Public Safety Issues at the Proposed Harpswell LNG Terminal

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1 Introduction

Fairwinds[1] has proposed to lease a site owned by the Town of Harpswell, Maine, for the purpose of constructing and operating a liquefied natural gas (LNG) import terminal. The LNG would be unloaded from marine tankers and stored on site for subsequent regasification and transmission via underwater pipeline to Cousins I. and thence overland to connect to a Portland Pipeline transmission line in Maine.

Natural gas, a hydrocarbon fuel, is usually piped directly from a gas well to the end consumer, never being stored locally in large amounts. When cooled to liquid form, however, as much as 50,000 tons can be stored in insulated tanks on land or aboard ship. In this form it is especially hazardous if it escapes by accident from its container, spilling onto ground or water and turning very rapidly into gaseous form whereupon it will mix with air and then burn if ignited. An LNG import terminal is therefore a hazardous industrial facility which could experience accidental fires that might harm surrounding populations and property.

To build and operate an LNG terminal at the Harpswell site, Fairwinds must obtain permission from the Federal Energy Regulatory Commission (FERC), an independent agency that regulates interstate commerce in natural gas and electricity. Although primarily an economic regulator, FERC has asserted jurisdiction over the safety aspects of the LNG facilities it permits. FERC requires facility owners to meet certain technical standards in site selection and equipment design and operation before it awards the right to import LNG and to connect the facility to an interstate natural gas transmission line. FERC's jurisdiction does not extend to safety aspects of marine tankers; they are regulated by the U.S. Coast Guard.[2]

FERC's objective in safety regulation is to limit, but not necessarily prevent, harm to persons and property outside the confines of the terminal site, should there be an accidental release of LNG at the site. The principal harmful effects are two: vapor plumes or clouds that can be ignited outside the site boundaries and harmful thermal radiation from on-site fires that extends across the site borders. But FERC's safety rules do not consider all credible spills on the site or from the LNG tankers while being unloaded.

This paper explains the safety requirements that will likely be applied by federal regulators to the proposed LNG terminal in Harpswell. It delineates the geographic extent of harmful effects that could be expected from LNG spills at the site, including those that are excluded from FERC and U.S. Coast Guard regulations.

2 FERC site selection criteria

FERC rules[3] require the LNG terminal owner to install extensive technological features that will limit the harmful consequences of an accidental spill of LNG to within the property line enclosing the terminal. The harmful effects are twofold: combustible mixtures of vapor and air, such as might be driven by the wind blowing over an evaporating pool of spilled LNG, and thermal radiation from a fire burning above a liquid spill on the site. The types of spills to be considered are also twofold: a

[1] Fairwinds LNG (www.fairwindslng.com) is a joint venture of ConocoPhillips Co. (www.conocophillips.com), an international energy company, and Transcanada Pipelines Limited (www.transcanada,com, a transmitter of natural gas in Canada and the United states.

[2] The safety of the natural gas pipeline connecting the terminal to the interstate transmission line is regulated by the Office of Pipeline Safety of the U.S. Department of Transportation, but the FERC permit for the LNG terminal confers on the terminal owner the right to seek seizure of private land to construct the connecting pipeline, if necessary.

[3] Code of Federal Regulations, 49 CFR 193.

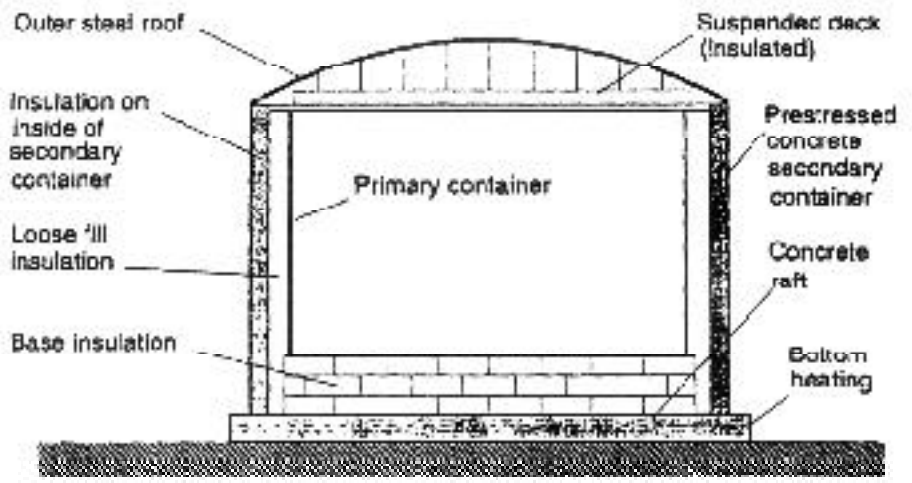

Figure 1: The primary and secondary containment tanks for a "full containment" storage tank of the type to be used at the proposed Harpswell LNG terminal.

spill from transfer piping connecting the storage tanks and the regasification or unloading facilities, and the failure of the primary storage tank enclosure.

Limiting the harmful effects requires the construction of impounding areas surrounding spill sources that will collect the spilled liquid and slow its vaporization or burning rate. If the latter are sufficiently small, harmful effects will not extend beyond the site line. For transfer line spills, the LNG is collected in a central impounding area. For storage tank spills, the inner storage container is surrounded by a secondary containment tank of slightly larger size, as shown in Figure 1, which can contain all the LNG that might spill from the inner primary container.

The harmful effect of ignitable natural gas vapor is measured by the flammability distance, a distance down wind from the spill site at which the vapor has been so diluted by mixing with air that it cannot be ignited. Any ignition at a closer distance can propagate a flame, but that flame will not propagate beyond the flammability distance. If the latter distance lies within the site boundary, no flame can extend beyond that boundary.

Thermal radiation from on-site LNG fires fed by an evaporating pool of spilled LNG can cause first, second or third degree burns to the skin of humans exposed to the radiation, depending upon the intensity of radiation. The least intense thermal radiation that FERC rules allow humans outside the site boundary to be exposed to is 5 kilowatts per square meter, an amount that produces second degree burns after only thirty seconds exposure.[4]

The FERC requirements for the proposed Harpswell terminal can be estimated from the Final Environmental Impact Statement for the Hackberry LNG project in Louisiana.[5] This project, consisting of three storage tanks and two unloading piers, employs the technology likely to be used at the Harpswell facility. Values from this report of the flammability and thermal radiation distances for a transfer line spill, and the thermal radiation distance for a primary containment spill, are listed in Table 1, together with the amounts of the respective spill volumes. These distances are shown

[4]More intense and thereby more damaging exposure is permitted depending upon land use characteristics at the site boundary.

[5]Final Environmental Impact Statement, Hackberry LNG Project, Cameron LNG, LLC. FERC/EIS-0156. Office of Energy Projects, Federal Energy Regulatory Commission, Washington, DC 20426. August 2003.

Table 1: Flammability and radiation distances for FERC-defined spills

Spill source	Size (ton)	Flammability (ft)	5 kW/m^2 Radiation (ft)
Transfer piping	840	770	320
Storage tank (primary)	74,000		929

as circles in the map of Figure 2, centered on the likely location of the spill site. It would appear that for these FERC-defined spills neither radiation nor flammability will exceed the FERC limits beyond the site boundary.

3 Risks that FERC ignores

There are several important public safety risks that are not considered in the FERC regulations discussed above.

1. First of all, FERC allows damaging thermal radiation beyond the site boundary as long as its level is below 5 kilowatts per square meter. However, it is not until the thermal radiation intensity falls below 1.6 kilowatts per square meter that there is no damage to exposed humans. A safe radiation distance for fires would be that for which the thermal radiation level does not exceed 1.6 kilowatts per square meter.

2. In considering a spill from the primary LNG tank into the secondary containment vessel, FERC regulations ignore the possibility that this spill may not be accompanied by a fire, but instead might evolve LNG vapor that could be ignited beyond the site boundary. The flammability distance for this type of accident should not extend beyond the site boundary.

3. Most of all, FERC's regulations ignore the greatest risks of all, that foreign or domestic terrorists could destroy the storage tank primary and secondary containment systems, or the LNG tanker cargo hold, allowing LNG to spill unhindered onto ground or water, where it may evaporate or burn. Because the lateral extent of such spills would be so much greater than those considered in the FERC regulations, it is to be expected that their harmful effects would exist very far beyond the site boundaries.

To show how public safety can be adversely affected by credible spills that have been overlooked by FERC, we have extended Table 1 to include the effects listed above. This expanded assessment is listed in Table 2. Two additional spills are considered, those from the secondary storage tank containment system and a single hold of a marine tanker (last two rows of Table 2). For these and the previous spills of Table 1, the safe radiation distance, mentioned in item 1 above, has been calculated for all spills (last column of Table 2). Also, the flammability distance for the FERC primary containment failure accident is shown in the flammability column.

The non-FERC flammability and radiation distances of Table 2 are shown in Figure 3. All of these extend beyond the site boundaries, especially so for the tanker and secondary tank spills with

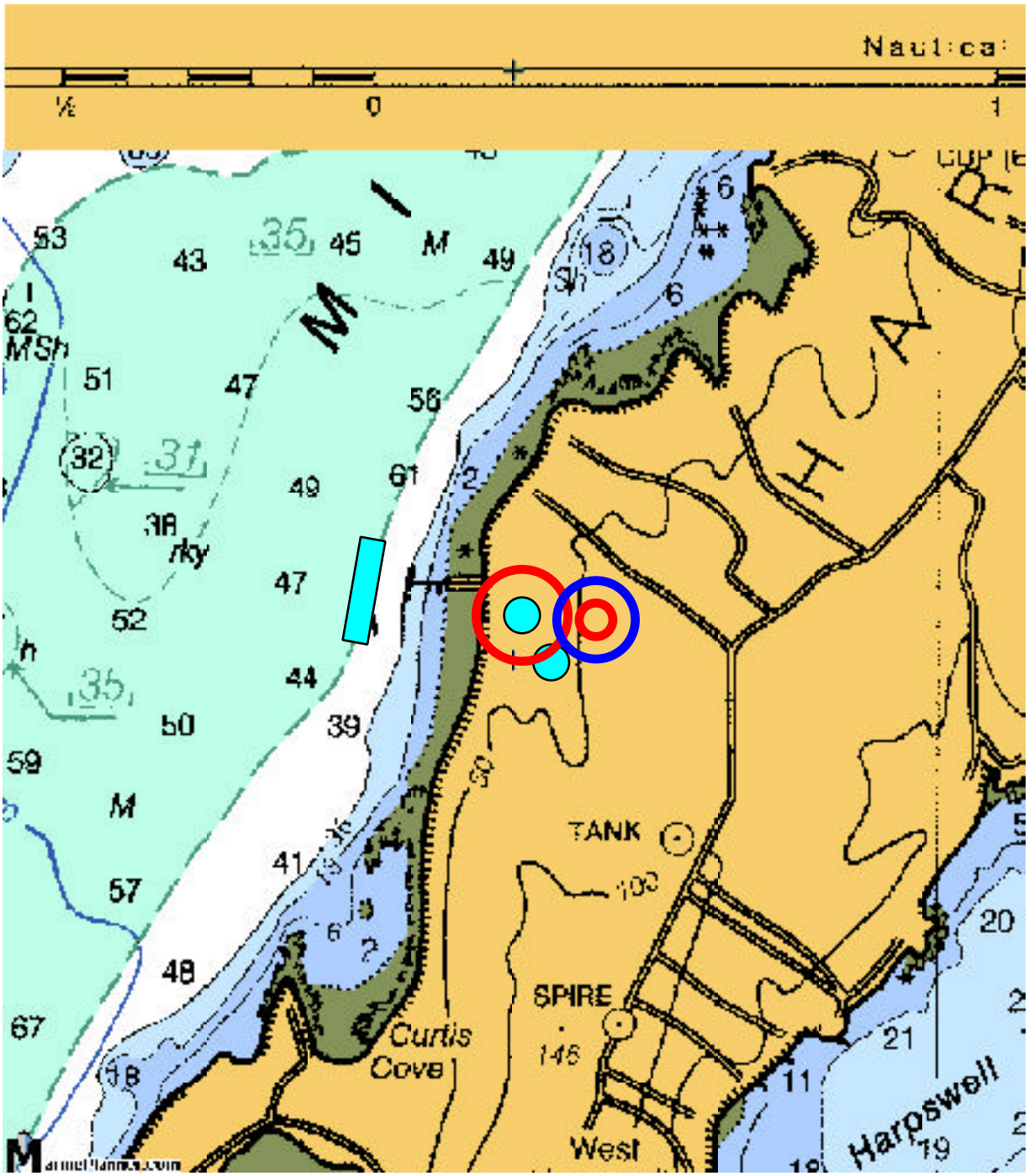

Figure 2: FERC-defined thermal radiation and flammability zones for the proposed Harpswell LNG terminal. Red circles are distances to radiation intensities of 5 kW/m^2 for a spill with fire; blue circle is the distance to the flammability limit for a spill without fire. Large red circle is for failure of primary tank containment; small red and blue circles are for transfer piping release.

Table 2: Flammability and radiation distances for all credible spills

Spill source	Size (ton)	Flammability (ft)	1.6 kW/m^2 Radiation (ft)
Transfer piping	840	770	1230
Storage tank (primary)	74,000	9500	1490
Storage tank (secondary)	74,000		9630
Tanker hold	6,000		5780

fire. But even the FERC spills with fire from transfer piping and primary containment send damaging radiation beyond the site boundaries. Altogether, about 3 square miles of the west Harpswell peninsular are at risk for damage to humans from on-site spills at the proposed LNG terminal.

The blue circle in Figure 3 depicts the flammability distance for the primary tank spill without fire. For any such spill, the flammable vapor plume or cloud would extend from the tank in the wind direction, encompassing an area smaller than that of the blue circle. Winds from the southwest, and clockwise to the northeast, would send the vapor over land areas of Harpswell.

The spills described in Tables 1 and 2 do not include spills without fire from the secondary containment containment of the storage tank and the LNG tanker. One estimate for such spills, almost certainly low, gives flammability distances of 3.25 and 2.5 miles, respectively.[6] If plotted as in Figure 3, these radii would encompass much of Orrs and Bailey Islands, as well as additional areas on Harpswell neck.

4 Conclusions

The federal safety requirements for the proposed Harpswell LNG terminal will not prevent harm to humans outside the site boundary for the spill scenarios that FERC considers.

For all credible spills, including terrorist attacks on the storage tank and LNG tanker, the danger zone for humans extends nearly two miles from the terminal site, encompassing three square miles of land on the Harpswell peninsular.

[6] Liquefied Natural Gas in Vallejo: Health and Safety Issues. Final Report, LNG Health and Safety Committee of the Disaster Council, City of vallejo, California.

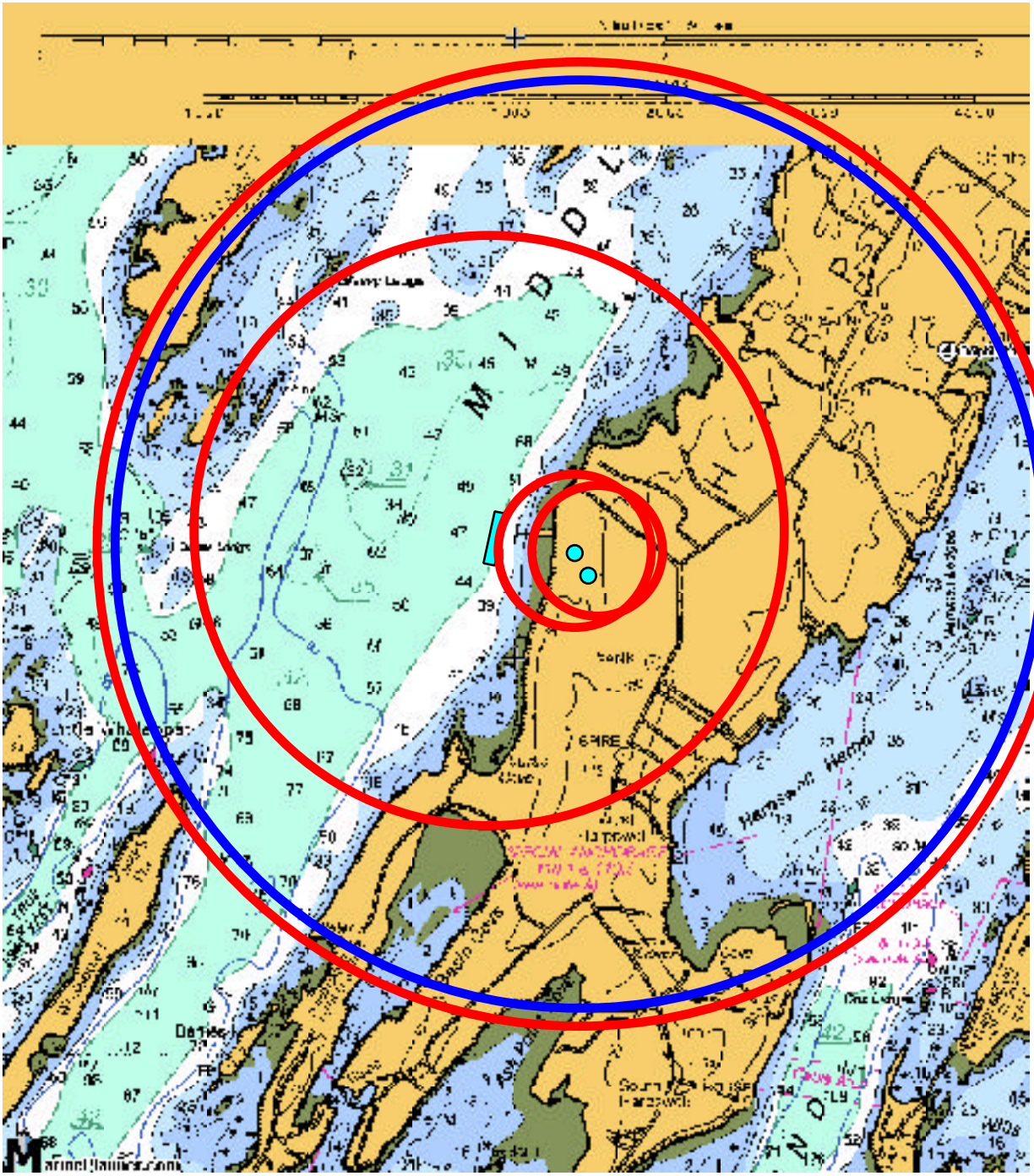

Figure 3: The non-FERC flammability and radiation distances of Table 2. Red circles are distances to radiation intensities of 1.6 kW/m^2 for a spill with fire; blue circle is the distance to the flammability limit for a spill without fire. Largest red circle is for failure of secondary tank containment; next smaller red circles: tanker hold contents, primary tank, and transfer piping. Blue circle is loss of primary containment.