

Comprehensive Risk and Environmental-Social Impact Assessment of Fuel Storage Tank Incidents in Infrastructure Projects Using Phast (A Case Study of the Esfahan Emergency Water Transfer Project)

Extended Abstract

Introduction: Fuel storage tanks, particularly in large-scale infrastructure projects such as emergency water transmission lines, present significant risks due to potential leakage, fire, or explosion. These incidents can cause extensive environmental contamination, human casualties, and disruption of critical services. The present study focuses on the emergency water transmission project in Isfahan Province, Iran, which includes diesel storage tanks essential for pump station operation. This research integrates Quantitative Risk Assessment (QRA) using the PHAST software to evaluate both technical (e.g., vapor dispersion, delayed explosion, thermal radiation) and socio-environmental consequences of two hypothetical accident scenarios: full tank rupture and wall perforation.

Materials and Methods: The study employed PHAST 8.0 software to model two main scenarios at three horizontal cylindrical diesel tanks located along the 202-kilometer transmission route. Environmental input data were derived from four synoptic meteorological stations in the project area. Parameters such as ambient temperature, wind direction, and terrain type were considered. Outputs included gas concentration vs. time/distance, explosion overpressure, and thermal radiation profiles. These were spatially overlaid on regional maps to evaluate potential impacts on nearby residential, agricultural, and ecological zones.

Results: In the full-rupture scenario, hazardous gas concentrations exceeded 1000 PPM up to 400 meters from the source, with maximum explosion overpressure reaching 0.02 bar at 300 meters. Thermal radiation levels were critical within a 10–50 meter radius. The wall-perforation scenario showed high concentrations (up to 100,000 PPM) in closer ranges (~90 m). Mapping outputs indicated that certain rural settlements and agricultural lands fall within danger zones.

Discussion and Conclusion: This research demonstrates that fuel tank failures along water transmission infrastructures pose significant human and environmental hazards. The use of PHAST provides reliable estimations of dispersion and impact radii under realistic conditions. Findings emphasize the urgent need for safety zoning, early detection systems, and design modifications to mitigate potential disasters. Moreover, integrating technical modeling with geographic and socio-environmental assessments offers a comprehensive approach for proactive risk management in critical infrastructure projects.

Keywords: Quantitative Risk Assessment, PHAST modeling, Crisis Management, Operational Risks, Regional Impacts.