scenarios were evaluated for the methanol (on site) as described below.

The first worst-case scenario modeled was the formation of a methanol vapor cloud. The hypothetical assumes a release where the entire contents of one methanol storage tank (300,000 gallons) is released into the atmosphere. In accordance with regulatory guidance, the methanol was assumed to be released over a 10-minute period and to form a vapor cloud where 10 percent of the flammable vapor explodes. An analysis was undertaken using Equation L-1 to determine the impact distance of a pressure wave for a vapor cloud explosion. For Equation L-1, the weight of methanol,  $W_f$ , was calculated to be 1,981,116 pounds and the heat of combustion,  $H_{Cf}$ , was calculated to be 22,700,000 joules/kg.

The second worst-case scenario analyzed was a methanol pool fire in accordance with the appropriate regulatory guidance. The modeling basis for a pool fire estimates the distance from the center of a pool fire to the heat radiation Endpoint as 5 kilowatts per square meter ( $\text{kW}/\text{m}^2$ ). The worst-case release that is assumed for the model is as follows: the entire contents of one methanol storage tank (300,000 gallons) is released forming a pool of fire of approximately 1 inch in liquid thickness.

Equation L-2 from Section 3.0 was used to estimate the possible impact distance from the pool fire. The input parameters for Equation L-2 in the methanol pool fire case are as follows:

## APPENDIX L

# HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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$H_C$	= heat of combustion of the flammable liquid (joules/kg) = 22,700,000 joules/kg
$H_V$	= heat of vaporization of the flammable liquid (joules/kg) = 1,100,000 joules/kg
$A$	= pool area ( $m^2$ ) = 44592 $m^2$
$C_P$	= liquid heat capacity (joules/kg $^\circ K$ ) = 2,482 joules/kg $^\circ K$
$T_B$	= boiling temperature of the liquid ( $^\circ K$ ) = 337.8 $^\circ K$
$T_A$	= ambient temperature ( $^\circ K$ ) = 320 $^\circ K$

Neither of the scenarios described above account for the safety systems that will be installed including nitrogen blanketing of the tanks vapor space, automatic fire detection and fire suppressant foam system within the storage tank and surrounding berm area, and fire water system for the Project Site. These safety systems will significantly reduce the likelihood of this event and the possibility of ignition. However, the results of the model presented in Section 3.2 below do not take into account any of these safety measures.

### 3.2 Results of Modeling

The following sections provide modeling outputs, calculations, and results of the OCAs conducted for the aqueous ammonia, hydrogen, acid gas, syngas, and methanol at the Project Site.

#### **Aqueous Ammonia**

The dispersion analysis does not account for prevailing wind direction and therefore, assumes that there is an equal probability of the ammonia vapor cloud dispersing in any direction. Thus, the model results in Figure L-1, Aqueous Ammonia Impact Area, show a circle of equal predicted ammonia concentration around the source for the greatest area of impact. The radius of the circle represents the distance to the 0.14 mg/L (200 ppm) concentration threshold provided by CalARP regulations. Higher concentrations would provide circular impact areas of smaller radii.

The concentration levels examined do not extend off site. CalARP regulatory threshold concentrations of 0.14 mg/L (200 ppm) only reached a distance of 189 feet, the 300 ppm concentration reached a distance of 162 feet, and the 2,000 ppm concentration reached a distance of 60 feet, even with worst-case assumptions and conditions. No off-site impact is expected to occur from a worst-case release scenario.

As additional protection measures for ammonia spills, the Project has also equipped the aqueous ammonia AST with automated controls and an alarm system with an emergency beacon and horn. The Project will provide employee training, enforce safe operation procedures, enforce the separate storage of incompatible chemicals, and provide scheduled inspection of equipment. Materials will be handled in accordance with all applicable LORS. Based on the above, the potential impacts of the use and storage of aqueous ammonia at the Project Site are less than significant.

# APPENDIX L

## HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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### Hydrogen

USEPA’s RMP Comp model results (presented in Section 3.3) show that the approximate distance reached by a 1 psi overpressure wave resulting from a worst-case release scenario would be 317 feet. The potential impact from the vapor cloud explosion resulting from a worst-case 29,000-scf release of hydrogen does not extend outside of the Project Site boundaries.

As an added examination measure, an analysis of the vapor cloud explosion area of impact was also performed following instruction from USEPA’s RMP OCA guidance document. Equation L-1 was applied to determine the approximate distance that would be reached by a hydrogen vapor cloud explosion. The equation was applied in the manner shown below (equation provided by the USEPA RMP OCA guidance):

$$X = 0.0081 \left( 0.1 \times 150.2 \text{ lbs} \times \frac{119,950 \text{ kilojoule/kg}}{4,680 \text{ kilojoule/kg}} \right)^{1/3} = 0.059 \text{ (miles)}$$

Results from vapor cloud explosion computations reflected those obtained through the RMP\*Comp modeling program. Both modeling practices showed a total distance of impact of 317 feet.

The OCA analysis result shows that even for the worst-case release scenario for hydrogen, the potential impact will be restricted within an area of 0.06 mile radius (317 feet) from the center of the storage tube trailer, which will remain within the property boundary. Any explosion or combustion of a worst-case release scenario for hydrogen at the Project Site will not have any negative impacts off site and will be contained within the Project Site boundaries. Based on the above, the potential impacts of the use and storage of hydrogen at the Project Site are less than significant.

### Acid Gas (45% Hydrogen Sulfide)

An OCA for the worst-case release of acid gas from the process pipeline between the AGR and SRU was examined. The hydrogen sulfide volume found in the process pipeline is shown below:

Diameter (inches)	Length (feet)	H <sub>2</sub> S Volume (cubic feet)	H <sub>2</sub> S Volume (cubic meters)
12	500	176.7	5.00

The ideal gas law (PV=nRT) was used to determine the total amount of moles found in the 5 cubic meters of hydrogen sulfide in the acid gas process pipeline. The results were then used to determine the approximate weight of the hydrogen sulfide gas in the process pipeline. The total weight for the hydrogen sulfide gas from the pipeline is shown below:

Pipe Dimensions (diameter x length)	Moles of H <sub>2</sub> S in Pipeline (mol)	Weight of H <sub>2</sub> S in Pipeline (pounds)
12-inch x 500 feet	0.85	28.98

## APPENDIX L

# HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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The weight shown above was input into the ALOHA 5.4.1 modeling program, under worst-case climate conditions to determine the distance to the Endpoint from the complete release of the pipe contents. The endpoint concentration for hydrogen sulfide is equivalent to a concentration of 0.042 mg/L, as required by CAA §112 (r) RMP and CalARP regulations. A 10-minute time of release was also selected for the scenario, following CAA § 112 (r) RMP and CalARP regulatory requirements. The distance to the Endpoint generated by an accidental release of hydrogen sulfide from the acid gas is shown below:

<b>Distance to Endpoint (miles)</b>
0.23

Results from the ALOHA 5.4.1 modeling program presented a distance to the Endpoint of 1,215 feet. The potential impacts from a vapor cloud under the worst-case release scenario will not extend off site.

As previously mentioned, in addition to conducting a vapor cloud OCA, the acid gas was also examined for the impacts from a vapor cloud explosion. The same volumetric amount was taken into consideration and same weight of hydrogen sulfide. By applying weight and heat of combustion parameters to equation L-1, the 1 psi overpressure wave impact derived from the acid gas was determined to reach a distance of 317 feet.

Equation L-1 was applied in the manner shown below (equation provided by the USEPA RMP OCA guidance):

$$X = 0.0081 \left( 0.1 \times 28.98 \text{ lbs} \times \frac{35,142 \text{ kilojoule/kg}}{4,680 \text{ kilojoule/kg}} \right)^{1/3} = 0.059 \text{ (miles)}$$

The 317-foot distance reached by the vapor cloud explosion from the acid gas worst-case scenario will not extend off site. As such, the use of acid gas at the Project Site will not have any impacts to the surrounding community and not present a significant hazard to the Project area. Based on the above, the potential impacts from the use of acid gas at the Project Site are less than significant.

### Syngas

The ideal gas law was used to determine the total amount of moles found for each component in syngas (as shown below).

$$PV = nRT$$

$$n = PV/RT$$

$$\text{Weight of Gas} = n \times \text{Molecular Weight}$$

A process pressure of 505 psi and process temperature of 480°F (249°C) were selected for the equation based on site conditions that will be found at the Project Site. Additionally, the Ideal

## APPENDIX L

### HAZARDOUS MATERIALS TECHNICAL ANALYSIS

---

Gas Constant (R), which is equivalent to 8.314 Pa m<sup>3</sup>/mol K, was applied to the equation. After calculating the moles of each component, the weights of each chemical were calculated by multiplying the molecular weight with the moles. The total weight for each of the relevant syngas components for the pipeline is shown below:

Chemicals	Moles (mol)	Molecular weight (g/mol)	Weight (gram)
Hydrogen (H <sub>2</sub> )	9,082.21	2	18,164.43
Carbon monoxide (CO)	11,352.77	28	317,877.5
Methane (CH <sub>4</sub> )	908.22	16	14,531.54
Hydrogen sulfide (H <sub>2</sub> S)	454.11	34	15,439.76

Equations L-1 and L-3 were applied to determine the approximate distance that would be reached by a syngas vapor cloud explosion. The equations were applied in the manner shown below (equations provided by the USEPA RMP OCA guidance):

$$H_{\text{syngas}} = \frac{18164 \text{ g}}{366013 \text{ g}} \times 11950 \text{ kilojoule / kg} + \frac{317878 \text{ g}}{366013 \text{ g}} \times 1011 \text{ kilojoule / kg} + \frac{14532 \text{ g}}{366013 \text{ g}} \times 50029 \text{ kilojoule / kg} + \frac{15440 \text{ g}}{366013 \text{ g}} \times 35142 \text{ kilojoule / kg} = 9416.3 \text{ kilojoule / kg}$$

$$X = 0.0081 \left( 0.1 \times 883 \text{ lbs} \times \frac{9,416.3 \text{ kilojoule/kg}}{4,680 \text{ kilojoule/kg}} \right)^{1/3} = 0.04 \text{ (miles)}$$

The modeling of the worst-case release scenario demonstrates that the total release of 10,000 cubic feet of syngas contained from the process equipment and piping may result in a vapor cloud explosion that could potentially reach a distance of 0.04 mile from the point of release in the process pipeline. Consequently, the potential impact of such an explosion will not extend off site. Even with this extreme scenario, there will be no impacts to sensitive receptors.

Based on the calculation above, the weight of carbon monoxide in the syngas was then input in to the ALOHA 5.4.1 and used to determine the distance to concentrations levels of 400 ppm, 800 ppm, and 1,500 ppm as low dose chemicals (LD<sub>CH</sub>) and lethal concentration low (LCLo) standards. Although carbon monoxide is not regulated by CalARP, a 10-minute time of release was selected for the scenario, following the CalARP regulatory guidelines for modeling of a worst-case release scenario. The distance to the each carbon monoxide concentration level generated by an accidental worst-case release of syngas is shown below:

Potentially Hazard Concentration (ppm)	Distance to Concentration (feet)
400	2,361
800	1,611
1,500	1,152

## APPENDIX L

# HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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Results from the ALOHA 5.4.1 modeling program present the maximum concentration found at a specific distance at the end of a 10-minute release. Concentrations for which modeling was performed represent the National Research Council developed Emergency Exposure Guidance Levels (EGLs) for carbon monoxide. Concentrations shown above can present negative health impacts or health hazards if present in the following manner: 400 ppm over 60 minutes, 800 ppm over 30 minutes, and 1,500 ppm over 10 minutes. Results from the modeling above indicate that the highest concentration level of 1,500 ppm will extend 1,152-feet in approximately 10 minutes, after which time it will begin to further dissipate.

Certain concentrations of the carbon monoxide vapor cloud generated from a worst-case syngas release scenario will extend off site. However, time-dependent conditions that are used to establish regulated concentration thresholds for carbon monoxide will not present themselves off site during a worst-case release scenario. Since hazardous conditions (based on relative concentration over time period) will not be developed as a result of worst-case syngas release, the potential off-site impact of carbon monoxide in the syngas release will not be significant.

Therefore, the potential off-site impact from the use of syngas at the Project Site will be less than significant.

### **Methanol**

As discussed in Section 3.1, two worst-case scenarios were modeled for methanol: (1) vapor cloud explosion, and (2) pool fire. The modeling of the worst-case release scenario (vapor cloud explosion case) showed that the impact distance from a potential methanol vapor cloud explosion after the complete release of a single tank would reach a distance of 0.8 mile from the location of the tank. This pressure wave may extend up to 0.5 mile off site. The immediate vicinity surrounding the Project Site is rural and there are no residences within the pressure wave impact distance. Therefore, even such an unlikely event will not impact sensitive receptors. The implementation of appropriate safety measures noted above in Section 3.1 will substantially reduce the potential impact of an accidental methanol release. The potential off-site impact from the use and storage of methanol at the Project Site will be less than significant.

The modeling of the worst-case scenario (pool fire case) showed that a potential methanol pool fire after the complete release of a single tank would reach a distance of 0.23 mile from the center of the methanol pool and will not extend off site. Even such an unlikely event will not impact sensitive receptors. The implementation of appropriate safety measures noted above in Section 3.1 will substantially reduce the potential impact of an accidental methanol release. The potential off-site impacts from the use and storage of methanol at the Project Site will be less than significant.

# APPENDIX L

## HAZARDOUS MATERIALS TECHNICAL ANALYSIS

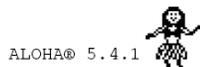
---

### 3.3 Modeling Outputs

#### Aqueous Ammonia

Outputs from the ALOHA 5.4.1 dispersion model obtained from the evaluation of the worst-case release scenario for aqueous ammonia are provided below.

Text Summary



ALOHA® 5.4.1

#### SITE DATA:

Location: TUPMAN, CALIFORNIA

Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)

Time: 2 July 2008 1019 hours PDT (using computer's clock)

#### CHEMICAL DATA:

Chemical Name: AQUEOUS AMMONIA

Solution Strength: 19.1% (by weight)

Ambient Boiling Point: 120.3° F

Partial Pressure at Ambient Temperature: 0.80 atm

Ambient Saturation Concentration: 813,459 ppm or 81.3%

Hazardous Component: AMMONIA Molecular Weight: 17.03 g/mol

ERPG-1: 25 ppm ERPG-2: 150 ppm ERPG-3: 750 ppm

IDLH: 300 ppm LEL: 160000 ppm UEL: 250000 ppm

#### ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 1.5 meters/second from se at 3 meters

Ground Roughness: open country Cloud Cover: 0 tenths

Air Temperature: 115° F

Stability Class: F (user override)

No Inversion Height Relative Humidity: 50%

#### SOURCE STRENGTH:

Evaporating Puddle (Note: chemical is flammable)

Puddle Area: 1.102 square feet Puddle Volume: 20,000 gallons

Ground Type: Concrete Ground Temperature: 115°F

Initial Puddle Temperature: Ground temperature

Release Duration: ALOHA limited the duration to 1 hour

Max Average Sustained Release Rate: 0.184 pounds/min (averaged over a minute or more)

Total Amount Hazardous Component Released: 11.0 pounds

# APPENDIX L

## HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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### THREAT ZONE:

Model Run: Gaussian

Red: 63 yards --- (0.14 mg/liter)

Orange: 54 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: 20 yards --- (2000 ppm)

Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

### Hydrogen

Given the same hydrogen amount, an impact distance calculated by USEPA RMP\*Comp software is also shown below (the result below is directly imported the USEPA RMP\*Comp software):

#### RMP Modeling Result

RMP\*Comp Ver. 1.07

Results of Consequence Analysis

Chemical: Hydrogen

CAS #: 1333-74-0

Category: Flammable Gas

Scenario: Worst-case

Quantity Released: 150.8 pounds

Release Type: Vapor Cloud Explosion

Estimated Distance to 1 psi overpressure: .06 miles (.09 kilometers)

-----Assumptions About This Scenario-----

Wind Speed: 1.5 meters/second (3.4 miles/hour)

Stability Class: F

Air Temperature: 77 degrees F (25 degrees C)

-----

### Carbon Monoxide

Outputs from the ALOHA 5.4.1 dispersion model obtained from the evaluation of the worst-case release scenario for carbon monoxide are provided below.

Text Summary  
ALOHA® 5.4.1



SITE DATA:  
Location: TUPMAN, CALIFORNIA

## APPENDIX L

### HAZARDOUS MATERIALS TECHNICAL ANALYSIS

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Building Air Exchanges Per Hour: 0.60 (unsheltered single storied)  
Time: July 8, 2008 0835 hours PDT (using computer's clock)

#### CHEMICAL DATA:

Chemical Name: CARBON MONOXIDE      Molecular Weight: 28.01 g/mol  
ERPG-1: 200 ppm    ERPG-2: 350 ppm    ERPG-3: 500 ppm  
IDLH: 1200 ppm    LEL: 125000 ppm    UEL: 740000 ppm  
Ambient Boiling Point: -313.0° F  
Vapor Pressure at Ambient Temperature: greater than 1 atm  
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

#### ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

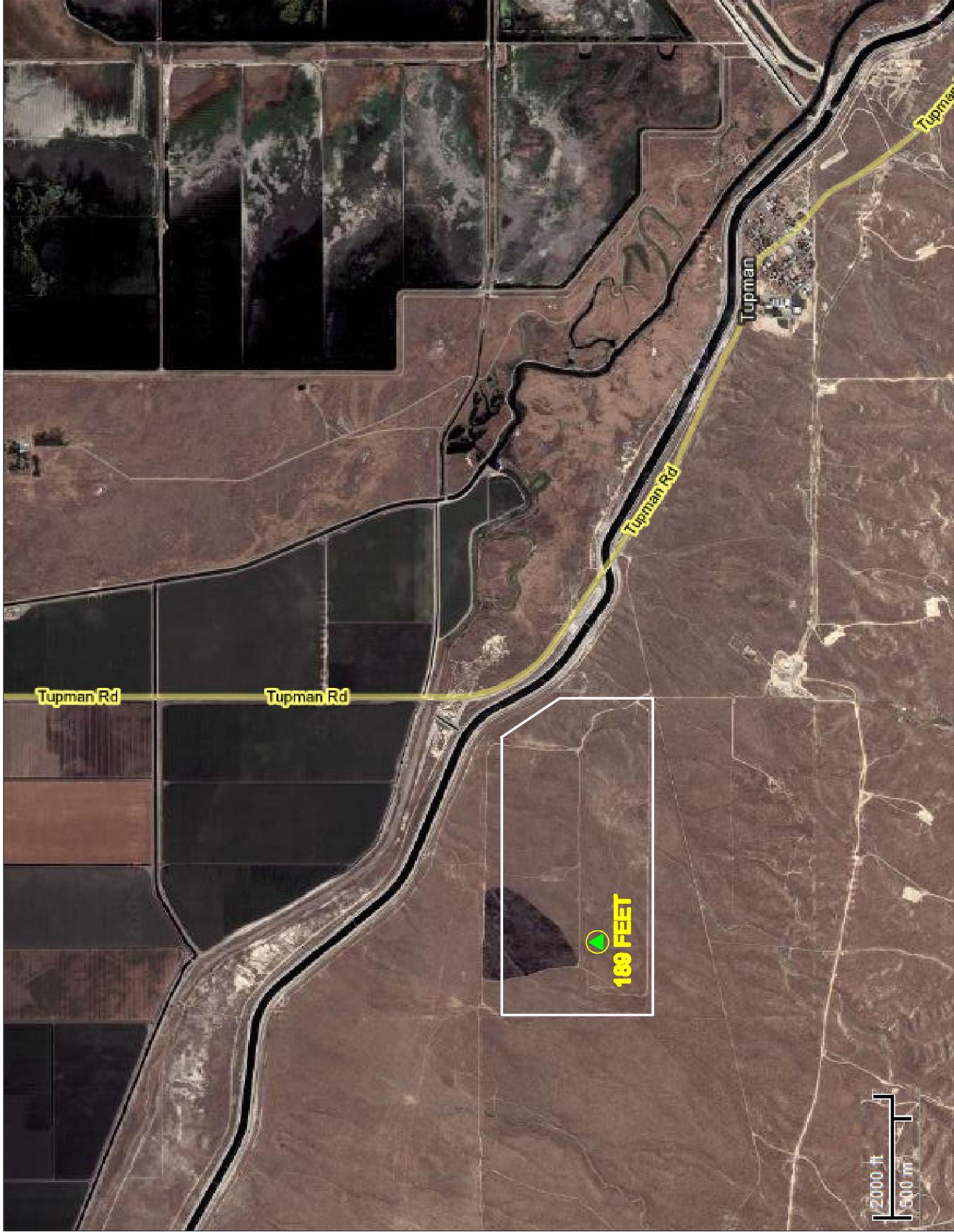
Wind: 1.5 meters/second from ese at 3 meters  
Ground Roughness: open country      Cloud Cover: 5 tenths  
Air Temperature: 115° F  
Stability Class: F (user override)  
No Inversion Height      Relative Humidity: 50%

#### SOURCE STRENGTH:

Direct Source: 31787.75 grams/min      Source Height: 0  
Release Duration: 10 minutes  
Release Rate: 70.1 pounds/min  
Total Amount Released: 701 pounds  
Note: This chemical may flash boil and/or result in two phase flow.  
Use both dispersion modules to investigate its potential behavior.

#### THREAT ZONE:

Model Run: Gaussian  
Red : 384 yards --- (1500 ppm)  
Orange: 537 yards --- (800 ppm)  
Yellow: 787 yards --- (400 ppm)



**FIGURE L-1 AQUEOUS AMMONIA IMPACT AREA**

