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Battery Rock LNG: A Risk Assessment

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BATTERY ROCK LNG: KEY JUDGMENTS

This analysis focuses on the security risk associated with an intentional spill of Liquid Natural Gas (LNG) from an LNG carrier transiting to or berthed at the proposed Battery Rock LNG facility on Outer Brewster Island. It does not address environmental impact, or political considerations associated with the proposal.

NET ASSESSMENT: We judge that there is a negligible security risk attendant to the Battery Rock proposal and that security concerns should not be a bar to the creation of an LNG offloading facility on Outer Brewster Island. Given the comparatively low consequences of a successful attack, the enhanced ability of the US Coast Guard and other law enforcement agencies to prevent the attack, terrorist groups determined to kill large numbers of Americans and inflict damage on our economy will likely seek more attractive targets. Attacking the proposed facility would not be consistent with the demonstrated intent and capability of terrorist organizations. We judge that there would be minimal casualties as a result of an attack on an LNG tanker at an LNG facility at Battery Rock. Moreover, given the route to and from the facility from Open Ocean, we judge that there would be minimal casualties resulting from an attack on the tanker during its transit to and from the facility.

As with any LNG offloading operation, there should be security measures in place to further reduce any threat. The Coast Guard, the State Police, and the facility operator should be able to concur on roles and missions for the execution of such security enhancements. Given the inherent security of the Battery Rock proposal, a relatively limited set of security measures is necessary and should be easily achieved. Good Harbor will remain engaged with AES to help design and facilitate the implementation of those measures.

To arrive at this conclusion we used a methodology that considers Risk as a function of Threat, Vulnerabilities, and Consequence. Below we review this methodology and the conclusion from each section.

1. METHODOLOGY: Traditional risk calculation methodologies are insufficient to deal effectively with the security risks now posed by terrorism. Terrorist events are inherently low probability events, particularly for attacks inside the United States. There is not sufficient data to use such methods effectively in determining the risk terrorism poses to individual facilities. Terrorism is however, now a foreseeable risk in the United States. Instead of calculating the probability of an attack, we suggest a five-part methodology that focuses on the potential security risk. These are subjective judgments based on the Good Harbor team's decades of experience in national security and homeland security, supported by our assessment of relevant scientific studies.

2. COMPONENTS OF RISK: An appropriate security risk management methodology examines THREAT, VULNERABILITY and CONSEQUENCE.

THREAT is defined as a function of INTENT and CAPABILITY. INTENT and CAPABILITY are further defined as:

> INTENT is defined as the extent to which terrorist groups have expressed interest in attacking a particular type of target or whether their strategic objectives would be served by such attacks;
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> CAPABILITY is defined as the extent to which terrorist groups have or could easily obtain the means necessary to conduct a significant attack against a class of facilities;

VULNERABILITY is defined as the extent to which a class of infrastructure has inherent weaknesses to certain vectors of attack, with and without mitigation efforts, that can be exploited to generate consequences;

CONSEQUENCE is defined as the range of damage from an attack on a certain class of infrastructure and to what extent surrounding communities have the capability to respond adequately to such circumstances; what the costs would be of creating missing capabilities and on whom the financial burden would be placed;

3. THREAT: In this report, we independently assess INTENT and CAPABILITIES to provide an understanding of the THREAT.

INTENT: Jihadist groups including al Qaeda and affiliated organizations have articulated goals including 1) killing large numbers of Americans; 2) conducting attacks in the United States; 3) damaging the US economy and 4) damaging oil and gas infrastructure.

A successful attack on an LNG carrier could fulfill all these intentions. Given our assessment of the vulnerabilities and consequences associated with this proposal, an attack on an LNG carrier transiting to or berthed at the Outer Brewster Island facility would not fulfill the intent of jihadists.

CAPABILITIES: Al Qaeda and related groups have demonstrated an ability to operate inside the United States, to carry out sophisticated planning and reconnaissance operations, and to attack maritime targets with sophisticated vessel-borne explosive devices. Such capabilities could be deployed against an LNG carrier. However, given the low consequences of a successful attack on a vessel at Outer Brewster Island, we judge that terrorist groups will choose to deploy these capabilities against more attractive targets.

4. VULNERABILITIES: LNG carriers have inherent vulnerabilities to terrorist attacks that could be exploited to generate high consequence events. Terrorist capabilities with small boat attacks and stand off weapons in particular could be used to exploit these vulnerabilities. The capability of the US Coast Guard and other law enforcement agencies to prevent such attacks is severely limited in congested inner harbors and inland

waterways. The location of Outer Brewster Island at the seaward entrance to Boston Harbor provides a much better opportunity to detect and intercept hostile actors before they carry out an attack. There are no shore-based positions from which a standoff weapons attack could be mounted. There are no marinas, coves or other locations in close proximity to the transit route that could be used to prepare for a small boat attack. The shore-side facility on Outer Brewster Island would be virtually immune from attack.

5. CONSEQUENCES: There is a spectrum of expert analysis on the extent of damage that would result from a worst-case scenario attack on an LNG carrier. In our prior analysis of the proposed facility in Providence, RI we focused on a 3-tank breach resulting in a pool fire of 572 meters in diameter. Within approximately a half-mile of the center of the fire, thermal radiation levels would produce catastrophic harm including instantaneous death, destruction of wooden structures and the bending of steel. Out to approximately 1.3 miles from the center of the fire, thermal radiation levels would be high enough to cause severe burns, detonate combustible fuels, and damage property. Applying these standards to the Outer Brewster proposal, there are no residences, no schools, no hospitals, and no additional infrastructure inside these limits. Residents in the Town of Hull, population 11,050, may be exposed to slightly higher levels of heat than is present on a normal day. Seeking shelter in doors should provide sufficient protection to remediate any harm. Local emergency response and hospital preparedness is likely sufficient to treat the small numbers of victims from an attack.

6. FURTHER RISK REDUCTION MEASURES: Constructing the facility in a remote, offshore location provides the best kind of security. The location is easier to protect and potential casualties are too low to make the investment in carrying out the attack worth it to terrorist organizations. Additional investments in security by AES and prudent security measures by the Coast Guard and other law enforcement agencies could provide additional deterrence, help to prevent an attack, and reduce the consequences of an attack. In constructing the facility, AES should work with law enforcement partners to embed security features including smart camera technology, intrusion detection and anti-swimmer technologies. Sensors for detecting releases of LNG should be deployed and the data fed to local law enforcement and emergency management watch centers. In general, AES should attempt to lessen the burden placed on federal, state and local security assets by investing in prevention. The Coast Guard and law enforcement partners should deploy security zones around the approaching vessel as is standard practice for the existing Everett terminal. Coast Guard boarding parties should have the capacity to sweep the ships for explosives, inspect the crew for weapons, and prevent an attempt to steer the vessel to any location other than the offloading terminal.

ABOUT GOOD HARBOR CONSULTING

Good Harbor Consulting, LLC provides strategic advice and counsel for a broad range of clients – including Fortune 500 companies, industry associations, systems integrators, and innovative technology start-ups – in the fast-developing areas of homeland security, cyber security, critical infrastructure protection and counterterrorism. Bringing to bear decades of U.S. Government, legal, and private sector consulting experience on the most pressing challenges in today's business environment, Good Harbor provides clients competitive advantage in four key areas: Strategic planning; Security product strategy evaluation; Partnership opportunities with private enterprises, critical infrastructure owners, venture capitalists, and systems integrators; and Corporate security risk management. Good Harbor Consulting, LLC is led by Richard A. Clarke, chairman, and former senior White House Advisor to three Presidents on national security and counterterrorism. This report was prepared by Richard Clarke, Roger Cressey, Daniel Dolgin, and Rob Knake.

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BATTERY ROCK LNG PROPOSAL

In the beginning of 2006, AES asked Good Harbor Consulting to conduct a risk assessment for their proposed LNG terminal facility on Outer Brewster Island in Boston Harbor. AES is a worldwide energy company with 30,000 employees with ownership or interest in 113 energy plants in 27 countries. Founded in 1981, AES has grown to be the single largest private provider of energy in the world. AES currently operates the Andres LNG Terminal in the Dominican Republic and is pursuing other projects in the Bahamas and Sparrows Point, Maryland, in addition to the proposed project on Outer Brewster Island.

Outer Brewster Island is a 20-acre granite outcropping located on the eastern most end of the grouping of islands known as the Boston Harbor Islands. It is managed in a joint partnership between the Commonwealth of Massachusetts and the National Park Service. The island is treeless and uninhabited. In the nineteenth century, it was used as a granite quarry. During World War II, it was a coastal defense battery. Current structures include an abandoned military barracks, abandoned desalinization plant, and the remnants of the north side of the island and other structures. The AES site plan calls for constructing a pier that would extend off the north side of the island for vessels to berth at, two LNG storage tanks, LNG vaporizers, and an admin and maintenance facility. The storage tanks will be built below grade to minimize the visual impact of the structures and for improved safety and security. The storage facility will be connected to the regional natural gas distribution system by a one-mile underwater pipeline where it will connect with the "Hubline" that runs through Boston Harbor and connects to the regional and national natural gas distribution system. The facility would receive up to three shipments per week, providing approximately 9 billion cubic feet (bcf) of gas.

RISK ASSESSMENT METHODOLOGY

In assessing the risk associated with a terrorist strike on an LNG tanker transiting to or berthed at Outer Brewster Island, we use the accepted equation that RISK is a function of THREAT, VULNERABILITY and CONSEQUENCE. The Good Harbor Team defines these terms to avoid redundancy between them and to focus on factors that can be separately examined in measuring the risk of a specific scenario.

THREAT is defined as a function of INTENT and CAPABILITY. INTENT and CAPABILITY are further defined as:

> INTENT is defined as the extent to which terrorist groups have expressed interest in attacking a particular type of target or whether their overall ends and priorities would be served by such attacks;
>
> CAPABILITY is defined as the extent to which terrorist groups have or could easily obtain the means necessary to conduct a significant attack against a class of facilities;

VULNERABILITY is defined as the extent to which a class of infrastructure has inherent weaknesses to certain vectors of attack, with and without mitigation efforts, that can be exploited to generate consequence;

CONSEQUENCE is defined as the range of damage from an attack on a certain class of facilities and to what extent the facilities and the communities in which they reside have the capability to respond adequately to such circumstances; what the costs would be of creating missing capabilities and on whom the financial burden would be placed;

In the next three sections, we look at THREAT, VULNERABILITY and CONSEQUENCE for an LNG terminal on Outer Brewster Island. Though considered separately, these three components make up a chain of causality, where threats are first considered, then mapped against known vulnerabilities that have the potential to generate high consequences. Our approach to risk analysis would suggest that a target is rated as high risk if a terrorist organization's capabilities could be used to exploit vulnerabilities that would generate high consequences.

In the final section, we offer a NET ASSESSMENT and conclude with a series of security measures that should be considered by AES, the US Coast Guard, and local law enforcement.

THREAT: INTENT AND CAPABILITIES OF TERRORIST GROUPS REGARDING LNG CARRIERS

The threat of terrorism resides at the nexus of intent and capability. In judging whether terrorists are likely to strike a particular target, we consider whether a successful strike will fulfill their intent but also whether executing a successful strike is within their capabilities. The attacks on September 11th showed the jihadists movement intent to attack the United States. It also demonstrated the kind of capabilities they can achieve in order to carry out their intent. Planning and reconnaissance phases lasted years. The attackers learned how to fly and how to engage in close quarter combat. They used these capabilities to hijack aircraft and turn them into guided missiles. Given the stated intent from al Qaeda and affiliated organizations to cause this level of destruction again, we should assume that they are looking for other opportunities to use our own infrastructure against us.

Intent

Jihadist groups including al Qaeda and affiliated organizations have articulated goals including 1) killing large numbers of Americans; 2) conducting attacks in the United States; 3) damaging the US economy and 4) damaging oil and gas infrastructure.

A successful attack on an LNG tanker could fulfill all these intentions. Transporting large quantities of this hazardous substance through inland waterways to urban terminals presents the sort of target that could kill large numbers of American citizens, destroy our economic centers, and eliminate critical assets for importing energy. As our Providence report concluded, a precisely timed assault against a slow moving LNG carrier transiting within close proximity to densely populated areas could cause death and destruction far greater than 9/11. In addition, it could bring global trade to a halt for a prolonged period of time and deprive us of a growing source of energy for both power generation and wintertime heat.

The rising number of attacks on the shipping industry show that jihadist groups are focused on the maritime sector in particular and further demonstrates why LNG carriers are likely in their radar. In the Straits of Malacca, groups continue to hijack ships such as the *Dewi Madrim,* practice steering the bulky tankers through narrow channels, and then abandon the ships without taking any cargo or hostages. The *Dewi Madrim* incident and others like it are likely the equivalent of flight training for a new breed of maritime terrorist. Additionally the IMB reported numerous attempts by armed men in multiple speedboats to commandeer tankers in the Gulf of Aden in August 2005. Later that month a Syrian with ties to al Qaeda was arrested and charged with planning to attack Israeli cruise ships using speedboats laden with explosives similar to the attacks performed against the *USS Cole* and French oil tanker *Limburg.*

In 2002, Al Qaeda's former chief of naval operations and a key organizer of the *Cole* and *Limburg* attacks, Abdul Rahim Mohammed Hussein Abda al-Nasheri (a.k.a. Mulla Ahmad Belal), was captured in Yemen. He has since provided information to American officials that confirm al Qaeda's intent to target the maritime sector. According to a

counterterrorism official familiar with the interrogation, al-Nasheri yielded substantial information on al Qaeda's intent to target super-tankers and alerted them to the presence of an al Qaeda naval manual that describes in detail "the best places on the vessels to hit, how to employ limpet mines, fire rockets or rocket-propelled grenades from high-speed craft and turn liquefied natural gas (LNG) tankers into floating bombs." The manuals are purported to show how to use fast boats packed with explosives to target larger vessels, using larger vessels to target onshore installations, and discusses underwater attacks.

Of more recent concern is the February 2006 prison escape that freed 23 al Qaeda operatives in Yemen. Among the missing fugitives are two high profile terrorists Fawaz al-Rabihi and Jamal al-Badawi both considered battle-proven experts in maritime terrorism. Al-Badawi was sentenced to 15 years for his involvement in planning the *USS Cole* attacks, while al-Rabihi was sentenced to death for his role in the attack against the *Limburg.* Their escape could signal that more attacks will be planned against commercial maritime targets, specifically against the oil and gas industry. Similarly, documents recently circulated by *jihadist* groups on the internet detail a high level of interest in US petroleum assets and provide critical information about the industry including location of distribution infrastructure, capacities, routes, facts and figures as well as advice about the ideal months to strike. The author of the document advises that smaller homegrown cells operating in tandem would be best able to conduct such attacks and asks readers to provide additional information about other vulnerable critical infrastructure in the US.

Capabilities

Al Qaeda and related groups have demonstrated an ability to operate undetected in the US. Even since 9-11, terrorist groups have maintained a presence in the US despite our attempts to expose them. A 2005 report indicated that the FBI has over 1000 Full Field Investigations underway against al Qaeda alone. Our border control efforts do little to deter illegal crossing into the United States, which continues to be a commonplace activity.

Weapons and other capabilities needed to conduct an attack on an LNG carrier can be readily obtained in the US, according to US Government reports. A variety of boats and scuba gear can be easily procured. General Aviation aircraft can easily be rented or stolen at numerous small airports throughout the United States. Explosives are readily available, both fertilizer based weapons, which can be procured without a license, and commercial explosives, which are frequently stolen and sold on the black market. Large caliber rockets can be obtained on the international gray arms market. Few containers entering the United States are inspected by US Customs and can deliver shipments of nefarious goods and materials needed to complete any mission.

Carrying out attacks against ocean vessels or other maritime targets provides a unique set of challenges in comparison to the more typical land based operations. Despite the inherent difficulties, small boats laden with explosives are emerging as the preferred weapon of choice. Al Qaeda and related groups have demonstrated an ability to learn from past mistakes, hone their craft and retry with often much deadlier results. In January 2000 an attempted attack against the *USS Sullivan* failed when the boat terrorists

had planned to use was overloaded with explosives and sank. Ten months later their second attempt to attack a naval vessel, the *USS Cole*, proved much more successful. As one naval expert describes, small boats provide terrorists with reduced radar detection, superior maneuverability and the ability to hide among crowds such as fishing fleets and recreational crafts. They are easy to acquire and difficult to trace.

Although double-hulled tankers are the most hardened and difficult to penetrate of all vessels in the maritime industry, they are not immune from attack. As the damage to the supertanker *Limburg* illustrated, the techniques employed by al Qaeda to attack vessels at sea are capable of penetrating double-hulled vessels. Using only a small boat filled with approximately 1,000 pounds of explosives terrorists steered into the side of the tanker and blew a 30 foot hole through the ship. Al Qaeda claimed responsibility for the attack, rejoicing in having "hit the umbilical cord and lifeline of the crusader community."[1]

In sum, al Qaeda and affiliated splinter groups, have shown they have the capability to carry out highly sophisticated attacks against their enemies all throughout the world. Furthermore, as the events of 9/11 made clear, terrorists are chillingly creative when devising how best to use the US civilian infrastructure as weapons against US facilities.

Threat Assessment

That al Qaeda and affiliate groups are intent on killing large numbers of Americans in the United States, harming our economy, and attacking our energy infrastructure is beyond dispute. That these organizations possess or could obtain the necessary capabilities to carry out a sophisticated attack using our own infrastructure against us was made clear on 9/11. Given the potential consequences of an attack on an LNG carrier, and the vulnerability of the vessels to the types of attacks al Qaeda has carried out in the past, we find that such an attack is within both the intent and capabilities of terrorist groups today.

In the next section we look at the vulnerability of LNG carriers given the capabilities outlined above and consider the specific circumstances of the Battery Rock Proposal. Following this vulnerability assessment, we look at the consequences of a successful attack on a vessel approaching Outer Brewster Island or berthed at the terminal. In the final section we offer a NET RISK ASSESSMENT that considers the threat, vulnerabilities and consequences as reviewed and make preliminary recommendations for enhancing security at the facility to offer further deterrence.

[1] Brian Whitaker, "Bali Bombing: Tanker blast was work of terrorists," The Guardian (London), Oct. 17, 2002, Home Pages, p. 6.

VULNERABILITY: LNG CARRIER VULNERABILITY AND COUNTERMEASURES

The attack scenarios developed in this section are based on our previous work on the Providence, RI proposal from the spring of 2005. That report, LNG Facilities in Urban Areas: A Security Risk Management Analysis for Attorney General Patrick Lynch, Rhode Island was publicly disclosed. The scenarios described below are based solely on open source information including government reports, scientific studies and site specifics. They draw extensively on known tactics of terrorist groups. We have carefully considered each decision to include or exclude information based on its sensitivity.

To review, vulnerability is defined as the extent to which a class of infrastructure has inherent weaknesses to certain vectors of attack, with and without mitigation efforts, that can be exploited to generate consequences. Despite an excellent record of safety, LNG carriers remain vulnerable to the type of terrorist attack that could generate high-level consequences. In this section we first review the general vulnerabilities of LNG carriers and the potential consequences of exploiting these vulnerabilities. The next sections look at the approach sectors to the proposed terminal on Outer Brewster Island and examine attack scenarios for each sector.

General Vulnerabilities of LNG Carriers

As the basis for our analysis, we consider the worst-case scenario to involve the intentional breach of two tanks with punctures of approximately 5 square-meters. In such an incident, a third tank is likely to rupture as the result of cascading damage to the tanker from the initial blasts and resulting fire. The explosive devices used in the attack will likely cause the escaping gas to ignite, resulting in a pool fire of approximately 572 meters in diameter. This figure was determined according to the parameters of a three tank intentional breach set by Sandia National Lab.[2] Sandia also determined that a fire of this magnitude can be expected to burn for 8.1 minutes and generate temperatures well above 3,000 degrees Fahrenheit. Within 630 meters/2,066 feet of the fire's origin (the Red Zone), thermal heat thresholds would exceed 11,800 Btu.[3] From 630 meters to 2,118 meters/6,947 feet (the Orange Zone) thermal heat thresholds would reach 1,600 Btu. People inside the Red Zone would be killed regardless of protective clothing or shelter, wooden structures would ignite and steel could bend. Inside the Orange Zone, people in the open air would be exposed to potentially life threatening levels of thermal radiation. As a point of reference, firefighters are unable to operate, even with protective clothing and equipment, at levels above 2,000 Btu.

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[2] Mike Hightower et al., Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water, Sandia National Laboratories, December 2004.

[3] Btu or British Thermal Unit is a standard industry measurement for heat. One Btu is a basic measure of thermal energy or heat. One Btu is the amount of energy needed to heat one pound of water one degree Fahrenheit.

To achieve a three-tank breach, the Good Harbor team in our prior analysis for Providence, RI considered seven attack modes. These include attack by aircraft, standoff weapons, mortars, shaped charges, small boats, limpets, and mines. In that report we concluded the highest risk attack (as a function of difficulty and consequence) to be a small explosive laden boat, followed by a rocket attack, followed by an explosive laden plane. Other modes of attack were deemed to be ineffective in achieving the targeted outcome of a three-tank breach and resulting pool fire. We add here an examination of the insider threat.

Approach Sectors to Outer Brewster Island

In our analysis of the Providence, RI proposal, we divided the transit route into eight sectors. The sectors were chosen based on their proximity to shore (within 1000 yards), proximity to fixed structures such as bridges and jetties, and proximity to marinas/inlets or bays where a small boat threat could originate. Applying these conditions to Outer Brewster Island, there is no point on the transit route that meets any of these criteria. Outer Brewster Island is located at the seaward entrance of Boston Harbor. The transit route for tankers bound for Outer Brewster Island is not through an inland waterway. The approach to the proposed terminal does not contain any high value targets. Once constructed, the terminal itself will have some value as a target. This will be particularly true as demand grows and in winter when reserves will be strained for home heating. We therefore divide the area into two sectors. Sector 1 begins at 5.75 miles from the terminal and continues to within 1.3 miles. Sector 2 begins at the 1.3 mile mark and continues to the berth at the terminal.

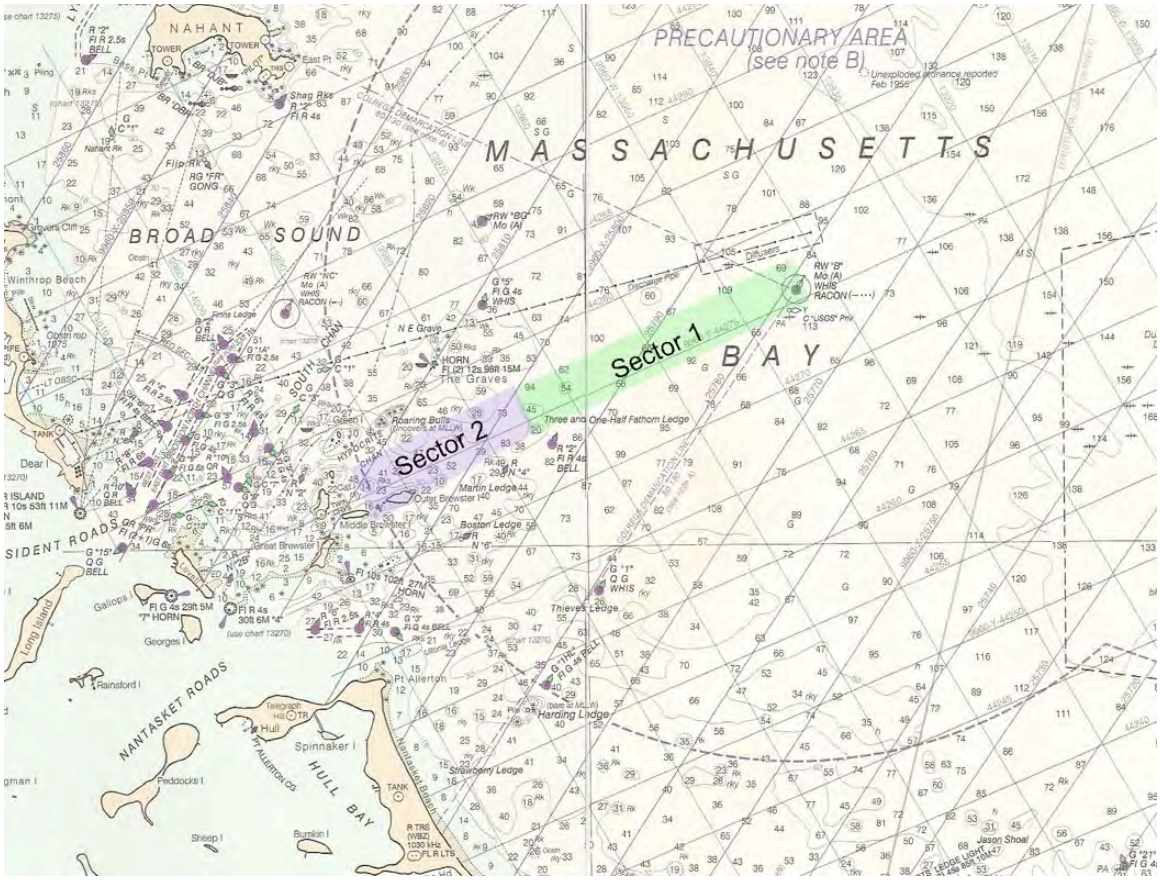

Figure 1: Approach to Outer Brewster Island, Sector 1 and Sector 2

Sector 1: Boston Lighted Horn Buoy B to the Graves Lighthouse

Sector 1 begins 5.75 miles east of Outer Brewster Island in the vicinity of Boston Lighted Horn Buoy B, where the harbor pilot will most likely meet the vessel. Sector 1 extends to within 1.3 miles of the island, the distance at which an attack on the tanker could result in damage to the terminal facility. In this zone, an attack on the tanker could cause the destruction of the ship and harm any accompanying vessels. Because this sector is not in close proximity to any shore-base communities, an attack would not generate the level of fatalities necessary to make the vessel a high value target. As the 2002 attack on the French oil tanker *Limburg* demonstrates, terrorist organizations may see value in attacking an energy vessel, even if the attack would not kill large numbers. However, the primary concern in this sector is that terrorists could attempt to commandeer the vessel and steer it towards an area where an intentional release could have a high impact.

Sector 2: Graves Light to Outer Brewster

Depending on the ultimate route determined for the approach to Outer Brewster Island, Sector 2 begins between Graves Light and the lighted bell buoy Navigational Marker Red "2" approximately .2 miles southeast of Three and One-Half Fathoms Ledge and extends to the waters in between Outer Brewster Island and Middle Brewster Island.

Once within 1.3 miles of the terminal facility, an attack on an approaching vessel could damage the LNG facility and would be closer to shore-based communities. The historic Boston Harbor Light on Little Brewster Island could also be impacted as could the other Outer Islands of Middle Brewster, Great Brewster, Calf Island, Little Calf Island and Green Island.

Regional Coast Guard Stations and Other Law Enforcement Agencies

There are three Coast Guard Stations located in the Boston Region. Coast Guard Station Boston is on the south side of the mouth of the Charles River, within 10 miles of Outer Brewster Island. Coast Guard Station Point Allerton is the closest station to Outer Brewster Island. There is a seasonal Coast Guard station located in Scituate Harbor. There are significant Coast Guard assets in the area. In addition, the Massachusetts State Police Marine Unit, the Massachusetts Environmental Police, and the Harbor Patrol unit of the Boston Police Department all have significant assets in Boston Harbor. These and over 30 other law enforcement agencies work together routinely to protect LNG transits to the Everett facility.

Attack Scenarios

In this section, we refine our analysis, combining mortar attacks with other stand off weapons and look at shaped charges under the small boat scenario. In the Providence report, our analysis of bottom mines and moored mines concluded that the risk posed by this category of weapons was extremely low under any foreseeable circumstances. We therefore do not include an analysis of these mines here. We have added here a scenario in which insider sabotage or hijacking could succeed in generating a 3-tank breach, which was not analyzed previously. Below, we review the attack modes and assess the risks that these scenarios pose to an LNG tanker transiting to or berthed at the proposed Outer Brewster Island facility.

For each attack scenario, we consider three factors: 1) opportunities to stage the attack given known or perceived capabilities of terrorist groups; 2) countermeasures to prevent the attack; and 3) the effects of a successful attack in terms of generating the worst-case scenario three tank breach.

A. Aircraft Attack Scenario

The potential use of aircraft as weapons against targets of opportunity has been a concern since before 9/11. Despite efforts of the Department of Homeland Security and the Transportation Security Administration (TSA), security of civilian aircraft, particularly general aviation, has not been adequately addressed. Once an aircraft is in the hands of terrorists, there is very little that can be done to prevent the aircraft from being used as a weapon against a target of opportunity. In examining this scenario, we conclude that the attack aircraft would be a light civilian model laden with explosives. A hijacked commercial aircraft would not be used to target a LNG tanker as the hijackers would seek a more spectacular target similar to the World Trade Center. The aircraft would need to

carry sufficient explosives to achieve tank penetration but could not exceed 700 pounds of payload. The attack would occur in daylight under clear conditions.

1. Opportunities to Stage the Attack: Availability of Aircraft within the Boston Region

There are 37 airfields within a 33-nautical mile radius of Outer Brewster Island. Aircraft suitable for attack in this scenario could be acquired at any one of them through rental or theft. Their proximity to Boston, the short duration of flight and the amount of air traffic in the area would all decrease opportunities for detection and reaction to an attack. The attack could occur anywhere along the transit route to Outer Brewster Island or when the vessel is berthed at the terminal.

2. Countermeasures to Prevent the Attack: General Aviation Security and Protection

Without prior knowledge of the attack, it is highly unlikely that the Coast Guard or other federal agencies would be able to recognize an attack in progress, receive authorization to shoot down the aircraft, and execute on that authorization before the plane reached its target. Given the low level of security for general aviation, determined terrorists would likely be able to commandeer the aircraft.

3. Effects of the Attack: Low Potential for Multiple Containment Failures

The effect of a kinetic strike (using the planes own speed and mass) is not likely to cause a rupture in the containment vessel. Fuel payload and the resulting fire on impact is not assessed as being sufficient to cause a breach. Utilizing a shaped charge to increase the destructive force is possible but would require extensive preparation and skill without guaranteeing results. Such steps would increase the probability of the plot being uncovered through the work of intelligence, law enforcement or civilians.

Summary: Low Potential of Successful Attack

Despite the limited capability to prevent an attack using an aircraft, the difficulties in generating significant enough force to cause a nominal breach under the worst-case scenario determine that the risk of this attack is low. Larger planes are more likely to be used against higher value targets.

B. Stand-Off Weapons

Al Qaeda and other terrorist groups have used man-portable stand off weapons to great effect in past incidences. Many of these weapons can be acquired on the black market and some are available for purchase legally in the United States. Their range and firepower, however, limit their effectiveness in attacking an LNG tanker transiting to Outer Brewster Island.

1. Opportunities to Stage the Attack: Land-Based Strike Positions and Water Mounted Attacks

For the transit to and berthing at Outer Brewster Island, most standoff weapons do not have sufficient power to penetrate the containment vessels on an LNG tanker. No standard models have sufficient range to be used from shore-based attack positions. Though the exact transit route has not been determined, in keeping within existing shipping channels, at its closest point to shore, an LNG tanker bound for Outer Brewster would not come closer than 3500 meters. Most standoff weapons have maximum ranges well shy of this distance. For an attack to succeed, the weapon would have to be fired from another vessel or from one of the adjacent harbor islands.

2. Countermeasures to Prevent the Attack: Security Zones and On Water Response

Given that the transit route is not through an inland waterway, the Coast Guard and law enforcement agencies have the capabilities necessary to prevent an attack with a standoff weapon. The open waters of Massachusetts Bay and Broad Sound provide a near ideal situation in which to observe vessels in the vicinity and detect any malicious actors. Preventing attackers from using the surrounding outer islands as positions can be achieved with near certainty.

3. Effects of a Successful Attack: Moderate Potential for Multiple Containment Failures

Most standoff weapons do not achieve sufficient blast effect to achieve the nominal case of a $5m^2$ hole that would result in a full loss of containment. These include large caliber machine guns, grenade launchers similar to the M79, mortars, and small rocket or RPGs. Larger caliber rockets, however, would be capable of creating breach sizes within the parameters of the worst-case scenario. Multiple rockets would have to be fired against separate vessels to cause more than a single loss of containment.

Summary: Low Potential for Successful Attack

Given the limited range and effectiveness of these weapons, attackers would face high hurdles in successfully employing these weapons. They would have to be fired from vessels within the harbor. The capabilities the Coast Guard and other law enforcement agencies have to prevent such an attack in the open water are considerable. We therefore judge there to be a low probability that terrorists would be able to stage a successful attack.

C. Small Boat Attacks

A small boat attack is considered to be the highest risk as a factor of difficulty and consequence. The effectiveness of the weapon against the target, al Qaeda's familiarity with its design and use, and problems with the use of force in recognizing and preventing such an attack make it a very dangerous weapon.

1. Opportunities to Stage the Attack: Known Capabilities of Terrorist Groups

The attacks on the French supertanker *Limburg* in 2002 and the US destroyer *Cole* in 2000 are frightening examples of the explosive force that can be delivered in a small boat. In the *Limburg* attack, a small boat laden with 1,000 pounds of explosives ripped a 30-foot hole in the side of the tanker. Both the inner and outer hulls of the vessel were breached. 90,000 barrels of oil were released. [4] In the *Cole* incident, attackers used a shaped charge mounted on a 25-foot rigid hull inflatable boat. The explosion ripped a 40ftx20ft hole in the ship and killed 17 US sailors. The tactic was first employed by the Tamil Tigers against the Sri Lankan Navy in the 1980s.

Figure 2: Damage to the *Cole.*

2. Countermeasures to Prevent the Attack: Security Zones and On Water Response

Because the vessel is not transiting an inland waterway, Coast Guard and other law enforcement agencies will have a better chance of establishing and enforcing security zones. The normal low volume of surface traffic for most of the transit route, provide the opportunity to identify and engage hostile actors. High traffic times and seasons will provide additional challenge. However, as stated in our previous report, establishing security zones will do little to secure the transport of LNG unless the Coast Guard is authorized the necessary use of force required to enforce these zones. Current Rules of Engagement (ROE) allow for the interception and shouldering of approaching surface traffic considered a threat to the LNG carrier. The use of deadly force is authorized if the surface contact demonstrates hostile intent or commits a hostile act. Determination of hostile intent in a congested maritime environment is nearly impossible and most, if not all law enforcement agencies lack the will to engage a civilian surface vessel even within a security zone. Heavy surface congestion would require the near instantaneous identification of a surface threat, interception, shouldering and in the event of a hostile act, engagement in order to prevent a surface vessel from contacting the LNG carrier.

[4] Jonathan Howard. Hazardous Seas: Maritime Sector Vulnerable to Devastating Terrorist Attacks. JINSA online, 1 April 2004. Available online at http://www.jinsa org/articles.htm/

Under the circumstances present in Sectors 1 and 2 for this proposal, the Coast Guard has a better opportunity to prevent a small boat attack than in many other locations.

3. Effects of a Successful Attack: High Potential for Multiple Containment Failures

If a terrorist group were able to replicate the tactics and weapons used in the *Cole* and *Limburg* incidents, they would likely be able to achieve the nominal breach in one or more tanks. The use of shaped charges and larger boats carrying bigger payloads would significantly increase the probability of a successful attack.

Summary: Moderate Potential for a Successful Attack

Despite Herculean efforts by the Department of Homeland Security and the U.S. Coast Guard, a terrorist group possessing a boat and armed with the necessary explosives could potentially achieve the same effect as the group that attacked the *USS Cole* or the *Limburg*. In such an incident, the attackers would be able to achieve a nominal breach of 1 or more tanks and possibly cause a cascading loss of containment on board the vessel.

D. Swimmer and Scuba Attacks

A swimmer or submerged (scuba) attack on an LNG tanker could be carried out while the vessel is at rest. The success rates of swimmer attacks against moving targets is very low.

1. Opportunities to Stage the Attack: Swimmer/Diver Attack Approaches

The unprotected waters surrounding the outer islands are not ideal for swimmer/diver operations. Though swimmer attacks could be launched from the north side of Hull, the minimum distance of over 3500 meters would mitigate the chances of a successful attack. Use of surrounding islands to rest or launching the attack from a boat would reduce the difficulty of reaching the target but would also expose the attackers to an increased chance of being caught.

2. Countermeasures to Prevent an Attack: Underwater Detection and Barriers

Standard surface level countermeasures can do little to stop an adequately trained diver from reaching its target. While divers can be placed in the water to act as deterrents, their capacity to stay in place for long periods is limited. Underwater detection devices and barriers can significantly reduce the likelihood of a diver attempting to or successfully reaching the target.

Effects of a Successful Attack: Low Potential for a Single Containment Failure

All but the largest Limpet mines would not be able to produce the nominal breach size for a worst-case scenario fire. The standard MK 1 Limpet used by the US Navy Seals is designed to create a breach of three square feet in a standard ship hull. The devices would not be effective in rupturing both the inner and outer hulls of an LNG tanker. Limpet mines that exceed the capabilities of the MK1 could be acquired through black market

sources. However, limpets even 10 times the size of the MKI would not achieve the desired effect.

Summary: Low Potential of a Successful Attack

The likelihood of a terrorist acquiring and successfully employing a Limpet of the size required to generate a nominal breach for the worst-case scenario is assessed as being very low. The swimming conditions from shore to Outer Brewster Island are difficult even in the best of conditions. Countermeasures can be taken that would effectively deter any attempt at a swimmer attack.

E. Insider Sabotage & Hijacking

Most of the United States natural gas imports originate in areas of well-known terrorist activity. Last year over 80% of our LNG came from Trinidad and Tobago where al Qaeda affiliated groups have expressed their intent to target US oil and gas interests. The remaining imports are from countries in West Africa and the Persian Gulf where terrorists are known to operate openly with relative anonymity and support of the local population. In addition, many of the tankers that reach our shores must first travel through narrow chokepoints, such as the Straits of Malacca, where the threat of piracy runs high.

1. Opportunities to Stage the Attack: Potential methods used to sabotage or hijack a tanker

A terrorist with access to the ship at anytime prior to or during the transit of an LNG tanker may be able to orchestrate a successful attack in a variety of ways. As mentioned earlier, in recent cases terrorists have been able to effectively hijack large vessels using multiple speedboats containing gangs of armed men. Once in control of the ship a terrorist may be able to set-off a large amount of explosives, intentionally crash the ship or override safety features to release the LNG onto the water and ignite it. Terrorists may also be able to pose as crewmembers using falsified documents, bribe or threaten legitimate crewmembers or even sneak onboard as stowaways. Similarly a terrorist who can access the ship before it departs may be able to conceal a timed explosive that could be remotely detonated by terrorists near or at the receiving facility. Considering the remote location of the Battery Rock facility, however, it is likely that terrorists in control of a ship would attempt to steer it towards downtown Boston where an LNG release would result in higher level consequences.

2. Countermeasures to Prevent an Attack: Onboard inspections and Proper Vetting of Crew

It is expected that Coast Guard interdiction teams will be able to detect and diffuse most crisis onboard the tanker well before any threat is presented to nearby communities. In addition to searching for explosives, these interdiction teams can be supplied with a list of crewmembers that have been properly vetted by US intelligence agencies prior to the ship's arrival. In the event that a hijacked boat attempts to enter US territorial waters, the Coast Guard can take counter-measures that include retaking the vessel, targeting the

ships engines and/or steering mechanisms in order to stop it dead in the water. Within the export country, the implementation of ISPS Codes to protect foreign ports from security breaches must be adhered too and verified, especially in those regions where LNG tankers originate. Lastly, security measures taken by the company can also ensure access to the tanker is limited to carefully screened personnel.

3. Effects of a Successful Attack: High Potential for Multiple Containment Failure

A terrorist armed with an equal amount of explosives used in the small boat scenario would be able to strategically place multiple devices in areas where the blasts would cause the most damage. Similarly, an override of safety features could result in multiple tank release of LNG that could then ignite over water to cause a large pool fire. A hijacked tanker that does manage to evade security zones in an attempt to crash into the facility is unlikely to produce multiple containment failure since LNG tankers are designed to withstand similar, albeit accidental, events.

Summary: Low Potential for Success

The remote location of the Battery Rock facility enables Coast Guard and other law enforcement agencies to board and inspect both crew and ship at a safe distance away from the terminal where potential crisis can be diffused before any real threat materializes. Therefore, we deem the probability of a terrorist successfully concealing explosives onboard or commandeering a tanker and steering it into a populated area to be low.

Vulnerability Assessment

In terms of the capability of determined terrorist groups to exploit the inherent vulnerabilities of LNG carriers, the open water in Sector One greatly improves the opportunities for the Coast Guard and law enforcement partners to prevent and deter terrorists from striking. Escort vessels will have unrestricted maneuverability and excellent standoff distances from the shore and other vessels. Though a small boat attack, a standoff weapon attack from a separate vessel, or an aerial attack might be possible, even with mitigation efforts, the consequences of an attack in this sector are considered low under any circumstances. In Sector Two, the existence of the terminal facility, the proximity of the other outer islands, and the relative proximity to Hull increase to a degree both the opportunities for and consequences of an attack. As discussed in the next section, however, the consequences of an attack in either sector remain low in comparison to other potential locations for LNG terminals and in comparison to other potential critical infrastructure targets.

CONSEQUENCE: INTENTIONAL RELEASE HAZARD AT OR NEAR OUTER BREWSTER ISLAND

In the previous section we determined that a small boat laden with explosives targeted on an LNG tanker at or near Outer Brewster Island is the most probable attack scenario that would result in a worst-case scenario breach. In this section, we examine the general effects of thermal radiation on people; the general effects of an intentional 3-tank breach in terms of destructive force generated; and then consider the specific effect such an event would have if it occurred at or near Outer Brewster Island.

As part of the US Coast Guard's Waterway Suitability Assessment, a detailed site specific assessment will be conducted which will take into account the specific environmental conditions, topography, and other relevant factors. The effects discussed below are preliminary assessments based on our knowledge of these factors and the guidelines provided in the Sandia report.

Effects of Thermal Radiation

Thermal radiation is the transfer of heat by electromagnetic waves. The example most commonly referred to is the transfer of heat from a fireplace to a person across a room in the line of sight. According to the ABS study, the extent to which people are injured by thermal radiation depends on both the incident heat flux and the exposure time. Experiments have been performed on both humans (at low level radiation) and animals to calculate various risks. ABS provided a list of other important factors to consider when gauging the affect of thermal radiation on people. These include:[5]

- Protection afforded by shelter
- Protection afforded by clothing
- Contribution of solar radiation to total exposure (250-330 Btu/hr-ft^2)
- Susceptibility of individual exposed
- Response of individual (e.g., ability to take shelter)

Burning LNG can emit levels of thermal radiation so intense that people as far as 1.5 miles from the pool fire would be exposed to a thermal flux of 5 kilowatts per square meter (kW/m^2) or 1,600 Btu. Using the thermal radiation burn criteria provided by FEMA in Table 1, that amount of radiant heat would be sufficient to cause unbearable pain to people exposed for 13 seconds and second-degree burns to people exposed for 40 seconds. At levels of 10 kW/m^2, or 3,200 Btu, 40 seconds is the maximum threshold a person can withstand before death.[6] Heat levels higher than 3,800 Btu were not analyzed by FEMA but according to conversations with fire officials, exposure to 10,000 Btu will result in near instantaneous death regardless of protective clothing or quality of shelter.

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[5] Consequence Assessment Methods for Incident Involving Releases from Liquefied Natural Gas Cariers, ABS Consulting, p. 31, http://www.ferc.gov/industries/gas/indus-act/lng-model.pdf

[6] James Fay, "Public Safety Issues at the Proposed Fall River LNG Terminal," Massachusetts Institute of Technology, January 2004, p. 2.

Table 1: Thermal Radiation Burn Injury Criteria

Thermal Radiation Intensity		Time for Severe Pain (sec)	Time for Second-degree Burns (sec)
BTU/hr/ft^2	kW/m^2		
300	1	115	663
600	2	45	187
1000	3	27	92
1300	4	18	57
1600	5	13	40
1900	6	11	30
2500	8	7	20
3200	10	5	14
3800	12	4	11

Source: ABS Consulting Report, p. 30

General Effects of a Three-Tank Breach: Pool Fire

Analysis of the scientific studies available on the consequences of an intentional release from an LNG carrier on water indicates that the worst-case scenario involves a three-tank breach. The explosive devices used in the attack will likely cause the escaping gas to ignite, resulting in a pool fire of approximately 572 meters in diameter. This figure was determined according to the parameters of a three tank intentional breach set by Sandia National Lab. The fire can be expected to burn for 8.1 minutes and generate temperatures well above 3,000 degrees Fahrenheit. Within 630 meters/2,066 feet of the fires origin (the Red Zone), thermal heat thresholds would exceed 11,800 Btu. From 630 meters to 2,118 meters/6,947 feet (the Orange Zone) thermal heat thresholds would reach 1,600 Btu.

People inside the red zone would almost certainly be killed within seconds of the ignition regardless of protective shelter. The damage to structures in close proximity would be significant with heat levels strong enough to cause spontaneous combustion of wood without an ignition source and in some cases the bending of steel. Within the orange zone, thermal radiation levels are high enough to cause severe burns that could prove fatal if medical treatment and/or access to evacuation routes are not immediately available. The thermal effects from the initial LNG pool fire can also result in the sympathetic detonations of other dangerous or flammable substances nearby. Were these present they would extend the red and orange hazard zones outward potentially resulting in a greater number of casualties.

First responders trying to rescue the injured and salvage burning property would need to adopt a "let-it-burn" approach until thermal levels subsided below 2,000 Btu, the maximum temperature at which firefighters would be able to operate. In a densely populated area with houses, critical infrastructure or commercial interests within 1.3 miles, there is little doubt that emergency responders and hospital trauma and burn units would be totally overwhelmed.

General Effects of a Three-Tank Breach: Unignited Vapor Release

Though possible, large, unignited LNG vapor releases are highly unlikely to result from a terrorist strike. The weapons used will provide the initial source of ignition and the scenario will unfold as described above. If they do not ignite, vapor clouds could spread over distances up to 3500m from a spill for a full-three tank breach. The actual hazard distances will depend on breach and spill size, site-specific conditions, and environmental conditions.

Specific Effects of an Attack on an LNG Tanker in Transit to Outer Brewster Island

LNG tankers bound for Outer Brewster Island will be kept within the Boston Harbor Inbound Traffic Lane. At its nearest point, the port side of the traffic lane comes no closer than 7 miles from the Provincetown area of Cape Cod. From the start of Sector 1 to the outside limit of Sector 2, distances to shore based communities are no closer than 4 miles. Therefore, an attack on a tanker in transit to the facility would result in a minimal number of casualties, mainly to the crew of the vessel, any accompanying vessels, and any boats within half a mile of the vessel.

Specific Effects of an Attack on an LNG Tanker Berthed at Outer Brewster Island

Once at or near the Outer Brewster Island terminal, the consequences of a detonation would be higher although only marginally so. In comparison to the death and destruction that could result from an attack on a tanker stationed or approaching a facility in a densely developed area, a successful attack at or near the Outer Brewster facility would not achieve a terrorists desired goals of large numbers of casualties. Outer Brewster Island is located approximately 9 miles east of the City of Boston, 5.5 miles from Logan Airport and 2.5 miles from the main shipping channel into Boston Harbor. The nearest residential area to the proposed terminal site is located on Point Allerton in Hull. Point Allerton is 2.3 miles from the proposed terminal site and one mile from the outer edge of the Orange Zone, the distance at which the probability of significant harm is reduced significantly. Known as the Outer Islands, other islands near to Outer Brewster include Middle Brewster Island, Little Brewster, Great Brewster, Calf Island, Little Calf Island and Green Island as well as the Shag Rocks.

Infrastructure, Facilities & Places within 630 Meters (the Red Zone)

Within the Red Zone for a three-tank breach at a vessel berthed or approaching the terminal, the ignited LNG will engulf all vessels within close distance to the tanker, including the tanker itself, instantly killing all crewmembers of these vessels. Within seconds of ignition, all terminal and security personnel on Outer Brewster Island will be exposed to intense radiant heat exceeding 12,000 Btu. At such a close distance, even those working inside non-combustible structures would not survive given the presence of thermal levels strong enough to cause significant damage to steel structures and industrial equipment. The presence of the island may force the burning vapors back into the water and afford some protection.

Potential for Sympathetic Detonation

Though the exact design of the terminal facility and LNG storage tanks are yet to be determined, plans call for the construction of below ground storage tanks quarried into granite. Below ground tanks should eliminate the risk that an attack could cause ignition of the stored fuels. Were ignition to occur, the secondary containment required under FERC regulation, is considered sufficient to contain the volume stored within the LNG tank. There are no chemical sources or other combustible fuels inside either the Red or the Orange Zone that could ignite. The risk of sympathetic detonation is therefore considered null.

Infrastructure. Facilities & Places between 630 & 2118 Meters (the Orange Zone)

The Orange Zone for an attack at or near the terminal will encompass the waters surrounding Outer Brewster Island and the other Outer Islands to a distance of 2118 meters. With the exception of Little Brewster Island, these islands are all uninhabited. Little Brewster Island is home to the Boston Harbor Light, the only lighthouse in the United States that is still staffed by US Coast Guard personnel. The Coast Guard maintains a small presence on the 3-acre island. Greater Brewster Island is the largest island in the vicinity to Outer Brewster. Rising to 104 feet above sea level, the island is 60 acres. There are no landing or other facilities for visitors. Middle Brewster and Calf Islands are 13.6 and 22.4 acres respectively. They are covered with vegetation and have the remains of some historical structures. Green Island and Little Calf Island are 1.7 and .8 acres respectively, with no vegetation.

Nearest to the point of ignition is Middle Brewster Island, followed by Calf Island. Any visitors to these and the islands within the Orange Zone would be exposed to thermal levels high enough to cause severe injury or death with the thermal radiation dissipating significantly as you move away from the source.

The Boston Harbor Light, just inside the probable outer limits of the Orange Zone would likely be exposed to thermal radiation at or near 1600 Btu. This level of thermal radiation is below the 3,960 Btu at which wood will ignite or plastic will melt. Though minimal surface damage to the structure may occur, and individuals outside the structure may be injured, the scenario does not suggest that the historic light would be irreparably damaged.

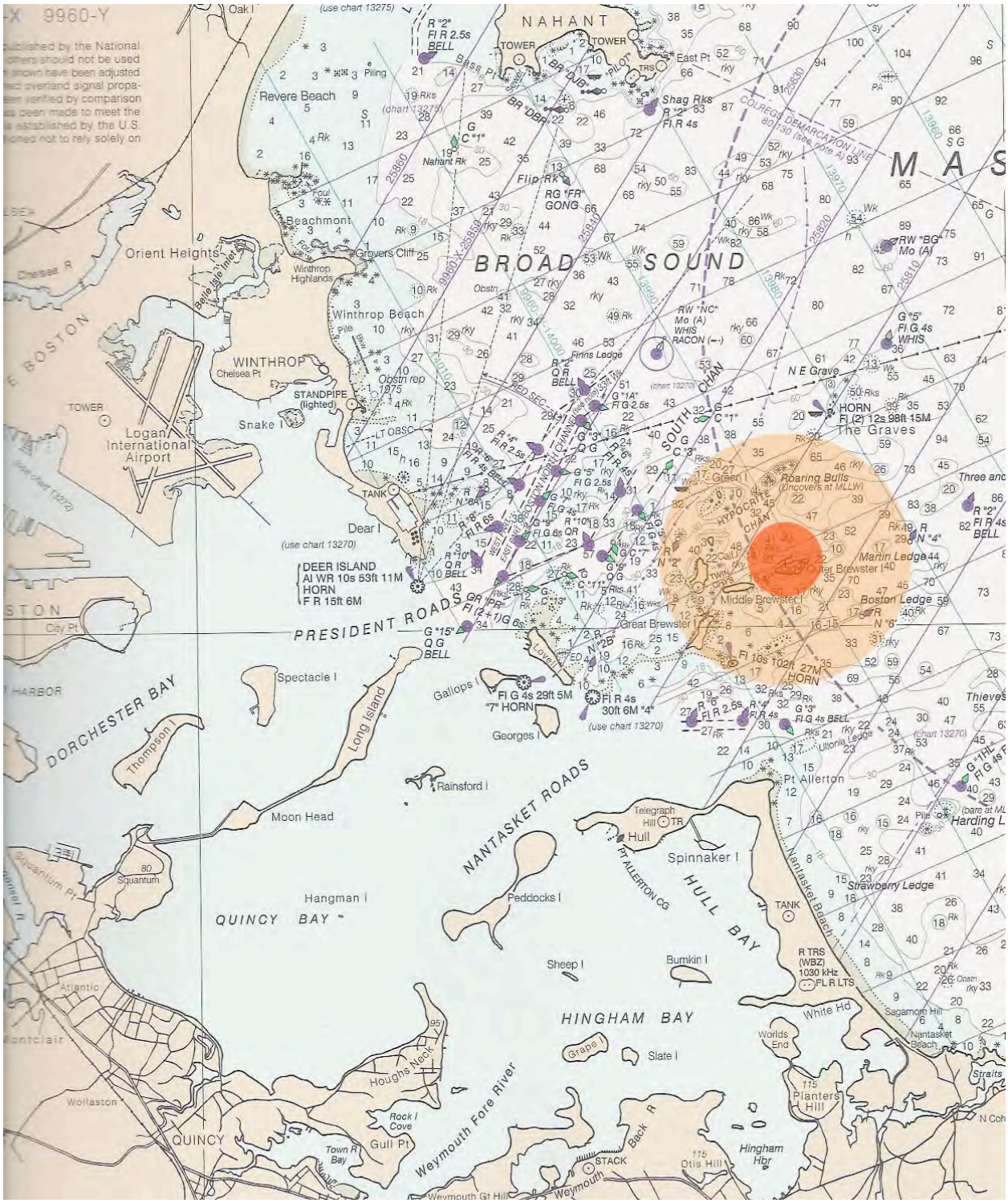

Figure 3: Red and Orange Rings for a 3-Tank Breach, Outer Brewster Island
Although shown here as perfect circles, the pool fires would likely extend in an oblong shape from the site of release given the prevailing winds in Boston Harbor. This effect, however, is not anticipated to be significant and would likely not impact additional islands or facilities outside the fire radius.

Effects Outside the Orange Zone

Outside of the Orange Zone the physical effects of a successful attack will be minimal. In the City of Boston and other adjacent coastal communities, residents would likely hear the initial explosion and witness the resulting pool fire. In the Town of Hull, residents may be exposed to slightly higher levels of thermal radiation than are present under normal environmental conditions. These should not be much in excess of a hot summer day. Any physical harm can be mitigated by seeking shelter indoors. Though highly flammable, liquid natural gas is not explosive and its ignition will not generate the acoustic effects and over pressure associated with an explosive device. The devices used to cause the breach and ignite the escaping gas are not, under the worst-case threat scenario, large enough to cause physical damage to the shore-based communities. The waterborne devices used in the attacks against the *USS Cole* and the French oil tanker *Limburg* each produced an explosion equivalent to 1,000 pounds of TNT. Devices of this size, as discussed earlier, are large enough to trigger a cascading loss of containment and result in the worst-case scenario pool fire. Such devices can also be carried in small, fast, boats, which are the likely vehicle to deliver the weapon.[7]

From the closest point vessels bound for Outer Brewster Island will get to onshore communities, even a device ten times more powerful than the devices used against the *Limburg* and *Cole* would not cause physical damage on shore. A bomb producing the explosive force of 1,000 pounds of TNT generates an air blast capable of shattering glass up to 1,000 feet away. Because energy from a blast decreases rapidly over distance, a 10,000 TNT equivalent device can shatter glass up to 1,500 feet away. Structural damage to buildings and other damage would be contained inside these limits.[8]

The Lillian M. Jacobs Elementary School is located 2.83 miles from the proposed terminal site and is 1.5 miles from the outer edge of the Orange Zone. The initial blast or the resulting pool fire would not affect the 550 students at Jacobs Elementary. Hull High School, located on Windmill Point, the western-most tip of Hull, is approximately 3.3 miles from the terminal and some 2 miles from the outer edge of the Orange Zone. The initial blast or the resulting pool fire would not affect students at Hull High School.

Effects of Vapor Dispersion

As stated above, this is an unlikely scenario given the presence of an ignition source from the device used in a potential terrorist attack. If a three-tank breach were to occur without an ignition source present, the vapor dispersion hazard could extend to 3500 meters from the point of release, just off the shore of Point Allerton. Environmental conditions could

[7] David J. Walton et. al, "Modeling Force Response to Small Boat Attack Against High Value Commercial Ships," Proceedings of the 2005 Winter Simulation Conference, M.E. Kulhl et. al, editors, 2005.

[8] "Figure 4-2: Explosives environments – blast range to effects," *Primer to Design Safe School Projects in Case of Terrorist Attacks,* Risk Management Series, Federal Emergency Management Agency (FEMA), December 2003, 4-8.

potentially extend the vapor hazard into the community. Consequence management efforts should therefore focus on this extremely unlikely scenario.

Consequence Assessment

The standoff distances between the facility and shore-based communities provide an inherent level of security that prevents the consequences of a successful attack on the facility from being high. Given the low level of consequences and the difficulty in staging the attack, as we conclude in our net assessment, it is unlikely that terrorist groups would find the Outer Brewster facility an attractive target.

NET ASSESSMENT: LOW POTENTIAL RISK

We judge that there is a negligible security risk attendant to the Battery Rock proposal and that security concerns should not be a bar to the creation of an LNG offloading facility there. Because the consequences of such an attack are low, vulnerabilities difficult to exploit and possible to protect against, we judge it unlikely that terrorists would find the target attractive. The planning required, the training necessary and the weapons capability suggest that an LNG tanker is only an attractive target if the consequences in terms of human loss and property damage are high. Though terrorist groups possess the necessary capabilities to attack an LNG carrier, the remote location of this facility prevents a successful attack from fulfilling their intent to kill large numbers of Americans. They would therefore likely not attempt such an attack and apply their capabilities to other, more spectacular targets that could kill large numbers.

Efforts to secure tankers bound for Outer Brewster or berthed there can provide an additional deterrent, reducing further the likelihood that terrorists will attempt an attack or that such an attack would succeed. Below we highlight security procedures that would provide an optimal level of security for a facility and transit route that is inherently at low risk of being attacked. Recommendation of these measures does not indicate that the Coast Guard or other law enforcement agencies would not establish this level of security. Nor does it indicate that these procedures are currently being used or not used for securing LNG tankers bound for existing facilities.

Security Measures that should be taken to Mitigate Risk

In the section, we offer preliminary recommendations on security measures that can further mitigate the risk of an intentional release. These and other measures should be considered as the proposal is further developed and proceeds through the exhaustive regulatory process. Good Harbor Consulting is committed to working with AES and security agencies to ensure that best practices for this facility are implemented.

From the point at which the vessel is brought under the control of the harbor pilot (assumed to be at Boston Lighted Horn Buoy B) the Coast Guard should board the vessel. The boarding team should be capable of:

- Sweeping the vessel for explosives
- Inspecting the crew and checking for any weapons
- Preventing any attempt to steer the ship to a location other than the off-loading facility

While moving, the Coast Guard and its local law enforcement partners should maintain a security zone similar to the zone used for the transit to the Everett terminal. This consists of a security zone 2 miles ahead of the vessel, 1 mile behind the vessel and 1500 feet on either side of the vessel. Cruise ships transiting to and from Boston Harbor should be kept outside the Orange Zone of 2118 meters from the vessel.

While berthed, the Coast Guard's current practice of enforcing a 1200-foot security zone is deemed adequate. Middle Brewster Island, within one half mile of the terminal should

be monitored for signs of hostile actors prior to a vessel arriving at the terminal and the Coast Guard or other law enforcement agencies should maintain awareness of visitors to the island while a vessel is berthed at Outer Brewster. The necessity of excluding visitors to Middle Brewster should be determined based on changing threat information and increases in security alert levels as part of an increased security posture. Calf Island, within one mile of Outer Brewster, should also be monitored. Visitors to these and the other islands outside the security zone should be greeted with visual warnings of the potential hazard, as should recreational boat traffic.

With the increase in the number of transits, Coast Guard assets in the Port of Boston may be severely taxed. Additional units should be assigned as needed to maintain security for LNG transits, while preventing any reduction in the capability of the Coast Guard to fulfill other missions.

Consequence Management

For consequence management, the Sandia National Labs team divides the areas through which LNG Tankers transit into three zones. These zones correspond to the areas inside the Red Zone, inside the Orange Zone and outside the Orange Zone in the previous section. For intentional spills, Zone 1 facilities are in areas within 500 meters of major infrastructure, population, and commercial centers. Zone 2 facilities are in areas with major infrastructure, population, and commercial centers between 500 meters and 1.6 km. Zone 3 facilities are in areas greater than 1.6km from major infrastructure, population, and commercial centers. The proposed facility would be a Zone 3 facility.

The guidance the Sandia report provides for Zone 3 facilities states that, "risk management strategies should focus on incident management and emergency response measures for dealing with vapor cloud dispersion. Measures should ensure that areas of refuge are available, and community education programs should be implemented to ensure that person know what to do in the unlikely event of a vapor cloud."[9] These are reasonable recommendations. Because natural gas is colorless and odorless, vapor detection should be installed on and around Outer Brewster Island to alert local authorities of a release. In the town of Hull, a limited number of steps should be taken to prepare for the extremely unlikely event of a large vapor cloud dispersion reaching the community. The measures we recommend here are practical all-hazard steps that every municipality should take. We recommend that an alert system be established that utilizes out door speakers for public communication. Use of email, cell phone text messaging and landline phone trees should also be considered. Local officials should develop instructions ahead of time to deliver to residents. These instructions should include specifics on sheltering in place. The cost of implementing these recommendations should be minimal and could be offset with a portion of the increased tax revenue that will be generated by the town once the facility is operational.

For the more likely event of a pool fire, the medical capacity in surrounding communities is significantly robust and should be capable of managing the low number of casualties.

[9] Sandia Report, p. 76.

The Hull Fire Department, as the closest municipal Fire Department should be equipped with a rescue boat capable of transporting severely injured individuals.

Steps AES Can Take to Improve Security

Given our understanding of the present risk of terrorism, facilities such as LNG terminals should be constructed with security as an embedded feature, not imposed post-construction as an afterthought. AES should consider security of the facility as their responsibility, not just that of the US Coast Guard, the Department of Homeland Security or local law enforcement. AES will submit a site security plan to the Coast Guard under the Maritime Transportation Security Act. The company's goal should be to surpass the minimum requirements of the plan. While the decision to pursue the project in a remote, offshore location represents a significant investment in security, additional measures that should be taken include:

- Security personnel at the facility should be armed and present at all times
- Security barriers should be erected around the island and monitored with Smart CCTV or other technologies
- Installing detection systems for an LNG release at the facility and feeding the data produced to the Coast Guard, Hull Police and Fire Department
- Hull should be equipped with a loudspeaker system to notify the public of any incident and provide instructions, which should be prepared ahead of time.
- Swimmer detection and anti-intrusion technologies should be deployed and the information fed to US Coast Guard
- Smart CCTV cameras should be deployed with day/night capabilities and should provide clear and complete views of the facility, the surrounding waters, and the other Outer Islands