APPENDIX E. LIQUEFIED PETROLEUM GAS (LPG) QUICK RESPONSE GUIDE

E.1 Overview of Spill Characteristics, Properties, Behaviors, and Hazards

Table E-1, Table E-2, and Table E-3 and provide high-level overview of liquefied petroleum gas (LPG) spill characteristics, properties, behaviors, and hazards.

Table E-1. LPG spill characteristics.

Behavior when Spilled	Dissipation or Degradation Rate	Ecological Impacts	Flammable / Explosion Risk	Toxicity	Air Displacement and Suffocation Risk to Crew	Spill Cleanup
Will float but rapidly evaporate, forming flammable vapor cloud	Fast	No long term impacts, but aquatic life in contact with spill may be poisoned	High	Yes, but limited to spill zone	Low	Will dissipate before cleanup can begin

Table E-2. Summary of key LPG properties and behaviors (ITOPF, 2024e).

	Properties	Behavior
Chemical Composition	Primarily propane or butane, or a mixture of both. Can contain propylene of isobutane and butylenes.	LPG properties vary slightly depending on the exact composition.
Boiling Point	-42 °C	At ambient conditions, LPG is a gas.
Liquid Specific Gravity (@ -50 °C)	0.51 - 0.58	LPG has half the density of water; therefore, as a liquid, LPG will float if spilled on water.
Vapor Specific Gravity (@ -13 °C)	2.1	Vapors of LPG at low temperatures are twice the density of air and will spread above the ground/water surface when spilled.
Vapor Specific Gravity (@ ambient temp)	1.5	Vapors of LPG at ambient conditions remain denser than air and will spread above the ground/water surface when spilled.
Solubility	Insoluble	Liquid LPG will not mix with water (run-offs) or seawater.
Flammability Range	2.2 - 9.5 (v/v) %	Outside of this range, the LPG/air vapor mixture is not flammable.

Table E-3. High-level overview of hazards associated with LPG (ITOPF, 2024g).

State		Longevity in the Environment	Toxicity to Humans	Health & Safety: Main Concerns	Protracted Response to Recover Pollutant
Under Ambient Conditions	During Transport				
Gas	Liquid (pressurized and refrigerated)	Hours	Non-toxic	Significant risks linked to flammability, explosivity, asphyxiation, and extreme low temperatures	Unlikely

E.2 Responder Safety Considerations

Liquefied Petroleum Gas (LPG) typically consists of propane, butane, or a mixture of the two, stored under pressure as a liquid and vaporized upon release.

Responders must approach from upwind.

Vapor cloud behavior should be anticipated, and safe perimeters established quickly based on atmospheric monitoring and environmental conditions.

Principal hazards include:

- Flammability and explosion risk: LPG has a wide flammability range (2.2 – 9.5% by volume in air) and can form explosive vapor-air mixtures.
- Asphyxiation risk: LPG vapor is heavier than air and can accumulate in low-lying areas, displacing oxygen.
- Cryogenic exposure (when released as a refrigerated liquid): Contact can cause frostbite and material embrittlement.
- Vapor cloud formation: A dense, visible cloud can develop, spreading horizontally and posing ignition risks at a distance.

Personal Protective Equipment (PPE):

- Self-contained breathing apparatus (SCBA).
- Cryogenic-resistant gloves if cold LPG is involved.
- Mandatory use of intrinsically safe equipment.

Personnel must be trained to recognize LPG-specific hazards, particularly in enclosed or poorly ventilated areas where vapor accumulation can quickly reach explosive concentrations. Decontamination and emergency medical support should be available for cold burns and inhalation exposure.

E.3 Detection and Monitoring

Detection of LPG releases relies primarily on combustible gas indicators (CGIs) and infrared gas detectors. LPG vapors, being heavier than air, accumulate in depressions, engine rooms, and enclosed compartments, necessitating multi-level atmospheric monitoring.

Visible vapor clouds often accompany LPG releases under humid conditions. However, absence of a visible cloud should not imply safety. Portable gas detectors should be calibrated for propane or butane, depending on the specific LPG blend in use. Thermal imaging can assist in detecting cold vapor clouds, especially when visual confirmation is difficult.

Uncrewed aircraft systems (UAS) equipped with gas detectors can survey larger spills or inaccessible areas to assist in exclusion zone delineation. Continuous air monitoring during response operations is critical for responder safety and hazard management.

E.4 Fire Fighting

In the event of ignition, LPG fires are extremely intense and require careful tactical response. Unignited vapor clouds pose the highest risk and should be dispersed through controlled ventilation if safe to do so.

- Small LPG fires - use dry chemical extinguishers.
- Large LPG fires - Focus on protecting exposures and allow LPG to burn off under controlled conditions. Direct extinguishment without controlling the source may result in re-ignition or catastrophic vapor cloud explosions.

Concerns/considerations:

- Water spray may be used to cool adjacent structures and prevent escalation.
- Foam is not effective on LPG fires.
- Fire crews must remain aware of BLEVE (Boiling Liquid Expanding Vapor Explosion) potential if LPG containers are exposed to heat and should withdraw to safe distances if tank integrity cannot be assured.

E.5 Spill Response

LPG spill response focuses on vapor control, ignition prevention, and public safety. Mechanical containment of LPG liquid is generally not practical, as it rapidly vaporizes when exposed to ambient temperatures.

Exclusion zones must be established based on the predicted spread of the vapor cloud. All ignition sources within the potential flammable range must be eliminated. Portable and fixed gas detectors should be deployed to track cloud movement.

If vapor clouds are confined, controlled ventilation may assist dispersion. In open areas, natural dispersion aided by wind conditions will reduce fire and explosion risks.

E.6 Environmental Impacts

LPG releases generally pose low long-term environmental risk. As a volatile organic compound, LPG does not persist in water or soil, and evaporates quickly under most conditions.

In marine environments, spilled LPG will float on water as a cold, evaporating layer and will not dissolve well. Aquatic toxicity is considered low for short-term exposures; however, localized freezing at the water surface may cause temporary harm to marine organisms directly beneath the spill area.

Infrastructure exposed to cold LPG releases may suffer from cryogenic damage, including embrittlement of metals and concrete. Post-incident inspections should be conducted to assess structural integrity.

Long-term remediation is rarely required following an LPG release, although environmental monitoring and impact assessments may be needed to verify natural recovery.