



VAPOR INTRUSION AND METHANE: CRITERIA FOR WORKER AND OCCUPANT PROTECTION



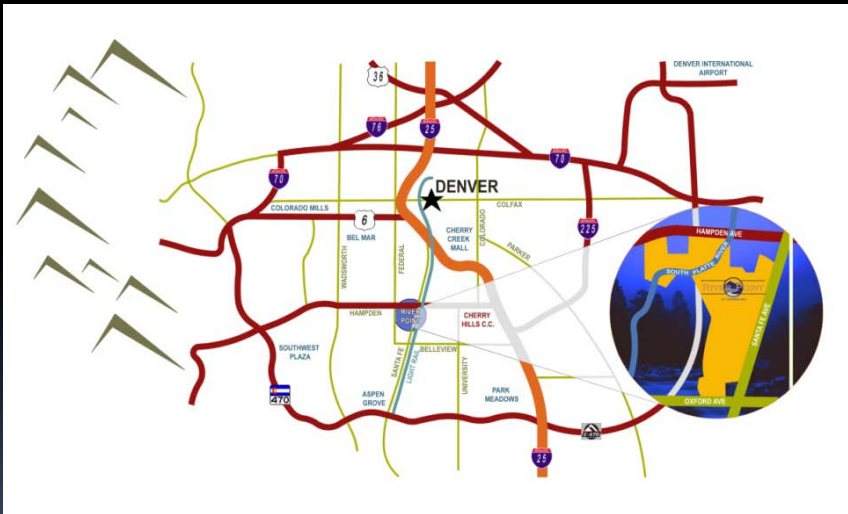
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Site Description

- 135 acres southwest of Denver
- 750,000 square feet building space
- Retail shops, restaurants, theater, Super Target, Costco



Site History

- Arapco Landfill
- Herbertson's Pay Dump
- Junk yards
- Gravel pits
- Repair/service stations
- Other commercial uses
- Nearby industrial sites



Site Clean-up

- Surface clearance
- 750,000 yd³ trash
- Asbestos containing materials
- Low level radioactive waste
- Abandoned/buried chemicals
- PCBs
- Lead-contaminated soil
- Petroleum products



Vapor Intrusion Issues

Soil Gas Concentrations ($\mu\text{g}/\text{m}^3$)		
Compound	Median	Maximum
Methane	44.7% v/v	99.9% v/v
PCE	27	9,800
TCE	34	8,900
cis-1,2-DCE	20	62,000
Vinyl Chloride	31	9,700
Benzene	290	5,700
Chloroform	18	3,200
Freon-12	530	550,000

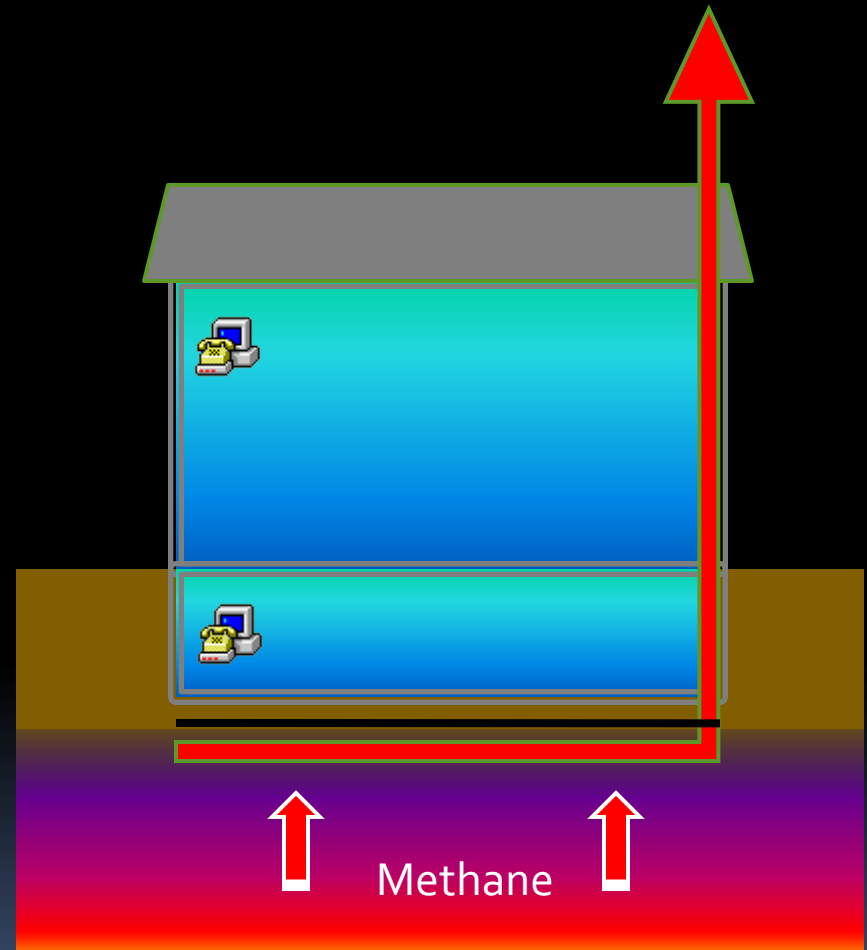


Methane Properties

- Produced by anaerobic decomposition of organic matter
- Flammable in air
 - Lower explosive limit = 5%
 - Upper explosive limit = 15%
- Simple asphyxiant

Building Design

- MSW at variable depth
- Sub-slab venting system
- Impermeable membrane
- Methane detection system

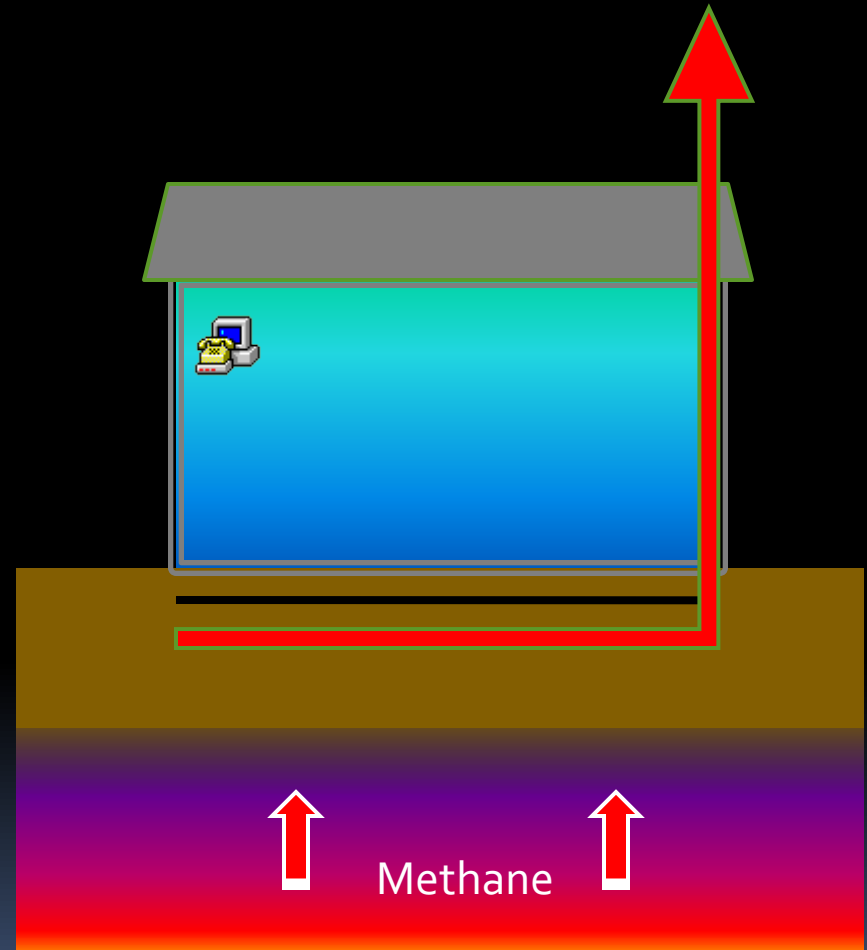


Methane Standards

- City of Los Angeles Code allows up to 25% LEL in buildings (12,500 ppm)
- Colorado Department of Public Health and Environment
 - 25% LEL (12,500 ppm) in landfill structures
 - 100% LEL (50,000 ppm) in soil gas at landfill boundary
- OSHA:
 - No PEL for methane
 - 67% LEL (33,000 ppm) based on oxygen deficiency
 - 10% LEL (5,000 ppm) in permit-required confined space
- ACGIH TLV = 1000 ppm (C_1 to C_4 hydrocarbons)

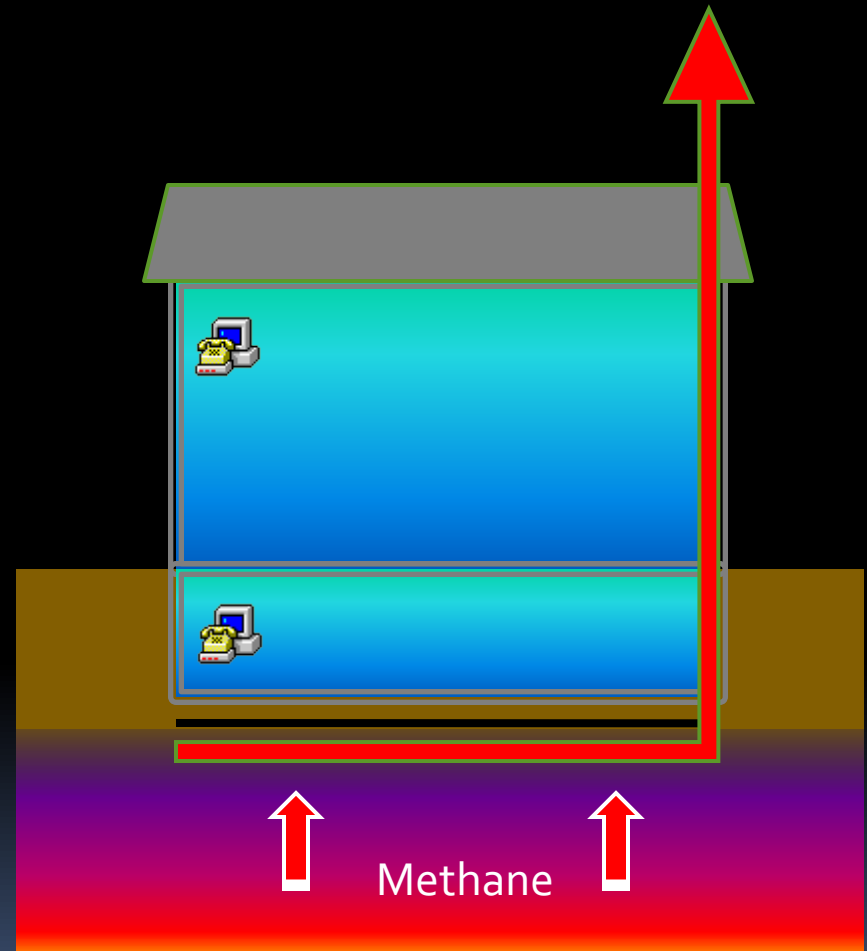
Scenario 1: No crawl space

- What concentration of methane is acceptable?
- Do OSHA PRCS criteria apply?
- Occupant and public perception



Scenario 2: Crawl Space

- What concentration of methane is acceptable in the occupied space?
- What concentration of methane is acceptable in the crawl space?
- OSHA prohibits crawl space entry if $>10\%$ LEL



Conclusions

- Short-term (“acute”) goal 10% LEL (5000 ppm) in indoor air and crawl space
- Don’t let methane get to 10% LEL
- Supervisory alarm at 5% LEL (2500 ppm)
- Long-term (“chronic”) goal 1000 ppm (quarterly monitoring using ASTM D1946)
- Should occupied spaces be evacuated if crawl space is >10% LEL?
- Underground structures (sewers, vaults, utility corridors) require consideration



Questions

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