Attachment No. PC 7

Preliminary Site Consequence Analysis

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April 29, 2024

Coyote Canyon Preliminary Site Consequence Assessment

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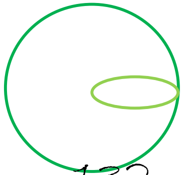
Note: This study has been preformed with the information available as of April 29, 2024 and is subject to change.

Executive Summary

- The purpose of this report is to outline the potential for flammable vapor clouds, jet fire, and toxic vapor clouds at Coyote Canyon and the possible effect they pose on the surrounding area, the Archaea control room, and the landfill county building.
- Standard 3200 SCFM V1 Archaea design with 44.5 ppm H_2S
- Note that Santa Ana wind modelling showed minimal effect on jet fire scenarios and reduced the effect of vapor cloud formation.
- This is divided into two parts: ground level occupied building, personnel and public receptor modelling and vegetation ignition modelling at 20 feet elevation.

Study Contents:

Clarification: The consequence radii are modelled as circles, representing the potential effect zone, should the wind be blowing in all directions at once. Should an event occur, the shape would realistically be conical depending on wind speed and direction.



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Risk to Occupied Buildings, Personnel and Public Receptors (Inside wall)

Site Process Hazard Mapping (Ground Level)

Legend

- 1.6 kW/ m^2 Jet Fire Boundary
- 30 PPM H2S Boundary
- Lower Flammability Limit Boundary
- 0.4 PSIG Vapor Cloud Explosion Boundary
- 12 ft. Wall

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Risk to Surrounding Receptors

Public receptors near by but not affected consequence radii:

- Sage Hill Highschool
- Newport Coast Drive
- California State Route 73/ San Joaquin Hills Transportation Toll Road

Private building affected by consequence radii:

- Landfill county Building

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Occupied Building Mitigation Recommendations

Landfill County Building: Potential for 0.6 PSIG

Worst case scenario is that windows facing process shatter from overpressure

Suggested Mitigations:

Archaea Control Room Building: Potential for 1 PSIG

Suggested Mitigations:

Table 1 - Blast overpressure design requirements

Overpressure range		Blast overpressure design requirements
mbar	**Psig**	
0 to 30	0 to 0,4	No specific blast resisting requirements.
30 to 42	0,4 to 0,6	No restriction on structural type. Glazing specified to reduce injuries in blast (i.e., toughened glass, laminated glass, or polycarbonate). Float glass coated with antishatter film. No brittle cladding materials (e.g., transite).
42 to 70	0,6 to 1,0	Framed structure in reinforced concrete or structural steelwork. Joints designed to ensure ductile behaviour. Walls and roofs ductile material, such as reinforced concrete or steel. Internal nonstructural features are restrained. *Refer to RD 44-301.* Windows conform to "low hazard" performance standard for blast loading at building location. *Refer to RD 44-302.* Windows facing overpressure sources conform to "low hazard" performance standard under reflected overpressure. Doors conform to "moderate damage" performance standard. *Refer to RD 44-303.* Doors facing overpressure sources conform to "moderate damage performance standard" under reflected overpressure.

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Risk to Surrounding Vegetation

Wildfire Considerations & Mitigations

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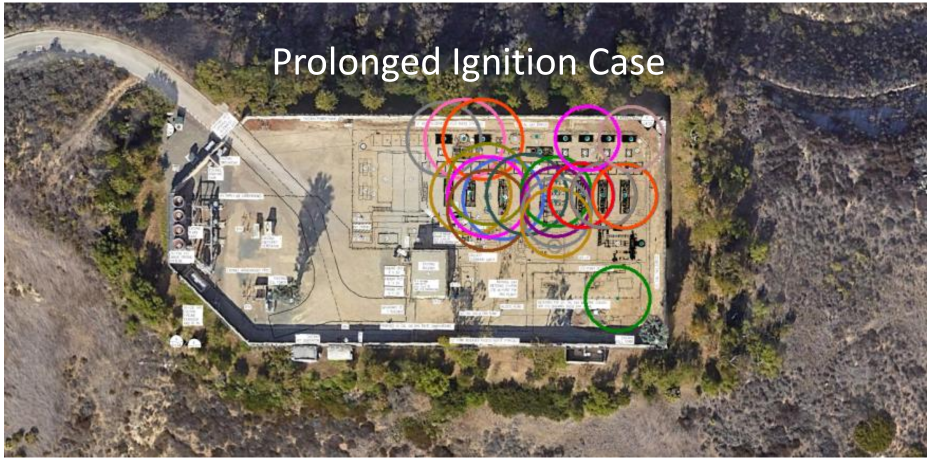
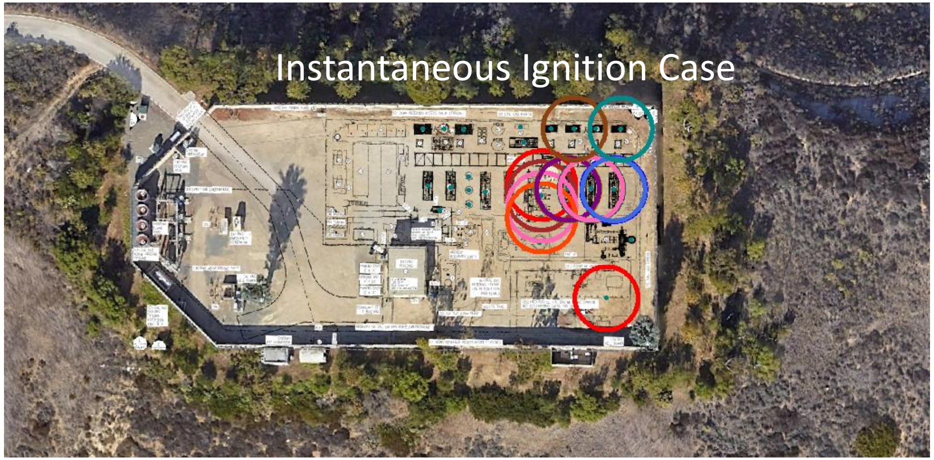
Jet Fire Radii (30 kW/m2, 50 kW/m2)





- A height of 20 feet is mapped on the XY plane because at 20 feet in the air, the jet fire thermal radiation reaches farthest.
- Two Cases:
  - Prolonged Ignition Case
    - 30 kW/m2
    - Ignites within 15-20 minutes of exposure
    - At 20 ft. elevation, reaches 10 ft. from wall
  - Instantaneous Ignition Case
    - 50 kW/m2
    - Ignites with 0-2 minutes of exposure
    - At 20 ft. elevation, reached 7 ft. from wall

- Mitigations preventing such events:
  - Fire and gas detection
  - Process control alarms
  - Process control shutdowns (Pressure safety high-highs, Pressure safety low-lows, composition analyzers)
  - Plant ESD System
  - Ignition Source Control, Hazardous Area Classification (Vapor cloud must find an ignition source to create jet fire depicted)

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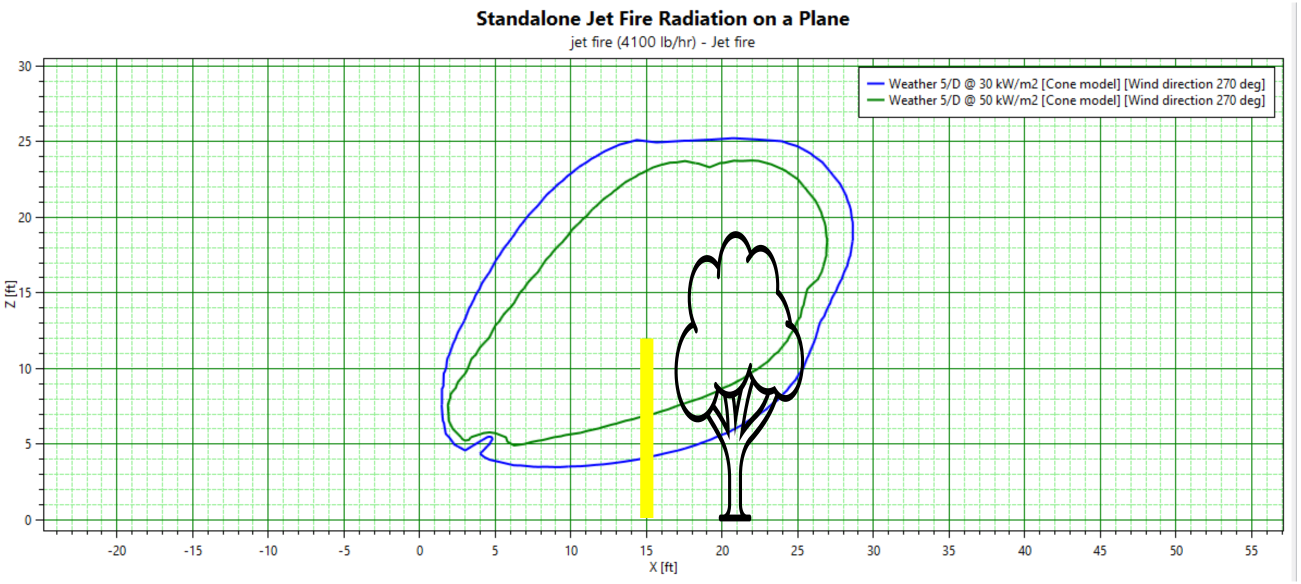
Worst Case Jet Fire (XZ plane)



- Under ideal conditions for vegetations ignition (moisture content, etc.), 50 kW/m2 can potentially instantaneously ignite vegetation in 0-2 minutes.
- All other instantaneous ignition radii do not reach outside of the facility

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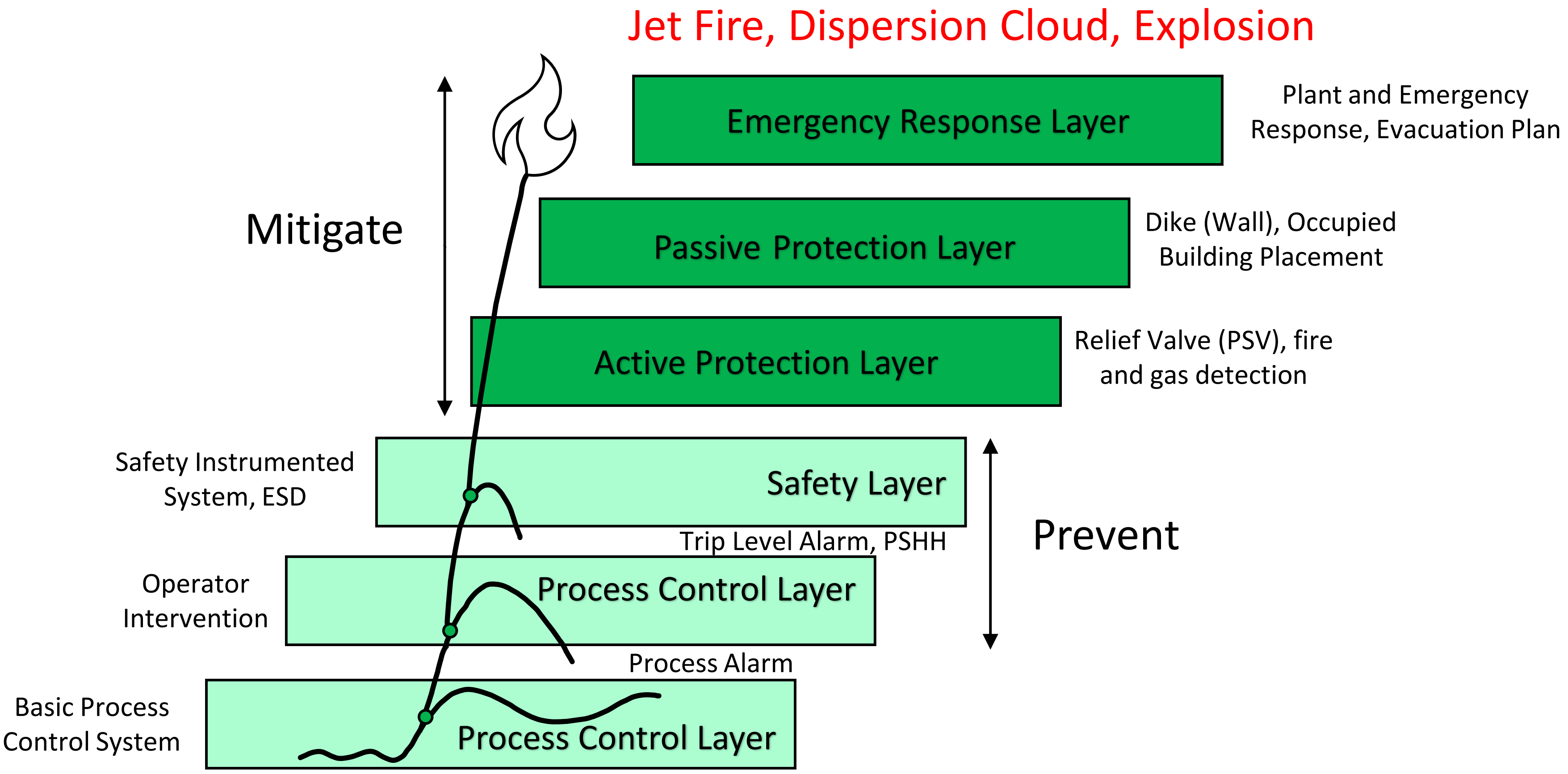
Consequence Prevention & Mitigations



Design (Equipment layout, Ignition Source Control, Hazardous Area Classification)

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Conclusion

- With suggested occupied building enhancements, models generated indicate that personnel, occupied buildings and public receptors are inherently safe outside of the generated consequence contours.
- Vegetation ignition is possible near the northeast portion of the wall within 10 feet.
- Any potential consequence stated in this study is unlikely to occur given the following mitigations:
    - Fire and gas detection
    - Process control alarms
    - Process control shutdowns (Pressure safety high-highs, Pressure safety low-lows, composition analyzers)
    - Plant ESD System
    - Ignition Source Control, Hazardous Area Classification (Vapor cloud must find an ignition source to create jet fire depicted)
    - PSVs and other active protection devices

Back-up Slides

Citations & Relevant Information

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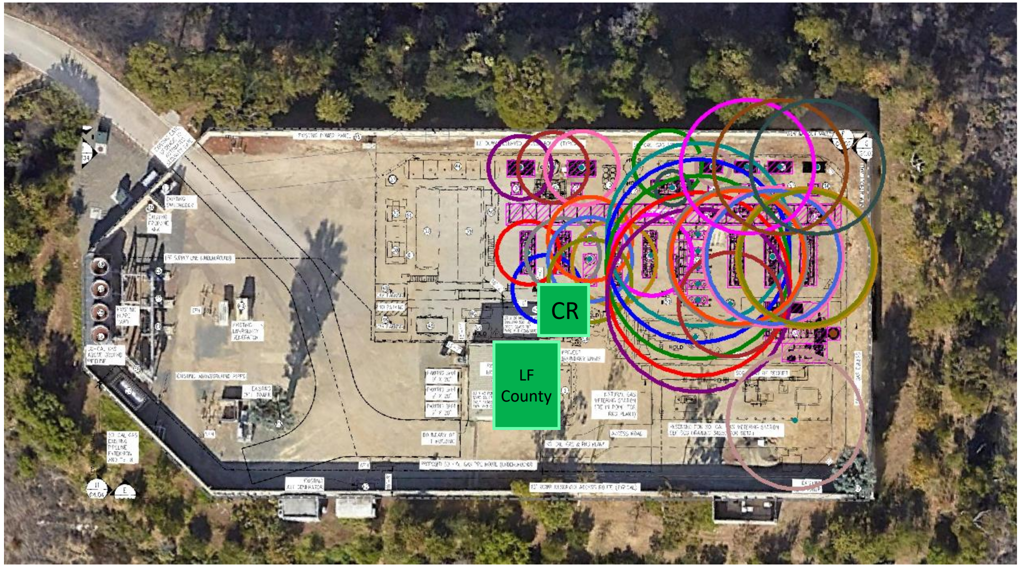
LFL (Lower Flammability Limit) Dispersion Cloud Radii



Dispersion cloud scenario basis:

Leak develops in process equipment AND process continues to operate (continuous leak at plant rate). Flammable vapor cloud accumulation with ignition can cause explosions and flash fires. All radii show the lower flammability limit (LFL) contours. The LFL is the lowest concentration of a gas in air capable of producing a flash fire in the presence of an ignition source.

Inputs:

- 2” horizontal leak at 0 ft elevation
- Plant normal operating conditions and flowrate
- Process stream compositions

Output:

- Dispersion clouds are not large enough to migrate and gather outside of plant walls
- The cloud would likely disperse before it is able to travel over the wall

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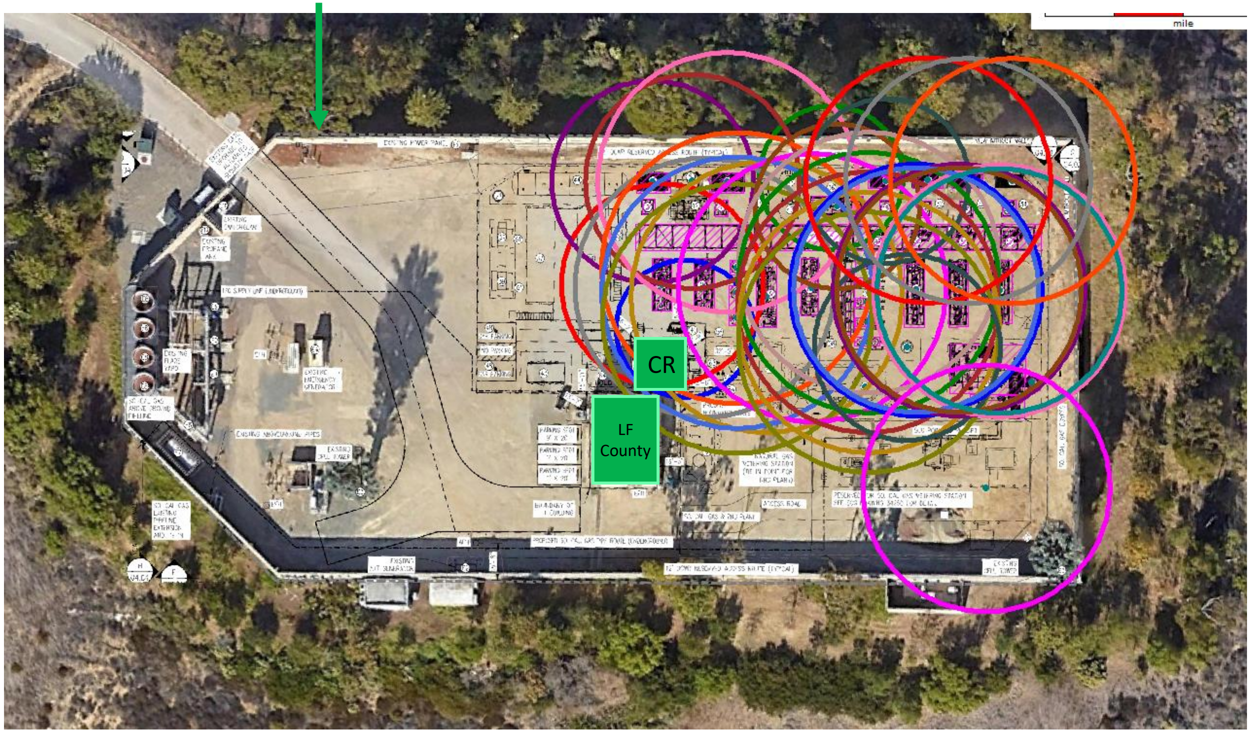
Jet Fire Radii (1.6 kW/m2)

12 ft. wall



Jet fire scenario basis:

Leak develops in process equipment AND process continues to operate (continuous leak at plant rate). All radii are 1.6 kW/m2 radiant heat contours in accordance with API 521 Table 12.

Inputs:

- 2” 45-degree leak at 3 ft elevation
- Plant normal operating conditions and flowrate
- Process stream compositions
- Height of Interest is 0 ft. as the concern is occupied buildings and personnel

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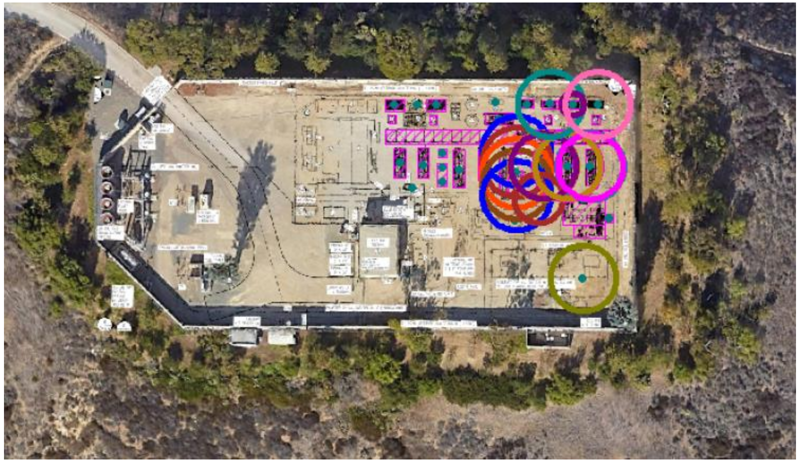
Jet Fire Radii

6.3
kW/m2



9.46
kW/m2

Jet fire scenario basis:

Leak develops in process equipment AND process continues to operate (continuous leak at plant rate).

Inputs:

- 2” 45-degree leak at 3 ft elevation
- Plant normal operating conditions and flowrate
- Process stream compositions

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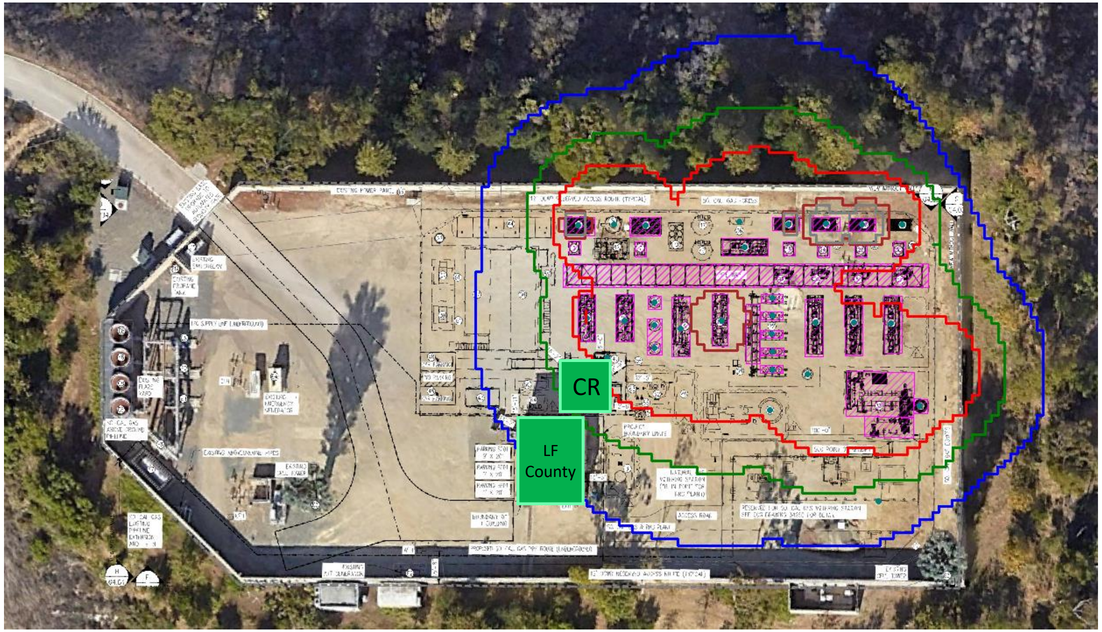
Vapor Cloud Explosion Radii



0.4 PSIG   0.6 PSIG   1 PSIG   3 PSIG   5 PSIG

VCE scenario basis:

Leak develops in process equipment AND process continues to operate (continuous leak at plant rate). The flammable mass grows and infiltrate areas of obstruction and confinement. If ignition occurs, these area(s) can generate explosive forces.

Inputs:

- 2” horizontal leak at 0 ft elevation
- Plant normal operating conditions and flowrates
- Process stream compositions
- Facility layout details (3D models, photos, drawings) to define obstructed regions

Results:

- Archaea Control room is reached by 1 PSIG contour (see slide 11 for mitigations)
- Landfill building is reached by 0.6 PSIG contour (see slide 11 for mitigations
- Wall is reached by ~1.2 psig and can absorb 2-3 psig. Pressure contours are **not** expected to reach outside of the facility due to the surrounding wall.

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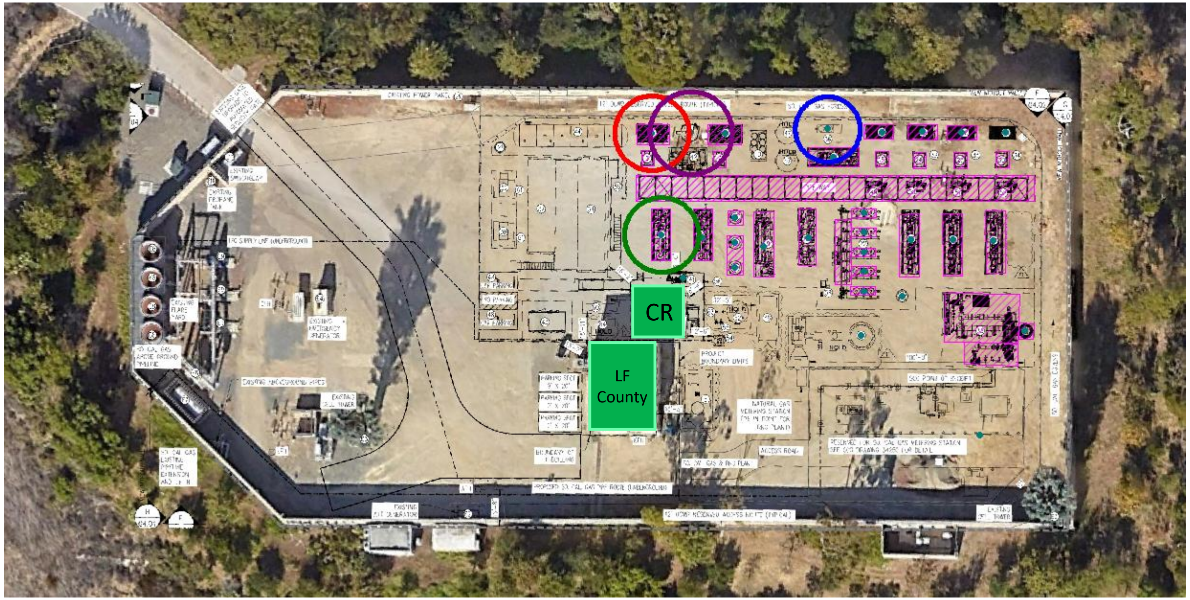
Toxic Cloud Radii (30 ppm radii)



Toxic cloud scenario basis:

Leak develops in process equipment AND process continues to operate (continuous leak at plant rate). All radii are 30 PPM H2S contours.

Inputs:

- 2” horizontal leak at 0 ft elevation
- Plant normal operating conditions
- Process stream compositions
- Process mass rate

Output:

- No significant toxic substance concerns

Jet Fire Radiation Back-Up Info for Occupied Buildings and Personnel (API 521)

Table 11—Exposure Times Necessary to Reach the Pain Threshold

Radiation Intensity kW/m^2 (Btu/h·ft^2)	Time-to-pain Threshold s
1.74 (550)	60
2.33 (740)	40
2.90 (920)	30
4.73 (1500)	16
6.94 (2200)	9
9.46 (3000)	6
11.67 (3700)	4
19.87 (6300)	2

Table 12—Recommended Design Thermal Radiation for Personnel

Permissible Design Level K kW/m^2 (Btu/h·ft^2)	Conditions
9.46 (3000)	Maximum radiant heat intensity at any location where urgent emergency action by personnel is required. When personnel enter or work in an area with the potential for radiant heat intensity greater than 6.31 kW/m^2 (2000 Btu/h·ft^2), radiation shielding and/or special protective apparel (e.g. a fire approach suit) should be considered. **Safety Precaution—It is important to recognize that personnel with appropriate clothing [a] cannot tolerate thermal radiation at 9.46 kW/m^2 (3000 Btu/h·ft^2) for more than a few seconds.**
6.31 (2000)	Maximum radiant heat intensity in areas where emergency actions lasting up to 30 s can be required by personnel without shielding but with appropriate clothing. [a]
4.73 (1500)	Maximum radiant heat intensity in areas where emergency actions lasting 2 min to 3 min can be required by personnel without shielding but with appropriate clothing. [a]
1.58 (500)	Maximum radiant heat intensity at any location where personnel with appropriate clothing can be continuously exposed.

[a] Appropriate clothing consists of a hard hat, a long-sleeved shirt with cuffs buttoned, work gloves, long-legged pants, and work shoes. Appropriate clothing minimizes direct skin exposure to thermal radiation.

Site/ Wall Photos

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Vegetation Ignition

- https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2004JE002279

Table 1. Spontaneous Ignition of Wood[a]

Varieties of Wood	Intensity ± Standard Deviation,[b] cal/cm²/s				Approx. Intensity,[b] kW/m²			
	MC = 0	MC = 20	MC = 40	MC = 60	MC = 0	MC = 20	MC = 40	MC = 60
European Whitewood (*Picea Abies*)	1.29 ± 0.07	1.44 ± 0.04	1.59 ± 0.01	1.65 ± 0.04	54	60	67	69
Columbian Pine (*Pseudotsuga taxifolia*)	1.13 ± 0.05	1.27 ± 0.16	1.44 ± 0.04	1.58 ± 0.03	47	53	60	66
Oak (*Quercus* sp.)	1.38 ± 0.35	1.37 ± 0.10	1.54 ± 0.04	1.58 ± 0.02	58	57	64	66
Larch (*Larix decidua*)	1				42			
Abura (*Mitragyna* spp.)	1				42			
Makoré (*Mimusops heckilii*)	1				42			

[a]Minimum intensity for spontaneous ignition of wood is from *Simms and Law* [1967]. Note that these values are for wood; twigs, leaves, and forest litter may ignite under different conditions, potentially from lower intensities. One to two minutes at these intensities is sufficient to spontaneously ignite these woods.
[b]MC, moisture content, in percent.

Table 2. Spontaneous Ignition of Wood, Foliage, and Sedge in Brief Irradiation Events[a]

Varieties of Wood and Litter	Radiant Exposure Needed for Ignition,[b] cal/cm²			Approx. Intensity,[b] kW/m²		
	YE = 0.035, EI ≈ 2	YE = 14, EI ≈ 10	YE = 20, EI ≈ 30	YE = 0.035, EI ≈ 2	YE = 14, EI ≈ 10	YE = 20, EI ≈ 30
Ponderosa pine wood (Excelsior)	-	23 ± 12	23 ± 12	-	96	32
Brown ponderosa pine needles	10 ± 2.5	16 ± 4	21 ± 5.3	209	67	29
Coarse "grass" (sedge)	6 ± 1.5	9 ± 2.3	11 ± 2.8	126	38	15
Fine grass (cheat)	5 ± 1.3	8 ± 2	10 ± 2.5	105	33	14
Dry, rotted fir wood	4 ± 2	6 ± 3	8 ± 4	84	25	11
Beech (deciduous) leaves	4 ± 1	6 ± 1.5	8 ± 2	84	25	11

[a]Radiant exposure data, which represent the total amount of thermal radiation needed for ignition, are from *Glasstone and Dolan* [1977]. The tabulated uncertainties are for laboratory conditions; they may be two times larger for field conditions. These data are for nuclear weapons blasts, which produce brief thermal pulses relative to the impact-generated heating described in this paper.
[b]YE, yield of explosion, in MT; EI, exposure interval, in s.

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Vegetation Ignition

- Drysdale Fire Dynamics Third Edition, 2011

Table 2.9 Effects of thermal radiation

Radiant heat flux (kW/m²)	Observed effect
0.67	Summer sunshine in UK[a]
1	Maximum for indefinite skin exposure
6.4	Pain after 8 s skin exposure[b]
10.4	Pain after 3 s exposure[a]
12.5	Volatiles from wood may be ignited by pilot after prolonged exposure (see Section 6.3)
16	Blistering of skin after 5 s[b]
29	Wood ignites spontaneously after prolonged exposure[a] (see Section 6.4)
52	Fibreboard ignites spontaneously in 5 s[a]

[a] D.I. Lawson (1954).
[b] S.H. Tan (1967).
The data quoted for human exposure are essentially in agreement with information given by Purser (2008) and Beyler (2008).

Effects of Thermal Radiation Intensity

Radiant Heat Flux (kW/m²)	Observed Effect	Reference
0.67	Summer sunshine in the UK	Drysdale – Fire Dynamics - Table 2.8
1	Maximum for indefinite skin exposure	Drysdale – Fire Dynamics - Table 2.8
1	Level just tolerable to a clothed man	Lee's Loss Prevention in the Process Industries (2nd Ed) – Table 16.75; HSE (1978b)
1.5	Threshold of pain	Lee's Loss Prevention in the Process Industries (2nd Ed) – Table 16.75; Atallah and Allan (1971)
2.1	Level at which pain is felt after 1 minute	Lee's Loss Prevention in the Process Industries (2nd Ed) – Table 16.75; Atallah and Allan (1971)
4.7	Threshold of pain. Average time to experience pain, 14.5 seconds	Lee's Loss Prevention in the Process Industries (2nd Ed) – Table 16.75; Crocker and Napier (1986)
6.4	Pain after 8 second skin exposure	Drysdale – Fire Dynamics - Table 2.8
8	Level which causes death within minutes	Lee's Loss Prevention in the Process Industries (2nd Ed) – Table 16.75; Crocker and Napier (1986)
10.4	Pain after 3 second skin exposure	Drysdale – Fire Dynamics - Table 2.8
12.5	Volatiles from wood may be ignited by pilot after prolonged exposure	Drysdale – Fire Dynamics - Table 2.8
16	Blistering of skin after 5 seconds	Drysdale – Fire Dynamics - Table 2.8
29	Wood ignites spontaneously after prolonged exposure	Drysdale – Fire Dynamics - Table 2.8
52	Fiberboard ignites spontaneously in 5 seconds.	Drysdale – Fire Dynamics - Table 2.8

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