SECURING LIQUEFIED NATURAL GAS TANKERS TO PROTECT THE HOMELAND

FULL HEARING

OF THE

COMMITTEE ON HOMELAND SECURITY
HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

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SECURING LIQUEFIED NATURAL GAS TANKERS TO PROTECT THE HOMELAND

Wendesday, March 21, 2007

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON HOMELAND SECURITY,
Washington, DC.

The committee met, pursuant to call, at 11:21 a.m., in Room 311, Cannon House Office Building, Hon. Bennie Thompson [chairman of the committee] presiding.

Present: Representatives Thompson, DeFazio, Jackson Lee, Langevin, Carney, Green, King, Shays, Dent, Brown-Waite, Bilirakis, McCarthy, and McCaul.

Chairman THOMPSON. [Presiding.] The Committee on Homeland Security will come to order.

The committee is meeting today to receive testimony on "Securing LNG Tankers to Protect the Homeland."

Natural gas accounts for about one-fourth of all energy consumed in the United States. The Department of Energy predicts that the United States will have to increase imports by 600 percent in the next 25 years to fulfill demand.

To meet this demand, energy companies have submitted 32 applications to build new terminals for importing liquid natural gas in 10 states and five offshore areas. Today, there are only five import terminals.

The dramatic increase in terminals will assist in meeting the demand, but it will also increase the number of potential terrorist targets. We must ensure that these new facilities and tankers are adequately secured.

Many agencies within the administration have a role to play in this endeavor. I look forward to hearing from our government witnesses today of the steps each has taken to improve the security of LNG transportation.

Additionally, the men and women who crew these tankers are the critical eyes and ears of the system. I applaud the Maritime Administrator's initiative in increasing the number of U.S. mariners on LNG tankers.

I look forward to hearing more about how we can increase U.S. presence on these tankers.

I am also interested in hearing from the Coast Guard about the impact of increased amount of LNG traffic and what it will have on it as an agency.

Coast Guard assets are aging by the day. I am concerned about whether or not the Coast Guard has the assets to meet this growing mission.

I recognize that Admiral Allen has set a course to fix the Coast Guard's Deepwater program, but I want to know if this course correction will occur before additional LNG facilities come online.

Finally, I am interested in learning from the Government Accountability Office about its recommendations to fix the conflicting assessments of the specific consequences of an LNG spill.

Mr. Wells's written testimony is correct. Access to accurate information will play a critical role in developing risk assessments for LNG placement decisions. The continued absence of this information is troubling and must be rectified.[1]

The chair now recognizes the ranking member of the full committee, the gentleman from New York, Mr. King, for an opening statement.

[The statement of Mr. Bennie G. Thompson follows:]

PREPARED STATEMENT OF THE HONORABLE BENNIE G. THOMPSON, CHAIRMAN, COMMITTEE ON HOMELAND SECURITY

Natural gas accounts for about one-fourth of all energy consumed in the United States The Department of energy predicts that the United States will have to increase imports by 600% in the next 25 years to fulfill demands. To meet this demand, energy companies have submitted 32 applications to build new terminals for importing liquid natural gas in 10 states and 5 offshore ares.

Today, there are only 5 import terminals. The dramatic increase in terminals will assist in meeting the demand, but it will also increase the number of potential terrorist targets. We must ensure these new facilities and tankers are adequately secure.

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Coast Guard assets are aging by the day, and I am concerned about whether or not the Coast Guard has the assets to meet this growing mission. I recognize that Admiral Allen has set a course to fix the Coast Guards's Deepwater Program, but I want to know if this course correction will occur before the additional LNG facilities come on line.

Finally, I am very interested in learning from the Government Accountability Office about its recommendations to fix the conflicting assessments of the specific consequences of an LNG spill. Mr. Wells' written testimony is correct—access to accurate information will play a crucial role in developing risk assessments for LNG placement decisions. The continued absence of this information is troubling and must be rectified.

Mr. KING. Thank you, Mr. Chairman. Thank you for yielding me the time. Thank you for calling this hearing and also for the closed session which we just had, which was also extremely interesting and illuminating.

I basically concur with everything you said in your opening statement.

The fact is the United States does consume more energy per capita than any country in the world. We definitely will have to make greater use of LNG. We definitely need more LNG facilities in this country.

At the same time, the issue arises whether or not we are able to secure those facilities, whether or not we have the resources to secure them. What is being done to make sure that there is security?

Certainly, near my own district there is the proposed Broadwater facility, which of course is causing a considerable amount of controversy.

So this is an issue which is going to be increasing many-fold over the next 5 years, 10 years, 15 years, 20 years, and to me, there is no doubt that we need the LNG. We have to be increasing facilities.

But at the same time, we have to ensure that our government is able to provide us with a level of security in the post-9/11 world in which we live.

So with that, I look forward to the testimony and yield back the balance of my time.

Chairman THOMPSON. Thank you very much.

Other members of the committee are reminded that, under committee rules, opening statements may be submitted for the record.

I welcome our first panel of witnesses. Our first witness, Mr. Jim Wells, is director of energy, natural resources environment team of the GAO.

Our second witness, Real Admiral Salerno, assumed his duties as director of inspections and compliance at the U.S. Coast Guard headquarters in May of 2006.

Our third witness, Mr. Keith Lesnick, is the director of the Office of Deepwater Port Licensing at the Maritime Administration.

And our fourth witness is Mr. Mark Robinson, who is with the Federal Energy Regulatory Commission and has been director of the Office of Energy Projects since 2001.

Without objection, the witnesses' full statement will be inserted in the record.

I now ask each witness to summarize his statement for 5 minutes, beginning with Mr. Wells.

STATEMENT OF JIM WELLS, DIRECTOR, ENERGY, NRC, NATURAL RESOURCES AND ENVIRONMENT, GOVERNMENT ACCOUNTABILITY OFFICE

Mr. WELLS. Thank you, Mr. Chairman, members of the subcommittee.

We at GAO are pleased to discuss the results of our released report on the public safety consequences of a terrorist attack on a tanker carrying LNG.

As you know, there is a lot of consternation about how we meet our increasing energy needs for natural gas at the same time that we can ensure public safety and security.

The supply of natural gas, as you referenced, in the future will be brought to us as LNG by tanker imports. Today we bring in our ports about two tanker ships every 3 days.

Industry is asking to build new or expanded existing terminals in 10 states and offshore. Going forward, this type of tanker traffic will grow by over 400 percent.

My testimony at this hearing summarizes the results of one of three GAO reports that this committee has asked for. A classified report on maritime security was discussed this morning in the closed briefing.

Our second report we are talking about today is a summarization of existing research and the existing knowledge on the consequences of an LNG spill.

Because some additional studies, research studies, are classified, we will be issuing a separate classified report with related findings at a later date.

The GAO report focuses on the effects on water and not on land or at the shore facilities. GAO reviewed six unclassified studies conducted since 9/11.

The GAO report summarizes their findings as they relate to the heat impact of an LNG fire, the possible potential hazards of a large LNG spill and the reported conclusions on explosion potentials.

These studies were conducted for differing purposes, used multiple scenarios, numerous assumptions, and relied heavily on computer modeling, since no real LNG event or large-scale fire has occurred to date.

While there is a general agreement on the type of effects of an LNG spill, the results are different enough to create conflicting assessments of specific consequences, creating uncertainty for regulators and the public.

These results are not just academic. The Coast Guard, for example, uses them to make risk-informed decisions on how to adequately protect and assess the waterways used by these tankers.

GAO went further and documented the opinions of 19 experts from industry, academia, government, consultants and experts with explosive and spills experience.

These experts generally agreed on the public safety impacts of an LNG spill, but they did disagree on specific conclusions of some government studies and suggested future research priorities.

They agreed on three main points. The most likely public safety impact of an LNG spill is the heat impact of a fire.

Explosions are not likely to occur in the wake of an LNG spill unless the LNG vapors are in a confined area, and that some of the hazards, such as freeze burns and asphyxiation, do not pose a hazard to the public.

However, not all experts were in agreement with the commonly used one to 1.25-mile proper heat zone hazard zone, with about half believing this number was about right, and others evenly split on whether the distance was too conservative or not conservative enough.

Experts also did not agree with some of the government conclusions that only three of the five LNG tanks on a tanker would be involved in a cascading failure.

Finally, the experts suggested priorities to help guide future research aimed at clarifying these uncertainties about heat impact distances, cascading failures including large-scale fire experiments, large-scale spill experiments on water, and the potential for cascading failures of multiple LNG tanks.

Knowing that DOE has recently funded a 2-year study involving large-scale LNG fire experiments addressing some, but not all, of the research priorities that I have identified here today, the experts and GAO have recommended that DOE consider expanding the scope of its existing work.

In closing, Mr. Chairman, it is important to know the public safety consequences of future LNG shipments. Access, as you said, to accurate information is critical for the Coast Guard, for FERC, for

DHS as they make important decisions about where and when and how to expand LNG facilities.

If the existing research underestimates, the public is exposed to inappropriate risk. If the research overestimates, we incur costly mitigation measures and we potentially lose the availability of a critical, valuable energy resource going forward.

DOE needs to go further. They need to prioritize the scope of their future research. And they need to settle some of these uncertainties.

I will stop here, Mr. Chairman. Thank you.

[The statement of Mr. Wells follows:]

PREPPARED STATEMENT OF JIM WELLS

Mr. Chairman and Members of the Committee:

I am pleased to be here to discuss the results of our recently released report on the public safety consequences of a terrorist attack on a tanker carrying liquefied natural gas (LNG).[1] As you know, LNG is a supercooled liquid form of natural gas, which, if spilled, poses potential hazards, such as fire, asphyxiation, and explosions. U.S. imports of LNG, now about 3 percent of total U.S. natural gas supplies, are projected to be about 17 percent of U.S. supplies by 2030. To meet this increased demand, energy companies have submitted 32 applications to federal regulators to build new terminals for importing LNG in 10 states and 5 offshore areas. Access to accurate information about the consequences of LNG spills is crucial for developing risk assessments for LNG siting decisions. Despite several recent modeling studies of the consequences of potential LNG spills, uncertainties remain about the risks such spills would pose to the public. One of these studies, conducted by Sandia National Laboratories (Sandia) in 2004, is used by the Coast Guard to assess the suitability of waterways for LNG tankers traveling to proposed LNG facilities. In this context, DOE has recently funded a new study that will conduct small—and large-scale LNG fire experiments to refine and validate existing models that calculate how heat from large LNG fires would affect the public.

My testimony today summarizes the results of our report. Specifically, I will (1) describe the results of recent unclassified studies on the consequences of an LNG spill and (2) identify the areas of agreement and disagreement among experts concerning the consequences of a terrorist attack on an LNG tanker. To address these issues, we examined six unclassified studies of the consequences of LNG spills. We also convened a Web-based panel of 19 experts to identify areas of agreement and disagreement on LNG spill consequence issues. Because some additional studies are classified, we will be issuing a separate classified report with related findings at a later date.

Summary

The six unclassified studies we reviewed all examined the heat impact of an LNG fire but produced varying results; some studies also examined other potential hazards of a large LNG spill and reached consistent conclusions on explosions. Specifically, the studies' conclusions about the distance at which 30 seconds of exposure to the heat could burn people—also termed the heat impact distance—ranged from less than 1/3 of a mile to about 1-1/4 miles. These variations occurred because, with no data on large spills from actual events, researchers had to make numerous modeling assumptions to scale up the existing experimental data for large LNG spills. These assumptions involved the size of the hole in the tanker, the number of tanks that fail, the volume of LNG spilled, key LNG fire properties, and environmental conditions, such as wind and waves. Three of the studies also examined other potential hazards of an LNG spill, including LNG vapor explosions, asphyxiation, and the sequential failure of multiple tanks on the LNG vessel (cascading failure). All three studies considered LNG vapor explosions unlikely unless the vapors were in a confined space. Only the Sandia study examined asphyxiation and concluded that asphyxiation did not pose a hazard to the general public. Finally, only the Sandia study examined the potential for cascading failure of LNG tanks and concluded that

[1] GAO, *Maritime Security: Public Safety Consequences of a Terrorist Attack on a Tanker Carrying Liquefied Natural Gas Need Clarification,* GAO–07–316 (Washington, D.C.: Feb. 22, 2007). This report was prepared at the request of this Committee, the House Committee on Energy and Commerce, and Representative Edward J. Markey.

only three of the five tanks on a typical LNG vessel would be involved in such an event and that this number of tanks would increase the duration of the LNG fire.

Our panel of 19 experts generally agreed on the public safety impact of an LNG spill, disagreed on specific conclusions of the Sandia study, and suggested future research priorities. Experts agreed on three main points: (1) the most likely public safety impact of an LNG spill is the heat impact of a fire; (2) explosions are not likely to occur in the wake of an LNG spill unless the LNG vapors are in confined spaces; and (3) some hazards, such as freeze burns and asphyxiation, do not pose a hazard to the public. However, the experts disagreed with a few conclusions reached by the Sandia study that the Coast Guard uses to assess the suitability of waterways for LNG tankers going to proposed LNG terminals. Specifically, all experts did not agree with the study's 1-mile estimate of heat impact distance resulting from an LNG fire: 7 of 15 thought Sandia's distance was "about right," 8 were evenly split on whether the distance was "too conservative" or "not conservative enough," and 4 did not answer this question. Experts also did not agree with the Sandia National Laboratories' conclusion that only three of the five LNG tanks on a tanker would be involved in a cascading failure. Finally, experts suggested priorities to guide future research aimed at clarifying uncertainties about heat impact distances and cascading failure, including large-scale fire experiments, large-scale LNG spill experiments on water, the potential for cascading failure of multiple LNG tanks, and improved modeling techniques. DOE's recently funded study involving large-scale LNG fire experiments addresses some, but not all, of the research priorities the expert panel identified.

Background

As scientists and the public have noted, an LNG spill could pose potential hazards. When LNG is spilled from a tanker, it forms a pool of liquid on the water. As the liquid warms and changes into natural gas, it forms a visible, foglike vapor cloud close to the water. The cloud mixes with ambient air as it continues to warm up, and eventually the natural gas disperses into the atmosphere. Under certain atmospheric conditions, however, this cloud could drift into populated areas before completely dispersing. Because an LNG vapor cloud displaces the oxygen in the air, it could potentially asphyxiate people who come into contact with it. Furthermore, like all natural gas, LNG vapors can be flammable, depending on conditions. If the LNG vapor cloud ignites, the resulting fire will burn back through the vapor cloud toward the initial spill. It will continue to burn above the LNG that has pooled on the surface—this is known as a pool fire. Small-scale experiments to date have shown that LNG fires burn hotter than oil fires of the same size. Both the cold temperatures of spilled LNG and the high temperatures of an LNG fire have the potential to significantly damage the tanker, causing a cascading failure. Such a failure could increase the severity of the incident. Finally, concerns have been raised about whether an explosion could result from an LNG spill.

The Federal Energy Regulatory Commission is responsible for approving applications for onshore LNG terminal sitings, and the U.S. Coast Guard is responsible for approving applications for offshore sitings. In addition, the Coast Guard reviews an applicant's Waterway Suitability Assessment, reaches a preliminary conclusion on whether the waterway is suitable for LNG imports, and identifies appropriate strategies that reduce the risk posed by the movement of an LNG tanker.

Studies Identified Different Distances for the Heat Effects of an LNG Fire, but Agreed on Other LNG Hazards

The six studies we examined identified various distances at which the heat effects of an LNG fire could be hazardous to people. The studies' results about the distance at which 30 seconds of exposure to the heat could burn people ranged from less than 1/3 of a mile (about 500 meters) to about 1—1/4 miles (more than 2,000 meters). The studies' variations in heat effects occurred because (1) different assumptions were made in the studies? models about key parameters of LNG spills and (2) the studies were designed and conducted for different purposes. Since no large-scale data are available for LNG spills, researchers made numerous modeling assumptions to scale up the existing experimental data for large spills. Key assumptions made included hole size and cascading failure, waves and wind, the volume of LNG spilled, and the amount of heat radiated from the fire. For example, studies made assumptions for the size of the hole in the LNG tanker that varied from less than 1 square meter up to 20 square meters. Additionally, the studies were conducted for different purposes. Two studies were academic analyses of the differences between LNG and oil spills; three specifically addressed spills caused by terrorist attacks, which was a concern in the wake of the September 11 attacks; and the final study developed appropriate methods for regulators to use to estimate heat hazards

from LNG fires. Results of these studies can be found in our report being released today.

Some studies also examined other potential hazards, such as explosions, asphyxiation, and cascading failure, and identified their potential impacts on public safety. Three studies examined the potential for LNG vapor explosions, and all agreed that it is unlikely that LNG vapors could explode if the vapors are in an unconfined space. Only one study examined the potential for asphyxiation following an LNG spill if the vapors displace the oxygen in the air. It concluded that fire hazards would be the greatest problem in most locations, but that asphyxiation could threaten the ship's crew, pilot boat crews, and emergency response personnel. Finally, only the Sandia study examined the potential for cascading failure of LNG tanks and concluded that only three of the five tanks would be involved in such an event and that this number of tanks would increase the duration of the LNG fire.

Experts Generally Agreed That the Most Likely Public Safety Impact of an LNG Spill Is the Heat Effect of a Fire, but That Further Study Is Needed to Clarify the Extent of This Effect

The 19 experts on our panel generally agreed on the public safety impact of an LNG spill, disagreed with specific conclusions of the Sandia study, and suggested future research priorities.[2] Specifically:

- Experts agreed that the main hazard to the public from a pool fire is the heat from the fire, but emphasized that the exact hazard distance depends on site-specific weather conditions; composition of the LNG (relative percentages of methane, propane, and butane); and the size of the fire.
- Eighteen of 19 experts agreed that the ignition of a vapor cloud over a populated area could burn people and property in the immediate vicinity of the fire. Three experts emphasized in their comments that the vapor cloud is unlikely to penetrate very far into a populated area before igniting.
- With regard to explosions, experts distinguished between explosions in confined spaces and in unconfined spaces. For confined spaces, such as under a dock or between the hulls of a ship, they agreed that it is possible, under controlled experimental conditions, to induce explosions of LNG vapors; however, a detonation—the more serious type of vapor cloud explosion—of confined LNG vapors is unlikely following an LNG spill caused by a terrorist attack. For unconfined spaces, experts were split on whether it is possible to induce such explosions under controlled experimental conditions; however, even experts who thought such explosions were possible agreed that vapor cloud explosions in unconfined spaces are unlikely to occur following an LNG spill caused by a terrorist attack.

Our panel of 19 experts disagreed with a few of the Sandia study's conclusions and agreed with the study authors' perspective on risk-based approaches to dealing with the hazards of potential LNG spills. For example:

- Seven of 15 experts thought Sandia's heat hazard distance was "about right," and the remaining 8 experts were evenly split as to whether the distance was "too conservative" (i.e., larger than needed to protect the public) or "not conservative enough" (i.e., too small to protect the public). Officials at Sandia National Laboratories and our panel of experts cautioned that the hazard distances presented cannot be applied to all sites because of the importance of site-specific factors. Additionally, two experts explained that there is no "bright line" for hazards—that is, 1,599 meters is not necessarily "dangerous," and 1,601 meters is not necessarily "safe."
- Nine of 15 experts agreed with Sandia's conclusion that only three of the five LNG tanks on a tanker would be involved in cascading failure. Five experts noted that the Sandia study did not explain how it concluded that only three tanks would be involved in cascading failure.
- Finally, experts agreed with Sandia's conclusion that consequence studies should be used to support comprehensive, risk-based management and planning approaches for identifying, preventing, and mitigating hazards from potential LNG spills.

The experts also suggested priorities for future research—some of which are not fully addressed in DOE's ongoing LNG research—to clarify uncertainties about heat impact distances and cascading failure. These priorities include large-scale fire experiments, large-scale LNG spill experiments on water, the potential for cascading failure of multiple LNG tanks, and improved modeling techniques. As part of DOE's ongoing research, Sandia plans to conduct large-scale LNG pool fire tests, beginning with a pool size of 35 meters—the same size as the largest test conducted to date.

[2] We considered experts to be "in agreement" if more than 75 percent of them indicated that they completely agreed or generally agreed with a given statement. Not all experts commented on every issue discussed.

Sandia will validate the existing 35-meter data and then conduct similar tests for pool sizes up to 100 meters. Of the top 10 LNG research priorities the experts identified, only 3 have been funded in the DOE study, and the second highest ranked priority, cascading failure, was not funded. One expert noted that although the consequences of cascading failure could be serious, because the extreme cold of spilled LNG and the high heat of an LNG fire could damage the tanker, there are virtually no data looking at how a tanker would be affected by these temperatures.

Conclusions

It is likely that the United States will increasingly depend on LNG to meet its demand for natural gas. Consequently, understanding and resolving the uncertainties surrounding LNG spills is critical, especially in deciding where to locate LNG facilities. While there is general agreement on the types of effects of an LNG spill, the study results have created what appears to be conflicting assessments of the specific heat consequences of such a spill.

These assessments create uncertainty for regulators and the public. Additional research to resolve some key areas of uncertainty could benefit federal agencies responsible for making informed decisions when approving LNG terminals and protecting existing terminals and tankers, as well as providing reliable information to citizens concerned about public safety.

To provide the most comprehensive and accurate information for assessing the public safety risks posed by tankers transiting to proposed LNG facilities, we recommended that the Secretary of Energy ensure that DOE incorporates the key issues the expert panel identified, particularly the potential for cascading failure, into its current LNG study.

DOE concurred with our recommendation.

Mr. Chairman, this concludes my prepared statement. I would be happy to respond to any questions that you or Members of the Committee may have.

Chairman THOMPSON. Thank you very much, and we will probably get back into that during the questions.

I now recognize Rear Admiral Salerno to summarize his statement for 5 minutes.

STATEMENT OF REAR ADMIRAL BRIAN M. SALERNO, DIRECTOR, INSPECTION AND COMPLIANCE, U.S. COAST GUARD, DEPARTMENT OF HOMELAND SECURITY

Admiral SALERNO. Good morning, Mr. Chairman and distinguished members of the committee. I am Rear Admiral Brian Salerno, director of inspections and compliance at Coast Guard headquarters.

It is my pleasure to appear before you today to discuss the Coast Guard's role in providing for the safety and security of liquefied natural gas vessels and facilities and the recently completed General Accountability Office reports on petroleum and LNG tanker security.

In coordination with other federal agencies and state and local stakeholders, the Coast Guard plays a major role in ensuring all facets of marine transportation of LNG are conducted safety and securely and that the risks associated with the operation of LNG vessels, shoreside terminals, and offshore deepwater ports are managed responsibly.

LNG vessels have an impressive safety record over the last 45 years. Since the inception of LNG shipping in 1959, there have been over 40,000 LNG shipments around the world but very few serious accidents, and those accidents which have occurred have not resulted in a breach of cargo tanks.

LNG vessels and other vessels transporting liquefied hazardous gases in bulk are built and inspected to the highest engineering and safety standards as established in the International Code for

the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, known more simply as the IGC Code.

Today there are over 200 LNG foreign-flag vessels operating worldwide. They are crewed by some of the most highly trained officers and merchant seamen afloat.

In response to the terrorist attacks of 2001, the Maritime Transportation Security Act of 2002 was enacted. It required a robust maritime security regime for both vessels and facilities.

These security requirements closely parallel the International Ship and Port Facility Security Code, or ISPS. Under ISPS, vessels in international service, including LNG vessels, must have an international ship security certificate.

To achieve the international ship security certificate by its flag state, the vessel must develop and implement a threat-scalable security plan that, among other things, establishes measures for access control, cargo handling and delivery of ship stores, surveillance and monitoring, security communications, as well as security incident procedures and training and drill requirements.

Additionally, like all deep draft vessels calling in the U.S., LNG vessel operators must provide the Coast Guard with a 96-hour advance notice of arrival and include information on the vessel's last ports of call, crew identities and cargo information.

That information is vetted to detect any concerns or anomalies. The Coast Guard conducts pre-entry security boardings of LNG vessels during which Coast Guard personnel conduct security sweeps of the vessel and ensure it is under control of proper authorities during its intended transit.

In order to protect the LNG tanker and other vessels carrying especially hazardous cargoes from external attack, these vessels are escorted by armed Coast Guard and other law enforcement vessels through key port areas.

By acting as a deterrent against a potential attack against the vessel, these escorts reduce the risk to nearby population centers from the consequences of an attack.

Coast Guard efforts are often augmented by other government agencies and the facility operators' private security forces, which also conduct activities such as waterway patrols and surveillance.

The combined efforts of federal, state, local and private assets contribute to the overall local LNG port risk mitigation plan.

The Federal Energy Regulatory Commission, FERC, has the siting authority for shoreside LNG terminals. However, the Coast Guard is a cooperating agency in the preparation of FERC's environmental impact statement associated with the siting of the facility.

Additionally, the local Coast Guard captain of the port must assess and make a determination regarding the suitability of the waterway for the proposed vessel transits, ensuring that full consideration is given to the safety and security of the port, the facility and vessels transporting LNG.

The process involves the local area Maritime Committee and the Harbor Safety Committee and includes identification of the mitigating measures to responsibly manage the safety and security risks identified during the suitability assessment.

The assessment also includes an analysis of the optimal mix of federal, state and local resources in addition to private resources needed to implement any necessary risk mitigation measures.

The Coast Guard continues to analyze resource allocation and resource needs in light of the potential growth of the LNG industry in the U.S.

This new work may be accommodated through reallocation of existing resources, expanding the use of other government agency and private security forces to conduct security operations, or requesting new resources. All of these options are under consideration.

It is important to note that there are other hazardous cargoes that the Coast Guard regulates to ensure safety and security. Moreover, there are 11 other missions for which the Coast Guard is responsible to execute.

Our prevention and protection strategies are aimed at ensuring the highest risk situations receive the highest level of protection. This is an ongoing process.

As you are aware, the GAO recently concluded two reports. One examined current security practices for energy commodity tankers, including LNG, and the Coast Guard had extensive interaction with GAO in the drafting of this report and has formally concurred with all of GAO's recommendations.

The second report is a comprehensive review of the existing LNG consequence studies. As DOE was the principal federal agency interacting with GAO, the Coast Guard had minimal input into this study.

However, we do agree that additional studies are needed to further examine potential consequences of an LNG spill and fire, particularly in the areas identified by the expert panel.

Thank you for the opportunity to discuss the Coast Guard's role in LNG. I will be happy to answer any questions.

[The statement of Admiral Salerno follows:]

PREPARED STATEMENT OF RADML BRIAN SALERNO

Introduction

Good morning Mr. Chairman and distinguished members of the Committee. I am Rear Admiral Brian Salerno, the Director of the Inspection and Compliance Directorate at U.S. Coast Guard Headquarters. It is my pleasure to appear before you today to discuss the Coast Guard's role in providing for the safety and security of Liquefied Natural Gas (LNG) vessels and facilities, and how the Coast Guard is cooperating with other Federal Agencies on this important national issue.

As the Federal Government's lead agency for Maritime Homeland Security, the Coast Guard plays a major role in ensuring all facets of marine transportation of LNG, including LNG vessels, shoreside terminals and LNG deepwater ports, are operated safely and securely, and that the risks associated with the marine transportation of LNG are managed responsibly. Today, I will briefly review the applicable laws and regulations that provide our authority and the requirements for the safe and secure operation of the vessels, shoreside terminals and deepwater ports. I will also describe how the Coast Guard is working with the other Federal entities here today, as fellow stakeholders in LNG safety and security.

LNG Vessel Safety

The Coast Guard has long recognized the unique safety and security challenges posed by transporting millions of gallons of LNG or "cryogenic methane." LNG vessels have had an enviable safety record over the last 45 years. Since international commercial LNG shipping began in 1959, tankers have carried over 40,000 LNG shipments and while there have been some serious accidents at sea or in port, there has never been a breach of a ship's cargo tanks. Insurance records and industry

sources show that there were approximately 30 LNG tanker safety incidents (e.g. leaks, groundings or collisions) through 2002. Of these incidents, 12 involved small LNG spills which caused some freezing damage but did not ignite. Two incidents caused small vapor vent fires which were quickly extinguished.

Today, there are over 200 LNG vessels operating worldwide and another 100 or so under construction. While there are no longer any US flag LNG vessels, all LNG vessels calling in the U.S. must comply with certain domestic regulations in addition to international requirements. Our domestic regulations for LNG vessels were developed in the 1970s under the authority of the various vessel inspection statutes now codified in Title 46 United States Code. Relevant laws providing the genesis for LNG vessel regulation include the Tank Vessel Act (46 U.S.C. 391a) and the Ports and Waterways Safety Act of 1972, as amended by the Port and Tanker Safety Act of 1978 (33 U.S.C. 1221, *et. seq*). Regulations located in Title 46, Code of Federal Regulations (CFR) Part 154, "Safety Standards for Self-Propelled Vessels Carrying Bulk Liquefied Gasses," specify requirements for the vessel's design, construction, equipment and operation. Our domestic regulations closely parallel the applicable international requirements, but are more stringent in the following areas: The requirements for enhanced grades of steel for crack arresting purposes in certain areas of the hull, specification of higher allowable stress factors for certain independent type tanks and prohibiting the use of cargo venting as a means of cargo temperature or pressure control.

All LNG vessels in international service must comply with the major maritime treaties agreed to by the International Maritime Organization (IMO), such as the International Convention for the Safety of Life at Sea, popularly known as the "SOLAS Convention" and the International Convention for the Prevention of Pollution from Ships, popularly known as the "MARPOL Convention." An addition, LNG vessels must comply with the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, known as the "IGC Code."

Before being allowed to trade in the United States, operators of foreign flag LNG carriers must submit detailed vessel plans and other information to the Coast Guard's Marine Safety Center (MSC) to establish that the vessels have been constructed to the higher standards required by our domestic regulations. Upon the MSC's satisfactory plan review and on-site verification by Coast Guard marine inspectors, the vessel is issued a Certificate of Compliance. This indicates that it has been found in compliance with applicable design, construction and outfitting requirements.

The Certificate of Compliance is valid for a two-year period, subject to an annual examination by Coast Guard marine inspectors, who verify that the vessel remains in compliance with all applicable requirements. As required by 46 U.S.C. 3714, this annual examination is required of all tank vessels, including LNG carriers.

LNG Vessel Security

In addition to undergoing a much more rigorous and frequent examination of key operating and safety systems, LNG vessels are subject to additional measures of security when compared to crude oil tankers, as an example. Many of the special safety and security precautions the Coast Guard has long established for LNG vessels derived from our analysis of "conventional" navigation safety risks such as groundings, collisions, propulsion or steering system failures. These precautions predated the September 11, 2001 tragedy, and include such measures as special vessel traffic control measures that are implemented when an LNG vessel is transiting the port or its approaches, safety zones around the vessel to prevent other vessels from approaching nearby, escorts by Coast Guard patrol craft and, as local conditions warrant, coordination with other Federal, state and local transportation, law enforcement and/or emergency management agencies to reduce the risks to, or minimize the interference from other port area infrastructure or activities. These activities are conducted under the authority of existing port safety and security statutes, such as the Magnuson Act (50 U.S.C. 191 *et. seq.*) and the Ports and Waterways Safety Act, as amended.

Since September 11, 2001, additional security measures have been implemented, including the requirement that all vessels calling in the U.S. must provide the Coast Guard with a 96-hour advance notice of arrival (increased from 24 hours advance notice pre-9/11). This notice includes information on the vessel's last ports of call, crew identities and cargo information. In addition, the Coast Guard now regularly boards LNG vessels at-sea, where Coast Guard personnel conduct special "security sweeps" of the vessel and ensure it is under the control of proper authorities during its port transit. In order to protect the vessel from external attack, LNG vessels are escorted through key port areas. These armed escorts afford protection to the nearby population centers by reducing the probability of a successful attack against an LNG

vessel. These actions are in addition to the safety and security oriented boardings previously described.

Of course, one of the most important post-9/11 maritime security improvements has been the passage of the Maritime Transportation Security Act of 2002 (MTSA). Under the authority of MTSA, the Coast Guard developed a comprehensive new body of security measures applicable to vessels, marine facilities and maritime personnel. Our domestic maritime security regime is closely aligned with the International Ship and Port Facility Security (ISPS) Code. The ISPS Code, a mandatory requirement of the SOLAS Convention, was adopted at the IMO in December 2002 and came into effect on July 1st 2004. Under the ISPS Code, vessels in international service, including LNG vessels, must have an International Ship Security Certificate (ISSC). To be issued an ISSC by its flag state, the vessel must develop and implement a threat-scalable security plan that, among other things, establishes access control measures, security measures for cargo handling and delivery of ships stores, surveillance and monitoring, security communications, security incident procedures, and training and drill requirements. The plan must also identify a Ship Security Officer who is responsible for ensuring compliance with the ship's security plan. The Coast Guard rigorously enforces this international requirement by evaluating security compliance as part of our ongoing port state control program.

Shoreside LNG Terminal Safety and Security

Presently there are six shoreside LNG terminals in the U.S. and U.S. Territories: the export facility in Kenai, AK; and, import terminals in Everett, MA; Cove Point, MD; Elba Island, GA; Lake Charles, LA; and Penuelas, PR. Under Title 33, CFR Part 127, the Coast Guard has responsibility for the facility's waterside "marine transfer area" and the Department of Transportation's Pipeline and Hazardous Materials Safety Administration has responsibility for shoreside portion of the facility. The safety requirements regulated by the Coast Guard in the marine transfer area include electrical power systems, lighting, communications, transfer hoses and piping systems, gas detection systems and alarms, firefighting equipment, and operational matters such as approval of the terminal's Operations and Emergency Manuals and personnel training.

The recently promulgated "Maritime Security Regulations for Facilities," found in Title 33 CFR Part 105, were developed under the authority of MTSA. These regulations require the LNG terminal operator to conduct a facility security assessment and develop a threat-scalable security plan that addresses the risks identified in the assessment. Much like the requirements prescribed for vessels, the facility security plan establishes access control measures, security measures for cargo handling and delivery of supplies, surveillance and monitoring, security communications, security incident procedures and training and drill requirements. The plan must also identify a Facility Security Officer who is responsible for ensuring compliance with the facility security plan. The six existing U.S. LNG terminals were required to submit their security plans to the Coast Guard for review and approval in 2003 and full implementation of the plans was required by July 1, 2004. These reviews have been completed, and the terminals' compliance with the plans has been verified by local Coast Guard port security personnel through on-site examinations. In contrast to our safety responsibility, whereby our authority is limited to the "marine transfer area," our authority regarding the security plan can, depending upon the particular layout of the terminal, encompass the entire facility.

Shoreside LNG Terminal Siting

The issue of constructing new shoreside LNG terminals has been controversial, due in large part to public concerns over both perceived and actual risks to the safety and security of LNG vessel operations. Under the Natural Gas Act, the Federal Energy Regulatory Commission (FERC) has permitting authority, including safety review of facility siting, for LNG terminals onshore and within state waters. The Coast Guard is not involved in any aspect of determining or approving the shoreside facility's location.

However, the Coast Guard plays an important role in the siting process once it has begun. Along with an application to the FERC, an owner or operator who intends to build a new shoreside LNG facility, or who plans new construction on an existing facility, must submit a "Letter of Intent" to the Coast Guard Captain of the Port (COTP) in whose zone the facility is located (in accordance with by 33 CFR 127.007). This letter must provide information on: the physical location of the facility; a description of the facility; the characteristics of the vessels intended to visit the facility and the frequency of visits; and, charts that show waterway channels and identify commercial, industrial, environmentally sensitive and residential areas in and adjacent to the waterway to be used by vessels enroute to the facility, within 15.5 miles of the facility.

The COTP reviews the information provided by the applicant and makes a determination on the suitability of the waterway for LNG vessels. Factors considered include: density and characteristics of marine traffic in the waterway; locks, bridges or other man made obstructions in the waterway; the hydrologic features of the waterway, e.g., water depth, channel width, currents and tides, natural hazards such as reefs and sand bars; and underwater pipelines and cables. If the waterway is found suitable and after the Coast Guard meets all of its National Environmental Policy Act (NEPA) requirements, the COTP will issue a Letter of Recommendation (per 33 CFR 127.009).

Both the Coast Guard and the FERC recognize that the "Letter of Recommendation" process, which dates from 1988, does not, in its current form, adequately take into account the security concerns of our post 9/11 environment. Also, the existing regulations are focused primarily on conventional navigation safety risk management issues such as traffic density, hydrologic characteristics of the waterway, etc. They do not focus on port security risk management issues, and in particular, they do not directly require an analysis of the consequences of an LNG spill on the waterway proposed for vessel transits.

To address this problem, on February 10, 2004, the Coast Guard entered into an Inter-Agency Agreement (IAA) with FERC and RSPA to work in a coordinated manner to address issues regarding safety and security at shoreside LNG facilities, including terminal facilities and tanker operations, to work together, avoid duplication of effort, and to maximize the exchange of relevant information related to the safety and security aspects of LNG facilities and the related maritime concerns.

Soon after the completion of the IAA, work began on a more detailed guidance document for use by the involved agencies. On 14 Jun 05, the Navigation and Vessel Inspection Circular (NVIC) 05–05, *Guidelines on Assessing the Suitability of a Waterway for LNG Marine Traffic,* was published to provide guidance on how to conduct and validate a Waterway Suitability Assessment so that full consideration is given to the safety and security of the port, the facility, and vessels transporting the LNG. Simply put, it established a uniform national process for conducting port-specific risk and waterway suitability assessments.

Under the NVIC 05–05 guidelines, since the Coast Guard is also a cooperating agency for the preparation of the FERC's Environmental Impact Statement, this guidance assists the Coast Guard in obtaining all information needed to assess the proposed LNG marine operations and fulfill its commitment to FERC to provide input to their Environmental Impact Statement (EIS). Once completed, the Coast Guard can adopt FERC's EIS to meet its NEPA obligations associated with the subsequent issuance of the COTP Letter of Recommendation.

The Waterway Suitability Assessment (WSA) process put forth in the NVIC uses a risk management approach to developing mitigation measures for the hazards introduced to the affected waterway due to the nature of LNG. The NVIC requires the applicant to conduct a risk analysis of the waterway and propose mitigating measures. In addition, the applicant is required to do an analysis of the resources necessary to perform the proposed mitigation measures. This WSA process usually begins very early in the process, typically during the FERC's pre-filing period.

In addition to an evaluation of conventional navigation safety risks, a critical part of the WSA is an analysis of an LNG spill on the waterway and the thermal effects from a resulting pool fire. The analysis includes the application of the hazard distances and zones of concern established by the spill consequence models described in the 2004 Sandia National Labs Report.

Once the WSA is completed by the applicant, it is submitted to the Coast Guard and reviewed and validated by key stakeholders at the port, such as the Area Maritime Security Committee and the Harbor Safety Committee, and other local port stakeholders. In previous cases, there have even been public meetings and workshops during the development and validation of the WSA and the public is encouraged to provide comments.

When the Coast Guard's WSA validation process is complete, the COTP makes a preliminary determination regarding the suitability of the waterway, whether the waterway can accommodate the proposed traffic and whether there is sufficient capability within the port community to responsibly manage the safety and security risks of the project. This preliminary determination is communicated to the FERC in a Waterway Suitability Report (WSR).

The WSR report conveys the assessment and analysis conducted by the applicant during the WSA process and it usually includes risk mitigation measures that the COTP determines is necessary for the vessel to safely and securely transit to the proposed facility. Once FERC receives the WSR, the report is incorporated into the EIS. FERC addresses the environmental impacts of the proposed vessel transits on the waterway, the environmental impacts of the proposed risk mitigation measures

and the public safety and environmental impacts of a LNG spill and fire on the waterway.

Once the FERC's EIS is published, it is subsequently reviewed by the Coast Guard's environmental specialists. If it is acceptable and meets all of the Coast Guard's NEPA requirements, the Coast Guard issues a Record of Decision that adopts the EIS for our Letter of Recommendation process.

Upon completion of the Record of Decision, the COTP issues a "Letter of Recommendation" to the owner or operator of the proposed facility, and to the state and local government agencies having jurisdiction, as to the suitability of the waterway for the proposal (33 CFR 127.009).

The Coast Guard is also working on the regulatory changes in 33 CFR Part 127 necessary to bring the existing "Letter of Intent" and "Letter of Recommendation" regulations up to date, specifically by requiring the waterways management information to be submitted to the COTP at the time of FERC "pre-filing" or conventional application, and adding specific requirements for a port security assessment, in addition to the waterways management information, to be presented to the COTP for evaluation.

LNG Deepwater Ports: Authority and Agency Relationships

The Coast Guard's authority to regulate Deepwater Ports (DWPs) derives from the Deepwater Port Act of 1974 (DWPA). The regulations pertaining to the licensing, design, equipment and operation of DWPs are found in Title 33 CFR Subchapter NN (Parts 148, 149 and 150). Originally pertaining only to oil, MTSA amended the DWPA to include natural gas. This Act allows for the licensing of DWPs in the Exclusive Economic Zone, outside of state waters, along all maritime coasts of the United States. The Secretary of the Department of Homeland Security (DHS) and the Secretary of DOT delegated the processing of DWP applications to the Coast Guard and the Maritime Administration (MARAD), respectively. MARAD is the license issuing authority and works in concert with the Coast Guard in developing the Environmental Impact Statement, while the Coast Guard has primary jurisdiction over design, equipment and operations and security requirements.The DWPA established a specific time frame of 330 days from the date of publication of a Federal Register notice of a "complete" application to the date of approval or denial of a DWP license. Among other requirements, an applicant for a DWP license must demonstrate consistency with the Coastal Zone Management Plan of the adjacent coastal States.

The Coast Guard and MARAD, in cooperation with other Federal agencies, must comply with the requirements of the National Environmental Policy Act in processing DWP applications within the timeframes prescribed in the Deepwater Port Act. To date the Coast Guard has received a total of 15 DWP applications, including four that have already been licensed: Louisiana Offshore Oil Platform, Chevron-Texaco's Port Pelican project, Excelerate Energy's Gulf Gateway project, and Shell's Gulf Landing. Recently, the Maritime Administrator has issued Records of Decisions for three others: Freeport

McMoRan's Main Pass Energy Hub, Suez's Neptune project and Excelerate Energy's Northeast Gateway. The latter two are off the coast of Massachusetts and the others are all offshore of Louisiana. Only the Gulf Gateway has been built so far. Three have been withdrawn and six others are in various stages of processing. We are anticipating between two and four additional applications within the next several months.

To expedite the application review process, and more efficiently coordinate the activities of the numerous stakeholder agencies, the Coast Guard entered into a Memorandum of Understanding (MOU), involving more than a dozen agencies, including FERC, NOAA, the Army Corps of Engineers and the Environmental Protection Agency.The MOU obliges the participating agencies to work with each other and with other entities as appropriate, to ensure that timely decisions are made and that the responsibilities of each agency are me these responsibilities include: assessing their particular role in the environmental review of DWP licenses; meeting with prospective applicants and other agency representatives to identify areas of potential concern and to assess the need for and availability of agency resources to address issues related to the proposed project.

LNG Deepwater Ports Safety and Security

While conventional crude oil DWPs have been in operation around the world for many years, LNG DWPs are an emerging concept. Currently, there is only one in operation, off the coast of Texas. There are a variety of different designs under development that borrow from designs and technology that have been time-tested in the offshore energy and the LNG industries. Proposals include ship-shaped hull designs similar to existing Floating Production, Storage and Offloading (FPSO) units,

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platform based storage and regasification units, gravity based structures, and innovative docking structures that attach directly to the LNG carrier to serve as both a mooring and offloading system. Because this is a new concept, the Coast Guard's regulations apply a "design basis approach, rather than mandate a series of prescriptive requirements. Under a "design basis" approach, each concept is evaluated on its own technical merits, using relevant engineering standards and concepts that have been approved by recognized vessel classification societies and other competent industrial and technical bodies. In addition, the Coast Guard's DWP regulations require that all LNG DWPs develop and implement a security plan that, at a minimum, will addresses the key security plan elements provided in Title 33 CFR Part 106, "Maritime Security: Outer Continental Shelf Facilities." A risk and consequence analysis is completed as part of the risk mitigation strategy and security measures are developed between the applicant and the Coast Guard local Captain of the Port.

Thank you for giving me this opportunity to discuss the Coast Guard's role in LNG safety and security and our relationships with other stakeholder agencies. I will be happy to answer any questions you may have.

Chairman THOMPSON. Thank you, Admiral.

The next witness is Mr. Lesnick, to summarize his statement for 5 minutes.

STATEMENT OF H. KEITH LESNICK, DIRECTOR, OFFICE OF DEEPWATER PORT LICENSING, MARITIME ADMINISTRATION, DEPARTMENT OF TRANSPORTATION

Mr. LESNICK. Good morning, Mr. Chairman and members of the committee.

I am pleased to have the opportunity to testify before you today to discuss the dramatic growth in U.S. liquefied natural gas imports, the deepwater port licensing program, and plans to increase the employment of U.S. mariners within this highly specialized and vital energy sector.

While worldwide natural gas is in plentiful supply, the United States holds less than 4 percent of world reserves. And by the year 2025 our LNG imports are projected to increase eightfold.

And today, the United States finds itself competing in a global market for our energy resources. Advances in vessel size, technologies, and the rapid expansion of the worldwide LNG fleet have made importing energy more efficient, cost-effective and available to emerging worldwide markets.

The Maritime Administration, by delegation from the secretary of transportation, is the lead federal agency for licensing offshore LNG and oil terminals.

In processing deepwater port license applications, the Maritime Administration works in concert with the U.S. Coast Guard and numerous federal, state and local agencies.

At the conclusion of the applicant's review process, the Maritime Administration issues a record decision approving or denying a deepwater port license.

To date, 15 LNG deepwater port applications have been filed and six projects have been approved. When ultimately constructed and operating, they will all represent over one-fourth of the nation's total gas capacity.

The deepwater port mandates the expedited licensing of deepwater oil and LNG terminals seaward of U.S. territorial waters.

And while this program has made significant progress, numerous logistical hurdles remain to the timely construction of offshore

LNG-receiving facilities that will be required to meet our growing energy needs.

For example, local opposition to the construction of LNG terminals is growing, compounding the already difficult task of locating suitable gas-receiving sites.

We are working to overcome these obstacles and meet congressional directives that clearly mandate the increased U.S. involvement in the safe and efficient transportation of LNG to our nation's shores.

In 2006 Congress amended the Deepwater Port Act and directed the secretary of transportation to develop and implement a program to promote the transportation of LNG to the United States on U.S.-flag vessels and give top priority to applications that use U.S.-flag vessels in their operations.

The act also requires that applicants provide the nation of registry for and the citizenship of officers and crews serving on vessels transporting LNG to U.S. deepwater ports.

In response to these legislative directives, the Maritime Administration developed a voluntary deepwater port manning program to promote the utilization of U.S. seafarers and accommodate the forecasted international LNG manning shortfall.

We are already seeing results. Last December, the Maritime Administration announced an innovative public-private U.S. crewing partnership with Suez Energy, the first official partnership of this kind within the international LNG industry.

Since that time, three additional companies have voluntarily joined this initiative. These agreements represent sound public policy, increased safety, security, improved transportation efficiencies, and provide vital training and employment opportunities for U.S. mariners in the LNG industry.

By the year 2010 the global LNG carrier fleet is expected to grow by over 200 vessels. This expanded fleet will require as many as 10,000 additional seafarers and offer tremendous employment opportunities for U.S. mariners.

However, if we do not act quickly, the magnitude of this shortage may negatively impact the LNG industry's excellent safety record.

To alleviate this growing worldwide manpower shortage, we have engaged the nation's maritime industry in an effort to ensure a reliable supply of U.S. citizen mariners for LNG service.

We are working with the U.S. Merchant Marine Academy, state maritime academies and other training facilities to develop and expand innovative LNG educational programs.

Our specific goal is to provide immediate training and employment for U.S. citizens in the LNG tanker fleet.

The licensing of deepwater ports also contributes to the Department of Transportation's strategic goal of improved mobility and reduced congestion by limiting the number of mega-LNG tankers entering our nation's port facilities.

Clearly, the construction of deepwater port terminals enhances transportation safety and security by isolating terminals away from congested land-based port facilities.

And finally, the maritime administrator is required to consider the national interest in the issuance of a deepwater port license.

My agency considers the safe, secure and efficient transportation of an environmentally friendly source of energy vital to the nation's interest.

We are proud of the deepwater port licensing program and our efforts to encourage the employment of qualified U.S. citizens. And I will be happy to respond to any questions that you might have.

[The statement of Mr. Lesnick follows:]

PREPARED STATEMENT OF H. KEITH LESNICK

Good Morning, Mr. Chairman and Members of the Committee. I am pleased to have the opportunity to testify before you today and to discuss the dramatic growth in U.S. Liquefied Natural Gas (LNG) imports, the deepwater licensing program, and the Department of Transportation and the Maritime Administration's plans to increase the employment of U.S. mariners within this highly specialized and vital energy sector.

While worldwide natural gas is in plentiful supply, the United States holds less than 4 percent of world reserves. During 2006, about 84 percent of all natural gas consumed in the United States was domestically produced. By the year 2025, as demand increases, domestic production is only expected to account for 79 percent of consumption. To accommodate this shortfall, LNG imports are projected to increase eight-fold to 4.4 trillion cubic feet per year.

Importing LNG will serve to relieve the Nation's growing energy needs by diversifying energy sources. Deepwater ports are necessary to enhance the Nation's ability to import LNG from world wide sources. The Energy Information Administration's recently released Annual Energy Outlook 2007 states U.S. energy consumption projected for the year 2025 will be about 23 percent higher than it was in 2006.

As a consequence, the United States finds itself in a situation unlike any we have experienced before. There is strong international competition from China, Japan, and Korea for energy resources. Advances in vessel size to transport oil and LNG, the number of LNG carriers, and advances in LNG transfer technology have made importing energy ever more efficient and cost effective.

Numerous logistical hurdles remain, however. Local opposition to the construction of LNG terminals is growing, compounding the already difficult task of locating suitable gas receiving sites. At present, the continental United States has 5 operational LNG import terminals—1 is a deepwater port located 116 miles off the coast of Louisiana. The combined capacity of the five terminals is equal to six percent of the Nation's gas consumption. Clearly, the Nation's growing need for imported natural gas necessitates greater investment in the infrastructure required to accommodate energy needs. As such, the Maritime Administration's Deepwater Port licensing program is designed to facilitate the licensing, construction, and operation of deepwater oil and LNG terminals located seaward of U.S. territorial waters.

In 2002, the Deepwater Port Act was amended to expand the Secretary of Transportation's existing authority to include authority to issue licenses for offshore natural gas terminals. (The permitting of LNG facilities onshore and in state waters remain under the jurisdiction of the Federal Energy Regulatory Commission.) The Maritime Administration, by delegation from the Secretary of Transportation, is the lead federal agency for licensing offshore LNG and oil terminals. The Secretary of Transportation delegated authority over "pipeline maters" to the Pipeline and Hazardous Materials Safety Administration. In processing of Deepwater Port license applications, the Maritime Administration works in concert with the U.S. Coast Guard, numerous federal agencies, and state and local governments. At the conclusion of the application's environmental review process, the Maritime Administration makes a final license approval determination through the issuance of a Record of Decision. The Record of Decision incorporates the reasons behind the Maritime Administration's decision to issue or deny a license. The Record of Decision also enumerates the various conditions of licensure that govern the operation of the deepwater port facility.

To date, 15 LNG Deepwater Port applications have been filed and 4 licenses have been issued. If all applications under consideration by the Maritime Administration were constructed and operating at full capacity, they would represent over a quarter of the Nation's total gas capacity.

Congress amended the Deepwater Port Act through the Coast Guard and Maritime Transportation Act of 2006, to direct the Secretary of Transportation to develop and implement a program to promote the transportation of LNG to the United States on U.S.-flag vessels. The Act further directed the Secretary to give top pri-

ority to applications that use U.S.-flag vessels in their operations. The Act also requires that applicants provide the nation of registry for, and the citizenship of officers and crew members serving on vessels transporting LNG to U.S. deepwater ports. The Maritime Administration interprets this requirement to include those international LNG tankers providing gas to the deepwater facilities licensed by the Agency.

Therefore, in responding to these legislative directives, the Maritime Administration is in the process of developing a voluntary deepwater port manning program to encourage employing highly trained and skilled U.S. mariners to meet the current and forecasted demand for professional mariners in the international LNG shipping industry.

We are already seeing results from our efforts. Last December, the Maritime Administration announced an innovative public-private partnership with SUEZ Energy—the first official partnership of its kind within the international LNG industry. Under this agreement, SUEZ will provide training and employment opportunities for U.S. citizen officers, cadets, and unlicensed mariners aboard their tanker fleet and at both of their planned deepwater port terminals off the coasts of Boston and Florida. Additionally, Excelerate Energy has entered into a similar agreement for the Northeast Gateway deepwater port facility in Massachusetts Bay and for its existing facility in the Gulf of Mexico. In January 2007, a Louisiana-based applicant, Freeport-McMoRan Energy, also committed to work with the Maritime Administration to develop programs to train and employ U.S. mariners on LNG vessels servicing their Main Pass Energy Hub facility being planned off the coast of Louisiana.

These agreements represent sound public policy—increased safety, security, and improved transportation efficiencies—and they open up vital training and employment opportunities for U.S. mariners in the LNG industry. The Maritime Administration intends to continue to reach similar voluntary agreements with our pending and future deepwater port applicants and all energy companies serving the Nation's international maritime markets.

It is estimated that as many as 3,700 to 5,000 additional mariners may be needed by next year. The magnitude of this manpower shortage will only serve to negatively impact this industry's excellent safety record. Over the last 5 years the global LNG carrier fleet grew by 73 percent, from 128 to 222 vessels. And, an additional 133 LNG vessels are scheduled for delivery to service the global LNG trades by 2010. This expanded fleet will require as many as 10,000 additional seafarers, of whom almost 3,000 will be licensed officers—and, offers tremendous employment opportunities for both licensed and unlicensed U.S. mariners. This dramatic increase also comes at a time when we are already experiencing a greater demand for seafarers in general due to a dramatic increase in international trade.

The worldwide LNG tanker fleet currently lacks a single U.S.-flag vessel. As a direct result, few U.S. mariners have the opportunity to gain vital hands-on experience in this growing industry. Clearly, the lack of U.S.-flag LNG tankers translates into a lack of job opportunities for U.S. citizens. It is the Maritime Administration's goal to help correct this situation and provide U.S. mariners opportunities in an industry vital to our energy and security needs.

The Maritime Administration strives to ensure a reliable supply of U.S. citizen mariners to serve on LNG vessels calling at U.S. energy receiving facilities. The Agency is working with the U.S. Merchant Marine Academy, state maritime academies, and other training facilities to develop and expand innovative educational programs. Specifically, the goal is to provide immediate employment for entry level mariners, both licensed and unlicensed, into the LNG industry upon graduation and courses for the retraining and/or recertifying of current mariners who are sailing on vessels other than LNG—permitting them to transition into LNG service.

Ultimately, employing highly trained and skilled licensed U.S. mariners will help alleviate the growing worldwide shortage of professional mariners confronting the international LNG shipping industry. It will also serve to help maintain the industry's excellent safety record by maintaining the LNG officer pool. U.S. mariners are highly skilled in the operation of steam plants used on the majority of LNG vessels and are experts in operating other marine main propulsion systems, such as diesel, diesel electric, and gas turbines. In addition, America's maritime officers unions continue to train their members to the highest industry standards in LNG technologies.

It is also important to note that from an economic and competitive perspective, the growing worldwide shortage of trained and qualified LNG ships' officers has created an opportunity for U.S. officers to work aboard foreign-flag LNG vessels. International vessel operators are dramatically increasing the wages and benefits offered to foreign officers to keep or attract their services, thus narrowing the gap between

the wages and benefits paid to Americans and those paid to their foreign counterparts.

The licensing of deepwater ports also contributes to the Department of Transportation's strategic goal of improved mobility and reduced congestion by limiting the number of mega LNG tankers entering our Nation's port facilities. The construction of deepwater port terminals enhances transportation safety by isolating terminals away from congested population areas.

The Maritime Administrator is required to consider the national interests in the issuance of a deepwater port license. The Maritime Administration considers the safe, secure, and efficient importation of an environmentally friendly source of energy vital to the Nation's economic growth.

We are proud of the Deepwater Ports Licensing Program and our efforts to encourage employing qualified U.S. citizens to work aboard the vessels serving the energy sector.

I want to thank the Members of the Committee and Chairman Thompson in holding this hearing today and I am happy to respond to any questions that you may have.

Chairman THOMPSON. Thank you for your testimony.

I now recognize Mr. Robinson to summarize his testimony for 5 minutes.

STATEMENT OF J. MARK ROBINSON, DIRECTOR, OFFICE OF ENERGY PROJECTS, FEDERAL ENERGY REGULATORY COMMISSION

Mr. ROBINSON. Thank you, Mr. Chairman. My name is Mark Robinson. I am director of the Office of Energy Projects.

Our office is responsible for approximately 2,500 non-federal dams, their safety and security, their licensing and their administration; the siting of natural gas pipelines; the siting of electric transmission lines; and, more significantly for this group, the authorization and the ongoing safety and security of LNG terminals in the U.S.

My testimony is going to go into three areas, the siting of those terminals, which includes the review of the tankers associated with those tankers; the tanker safety record, which the admiral has already mentioned today; along with the GAO report and our general agreement with that, with some clarification.

When it comes to siting LNG terminals, safety and security are integral to every aspect of that in our review.

We have a very well-choreographed review of LNG terminal safety and security that we do with the Department of Transportation and the Coast Guard.

It starts before the authorization occurs at the commission with a pre-filing process that the Congress has dictated that we ensure occurs with every LNG terminal siting activity that we do.

The pre-filing process involves all the federal agencies, state agencies and local citizens that exist around the terminal. Everything is above the board. Everything is on top of the table. There are no secrets involved. And that does include how the facilities are going to be maintained and safe.

This is performed along with our environmental impact statement as we prepare that, with public meetings and public discussion. Some of your areas—we have actually had meetings in your areas on LNG facilities that are proposed.

If the commission does, in fact, authorize one of these LNG terminals, then we go into the pre-construction phase of our review process.

We look at detailed design drawings that include exactly where safety equipment would be, safety monitors would be in place. More than 100 safety monitors are typically imposed at any LNG terminal.

Those are all reviewed, ensured that they are properly sized and spaced. And no construction is allowed until that review and authorization has occurred.

One other thing that does happen in the pre-construction phase is that there is the development of an emergency response plan.

That emergency response plan identifies who would do what if there was, in fact, some action that occurred either at the terminal or at the docks, who is responsible for the boats, who pays for them.

There is a cost-sharing plan developed with the local entities on who does pay for things such as extra police patrols or maritime patrols. This is done with the Coast Guard and worked out prior to any construction being allowed.

If construction does initiate, then we do inspections about every 8 weeks or so to make sure the project is constructed with all the safety equipment that we have required through about a 3-year construction period.

If that occurs to our specification, we will then do the third authorization on the LNG terminal, which is to allow it to, in fact, operate.

We have had experiences in each of those areas where we have not granted that authorization either at the authorization phase at the commission, or at the construction phase, or at the operation phase.

Ultimately, the commission has vested in our office the right to take whatever action is necessary to protect life, health and property. And we take that very seriously, and we do take those actions.

On tanker safety, I think the only thing I would like to mention, since the admiral pretty much covered that in terms of its excellent record, is that the commission does ensure that they understand what measures would be taken to allow a tanker to safety come in, in a fashion that would protect the public.

If they don't have confidence in that, that goes into the siting decision and whether or not the commission would, in fact, authorize a plant.

To date, working very closely with the Coast Guard, we have managed to review and be satisfied that for those plants that we have authorized, tankers can, in fact, come into the terminal and do that safely.

Finally, I would like to briefly discuss the GAO report. I am very pleased that much of the GAO findings are consistent with the findings that we have made repeatedly in our EISs; namely, that it is very unlikely that there would ever be any type of an explosion associated with unconfined LNG vapor—in fact, we would probably term that somewhere resting between improbable and impossible, and I would be more than happy to discuss that—that there would be no risk to the public in terms of asphyxiation or freeze burns, and that the most likely consequence of an LNG event would be a pool fire.

As far as the distance that the radiant heat effect of a pool fire would extend to, GAO cited that as a disagreement among the experts.

I would like to note that 11 out of the 15 experts either agreed with our estimates or thought we were too conservative, meaning that our estimate of the extent of the consequence zone is overly stated.

I tend to agree with the latter, because when I—we did the ABSG study, which is one the studies reviewed. When I gave directions to the staff on how to conduct that study, I asked them to make sure wherever there was uncertainty to take the most conservative position that we could take. And we have done that.

The research that GAO indicated should occur we agree with. We think that that will result in a shrinkage of the consequence zones.

Ultimately, we have a policy of—we are constantly raising the floor on LNG safety and security, and we will continue to do that. We think it can be and is a safe and secure fuel source for America.

Thank you very much.

[The statement of Mr. Robinson follows:]

PREPARED STATEMENT OF J. MARK ROBINSON

My name is J. Mark Robinson and I'm Director of the Office of Energy Projects (OEP) at the Federal Energy Regulatory Commission (FERC or Commission). I am here as a staff witness and do not speak on behalf of any Commissioner. Our office is responsible for non-federal hydroelectric licensing, administration, and safety; siting of electric transmission lines; certification of interstate natural gas pipelines and storage facilities; and, more significantly for today's session, authorization and oversight over the construction, operation, and safety of on-shore and near-shore Liquefied Natural Gas (LNG) terminals. We also share security responsibilities for these facilities with the U.S. Coast Guard (Coast Guard), which has primary responsibility under the Maritime Transportation Security Act of 2002.

I want to thank you for this opportunity to speak today and to specifically address how we ensure the safety and security of LNG import facilities and the related LNG shipping. Overall, the safety record of the industry is commendable. LNG terminals in the United States have never had an LNG safety-related incident that harmed the public or the environment. Similarly, no shipping incidents have occurred worldwide that resulted in a significant loss of cargo during the almost 50 years of LNG transport. I will first describe the measures we use to provide for safe and secure LNG import terminal siting, construction and operation. Next, I will briefly address the measures taken to ensure the continuing safe history of LNG shipping. And finally, I will comment on the GAO report.

Safety, Security and Siting of LNG Import Terminals

Be assured that consideration of public safety is our highest priority when fulfilling our Congressional mandate under the Natural Gas Act to regulate facilities for the importation of natural gas. The Commission has been proactive in addressing safety concerns and rigorously applies high safety standards to these projects. When projects meet our safety standards and are found to be in the public interest, the Commission will approve them. If a proposed project falls short of these standards, the Commission will reject it, as was done with the proposed Keyspan LNG Terminal Project in Providence, Rhode Island.

The excellent safety record of the LNG import facilities in the U.S. extends over the past 35 years. The siting and oversight of LNG facilities is governed by a comprehensive scheme of federal regulation that guarantees that the FERC and other federal agencies work together to ensure public safety. The FERC's LNG project review process works to address all siting and operational issues with the full participation of the federal and state agencies, and the public, and, only after that comprehensive review, attempts to ensure the timely development of necessary energy infrastructure. Once in operation, FERC oversight and inspection is an on-going process for the life of the facility.

Every aspect of our engineering and siting review, and our coordination with the Coast Guard and the U.S. Department of Transportation (DOT), is geared toward assuring that a facility will operate safely and securely. This review may be broken

into three distinct phases: pre-authorization review; pre-construction review; and pre-operation review.

Pre-Authorization Review—During the pre-authorization phase, Commission staff addresses the safety and security of an LNG import terminal by reviewing facility designs and ensuring that the proposal includes a number of design and operational features. FERC regulations require that from the early stages of project development, potential applicants meet with FERC staff to describe the proposal and solicit guidance on required design features. At this point, we make sure that DOT and the Coast Guard are aware of new projects or proposed expansions. These meetings provide the opportunity for FERC staff to offer suggestions related to the environmental, engineering and safety features of the proposal and review conceptual designs. These activities occur over at least a six month time span during the mandatory pre-filing period required by the Energy Policy Act of 2005 and are detailed in the FERC's regulations under Title 18 of the Code of Federal Regulations (CFR) § 157.21.

Based on this input from FERC staff, the project sponsors continue to develop the front-end-engineering-design (FEED) to be filed as part of the formal application for the proposed LNG facility. The design information, which must be contained in the formal application, is extensive and is specified by 18 CFR § 380.12 (m) and (o). In order to ensure that the filings are complete, FERC publicly issued "Draft Guidance For Filing Resource Reports 11 (Reliability and Safety) & 13 (Engineering and Design) For LNG Facility Applications" in December 2005. This document clarified the level of detail required for the engineering submittal so FERC staff can adequately assess the safety, operability, and reliability of the proposed design. Areas for specific guidance and clarification include:

- the level of detail, including a requirement for a hazard design review, necessary for the FEED submitted to the FERC;
- LNG spill containment sizing and design criteria for impoundments, sumps, sub-dikes, troughs or trenches;
- design spills to be used in the calculation of thermal and flammable vapor exclusion zones; and
- use of the Coast Guard's Navigation and Vessel Inspection Circular 05–05 and the waterway suitability assessment process.

The level of detail required to be submitted in the proposed design will require the project sponsor to perform substantial front-end engineering of the complete facility. The design information is required to be site-specific and developed to the extent that further detailed design will not result in changes to the siting considerations, basis of design, operating conditions, major equipment selections, equipment design conditions, or safety system designs considered by the FERC during the review process. The required information must include all features necessary for commissioning, start-up, operation and maintenance of the facility, including details of the utility, safety, fire protection and security systems. Novel designs require additional detail for proof of concept.

A complete FEED submittal will include up-to-date piping and instrumentation diagrams (P&IDs). Information on these drawings allows FERC staff to begin assessing the feasibility of the proposed design. Adequate P&IDs will include:

- equipment duty, capacity and design conditions;
- piping class specifications;
- vent, drain, cooldown and recycle piping;
- isolation flanges, blinds and insulating flanges;
- control valves and operator types (indicating valve fail position);
- control loops including software connections;
- alarm and shutdown set points;
- shutdown interlocks;
- relief valve set points; and
- relief valve inlet and outlet piping size.

Once an application is formally made to the Commission, FERC staff performs a detailed review of the information supporting the proposed LNG facility design. Since the enactment of the Energy Policy Act of 2005, no later than 30 days after the application filing, the agency designated by the Governor of the state where the terminal is proposed may file an advisory report on state and local safety considerations. Before issuing an order authorizing an applicant to site, construct, expand, or operate an LNG terminal, the Commission shall review and respond specifically to the issues raised.

During the analysis of the application, FERC staff compiles pertinent technical information to assess the design of the LNG facility. Although operability and reliability of the proposed design are considered, our primary focus is on the safety fea-

tures that must be built into the system. This review is performed prior to any Commission approval and evaluates the safety of:

- the LNG transfer systems;
- storage tanks and process vessels;
- pumps and vaporizers;
- pressure relief, vent and disposal systems;
- instrumentation and controls;
- spill containment systems;
- hazard detection and control systems; and
- emergency shutdown systems.

Each LNG import terminal must have an extensive array of hazard detection devices to provide an early warning for the presence of combustible gases, fires, or spills of LNG and activate emergency shut-down systems. Using the submitted design, FERC staff assesses the conceptual hazard detection system, which typically consists of combustible-gas detectors, fire detectors, heat detectors, smoke or combustion product detectors, and low temperature detectors. Typically, each facility will have over 100 of these types of detectors.

Use of these active systems to automatically shutdown equipment, and other passive safety protections, such as impoundments, are reviewed to ensure that appropriate safety provisions are incorporated in the plant design. A detailed layout of the passive spill containment system showing the location of impoundments, sumps, sub-dikes, channels, and water removal systems is evaluated to allow FERC staff to assess the feasibility of the location, design configuration, dimensions, capacity and materials of construction for this system. In accordance with Title 49 of the Code of Federal Regulations, § 193.2181, these spill containment systems must accommodate 110 percent of an LNG tank's maximum liquid capacity.

Active hazard control systems consisting of strategically placed dry chemical extinguishers; carbon dioxide or nitrogen snuffing equipment; high expansion foam systems; and fire-water systems throughout the terminal are evaluated in accordance with Federal regulations and good engineering practices. A detailed layout of the fire water system showing the location of fire water pumps, piping, hydrants, hose reels, and auxiliary or appurtenant service facilities is reviewed for adequacy.

In addition, each storage or process area containing LNG must be surrounded by an impoundment structure to contain and limit potential spills associated with that equipment. Based on the size and location of these impoundments, the project sponsor must establish exclusion zones around the facility so that the effects from potential LNG pool fires and flammable vapors from an unignited LNG spill do not pose a hazard to the public. In accordance with Title 49 CFR § 193.2057 and 193.2059, and in conjunction with the National Fire Protection Association 59A LNG Standards, thermal radiation and vapor dispersion exclusion zones are calculated by FERC staff based on spill scenarios and heat flux levels. The operator must be able to legally control land uses within any portion of these zones extending beyond the terminal site to prevent damaging effects of an LNG pool fire or a flammable vapor mixture from impacting public safety.

Further, during the pre-authorization phase and beyond the cryogenic design review, each application for an LNG facility is subject to a detailed review by the FERC staff of numerous other studies and reports that the applicants are required to complete. These include:

- seismic analyses;
- fire protection evaluations;
- threat and vulnerability assessments; and
- Operation and Maintenance manuals.

The information used for the pre-authorization review is gathered from the application, data requests, and a *Cryogenic Design Technical Conference* held with the applicant's design team. This meeting allows FERC staff and company engineers to discuss specific engineering-related issues. Representatives from the Coast Guard and DOT, as well as state and local fire marshals, are invited to attend. Although the Coast Guard is generally in attendance to address facility issues, the issues specifically related to LNG vessel transit are dealt with during the Coast Guard's separate waterway suitability assessment (WSA) process.

The staff's conclusions and recommendations on the proposed design, including all safety measures, are presented in the Safety section of the publicly-released FERC environmental assessment or environmental impact statement (EIS). Ultimately, these recommendations have appeared as conditions in Commission Order approving the project. In addition to design considerations, the Order may also contain other LNG-specific standard conditions that pertain to the safe operation and security of the facility. If the Commission decides that a project would be safe, is in the

public interest, and authorizes it, continued review would occur during the pre-construction phase.

Pre-Construction Review—If a project sponsor receives a Commission Order and decides to pursue the project, it will engage the services of an Engineering, Procurement, and Construction (EPC) firm to commence detailed engineering of the facility. This process results in a "final design" that usually contains further development or minor refinements to the approved FEED on file with the FERC. For these modifications, the FERC Order requires the project sponsor to request approval for the change, justify it relative to site-specific conditions, explain how that modification provides an equal or greater level of protection than the original measure; and receive approval from the Director of OEP before implementing that modification. For more significant changes, the project sponsor would be required to file an amendment or a new application, initiating another extensive review at the Commission.

The final design will typically include hundreds of pages of detailed engineering drawings and specifications for every area and piece of equipment in the facility including the marine platform, transfer lines, tanks, sumps, pumps, compressors, vaporizers, and blowers. Only after FERC staff has reviewed the final design for a particular facility component to ensure it complies with all the safety conditions of the Order and that it conforms to the approved design on file, will authorization to construct that component be granted. We review large scale issues such as the facility's final plot plan and location of equipment, tanks, and impoundments to verify that all exclusion zones remain in compliance with siting regulations. These final review checks will also confirm that the number, location, type, and size of hazard detection and hazard control equipment match or improve upon the approved design and that redundancy, fault detection, and fault alarm monitoring exist in all potentially hazardous areas and enclosures.

Prior to entering the detailed design phase, project sponsors perform a hazard and operability study of the initial design. This study is intended to identify potential process deviations that could occur during operation and lead to personnel injury or equipment damage. The analysis proceeds by systematically identifying possible causes for operational deviations and the consequences of these deviations at numerous locations in the regasification process. Areas of concern typically include equipment failures, human failure, external events, siting issues, previous incidents, and safeguard or control failures. These causes and consequences are in turn used to evaluate the inherent safeguards in the design and to identify suitable design modifications as required. Examples of the additional safeguards that are required are: detection systems, prevention systems, procedural safeguards, active and passive safety equipment, emergency response procedures, and secondary containment.

During the pre-construction phase, FERC staff will review this study as well as review all piping and instrumentation diagrams, including every valve and thermocouple, to make sure that the overall safety of the final design provides an equal or greater level of protection as the original design approved by the FERC.

Furthermore, the design of some facility components such as the foundation of the LNG tanks will be reviewed by geotechnical experts who determine if the foundation structure is capable of safely supporting the load of a full LNG tank, even during seismic events.

In accordance with the Energy Policy Act of 2005, Commission Orders authorizing an LNG import terminal require the project sponsor to develop an Emergency Response Plan (ERP) in consultation with the U.S. Coast Guard and state and local agencies. Prior to any construction at the facility, this plan, which must also include cost-sharing provisions for safety and security, must be approved by the Commission. The ERP must include written procedures for responding to: emergencies within the LNG terminal; emergencies that could affect the public adjacent to an LNG terminal; and emergencies that could affect the public along the LNG vessel transit route. The ERP must be prepared in consultation with the Coast Guard and state and local agencies, and it must be approved by the Commission prior to any final approval to begin construction at the terminal site.

Commission engineering staff reviews each ERP to ensure that the appropriate state and local agencies have been involved in preparing the plan, that the local Coast Guard Marine Safety Office has been consulted and concurs, and that the following topics are completely addressed:

- Structure of the incident management organization of the LNG terminal; and name, title, organization, and phone number of all required agency contacts;
- Procedures for responding to emergencies within the LNG Terminal—identification of the types and locations of specific emergency incidents that may reasonably be expected to occur at the LNG terminal due to operating malfunc-

tions, structural collapse, personnel error, forces of nature and activities adjacent to the terminal;

- Procedures for emergency evacuation adjacent to the LNG Terminal and along LNG vessel transit route; detailed procedures for recognizing an uncontrollable emergency and taking action to minimize harm to terminal personnel and the public; procedures for the prompt notification of appropriate officials and emergency response agencies based on the level and severity of potential incidents; and the sequence of such notifications;
- Plans for initial and continuing training of plant operators and local responders; and provisions for annual emergency response drills by terminal emergency personnel, first responders, and appropriate federal, state and local officials and emergency response agencies; and
- Documentation that the required consultation with the Coast Guard and state and local agencies has been completed through correspondence with consulting agencies, and minutes or notes of coordination meetings.

In addition, both the Energy Policy Act of 2005 and Commission Orders authorizing LNG terminals require that the ERP include a Cost-Sharing Plan identifying the mechanisms for funding all project-specific security costs and safety/emergency management costs that would be imposed on state and local agencies. The cost-sharing plan must specify what the LNG terminal operator will provide to cover the cost of the state and local resources required to manage the security of the LNG terminal and LNG vessel, and the state and local resources required for safety and emergency management, including:

- Direct reimbursement for any per-transit security and/or emergency management costs (for example, overtime for police or fire department personnel);
- Capital costs associated with security/emergency management equipment and personnel base (for example, patrol boats, fire fighting equipment); and
- Annual costs for providing specialized training for local fire departments, mutual aid departments, and emergency response personnel; and for conducting exercises.
- The cost-sharing plan must include the LNG terminal operator's letter of commitment with agency acknowledgement for each state and local agency designated to receive resources.

FERC and other federal agencies work with state and local entities, as well as the general public, to ensure that all public interest considerations are carefully studied and weighed before a facility is permitted and allowed to begin construction and operate, and that public safety and the environment are given high priority. No construction may commence until the Director of OEP finds that all safety requirements have been met.

Pre-Operation Review—Once construction of the project has been authorized to begin, Commission staff inspects each site at least once every eight weeks to ensure that project construction is consistent with the designs approved during the pre-authorization and pre-construction review phases.

During these inspections, Commission staff physically examines the entire site to verify the ongoing construction activities in each area. Staff confirms that the locations of individual process equipment under construction are in accordance with the approved site design, ensuring that the safe distances required between property lines, equipment, and facilities are being maintained. Staff verifies that all site activity and equipment under construction comply with the conditions of the Order that are applicable for that phase of the project. Commission engineers also meet with the owner's project design engineers to discuss any modifications or design refinements that may result from the detailed design phase of development - for example, adjustments considered necessary as a result of equipment vendor specifications or other insights realized during construction.

In addition, staff reviews both the owner's and the EPC firm's quality assurance plans to verify that rigorous and stringent quality control inspections are being conducted by both parties during all phases of the construction process. Inspections must apply to equipment and components being fabricated at manufacturing sites, material and equipment received at the construction site, specific assembly or fabrication methods employed during construction, and also the continuous verification of the precision and quality of all structural work carried out during the construction process.

Staff reviews all of the non-conformance reports generated by the project's quality control inspectors and how these incidents have been satisfactorily resolved. These deviations from the intended quality of work are evaluated by FERC staff to ensure that the final quality of the work will meet or exceed design requirements. Problems

of significant magnitude are required to be reported to the Commission within 24 hours.

During the later stages of the typical three-year construction period, FERC staff monitors the EPC contractors' efforts to commission (*i.e.,* test and start-up) the various process systems and equipment throughout the terminal in preparation for the commencement of commercial operations. Commission staff is actively involved in the commissioning phase to verify that the final, constructed facility complies with the design authorized by the Commission Order, and that the project sponsor has complied with all conditions. This review includes verification that all of the cryogenic design recommendations in the Order applicable to the facility's pre-construction and construction phases have been fulfilled. Multiple on-site inspections are performed to confirm the construction and location of all plant equipment, process systems, and safety systems, including:

- Verifying LNG spill containment structures for completion of walls, piping, correct slope, size, materials used, sump pumps, and instrumentation for cold detection shutoff, and confirmation that proper materials have been used to complete containment;
- Checking critical instrumentation against the P&IDs with the actual piping, valves, and controls; and the instrument readouts, controls, and alarm/shutdown functions in the plant control room;
- Confirming that all required hazard detection devices (combustible gas, fire, smoke, low temperature) have been installed, including an examination of the cause and effect diagrams and instrument locations for appropriate redundancy and "alarm" and "shutdown" conditions. The physical inspection also evaluates detector location and orientation for blind spots that may require additional hazard detection devices;
- Confirming that all dry chemical, carbon dioxide, or other fire extinguishing units/bottles have been installed. The devices are checked to confirm proper weight and areas have been covered;
- Confirming that all critical pressure relief valves have been installed, have proper discharge orientation, and vent collection systems are operable;* Confirming that the entire firewater system is in place, including monitors, hydrants, pumps, screens, deluge and water supply, and has been tested for operation;
- Checking each LNG storage tank's equipment including elevation bench marks, rotational devices, liquid level gauges, pressure and vacuum relief valves, and discretionary relief valves for proper installation and confirming that all permanent covers have been installed. After cool-down, the fill lines and tank penetrations are inspected for presence of excessive low temperature conditions;
- Checking critical, required alarms and shutdowns, including set points (*e.g.,* tank foundation temperatures, send-out temperature shutdown set points) within the plant's Control Room and satellite control centers;
- Confirming that all temporary construction structures have been removed and the facility complies with National Electrical Code Division requirements; and
- Confirming that the plant's Emergency Shutdown System has been tested and is fully operational, including that all required systems have been tied into it.

Prior to operation, each LNG tank is hydrostatically tested to gauge the tank's ability to handle expected loads. During the hydrostatic test, the FERC Order will require the project sponsor to include a reliable measurement system to monitor any deflections in the tank foundation or structure during the hydraulic test. At a minimum, this system must include as many monitoring points as is necessary so that sag, warping, tilt, and settlements can be monitored. Tolerances for sag, tilt, and shell warping must meet or exceed the limits specified by the tank manufacturer. In this manner, the strength of the tank is thoroughly examined under loads similar to what will be experienced in actual operation. The final design review will ensure that adequate plans for such testing are in place for all facility components.

As part of the pre-commission inspection, FERC staff also reviews the Start-up Manual, Safety Plan Manual, and Operations and Maintenance Manuals applicable to the installation. This review includes verifying that the terminal staff has received the necessary training to operate the plant or new systems, if an existing plant is being expanded. We confirm that the plant has employed the required staffing with a level and function appropriate for the facility.

FERC staff confirms that all plant security systems are in place (personnel, cameras, and other equipment), and that the Facility Security Plan is current. This re-

view also includes confirming that all spare equipment that was authorized is on site and properly installed.

FERC staff also checks the entire facility site to ensure that all recommended environmental mitigation measures including erosion and sediment controls are in place, are being properly maintained, and that the company is making prudent steps to ensure that the site is properly stabilized for the operational life of the facility (e.g., installation of shore line stabilization mats and rip rap).

Prior to operation, FERC staff also reviews the facility security to ensure compliance with the authorized design. Principal concerns are compliance with the DOT regulations, as well as sufficient levels of security provided by surveillance cameras; intrusion detection systems; security fencing; and on-site access control plans.

Only after all of the above-identified inspections and reviews have been successfully completed would FERC staff recommend that the terminal is ready for operations. The Director of OEP must issue a letter to the company that authorizes commencement of service from the facility.

Prior to operation, the terminal must also satisfy other federal agency requirements. For example, the facility must have a Facility Security Plan approved by the Coast Guard and a Vessel Transit Management Plan prepared by the Coast Guard and port stakeholders.

FERC oversight continues after an LNG import terminal project commences commercial operations. In fact, the Office of Energy Projects was reorganized to specifically create a Branch that is dedicated to ensuring that all FERC requirements, including safety and security measures, are complied with throughout the life of the project. Each LNG facility under FERC jurisdiction is required to file semi-annual reports to summarize plant operations, maintenance activity and abnormal events for the previous six months. LNG facilities are also required to report significant, non-scheduled events, including safety-related incidents (e.g., LNG or natural gas vapor releases, fires, explosions, mechanical failures, unusual over-pressurization, major injuries) and security-related incidents (e.g., attempts to enter site, suspicious activities near the plant site or around the marine terminal), as soon as possible but no later than within 24 hours. In addition, FERC staff conducts annual on-site inspections and technical reviews of each import terminal throughout its entire operational life. The inspection reviews the integrity of all plant equipment, operation and maintenance activities, safety and security systems, any unusual operational incidents, and non-routine maintenance activities during the previous year. Ultimately, the Director of the Office of Energy Projects has the authority to take whatever measures are necessary to protect life, health, property or the environment.

We are proud of our track record working with DOT, the Coast Guard, states agencies, and with all interested stakeholders on these projects, and we are committed to continuing LNG's outstanding operational performance.

The Safe History of LNG Shipping

In addition to ensuring safe and secure terminal sites, FERC coordinates closely with the Coast Guard to ensure the safety and security of the LNG vessel transit to the import facility. Under our pre-filing regulations, applicants are required to prepare a WSA, which is reviewed by the Coast Guard and members of the local Area Maritime Security Committee. The Coast Guard convenes a working group consisting of members of the local Area Maritime Security Committee, federal agencies, state and local law enforcement, state and local firefighters, maritime and security professionals, and key port stakeholders throughout the port area.

Under Coast Guard supervision, this group, through a series of focused meetings, brings together its viewpoints to form a consensus on appropriate measures and mitigation needed to manage responsibly the safety and security risks posed by LNG marine traffic. At these meetings, FERC staff serves as the LNG technical advisor to the working group, provides insight from our participation in other waterways, and assists in identifying credible hazard scenarios. The group's detailed recommendations from the meetings are presented to the Coast Guard to assist in the Captain of the Port's review of the applicant's WSA. Based on its review, the Captain of the Port will make a preliminary determination on the suitability of the waterway. This determination will be presented to the FERC in the Coast Guard's Waterway Suitability Report.

The Waterway Suitability Report, filed with the Commission, preliminarily determines whether the waterway is suitable for LNG vessel transits, from both a safety and security perspective, and identifies additional resources that may be required. The results of this analysis are incorporated into the draft EIS and released for public comment. The 45-day comment period usually includes a public meeting near the proposed facility and along the pipeline route. In this manner, after public comment

has been received and the final EIS is published, the Commission has a complete record on the suitability of the waterway and potential resource requirements prior to deciding whether to approve a particular LNG import terminal.

Since the beginning of commercial operations in 1959, LNG carriers have made over 46,000 voyages worldwide without a significant release of cargo or a major accident involving an LNG carrier. In no instance has an LNG cargo tank been breached either by an accidental or intentional event.

Any LNG carriers used to import LNG to the United States must be constructed and operated in accordance with the International Maritime Organization's (IMO) *Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, the International Convention for the Safety of Life at Sea,* as well as 46 CFR Part 154, which contain the United States safety standards for vessels carrying bulk liquefied natural gas. Foreign flag LNG carriers are required to possess a valid IMO Certificate of Fitness and a Coast Guard Certificate of Compliance.

LNG carriers are well-built, robust vessels employing double-hull construction, with the inner and outer hulls separated by about 10 feet. The LNG cargo tanks are further separated from the inner hull by a layer of insulation approximately one-foot thick. As required by the IMO conventions and design standards, hold spaces and insulation areas on an LNG carrier are equipped with gas detection and low temperature alarms. These devices monitor for leaks of LNG into the insulation between primary and secondary LNG cargo tank barriers. In addition, hazard detection systems are also provided to monitor the hull structure adjacent to the cargo tank, compressor rooms, motor rooms, cargo control rooms, enclosed spaces in the cargo area, specific ventilation hoods and gas ducts, and air locks.

Even in the few instances worldwide where there have been incidents, the integrity of LNG vessel construction and safety systems has been demonstrated. One of the more significant incidents involved the *El Paso Paul Kayser* which grounded on a rock in the Strait of Gibraltar during a loaded voyage from Algeria to the United States in June 1979. Extensive bottom damage to the outer hull and the ballast tanks resulted; however, the cargo tanks were not damaged, and no cargo was released.

There have been a few other instances where LNG ships have grounded. In 1980, the *LNG Taurus* grounded near the entrance to Taboata Harbor, Japan. The grounding resulted in extensive bottom damage, but the cargo tanks were not affected and no cargo was released. The ship was refloated and the cargo was unloaded. In 2004, the *Tenaga Lima* was grounded on rocks, due to a strong current while proceeding to open sea East of Mopko, South Korea. The ship's shell plating was torn open and fractured over an approximate area of 20—by 80-feet. Internal breaches allowed water to enter the insulation space between the primary and secondary membranes. However, the ship was refloated, repaired, and returned to service. Although damage was incurred when these LNG ships were grounded, their cargo tanks were never penetrated and no LNG was released.

In another incident, the *Norman Lady* was struck by the nuclear submarine USS Oklahoma City while the submarine was rising to periscope depth near the Strait of Gibraltar in November 2002. The LNG carrier sustained only minor damage to the outer layer of its double hull but no damage to its cargo tanks.

More recently, the *Khannur* had a cargo tank overfill into the ship's vapor handling system during unloading at Everett, Massachusetts, in 2001. Approximately 100 gallons of LNG were vented onto the protective decking over the cargo tank dome resulting in several cracks. After inspection by the Coast Guard, the *Khannur* was allowed to discharge its cargo. In 2002, the *Mostaefa Ben Boulaid* had LNG spill onto its deck during loading operations in Algeria. The spill, which was believed to be caused by overflow, caused brittle fracturing of the carbon steelwork. The ship was required to discharge its cargo and proceed to dock for repairs. Although all these incidents resulted in an LNG release, there were no injuries in any of these incidents.

The most recent incident occurred in 2006 when the *Golar Freeze* moved away from its docking berth during unloading in Savannah, Georgia. The powered emergency release couplings on the unloading arms activated as designed, and transfer operations were shut down, preventing release of significant amounts of LNG or any structural or environmental damage. After inspection and onsite clearance by FERC staff and the Coast Guard, the arms were reactivated and transfer operations resumed without incident.

The low number of LNG tanker incidents can be attributed to the careful handling of the tankers, as well as safety and security procedures used in the ports. The transit of an LNG vessel through a waterway is strictly controlled by the Coast Guard to prevent accidental or intentional incidents that could damage the vessel

or endanger the public. Entry into a port typically involves Coast Guard requirements such as:

- 96 hours advance notification of arrival and the vessel crew manifest;
- Coast Guard boarding of the LNG Vessel for an inspection of the ship safety system;
- Moving safety/security zones around the LNG vessel;
- Armed and unarmed escorts;
- Tug escort to assist with turning and mooring operations;
- Safety and security zones around the terminal dock while the vessel is berthed;
- Accompaniment by a state-licensed pilot; and
- Inspection of the dock safety systems before commencing cargo transfer.

With these operational measures, the transit of LNG carriers has been demonstrated to be safe along the waterway from the berthing area to the territorial sea.

GAO Report [No GAO–07–316]: "Public Safety Consequences of a Terrorist Attack on a Tanker Carrying Liquefied Natural Gas Need Clarification."

I am encouraged that the GAO report reached many of the same conclusions on LNG hazards which we have published in each FERC environmental impact statement. The findings of the GAO expert panel concur with FERC staff's assessment of the potential public safety consequences of a terrorist attack on an LNG tanker regarding:

- unconfined vapor cloud explosions;
- freeze burns;
- asphyxiation; and
- rapid phase transitions (RPTs).

These phenomena do not pose a significant hazard to the on-shore public during a large-scale LNG spill. Natural gas vapors (primarily methane) can detonate if contained within a confined space, such as a building or structure, and ignited. However, unconfined methane-air mixtures have been ignited but not detonated in experiments. Although the addition of heavier hydrocarbons influences the tendency of an unconfined vapor cloud to detonate, the possibility for detonation of a large unconfined vapor cloud is unrealistic due to precise timing, necessary mixing, and required amount of initiating explosives.

Similarly, the public is not at risk from freeze burns or asphyxiation. Clouds from an LNG spill would be continuously mixing with the warmer air surrounding the spill site. Dispersion modeling estimates that the majority of the cloud would be within 25 degrees Fahrenheit of the surrounding atmospheric temperature, with colder temperatures closest to the spill source and away from the public. In addition, the majority of the cloud would be below concentrations which could result in oxygen deprivation effects, including asphyxiation, with the highest methane concentrations closest to the spill source.

The report also focused on potential impacts from RPTs. Our project-specific EISs include a discussion of this issue. While RPTs can occur during a spill on water, impacts would be limited to the area within the pool and would be unlikely to affect the public. The overpressure events observed during experimentation have been relatively small, estimated to be equivalent to several pounds of TNT. Although such an event is not expected to cause significant damage to an LNG vessel, it could increase the rate of LNG pool spreading and the LNG vaporization rate for a spill on water.

FERC staff also concur with the GAO report on the potential for a boiling liquid expanding vapor explosion (BLEVE). While it may be theoretically possible, the low storage pressure, use of insulation, and installation of relief valves on both onshore LNG storage tanks and LNG carriers render the possibility of a BLEVE unlikely for LNG as it is normally transported and stored.

The report further states that the most likely public safety impact from an LNG spill would be from heat associated with a pool fire. FERC staff has also analyzed this issue in the course of project specific reviews and has reached that same conclusion. In its 2004 report, Sandia considered scenarios likely to breach an LNG cargo tank. Events ranged from accidental collisions, groundings, rammings, sabotage, hijackings, attacks with small missiles and rockets, and attacks with bulk explosives. These types of events which could potentially lead to a large LNG spill would likely be accompanied by a number of ignition sources. Surrounding impacts would be from an LNG pool fire, and subsequent radiant heat hazards, rather than the formation of a large unconfined vapor cloud. Each of our EISs describes those potential impacts on the local waterway.

As stated in the 2004 Sandia report, the most significant impacts to public safety and property exist within approximately 500 meters (1,640 feet) of a spill due to thermal hazards from a fire, with lower public health and safety impacts beyond 1,600 meters (approximately 1 mile). We believe the Sandia report and FERC's site-specific analysis are a reasonable and conservative basis to examine potential impacts from an LNG tanker fire.

The GAO study reports four experts thought the Sandia distance calculations were "too conservative"; four thought "not conservative enough"; seven thought "about right." Although the report characterizes this as disagreement, the majority of the panel (11 of 15) responded that the calculations were either accurate or overly conservative.

Although FERC staff generally agrees with the material presented in the GAO report, further explanation of some information is necessary. For instance, the report mentions that an LNG vapor cloud is visible, but natural gas vapors are colorless. The fog-like appearance usually associated with an LNG vapor cloud results from condensation of water vapor in the air due to the lower temperatures of the cloud. However, appearance of this visible water vapor does not necessarily reflect the flammable portion of the cloud. In addition, the report states that LNG fires burn hotter when the maximum flame temperature of methane is nearly the same as other fuels. Radiant heat from a large-scale LNG pool fire is assumed to be greater than other common hydrocarbon fuels based on the results of small-scale fire measurements. However, it has not been proven that this effect would scale up to larger fires. Oxygen deprivation and smoke generation in a larger fire may lead to lower surface emissive power.

In each EIS, FERC staff includes site-specific modeling done with the methodology developed for FERC by ABS Consulting. In areas of uncertainty due to the lack of large-scale field data, the FERC model uses conservative assumptions (i.e., resulting in longer hazard distances). These conservative assumptions concern: calculation of the pool spread; determination of the pool fire flame height; and use of a higher surface emissive power. Our results have been in agreement with the Sandia guidance zones of concern, and support the conservative nature of the calculations.

Cascading failure of the LNG storage tanks, addressed by Sandia in its previous examination of currently operating LNG carriers, was another topic of disagreement among the experts. Sandia stated that the events would not likely involve more than two or three cargo tanks. As stated in the 2004 Sandia report, the nominal hole size of an intentional breaching scenario would be no more than 5—to 7–m2, which is the appropriate range we use in the FERC staff EIS for calculating potential hazards from spills. For a breach of a 7 m2 in a single tank, the fire duration would be approximately 10 minutes. Whereas smaller hole sizes could result in fires lasting over 1 hour. While the expected fire duration from cascading tank failure would increase, the overall fire hazard was not expected by Sandia to increase by more than 20 to 30 percent. GAO recommended that further study of this issue could be undertaken by Sandia. We concur that further study on cascading mechanisms may clarify if the subsequent failure of the fourth and fifth cargo tanks would occur over time with the most probable consequence of further extending the duration of the fire.

Related to cascading failure mechanisms are the effects such an event may have on a pool fire (*i.e.,* whether it would increase the duration of the event, increase the size of the pool fire, or lower the radiant heat due to increased smoke generation). Current knowledge of the physical properties associated with an LNG spill are based on small-scale (<35 meter diameter pool) tests. How the data collected from small-scale pool fires can be extrapolated to the potentially large-scale cargo releases is a subject of much debate among the modeling community. Quantifying the physical properties of large-scale LNG spill should be a priority. This will allow analysts to refine the consequence models and generate more consistent results. Sandia currently has this effort underway with the Advanced LNG Pool Fire Testing Program.

Initial experimental results are expected in a few months, and the large-scale experiments are planned to be complete by August 2008. The initial results of these experiments will determine better correlations for the flame height and mass fire behavior which could be expected during larger fires. The large-scale tests will result in better data on vapor production rates, smoke generation, and surface emissive power. In a separate effort, Sandia is also applying its threat analysis and spill probability methodology to LNG tankers larger than those previously studied. The research is designed to provide an estimation of the sizes of breaches, including hole size, spill volume, and number of tanks breached, for membrane-designed ship classes ranging from 216,000 m^3 to 267,000 m^3. These are representative of LNG

ships that are currently being designed, constructed and proposed for use at LNG facilities in the United States. Presently, each Order issued by the Commission requires the applicant to prove that staff's modeling of hazards for those large tankers is accurate. They must do this and get approval from the Director of OEP prior to accepting the larger size ships.

We will use this new data to enhance our modeling capabilities for determining possible consequence areas resulting from a successful intentional attack on an LNG tanker. FERC staff has always committed to modify our analyses, when appropriate, as new data and improved modeling technologies are developed.

I believe that this research is beneficial and necessary and will provide more exact information and technical details. Removing the uncertainty inherent in modeling phenomena will result in more accurate models. However, in current areas of uncertainty, we have made conservative assumptions. FERC staff believes the refined models will likely show smaller consequence areas. FERC, and along with it, the Coast Guard and DOT have a competent understanding of the risks and how to mitigate them effectively to ensure public safety.

In conclusion, LNG is a commodity which has been and will continue to be transported safely in the United States. The U.S. Coast Guard, the U.S. DOT and FERC are committed to ensuring that safety. As a matter of policy, the Commission is committed to continually raising the bar on energy infrastructure safety. As new safety measures, improved monitoring equipment, and enhanced safety and security protocols are developed, the Commission will ensure that LNG remains a safe and secure fuel source for the country.

Chairman THOMPSON. Thank you very much, Mr. Robinson. I thank you and all the witnesses for your testimony.

I will remind each member that he or she will have 5 minutes to question the panel.

I will now recognize myself for the first 5 minutes.

Mr. Lesnick, it is my understanding that the maritime administrator is working with individual companies to increase the number of U.S. mariners on LNG tankers.

How many companies have agreed to increase their number of U.S. mariners at this point?

Mr. LESNICK. At this point in time, I think it is four, Congressman.

Chairman THOMPSON. Four out of——

Mr. LESNICK. Four out of perhaps any number that—there are numerous companies that deliver LNG to the United States.

Chairman THOMPSON. For the record, share with the members of the committee just what the maritime administrator is proposing for each LNG tanker that comes on our shores.

Mr. LESNICK. Well, essentially, when we began the program, it is just dealing with the offshore facilities, Mr. Chairman.

But what we have done is we have asked each applicant to agree voluntarily to provide a certain level of U.S. licensed and unlicensed crew on every vessel that is delivering gas to one of the deepwater port facilities.

What happened with Suez Energy is that when they entered into that agreement with us, they also entered into an agreement to provide the same level of U.S. crews on all of the tankers coming to all of their facilities into the United States.

We are working now with British Gas and with Shell. We don't specifically have offshore facilities with the same type of agreement.

Chairman THOMPSON. Okay. Well, I guess my point is what is the percentage the administrator——

Mr. LESNICK. Twenty-five percent of the licensed and 10 percent of the unlicensed mariners aboard the vessel, every vessel coming in.

Chairman THOMPSON. Okay. Is there any effort to increase that percentage?

Mr. LESNICK. There will be efforts to do that once we meet that particular quota.

Chairman THOMPSON. So you are saying only four companies have agreed so far.

Mr. LESNICK. So far, but there are more—there are at least three additional ones that are interested in doing such. We are in conversations with them.

Chairman THOMPSON. Well, now, are the ones who are not—who have not agreed—are they allowed to come and utilize the facilities?

Mr. LESNICK. At present, we only have one operating deepwater port, sir. When they are all—yes, they will be allowed to use the facilities.

Chairman THOMPSON. They will be.

Mr. LESNICK. Yes.

Chairman THOMPSON. Does the administrator have any plans to deny the use because they won't hire American to a certain percentage on the ships?

Mr. LESNICK. Under the Deepwater Port Act, we wouldn't have the authority to do that, sir.

Chairman THOMPSON. So basically you are saying the administrator is just using his influence to get the percentages?

Mr. LESNICK. What we do is we give priority processing to people who agree to this manning agreement. And we are also working with applicants to actually re-flag vessels, LNG tankers, to the U.S. flag.

Through that priority, they get moved to the front of the queue in terms of the license application process, and that has enticed them, along with all of the security and political pressures attached to that. It has enticed other companies to agree to do the same thing.

They understand that there is a shortfall and that there is going to be a worldwide shortfall, and they need Americans on board all of those vessels. They are seeking U.S. crews.

Chairman THOMPSON. Well, personally, I think it is a good idea to hire Americans, you know, and would have no problem making that part of the requirements. And I guess we will look at that at some point.

Admiral is there a reason why the TWIC identification card at this point is only applied to U.S. mariners and not everybody who is coming in?

Admiral SALERNO. Yes, sir. The provisions of MTSA, which required the credential, the transportation worker identification credential for mariners, applies to U.S. mariners. It does not extend to foreign mariners.

So there is no requirement or mandate in law to require that for foreign mariners.

Chairman THOMPSON. So in other words, we vet the Americans who come but everybody else on the ship—we don't vet them.

Admiral SALERNO. Sir, there is other dimensions to this. For other people on—everybody that is arriving in the U.S. is vetted through a security protocol.

Not everybody will have a TWIC, but they will be vetted through the 96-hour advance notice protocol.

Chairman THOMPSON. I understand that, but if TWIC is for people who are somehow handling hazardous cargo, why—I mean, do you see a value in vetting everybody under TWIC who is on that ship?

Admiral SALERNO. Sir, the TWIC is intended for people who have unescorted access to facilities and to secure areas of a vessel.

If a foreign mariner were to come ashore into a facility and to be granted access into a secure area, he would have to be escorted. So he would not need a TWIC to be escorted, but that can be covered within the facility security plan.

Also, as I mentioned, each ship under the international code is required to have its own security plan, which we verify, that is in place and that there is a ship security officer on board the ship that makes sure that the plan is followed.

So there are security provisions that apply to the ship and to the mariners on that ship.

Chairman THOMPSON. I guess my point, though, is if that is in place, why give Americans the extra level of vetting that you don't give other individuals?

Admiral SALERNO. Sir, the expectation is that with a TWIC, a U.S. mariner would be able to have unescorted access through a facility and to areas of a vessel operating within our waters.

It is to have additional freedoms, if you will, by virtue of having that TWIC that would not be granted to a foreign mariner through a U.S. facility.

Chairman THOMPSON. Thank you.

I yield to the ranking member.

Mr. KING. Thank you, Mr. Chairman.

Admiral Salerno, would you describe what the rules of engagement are regarding the use of deadly force to protect an LNG shipment? And has deadly force ever been used or a weapon ever been discharged?

Admiral SALERNO. To answer your last question first, sir, deadly force has not been used. It is authorized in conformity to Coast Guard instructions, commandant policy.

Generally speaking, we only use as much force as is necessary to compel compliance. If we can use nonlethal means, that is what we will do if we can protect the ship.

Only if there is an imminent danger of loss of life either to our own crews or to another person would deadly force be used. But our crews are trained in judgmental shooting and proper procedures for the use of that force.

Mr. KING. Mr. Robinson, can you tell me how many new LNG projects are being considered by FERC?

Mr. ROBINSON. We have nine under review right now.

Mr. KING. And maybe you mentioned this in your testimony, but approximately how long does that process take? I mean, is there any standard? Is there any guideline you use?

Mr. ROBINSON. If everything goes well, the pre-filing process—which, again, is legally mandated—we like to see that accomplished in 8 months to 10 months, something in that time frame.

The application, once it is on file—we authorize the facility within 11 months, but we don't have a standard where we have to meet that.

We also have projects that we have been looking at—as an example, the port of Long Beach in California—for about 3 years now. We won't go to the commission for authorization until we have a complete record, to include the record on safety and security for each facility.

Mr. KING. Have you had any companies withdraw their application?

Mr. ROBINSON. We have had companies approach us and talk to us about an LNG facility and then withdraw from that proposal. Once somebody has reached pre-filing, they have usually spent a considerable amount of money at that point, and they pursue their application.

We have had no one withdraw once they got into a formal application with the commission.

Mr. KING. Once the process is started, are there modifications undertaken? I mean, is that standard, or, I mean, can it be adjusted as it goes along, or is it—

Mr. ROBINSON. It is adjusted from day one as it goes along. And just as an example, almost every authorization the commission issues has—not almost. Every authorization the commission issues has a list of requirements and modifications to what is proposed.

Typically that runs 70 or 80 very specific requirements that are imposed upon a terminal operator.

Mr. KING. Do you get much resistance or they pretty much do what they are told? I mean, you know, are you definitely holding the upper hand? I guess what I am talking about—you know, when you are dealing with the industry—

Mr. ROBINSON. I have had the opportunity to hold tankers offshore because I wasn't satisfied that a particular valve was installed correctly.

I have stopped work on projects and held complete work forces off for a week while we reviewed soldier beam installation for tanker design.

No, we have no problem protecting life, health and property and we have the authority to do it.

Mr. KING. How would you compare the compliance record or the cooperation, let's say, between LNG and the oil industry?

Mr. ROBINSON. Well, I don't have that much experience in the oil industry, but as far as the cooperation with the LNG industry, we have never met any resistance.

And along with that, the Congress was good enough to give us the authority through the Energy Policy Act of 2005 to fine our companies $1 million a day if they don't comply with our requirements.

Mr. KING. So long as I have you here today, is there anything you can tell me about Broadwater?

Mr. ROBINSON. Currently the status of that offshore facility—and we do the authorization for offshore facilities in state waters such as Broadwater.

We have issued a draft environmental impact statement. That included the water suitability report that was prepared by the Coast Guard. I personally was involved in about five public meetings on Long Island and Connecticut post-draft EIS.

We are now reviewing the thousands of comments that we have received on that project and will treat each and every one of them—respond to them. That will take us some time. We don't have a time frame right now for the final EIS and commission order.

Mr. KING. Thank you, Mr. Robinson.

I yield back, Mr. Chairman.

Chairman THOMPSON. Thank you very much.

We now recognize the gentleman from Rhode Island, Mr. Langevin.

Mr. LANGEVIN. Thank you, Mr. Chairman.

Gentlemen, I want to thank you for your testimony here today.

I have been following and been involved with the LNG issue for quite some time now. We have an LNG facility in my home state, my district, in downtown Providence which is located right in the heart of a very densely populated area.

There was a proposed expansion of that facility not too long ago which was denied for a variety of reasons, I think less because of safety and security reasons as it was dealing with the actual infrastructure, things that needed to be changed in order to accommodate the facility. It is an older facility and such.

I didn't agree necessarily that safety concerns were taken into account in the way they should be, but—and there is also the Weaver Cove facility that is near my district, and we are by—the tanker ships would need to go by areas in my district if that facility were to be expanded.

But let me turn to a couple questions I have. As we continue to increase our reliance on natural gas, I certainly understand that we will need to establish new and also enlarge existing LNG import facilities throughout the country.

However, I believe that we must carefully coordinate these efforts with our expected demand. So to this end, it is crucial that proposed facilities be examined using a regional approach rather than on a case-by-case basis.

And let me give you an example. Again, in my home state of Rhode Island, there was a proposal to expand an LNG facility in Providence, and there was also this proposal to build a facility at Weaver's Cove in Fall River, Massachusetts—that is less than 20 miles away—that FERC was considering at the same time.

Now, each of these proposals was considered on its own merit independent of the other proposed facilities within the region.

Though FERC, again, ultimately denied the Providence proposal, I understand that other LNG facilities are under consideration in the New England area, raising the prospect of numerous tanker shipments along populated coastlines with no greater coordination among the proposals.

So my question, to start with Mr. Robinson, would you please explain to us why FERC has not yet adopted a regional approach? And do you think that we should only consider each proposal independently? Or do you think that regional aspects should be taken into consideration as well?

And if I could also on this same point, Mr. Wells, in light of the findings of your recent report, what would you say about adopting a regional approach for building new LNG facilities?

And I would like to give the entire panel the chance to answer this question as well, going back to Mr. Wells.

And again, should we adopt a more regional-based approach to determining where new LNG facilities should be located to promote a more comprehensive approach to security?

And I will start with Mr. Robinson.

Mr. ROBINSON. Thank you. We do look at regional issues when we site an LNG facility.

As an example, for the KeySpan project, the one that we did turn down for safety reasons—it was very specifically for those reasons that we did reject that application—I think we looked at something on the order of 14 other sites that were in three other states in that area to see if there were any other facilities that might have superior characteristics, and concluded that in that instance there certainly were, because we denied that application.

As to regional planning in general, ultimately—and I have been siting energy infrastructure for almost 30 years now. When it comes to siting a piece of energy infrastructure, be it a dam, an LNG facility, a pipeline or transmission line, it always comes down to those local concerns and the local issues that people have who would be near that facility.

Those are what have to be treated, and that is what the commission takes very seriously.

A regional planning effort in that context—I think it would be difficult for a group to ultimately conclude that this is the best site, when they are approaching it from a regional perspective, because they don't know the details of that specific site.

Ultimately, you have to do a site-specific analysis and assessment to see if, in fact, that is correct. That is why the commission takes the approach that it does. We understand that all facilities will not be constructed. The market ultimately will dictate what gets built and what doesn't.

But what the commission does is make sure that they believe that they have the information necessary to determine if it is in the public interest to allow a site to be constructed at that particular point.

Mr. LANGEVIN. Mr. Wells, could you comment?

Mr. WELLS. Clearly, GAO over the years has had experience in assessing the success or failure of various regulatory approaches and permitting approaches.

You can pick and choose the issues where we have had piecemeal approvals that have involved local issues and have not been as desirable in the actual approval process.

We have had successes in regional approaches, particularly in electricity. Whether you agree or disagree with deregulation in the electricity market, regional approaches have achieved successes.

You would think as we move forward into the future that we would be able to bring some lessons learned in terms of what works and what doesn't work and maybe have a combined approach.

But typically, in the Federal Regulatory Agency, we see a tendency to stick with what you have always done.

Mr. LANGEVIN. Do either of the other two gentlemen care to comment?

Admiral SALERNO. Sir, from the Coast Guard perspective, we evaluate each of the applications presented to us on a case-by-case basis, not from a standpoint of deciding which is the best site.

We look at the applicant's package and we make the assessments for navigational safety, the security concerns and so forth.

As was mentioned, there is approximately 40 applications submitted. Probably only a dozen or so will actually be built. So the determination as to the best regional location would probably come after our assessment.

Mr. LESNICK. We are a market-driven—deciding is market driven. However, the Deepwater Port Act itself is unique in the fact that the governor of the adjacent coastal state has the right to approve or deny the application, and also approve it with conditions.

And that usually provides safeguards for the local state and the region in terms of exactly where a siting is going to occur.

Mr. LANGEVIN. I see my time has expired. I have got some other questions for the record I will submit with regard to safety and what weight safety issues go into making a determination about where to site or if a site should be approved. But again, my time has expired.

I thank the chairman, and I yield back.

Chairman THOMPSON. Thank you very much.

I now yield to the gentleman from Connecticut, Mr. Shays.

Mr. SHAYS. Thank you, Mr. Chairman. Thank you for holding this hearing.

And, gentlemen, thank you for your service to our country. I have been one who believes that while we don't feel that we are safer today, we are. We just had a very false sense of security in the past.

But saying we are safer doesn't mean we are safe. And I know that you all are working every day to have that happen.

I would just like to encourage you publicly to make sure that you are blunt as can be when you are in the public forum about the risk, because—and I will just quickly make this analogy.

We all knew we had problems at Walter Reed Hospital. There were reports about it. But frankly, when I had hearings about it, and others, the press wasn't there, and nobody paid any attention.

And then when there was a graphic picture of mold on a wall, the lightning struck. And then all of a sudden the press is saying where were we. And a lot of us were trying to address that issue.

I want to know if the concern about LNG plants is overblown. I look at these—and there are different types of tankers, correct? I see some that have the ball, and I see some that look straight.

Somehow the ones with the spheres look more frightening, and are they the older model? A nodding of heads won't get the answer here.

Admiral SALERNO. Sir, there are different designs, but essentially they are all meant to meet the same performance criteria.

Mr. SHAYS. And by performance, security as well?

Admiral SALERNO. Actually, the design of the ship, the containment of the cargo, the double-hulled design, all of—regardless of the design, they are all meant to perform——

Mr. SHAYS. Now, everyone who is a politician has opposed the location of an LNG plant everywhere around the world—in the United States, excuse me, practically. I don't want to over—but certainly, we have on Long Island Sound.

And I take that position—I take that position because I want us to deal with the energy problem in total, and then I am open to looking at a lot of things like offshore drilling. I am willing to look at nuclear. I am willing to look at everything.

But I want to see us deal with being more efficient with what we have before we start robbing the bank—not robbing the bank—before we start using our savings account. My view is let's spend the money better and then let's decide.

And I feel a little guilty, frankly, as someone who lives in Connecticut, New England, where I feel like we are at the end of the pipeline, and we are constantly saying no to more energy supply and so on.

So I am being honest with you about where I am coming from. When I am told that the LNG plant in Long Island would endanger someone within a mile radius, I then think well, here in Providence or in Boston, and I say, "My God, that is the target." I mean, we are wondering, that is the target.

I want you to tell me how dangerous are these facilities—these ships, excuse me, and the facilities where they connect, but basically the ship. The flame is hot. I am told it is extremely hot, very efficient.

And while you wouldn't get an explosion, you would get a huge flame, a fire. I am told the bigger—there is projection that the larger the fuel that the less likely of a more intense fire because it would conflict, that it would—you might have more smoke than fire.

Tell me what your studies tell you and what your experience tells you.

Mr. WELLS. I will start by saying your description of the conclusions reached by the few somewhat small number of studies confirm what you just said in regards to what the computer modeling tells them may exist, which falls into the gap that we have addressed in asking the Department of Energy to address.

Much of these conclusions and results are speculated based on assumptions and modeling techniques, and we are asking the Department of Energy to do the type of research to actually do a better job of assessing the consequences of a large fire, bigger spill volumes, larger holes in hulls, to, in fact, determine if that conclusion is valid.

Mr. SHAYS. I am more interested in—and I am just going to ask for a comment, but I am more interested in, say, a shoulder-fired missile, a portable air defense missile, you know, manual—I am more interested in that type of terrorist activity.

But let me go down the line here, if you have something to add.

Admiral SALERNO. Sir, in light of the threats that were identified in the report, certainly, a standoff weapon is one of the concerns that we would have.

But I think as the report pointed out—and I think we could say this in a non-SSI environment—the likelihood that—

Mr. SHAYS. No, I am going to ask you to—I will make the judgment here. If there is a terrorist attack using a manual—you know, handheld rocket, what is our determination?

Admiral SALERNO. The determination would be the consequence—the damage to the vessel would be less than a suicide attack.

Mr. SHAYS. Okay. Oh, I am sorry, suicide would be a ship coming up with more explosives?

Admiral SALERNO. Similar to a——

Mr. SHAYS. Well, then let me add—I mean, a terrorist attack as opposed to something that happened because they ran aground or something.

Admiral SALERNO. No, that is the way I meant it, sir.

Mr. SHAYS. I am sorry.

Admiral SALERNO. Comparable to the attack on the USS Cole.

Mr. SHAYS. I got you. Fair enough.

Yes, sir?

Mr. LESNICK. In terms of the damage done, that would be for someone else to assess, other than—but one of the reasons we remotely site these facilities is that is one of the reasons these sites are put offshore, so far offshore.

Mr. ROBINSON. Your question was is it overblown. It depends on where your information comes from. Certainly, if you read the popular press, it is completely overblown.

If you read the analyses that go into each of the projects, the very lengthy analyses that go in, I think you will get a clear picture of what the potential risks are.

As an example, the recent press on the GAO report—one of the headlines I saw was "LNG Explosion Burns People One Mile Away." The GAO report was very clear that explosions were unlikely. Again, I phrased it somewhere between improbable and impossible.

So even though in the popular media you will see explosions all the time, that is just not the case.

Burns One Mile Away—what they are talking about there are second-degree burns at a mile distance, if you hold your exposed skin up for 20 seconds to 30 seconds and don't move it. If you have clothes on, you are protected.

So the way it comes across in the media is everybody will be burned up to a mile out, when actually we are talking about just move away within 20 seconds to 30 seconds and you won't have a burn.

I think there is a difference between where you pick up your information and how it is portrayed.

Mr. SHAYS. Thank you.

Let me just make a summary comment, if I could, Mr. Chairman.

If you tell the American people the truth, they will have you do the right thing.

The problem we have in this whole dialogue is in some cases they have a fear that may not be warranted, and in other cases, based on reports that you have stated to us under closed meeting, they have a lack of knowledge of things that they should fear.

Our struggle needs to be to tell the American people the truth and then they are going to push us to do the right thing.

Thank you, Mr. Chairman.

Chairman THOMPSON. Thank you very much.

We now yield to the gentleman from Pennsylvania, Mr. Carney.

Mr. CARNEY. Thank you, Mr. Chairman.

And, gentlemen, thank you for coming in today. We appreciate it. I have just a couple of questions.

First, for Mr. Wells, and this is a quick one. You mentioned in your opening statement that there is a classified report that is almost ready, available soon?

Mr. WELLS. Available soon to people that have the national security clearance. That is correct.

Mr. CARNEY. So like guys like us on the committee—

Mr. WELLS. Can, in fact, hear the results and answer Congressman Shays's most recent question.

Mr. CARNEY. Very good. Do we have a time frame, kind of a date certain on that?

Mr. WELLS. I don't have a date certain. It is with the intelligence agency now for classification, so it is pretty much finished. We are just getting the clearances.

Mr. CARNEY. Very good. Okay.

Chairman THOMPSON. Well, I guess, let me take it a little bit—as soon as it is ready, will you notify the committee so we can schedule a time for the briefing?

Mr. WELLS. Absolutely, Mr. Chairman.

Chairman THOMPSON. Thank you.

Mr. CARNEY. The unfortunate reality is that the committee has been promised reports that now, in some cases, are a couple of years past due. I am not saying that is your case, Mr. Wells.

Mr. WELLS. Thank you.

Mr. CARNEY. We are especially sensitive right now on this sort of thing. Certainly, I am.

This is a general statement for—or question, rather, for you all. We have learned that there are up to 32 applications for new LNG facilities. I don't know if they are all going to come to life. Probably not.

But do we have the resources available to protect many more facilities?

Admiral?

Admiral SALERNO. We are very mindful of the fact that there will be a number of new facilities coming online, and certainly the question of resources is something that is before us.

We are looking at that very, very closely. In recent years, we have, in fact, looked at the overall requirements for our presence in ports, not only for LNG but for dangerous cargoes generally, and in the past have had requests submitted successfully for additional resources.

Mr. SHAYS. Would the gentleman yield? Would you mind, just——

Mr. CARNEY. Yes, Mr. Shays, I yield.

Mr. SHAYS. Isn't the honest answer "no"?

Admiral SALERNO. Sir, we are assessing the risks on that.

Mr. SHAYS. Isn't the honest answer "no" based on what we heard previous? Isn't that the honest answer? I will just leave it hanging.

I don't want to take your time.

Admiral SALERNO. Honestly, sir, it is on the table.

Mr. SHAYS. I think that is a punt, and I don't think it is an honest answer. I am sorry.

And I thank the colleague. I am sorry to interrupt.

And I hope the chairman gives him more time.

Mr. CARNEY. Thank you, Mr. Shays.

Mr. Lesnick, what do you think? From your perspective, do we have the resources available at the Coast Guard?

Mr. LESNICK. From my interaction with the Coast Guard——

Mr. CARNEY. Right.

Mr. LESNICK. —in terms of the applications that we have on the table right now, yes.

Mr. CARNEY. Okay.

Mr. LESNICK. But I know how hard they work through this whole process.

Mr. CARNEY. Mr. Robinson?

Mr. ROBINSON. Yes. I would like to bring in one other aspect here that goes directly to this, and I mentioned it earlier. Once a project is authorized—you have 30 to 40 applications—however many are out there.

But once a project is actually authorized, before they can start construction they have to develop an emergency response plan which identifies the resources, and who is going to pay for them, and where they are going to come from to ensure the safety and security of that facility.

That is done with the Coast Guard. There is about a 3-year period post-construction authorization to build the plant out. During that period, resources are acquired. The Coast Guard, our licensee, the locals, paid for as directed by this plan.

At the point that a tanker would come in, if the safety facilities are not in place, we wouldn't allow the plant to start operating, and I am sure the Coast Guard wouldn't allow a tanker to come in if they didn't have the facilities to ensure its safety as it came in.

So it is not like there is just an authorization and everything is there. You wouldn't want those facilities there before it is authorized. You have to bring them on as you approach actual operation. And we have a plan in place to make sure that happens.

Admiral SALERNO. If I could just add to that, that is very much in our thinking and in our method of operation that we look at other partner agencies within the port, because there are concurrent responsibilities and jurisdictions, as well as to the private sector, because they have a role in providing security resources as well.

And it is that composite mix that really goes into our assessment of whether it is suitable for a vessel to operate in a port area.

Mr. CARNEY. Well, I appreciate that. I guess I do go back to Mr. Shays's point. It sounds like the answer is no.

Does the Coast Guard—or are the LNG facilities or the applications—is that what drives Coast Guard growth?

Admiral SALERNO. As part of the review process, what the captain of the port will do is assess the security needs, and figure out what are the resources required and can he meet those requirements with his own resources and with other agency resources.

That is absolutely essential in the assessment. And overall, within the Coast Guard, if we cannot meet those requirements, obviously that may drive the need for more resources.

However, we also have to look at our ability to shift resources internally before we get to the point where we decide that we do, in fact, need more resources.

Mr. CARNEY. Okay.

Thank you, Mr. Chairman.

Chairman THOMPSON. Thank you very much.

Very rarely do I find a committee offering to help and help is denied. I just want to put that on the record. Clear, if the 15 applications that we had on file were approved, 3 years out, based on what I heard, we would have 15 more LNG facilities that obviously would have to meet the requirements.

I would hope that in meeting the requirements we would not delay ships coming in because we don't have help to do the inspections.

And I think if somebody—and maybe, Admiral, what I would like for you to do for the committee is looking at the 15 applications, will you provide us what assets, being personnel as well as boats, that would be needed to support those 15 applications that we presently have on file?

We will now go to Mr. Bilirakis of Florida for 5 minutes.

Mr. BILIRAKIS. Thank you, Mr. Chairman.

All ships carrying LNG that come into the U.S. ports must have additional safety measures you have described. This is for the admiral.

My understanding is that when these ships leave their initial port of call they are unaware of their final destination, which is determined by market demand.

At what point does the Coast Guard confirm that these ships meet U.S. safety standards? And if they do not, are they turned away?

Admiral SALERNO. Sir, the 96-hour advance notice of arrival gives us that ability to make sure that the ships meet all of the required safety, environmental and security standards.

That applies to every ship coming to the U.S. Now, in reality, there is relatively few ports that supply LNG to the United States. The primary one by ship is Trinidad and Tobago. Algeria is a second.

We frequently or routinely see the same ships over and over again, so they become very much a known quantity. We have frequent interaction with them. We inspect these ships on a regular basis.

In many cases, we send Coast Guard inspectors to ride the ships from the loading port to the port of destination in the United States. That gives us a great deal of familiarity with the operations on the ships, the nature of the crews.

Additionally, the crew members on many of these ships are a different caliber than we see on many other merchant ships. They tend to be long-term employees of the companies that employ them. They are very highly trained.

The companies invest a lot of time in training in these people. They tend to keep them for a long time, because of the sophistication of the ships. So our confidence level not only in the maintenance of the ships but in the crewing of the ships is very high.

Mr. BILIRAKIS. Thank you.

In 2005 the Coast Guard received 14 new boats to meet the port and waterway security mission. Four went to LNG vessels.

Were there any resources requested in fiscal year 2006, 2007 or in your proposed 2008 budget to meet the expected growth in the LNG industry?

Admiral SALERNO. You are correct on the fiscal year 2006 request. And for 2007 and 2008 there was not a request, and we are evaluating future needs based on the anticipated growth in LNG and other dangerous cargoes.

Mr. BILIRAKIS. Thank you, Mr. Chairman.

Chairman THOMPSON. Thank you very much.

We now recognize Mr. DeFazio for 5 minutes.

Mr. DEFAZIO. Thank you, Mr. Chairman.

To Mr. Lesnick, we have had a discussion of the resources that are available to the Coast Guard. What about the resources available to your agency? Do you have adequate staffing and expertise to process this crush of applications and do all of the work necessary?

Mr. LESNICK. At the moment, Congressman, we don't have a line item in our budget for this program. We take it out of the pie.

We have attempted to try to keep a certain portion of the fees for this so that we could use it to support the staff. So it can become difficult at times in this sense, but we have been able to, you know, keep up with the load so far.

Mr. DEFAZIO. Okay. So the answer is "no."

I know it is hard. You know, you have—you know, OMB is listening, you know. I mean, we had one honest head of—you know, the Army Corps of Engineers secretary for a short period of time, a former member of Congress.

And when he came before the Transportation Committee and Infrastructure Committee and admitted his budget was inadequate, totally inadequate, to meet the critical needs, he was fired.

I hope you gentlemen don't feel that kind of pressure operating in an environment that has to do with national security from this administration.

And so, you know, I would say that, you know, Mr. Shays's line of questioning and others—and to the admiral, and knowing the Coast Guard, the Coast Guard does not have a budget that is optimal to perform this task and provide maritime security.

I am not going to put them on the spot, but I am going to make that as an assertion. And I have been on and off the Coast Guard Committee for more than 20 years. And now we hear that MARAD doesn't have the resources it needs, and that causes me concern.

Mr. Lesnick, you said something else that puzzled me, something about governors of adjoining states having veto authority over siting. What was that?

Mr. LESNICK. Under the Deepwater Port Act, Congressman, the governor of the adjacent coastal state has the ability to approve or deny or approve the application with conditions any deepwater port application.

And in doing so, normally, they set conditions into the license that protect the state's interests in the operation of the port.

Mr. DEFAZIO. Okay.

Well, then I would turn to Mr. Robinson from FERC. Now, if California proposed putting an LNG facility offshore, my governor could veto it in Oregon. But an LNG company can propose to put an LNG facility in Oregon, and my governor has no say, is that correct?

As I understand the changes mandated by the Energy Act, it is up to FERC whether or not that facility can be sited. My governor does not have veto power. Is that correct?

Mr. ROBINSON. Does not have veto power similar to the Deepwater Port Act. However, the state does have authority under the Coastal Zone Management Act to withhold that permit. If it is withheld, no site can be constructed.

Mr. DEFAZIO. Withhold it under what conditions?

Mr. ROBINSON. Under inconsistencies with the state's plan for preserving the coast.

Mr. DEFAZIO. And does the state have to make a legal case or can they make an assertion? What is the level of proof?

Mr. ROBINSON. They have to follow the state's procedures for issuing or denying a coastal zone permit, whatever those state's procedures may be.

Mr. DEFAZIO. Okay. And if a state makes that finding, then FERC cannot——

Mr. ROBINSON. FERC cannot issue an authorization for the facility.

Mr. DEFAZIO. Okay. All right. Let me ask another question. Is it ideal to build an LNG facility very remote from the projected point of demand?

I mean, is it a good idea to locate something in another state and then build a land line for, say, 800 miles or 1,000 miles to the preferred market for that LNG? I mean, do you think that is optimal? Or maybe we should locate the LNG facility closer to the end point.

Mr. ROBINSON. I think a combination of both. We have existing infrastructure which allows the transport of natural gas from distant sources. I mean, we grew up with the gulf production.

Mr. DEFAZIO. Right, but this is to build an entirely new pipeline.

Mr. ROBINSON. But to build a new pipeline from there—I think that would probably be cost-prohibitive. If you can locate an LNG facility in a load center, it clearly has economic and reliability aspects to it that are very positive.

Mr. DEFAZIO. And what about the FERC approval process for a very lengthy new pipeline crossing thousands of privately owned parcels of land?

Mr. ROBINSON. We do that. I mean, we are currently in the midst of looking at whether or not to authorize the Rockies West and

Rockies East pipeline, which is a combined 1,500 miles, bringing new gas out of the Rockies to the load centers in the East.

Mr. DEFAZIO. Right. But of course, we don't have much option. If the gas comes out of the mountains, you have got to go there to get it.

Mr. ROBINSON. That is correct.

Mr. DEFAZIO. But with LNG, you could take it to a different place.

Mr. ROBINSON. That is why there is such interest in bringing LNG terminals into the load centers.

Mr. DEFAZIO. Okay. Because in my case, California doesn't want an LNG facility, so they want to locate it halfway up my state, and then build a pipeline that extends for about 800 miles or 1,000 miles down to California to serve the California market.

And you are saying that would be cost-prohibitive in your estimation.

Mr. ROBINSON. No, it depends on what they will pay for the gas. And California pays a good deal for the gas, because they are at the end of the pipe.

Mr. DEFAZIO. Right. Okay.

If we could just—if the chair would indulge us for a moment, I just want to return to—again, having served on the Coast Guard and Maritime subcommittee for many years, and as raking member for a while.

It is mentioned in the deepwater application—or Mr. Lesnick mentioned about the preference for U.S.-flag vessels. We will hear about that later.

But it says provide the nation of registry for and the citizenship of officers and crew members serving on vessels transporting LNG to deepwater ports.

What does the nation of registry for mean, Admiral? Does that mean we know who actually owns that ship?

Admiral SALERNO. Sir, the nation of registry just simply indicates where the vessel is registered, what flag it flies.

Mr. DEFAZIO. And it has nothing to do with where the ship is from or who owns it.

Admiral SALERNO. It is not an indication of ownership.

Mr. DEFAZIO. Okay. Now, are we able to pierce the veil now? I understood that supposedly we were creating more transparency for ownership post-9/11, because in the pre-9/11 world Osama bin Laden could own a fleet of freighters that are registered at Malta.

And I have been to Malta and asked the registrar there if he would please reveal the ownership of vessels to me, and he said, "Absolutely not. We keep that secret." Has that changed?

Admiral SALERNO. We do track ownership, managing owners, of each vessel. Often, as I am sure you are aware, the owners are owned by other entities.

Mr. DEFAZIO. Right.

Admiral SALERNO. And that does become somewhat difficult to pierce the veil, as you say, but I think we have gotten somewhat better in the past few years. But certainly——

Mr. DEFAZIO. But wouldn't it be desirable to just have an outright requirement that the U.S. would sponsor at the IMO that

would say we want to know who the ultimate owner of each and every ship that is going to call on the United States is?

Wouldn't that be a good thing to know? I mean, I am really not comfortable with the idea Osama might own a fleet out there.

Admiral SALERNO. Sir, I could probably get back to you on the record——

Mr. DEFAZIO. Okay.

Admiral SALERNO. —for the extent of our knowledge on that, on how we pierce that veil.

Mr. DEFAZIO. Right. Okay. And then I won't belabor it again since I brought it up in the other session, but it is not—and that is the not really knowing who the crews are outside of those on these LNGs, and we will get into that another time.

Thank you, Mr. Chairman, for being so tolerant.

Chairman THOMPSON. Thank you very much.

We will now yield to the gentlelady from Texas, Ms. Jackson Lee, for 5 minutes.

Ms. JACKSON LEE. Mr. Chairman, thank you so very much.

Thank the witnesses. And bells have begun to ring, so let me be as focused as I can, coming from one of the largest ports in the world, the port of Houston.

This is a vital, vital concern to me. And whenever I am in front of the Coast Guard or they are in front of me, I take it upon myself to again thank them for work that is usually unsung and sometimes not noted, the vitality of your work.

And let me applaud you for what I think will be part of the annals of history of the heroic work in Hurricane Katrina. And I know you continue to do that every day.

To Mr. Wells, let me just—I noticed that part of your research had to do with acknowledging that in the LNG tankers it might be more susceptible to fire as opposed to explosion, if I am hearing or reading correctly.

And if not, just clarify that, because we are here dealing with terrorism and homeland security. What is the danger of an LNG as it relates to a terrorist attack, a tanker?

You had your study—were you able to assess that?

Mr. WELLS. The available research that has been conducted—we were focused on LNG threats to public safety. It is clearly the fire potential, and there was consensus among the experts it is extremely unlikely and very difficult to effect an explosion in an unconfined space.

Clearly, the research indicates there are other energy commodity vessels, like LPG, that have even greater explosive capability than LNG.

Ms. JACKSON LEE. Well, Mr. Chairman, just on that note, I hope that we will take it to the next step of exploring additional research, because I think this is a vital question. And let me move quickly.

Mr. Wells, do you have an assessment as to whether the Coast Guard—GAO has an assessment—needs or has enough resources as relates to this issue with the LNG tankers?

Mr. WELLS. Fortunately, as an audit agency and oversight agency reporting to the Congress, we are not involved in the resource allocation decisions by the Congress.

But clearly, GAO has work that is in reporting form that will talk about the Coast Guard's achievement of their current mission or not achieving getting everything done with their existing resources.

And couple that with the increasing demands, it is certainly going to be challenging for them to figure out a way to get the necessary resources to meet the needs.

Ms. JACKSON LEE. Thank you very much. That answers it. They have needs and they have responsibilities, and they may not have matching resources.

Admiral Salerno, let me just ask the pointed question. Again, I think it is important. We are here to help. Do you have enough resources, as was just indicated, to meet the mission and responsibilities that you have?

Admiral SALERNO. Let me answer that in a couple ways. We are assessing that. We are doing a number of things. And as was just indicated, the overall port security mission is broader than just LNG.

Ms. JACKSON LEE. Well, Admiral, because the time is going, can you indicate that you don't think you have enough resources but you are assessing it?

Admiral SALERNO. We are assessing. We are looking at risk across the board, through all dangerous cargoes.

Ms. JACKSON LEE. And you may not have enough, but you want to assess it before you tell us.

Admiral SALERNO. We want to fully characterize the risk and then take a look at where we have our resources placed to see if they can be reallocated. And then if we are short, then obviously we would look at——

Ms. JACKSON LEE. That is a good soldier, Admiral, and I really do respect you. I don't think you are going to find that you have enough resources.

But let me ask you whether or not you know the countries that we receive LNG from. And also, are these countries compliant with the International Ship and Port Facilities Security Code? Do you know the countries?

Admiral SALERNO. Yes, ma'am.

Ms. JACKSON LEE. Are they compliant?

Admiral SALERNO. Yes, they are.

Ms. JACKSON LEE. All of them, Nigeria, Algeria?

Admiral SALERNO. We have visited—the primary is Trinidad and Tobago and Algeria, and we have sent Coast Guard teams to those countries and assessed that.

Ms. JACKSON LEE. Would you provide this committee with a report on that? I am not sure whether we have that. I would appreciate it. I am only moving because I need to move—I would like a report on that, sir. And you have added Trinidad, so that is good.

Are you concerned about the frequency and the nationality of stowaways that have been confirmed on international vessels, particularly from international ports? And have they been vetted by the U.S. Coast Guard?

Admiral SALERNO. We are concerned about stowaways. We have procedures in place to deal with them. Part of our port visits over-

seas—and we visit about—on tap to visit about 150 different countries—is to look at the security systems in place.

Ms. JACKSON LEE. You are on tap. Have you visited those countries or are you in the process of visiting?

Admiral SALERNO. In the process. We visited about over 70 countries so far. And part of our assessment is the security measures at the facility.

Ms. JACKSON LEE. And have you vetted the stowaways? Have you been able to—once they get off, or——

Admiral SALERNO. When stowaways are detected—and typically, they are reported by the ship's crews at sea, so we know in advance of——

Ms. JACKSON LEE. And are you there to receive them?

Admiral SALERNO. There is a Coast Guard and Customs and Border Protection response.

Ms. JACKSON LEE. I would that you would need more money just to go to 150 countries. This is my last question.

According to your testimony, the Maritime Administration is working to develop and expand LNG training programs so as to provide immediate employment for entry-level mariners, both licensed and unlicensed.

Can you provide us with information about this training?

Mr. LESNICK. Yes. We are working with the state academies, one of which would be in your state——

Ms. JACKSON LEE. Absolutely.

Mr. LESNICK. —and the federal maritime academy and the union training schools to get a curriculum together to stand up——

Ms. JACKSON LEE. What is your time frame for that?

Mr. LESNICK. It is almost immediate. They were already ready to go. These new manning agreements that we have been signing——

Ms. JACKSON LEE. Will we have some of those in the school that is in my area?

Mr. LESNICK. Yes, Congresswoman.

Ms. JACKSON LEE. And do you have the resources to add for this training?

Mr. LESNICK. The state schools could use additional resources to provide that.

Ms. JACKSON LEE. Mr. Chairman, I think there is a lot of work that we could do in helping the Coast Guard.

And I do think there is a question of resources, and I would like to join you in your leadership in helping with the training and helping with some of the ports that are going to need additional resources for the Coast Guard.

With that, I yield back. I thank you.

Chairman THOMPSON. Thank you, Madam Jackson Lee. I look forward to working with you, too. There is no question about the need for additional resources.

Let me thank the panel for your testimony here before the committee.

Let me say, before our second panel, we have about six votes to take before we can come back. So we are probably looking at about an hour from now. Do you want to say 2 o'clock?

Okay, about 2 o'clock we will reconvene for panel two. The committee is recessed.

[Recess.]

Chairman THOMPSON. We have talked with Ranking Member King, who has indicated it would be all right to start until he comes.

We would like to reconvene this hearing and welcome our second panel. I welcome the panelists, Mr. Ron Davis and Dr. Phani Raj, to the audience.

Mr. Davis has served as MEBA's district and national president since early 2002. He began his seagoing career in the Navy, which included time in Vietnam. He also sailed on MEBA contracted ships from 1978 to 1991, when he was elected to union office.

Dr. Raj—I hope I am pronouncing it—all right, thank you very much—has over 30 years of experience working in the LNG field. He has authored over 80 technical reports and 50 papers in this highly complex area. He was also one of the experts GAO consulted during the audit that we heard about from the previous panel.

Without objection, full statements will be inserted into the record. I now ask each witness to summarize his statement for 5 minutes, beginning with Mr. Davis.

STATEMENT OF RON DAVIS, PRESIDENT, MARINE ENGINEERS' BENEFICIAL ASSOCIATION

Mr. DAVIS. Thank you, Chairman Thompson. The safe and secure transportation of liquefied natural gas to the United States is of critical importance, and we all appreciate your holding this hearing.

For 137 years, MEBA has represented Coast Guard-licensed deck and engineering officers serving in the commercial and government fleets. Despite our presence in nearly every aspect of the maritime industry, there are practically no Americans employed on LNG ships today.

The worldwide demand for LNG is increasing at such a tremendous rate that it is very difficult for the maritime industry to keep up. It took over 40 years for the LNG fleet to reach 200 vessels. It is now expected that the fleet will hit 300 vessels by 2010, just 3 years away.

With this rate of expansion, there is an increased demand for qualified mariners. Right now, the international fleet is facing a severe shortage of qualified crews.

The various ship operators have even resorted to poaching officers from each other, paying over $20,000 a month for qualified officers.

As the size of the fleet expands, the qualified mariner pool shrinks. There is a significant chance that the standard of education will suffer and mariners with substandard training will begin taking these jobs.

That puts our nation at risk. If this shortage is not addressed, it will only be a matter of when, not if, a major safety incident takes place.

Security is the major concern as well. As you know, a number of studies discuss terrorist attacks on LNG tankers. MEBA believes

that the greatest threat to an LNG tanker would come from a knowledgeable crew member deliberately sabotaging the vessel.

Therefore, we must ensure the proper vetting for LNG crews. Because there is no uniform, completely trustworthy system for vetting foreign mariners, this is next to impossible under the current system.

Background checks of the level of thoroughness conducted on Americans by the Coast Guard and TSA are only performed on Americans and not foreign crews.

While the Coast Guard does require crew lists from vessels entering U.S. ports, they have no real way to be sure that those foreign crews on board are who they say they are.

U.S. merchant mariners receive their credentials to work from the Coast Guard. Foreign mariners do not. U.S. mariners undergo extensive background checks through the FBI. Foreign mariners do not.

U.S. mariners are vetted through the National Driver Record Database. Foreign seafarers are not. U.S. mariners will be subject to terrorism background checks through TSA. Foreign seafarers are not.

Finally, U.S. merchant mariners are U.S. citizens or persons lawfully admitted for permanent residency. The mariners crewing these ships are not.

My solution to this problem is a simple one. Use U.S. crews on LNG vessels calling on U.S. ports. Americans are available, well-trained, economical and thoroughly vetted.

Putting Americans on board these ships will go a long way to ensuring the safety and security of these vessels both at home and abroad.

The United States is the leading producer of mariners. All of the state and federal training academies and union training schools have added or updated their LNG courses.

The Calhoun MEBA Engineering School, for instance, recently installed a state-of-the-art vessel and LNG simulator. Right now, MEBA has a pool of qualified and experience senior LNG mariners who are ready, willing and able to sail LNG ships.

And as I have already stated, we undergo the most rigorous background checks in the maritime world. Despite all of this, it has been extremely difficult for Americans to break back into the LNG trade.

Foreign prejudice against American mariners is rampant. Congress has recognized this and has taken steps to assist us.

Thanks in part to these efforts, several operators have agreed to expand their LNG crews to include U.S. citizens, including Suez LNG, Freeport McMoRan and Excelerate Energy, which I must commend.

I am pleased to announce that MEBA has recently signed a memorandum of understanding with Excelerate Energy that will allow our members to sail on their international fleet of LNG tankers.

This is a major step forward for the U.S. merchant marine and we look forward to a continued long-term relationship with Excelerate. We hope the other operators soon follow suit.

We have made progress, but we can't afford to rest here. The responsible operators I have mentioned are only a portion of the LNG industry. Congress must continue to press for Americans on board LNG vessels, and MEBA offers any assistance you may need in this endeavor.

The American merchant marine is known as the fourth arm of defense. Why not use us? Why not put us on LNG ships?

Thank you.

[The statement of Mr. Davis follows:]

PREPARED STATEMENT OF RON DAVIS

Thank you Chairman Thompson and Ranking Member King, and thank you to the rest of the Committee for inviting me to speak before you today. I would specifically like to thank you for allowing us the opportunity to discuss the unique issues we face in safely and securely transporting Liquefied Natural Gas to the United States.

My name is Ron Davis, and I am the President of the Marine Engineers? Beneficial Association. The MEBA is the nation's oldest maritime labor union, representing deck and engineering officers licensed by the United States Coast Guard. Our mariners serve in a variety of capacities in the commercial, government owned and operated, and domestic fleets, as well as in shore side employment.

The MEBA was proud to take a leading role in the development of the transportation of LNG by ocean tank vessel in the 1970s. Our members crewed U.S. flag LNG vessels until 2001. Today, however, not a single LNG tanker flies the American flag, and none of these vessels are crewed by Americans. We feel that this represents a serious threat to America, and we have been working to restore American mariners aboard this important segment of the maritime community.

Need for Shipboard Import of LNG to the United States

According to the Federal Energy Regulatory Commission, U.S. natural gas demand is expected to increase by 40% by 2025 to 30.7 trillion cubic feet (TCF).[i] However, domestic supply, which has not equaled demand for many years, will only increase by 14.5%. Without intervention, our natural gas supply will not keep pace with industry and the public's demand. Mr. Jeff Wright, Chief of the Energy Infrastructure Group, Office of Energy Project, Federal Energy Regulatory Commission cites the following reasons for this situation:

- Decline in the United States' underground domestic gas reserves;[ii]
- Canada's problems with flattening gas production in the Western Canadian Sedimentary Basin (WSCB) and its need to fulfill its own demands;[iii] and
- Continuation of Mexico's growing economy with Mexico keeping an increasing share of its natural gas to meet its future demands.[iv]

This means the United States cannot rely solely on natural gas produced in North America. Therefore, LNG will need to be imported to the United States on ocean-going LNG tankships.

Thorough Vetting of U.S. Merchant Mariners Provides Unmatched Shipboard and Deepwater Port Security

All LNG entering the U.S. is carried on foreign flag ships operated by either *non*-U.S. citizen mariners, or aliens who are *not* lawfully admitted to the United States for permanent residence. Unlike foreign seamen:

- U.S. Merchant Mariners receive their credentials to work from the U.S. Coast Guard;
- U.S. Merchant Mariners undergo extensive background checks performed by the Federal Bureau of Investigation;
- U.S. Merchant Mariners are background checked through a National Driver (vehicle) Record database;
- U.S. Merchant Mariners will also be subject to jurisdiction of the Transportation Safety Administration (TSA) where they will be vetted through a terrorist watch database in order to receive a Transportation Worker Identification Card (TWIC).
- U.S. Merchant Mariners are citizens of the United States or aliens lawfully admitted for permanent residence.

American mariners undergo a stringent and thorough vetting and credentialing process. Our Coast Guard-issued license is considered accurate (with regard to identity of the holder) and valid with respect to the qualifications and ability of the individual mariner. Moreover, the document is relatively tamper-proof. Each mariner goes through an extensive background check by several federal agencies including

the Coast Guard, Federal Bureau of Investigation and now with the TWIC coming into effect, the Transportation Security Administration.

While foreign mariners may be required to comply with their government's regulations as well as international standards, the validity of some of the credentials is suspect. A few years ago, International Transport Workers Federation President, David Cockroft, purchased an authentic Panamanian first officers certificate and sea book despite no practical maritime experience. The Seafarers' International Research Centre at the University of Wales investigated the issue of fraudulent qualifications. Its preliminary findings revealed 12, 653 cases of forgery in 2001.

Federal and state government, local municipalities and the communities surrounding LNG import terminals can be assured, that with American mariners, the LNG vessels are manned by professional seafarers who have the integrity and the training necessary for the safe transport of LNG.

Congress Recognizes Need for U.S. Mariners

Congress has recognized the security that U.S. mariners bring to LNG vessels and has taken steps to promote enhanced security. Last year's Coast Guard Authorization bill included language that gave priority application processing to companies seeking LNG terminal licenses if they commit to using American crews, and it also directed the Maritime Administration to find ways to promote the use of Americans in this sector.

Problems in Growth of Demand for LNG and with Incoming Generation of LNG Officers

On June 20, 2006, Reuters reported that a growing global demand for liquefied natural gas and tight supply of specialized tankers and crew create a risk of dangerous lapses in standards of security. See, *Darwin (Reuters), LNG Demand Growth Risks Fall in Shipping Standards, June 20, 2006.*

Setting aside the security issue of foreign mariners, the United States must take into consideration the risks involved with poorly trained, insufficiently qualified and questionably vetted mariners who may deliver LNG to its shores. For instance, Yea Byeon-Deok, professor and LNG initiative coordinator of the International Association of Maritime Universities, recently stated at a conference in Australia: "Nobody knows what would happen if a significant accident occurred on a large LNG carrier. All we can say is that a 100,000 ton tanker has four times the energy potential of the atomic bomb used to hit Hiroshima. . . Many sub-standard vessels have begun to appear as demand for LNG increases, while there is a chronic shortage of experienced crew."

New orders for construction of LNG vessels imply a need for 3,575 officers over the next three years, Professor Yea said, of which 60% would need to be at senior or experienced level. Yea warned that "recruitment and training were falling ***dangerously short of requirements to staff complicated vessels which could make dramatic targets for potential terror attacks." Reuters,*** June 20, 2006. Mr. Yea pointed out that the growth in ''flag of convenience'' ships which fly alternative flags to the country of ownership, allow the owners to avoid taxes, quality control and labor regulations which evidences deteriorating standards.

The younger generation of sea-going deck and engineering officers is withdrawing from the industry prematurely. These junior officers are showing less and less interest in continuing to go to sea and they are typically leaving for shore-side positions prior to taking on senior level seagoing positions. This has made it difficult for ship owners and operators to ensure a sustained supply of senior officers. There is as of yet no effective means to counter this tendency. This data is based on a report in the U.S. Coast Guard *Journal of Safety at Sea, Proceedings* regarding the international (non-U.S. Merchant Mariner) pool of shipboard officers.

The U.S. Merchant Marine was not considered in the aforementioned report. Indeed, had the U.S. Merchant Marine been considered, the resulting report would have shown that there is a vibrant and growing U.S. Merchant Mariner pool resulting in part by investments made in the passenger, freighter and tanker vessel maritime sectors. Moreover, it makes sense to staff LNG vessels delivering cargo to the United States with U.S. merchant mariners. U.S. merchant mariners are true patriots and care about their country—they would not be "for hire" foreign personnel with little or no connection to America other than a job that provides a paycheck. U.S. Coast Guard licensed officers and crew provide answers and solutions to many of the safety and security concerns surrounding the importation of LNG.

Wide Scale Officer Shortage is Resulting in Foreign Ship Operators "Poaching" LNG Officers; Poor Training; Steep Decline in Safety and Security; and Violations of International Law

As reported in numerous articles and studies conducted by leading international maritime trade publications including *Tradewinds* and *Fairplay,* LNG owners and

operators are lashing out at each other with allegations of "poaching", conducting insufficient training in violation of ISM Code as well as failing to properly check past employment references.

The sudden and sustained surge in global demand for liquefied natural gas and the worldwide shortage of mariners with LNG and steam experience is leading to predictable results. Ship managers seem willing to do whatever they can to get their ships fully crewed in the face of a growing wide-scale officer shortage. "The industry had previously grown slowly, so companies were able to train manpower and expand operations at a comfortable rate of two to three ships every two years," Keith Bainbridge, director of LNG Shipping Solutions, told *Fairplay* magazine in 2005 "But where an industry experiences 40—50% growth within a couple of years, it will split at the seems," he predicts.[v]

This manpower crisis is made even worse by new ship managers entering the LNG trade. A Fairplay article titled, *Poaching War for Crew Erupts,* cited the "voracious appetite for scarce manning resources, both at sea and onshore. This has created severe competition among LNG owners."[vi]

The Society of International Gas Tanker and Terminal Operators LTD (SIGTTO) has recognized the acute shortage and the reaction by some. "A short-term answer for an LNG vessel operator is to "poach" crew from another such operator but, clearly, the long-term answer is training, training, and further training. SIGTTO members, as much as anyone, wish for the quite unique safety record of LNG shipping to be preserved. The influx of new personnel into the industry is of concern, especially if there is a temptation by a minority of operators to "cut corners" and put officers into positions of responsibility on a LNG carrier before they have been properly trained."[vii]

In an article titled *Officer Crunch Sparks Safety Alarm,* Anglo Eastern Ship Management's training director Pradeep Chawla states that "intense pressure to promote more maritime officers is resulting in inexperienced officers making more mistakes and more dangerous situations on board. The training director noted that, "shortages have made it harder to retain officers because manning agents use higher wages to lure away experienced seafarers, especially in LNG/LPG and other specialized trades." [xiii] Moreover, not all companies train officers, with many resorting to poaching.

The crewing crunch is giving rise to new and dangerous theories of crewing to meet the sustained demand. "Some operators are contemplating an airline-style approach, training their crew units to ever-higher standards and frequently rotating them among vessels. That would fly in the face of an industry that had, until last year, been characterized by its conservatism on crewing and had viewed rapid crew rotation as a threat to safety." The article mentions that with the shortage, there is an "increasing incidence of crews of strangers being cobbled together with precious little time to develop mutual trust and overcome their natural fear of blame."

In an article titled *Near Calamities in Cargo Operations, Fairplay* details two case studies, on international vessel crewing practices, to illustrate the dangers of new crew members who are unfamiliar with the vessel or on-board procedures. "In both incidents, one of the factors that contributed to the near calamities was the fact that one or more of the crewmembers involved were new to the ship and unfamiliar with all aspects of the vessel." "The importance of learning the idiosyncrasies of a particular vessel cannot be overstressed, and even when crew are transferred to sister ships they should not assume that every feature of the ships will be the same." As noted above, short cuts in manning and "inventive" solutions to crew shortages can prove to be a recipe for disaster.[ix]

The consequences of crewing instability and poaching can also lead to serious deterioration of the relationship between mariner and management. "There has to be a management team in which officers can pick up the phone and discuss problems openly, rather than hiding them until it is too late" says Simon Pressly, GM of Dorchester Marine, an LNG vessel operator in a *Fairplay* article. The author continues with the observation that, "Unfortunately, with poaching so rampant, the dangerous lack of crew continuity is likely to continue until operators start making the requisite investments in manpower training." [x]

Tradewinds states that the LNG-crewing shortage is giving rise to some serious shortcomings that are a direct threat to the industry's safety record and are in violation of the International Safety Management (ISM) Code. Some operators and ship managers are employing senior-level ship's officers that were terminated from employment by competing companies due to poor performance and substance abuse.[xi]

On another front, big international shipping companies and ship management firms are feeling the LNG crewing pinch. Some operators are enticing LNG shipboard officers to switch companies by offering wages at 30%—40% higher than what has been paid in the past—and officers are switching companies and leaving their

former employer in crisis. Some companies are offering over $18,000 a month (in wages only, not including benefits) to attract qualified LNG officers.[xii]

All decision makers and stakeholders involved with the importation of LNG to the United States must take notice of what is going on in the international market. With growing natural gas demands and some 50-plus applications on the books for LNG import terminals, the American people need to be assured that the most highly trained and experienced personnel are transporting security sensitive LNG to the United States. There is no room for error when it comes to liquefied natural gas. Like no other time in history, the economics are in place whereby the U.S. Merchant Marine can economically and safely deliver LNG cargo; provide a stable pool of mariners for the long term; provide the highest amount of training; and comply with all U.S. and international laws.

International Consequence: Insurance Underwriters Deeply Concerned with Inexperienced Crews Aboard LNG Vessels

A recent article titled *LNG Ships Facing Premium Boost* details the nervousness of the insurance industry as the LNG fleet suffers through poorly managed growing pains. "Underwriters appear to be changing their view of LNG vessels, which have traditionally been regarded as particularly well managed, despite being costly and potentially hazardous." Now, higher insurance premiums are the prospect for LNG vessel owners as a result of "a big deterioration in the claims record of the world gas fleet." Marsh, the largest insurance brokering group issued a report concerning claims of more than $400 million run up by the LNG fleet.[xiii]

Higher insurance premiums are in prospect for owners of LNG carriers after a spate of claims including operational incidents have left insurance underwriters facing big losses according to Marsh.[xiv] Marsh reports that risk profile is increasing due to a shortage of crew with LNG experience.[xv]

With 200 LNG vessels in service and over 100 on order, Marsh identifies a number of factors associated with the rapid growth as adding to the risk profile of the gas-ship fleet including shortage of crews with LNG-carrier experience and new owners entering the market with the intention of trading vessels on the spot market rather than traditional long term charters.[xvi]

The shortage of mariners in the international fleet is dire. It is abundantly clear, therefore, that the U.S. Merchant Marine must enter the market.

International Reaction: Responsible Shipping Ministries React to Manning Shortcuts and Abuse; Use of National Flag Vessels Promoted By Major Importers

Some of the world's largest importers of LNG, Japan and Korea, are an increasingly powerful consumer of LNG, have made registry of LNG ships a matter of national maritime policy. "Japan transported about 43% of its total LNG import of 59.1 million tons in 2003 on Japanese owned and controlled ships. Similarly, Korea transported about 61% of its LNG imports of 19.3 million tons in the same year on Korean controlled ships. In the combined import of Japan and Korea, third-party owned ships constituted only 8.3 percent," says a shipping industry representative.[xvii] It is notable that Japanese and Korean controlled vessels are in respectable registries and do not cut corners on crewing in order to compete on the world market.

India's Shipping Ministry has attempted to rejuvenate its merchant marine by requiring Indian manning and Indian registry for LNG vessels importing to the Indian coastline. However, another branch of the Indian government, the Indian Ministries of Commerce and Petroleum & Natural Gas, has prevailed in the internal battle, handing India a set back in its efforts to build a domestic flagged LNG fleet.

Conclusion

With 97% of all cargo imported to United States being carried on vessels that are not registered under the American-Flag and not crewed by U.S. citizens, one would think that the safe and secure transportation of security sensitive cargo would be a serious concern. More to the point, at this time 100% of all Liquefied Natural Gas that enters the United States is carried on ships staffed by non-U.S. citizen mariners. The MEBA strongly believes that the use of American mariners is a critical component to the safe and secure importation of LNG to the United States.

With this in mind, some responsible corporate citizens in the LNG sector have recently agreed to expand their crewing practices to include U.S. citizen crews on LNG tankers. These companies, Suez LNG/Neptune, Excelerate/Northeast Gateway and Freeport-McMoRan, must be commended. We must also praise Maritime Administrator Sean Connaughton and the Maritime Administration for their efforts to promote American mariners on LNG tankers. Without their help, the progress made with these companies would have been much more difficult.

We look forward to working with Congress and the Administration moving forward to further protect our communities and maritime infrastructure.

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[i] Annual Energy Outlook 2005, Energy Information Administration, U.S. Department of Energy, February 2005, Table 13.

[ii] Mr. Wright cites the Annual Energy Outlook 2005, Energy Information Administration, U.S. Department of Energy, Table 13, which reaches the conclusion that production from conventional underground gas deposits is projected to decline between now and 2025. This decline is somewhat offset by increased gas production from non-conventional domestic gas sources (most notably coal-bed methane), increased production from deep water sources (greater than 200 meters) in the Gulf of Mexico, and commencement of deliveries of Alaska gas to the lower 48 states. The Alaskan volumes are problematic according to Mr. Wright, because there has been no application to construct necessary infrastructure to transport the gas, and the timeline from application to first delivery is approximately 10 years.

[iii] The National Energy Board of Canada states, the Western Canadian Sedimentary Basin (WSCB) accounts for more than 90% of the gas production in Canada and for about 23% of North American natural gas production annually. In the last few years, gas production from the WSCB appears to have flattened after many years of growth, leading to increased uncertainty about the ability of industry to increase or even maintain current production levels from the basin over the longer term. See, Canada's Conventional Natural Gas Resources: A Status Report, National Energy Board, April 2004, pp. 9—10.

[iv] Exports of gas to Mexico have increased greatly in the last few years. These exports do not constitute a large out-flow of gas at present. However, the Mexican economy is growing and if it continues to grow, its demand for natural gas will increase and require the United States to import an increasing amount of gas to meet, not only domestic needs, but also the needs of Mexico. In other words, what Mexico imports and shares today by way of natural gas, Mexico may not be able share later. Jeff Wright, Chief, Energy Infrastructure Policy Group, Office of Energy Project, Federal Energy Regulatory Commission, Fall 2005.

[v] Poaching War for Crews Erupts, Fairplay International Shipping Weekly, February 24, 2005.

[vi] *Id.*

[vii] *SIGTTO News,* September 2005, p.5.

[viii] *Poaching War for Crews Erupts,* Fairplay International Shipping Weekly, February 24, 2005.

[ix] *Near Calamities in Cargo Operations,* Fairplay International Shipping Weekly, December 1, 2005.

[x] *Poaching War for Crews Erupts,* Fairplay International Shipping Weekly, February 24, 2005.

[xi] *LNG Crewing Shock,* Tradewinds, February 25, 2005

[xii] *Philippines Dangles $18,000 Carrot,* Tradewinds, January 9, 2006; See also, *LNG Wage Anger,* Tradewinds, November 4, 2005; *Officer on $320,000 a year, claims Sigtto,* Tradewinds, November 4, 2005.

[xiii] Tradewinds, Insurers Get LNG Jitters, LNG Ships Facing Premiums Boost, March 17, 2006

[xiv] *Id.*

[xv] *Id.*

[xvi] *Id.*

[xvii] *Foreign Flag Vessels May Bring Down LNG Import Costs, The Hindu Business Line,* December 13, 2005.

Chairman THOMPSON. Thank you very much, Mr. Davis.

Dr. Raj, please summarize your statement for 5 minutes, please.

STATEMENT OF PHANI RAJ, PhD PRESIDENT, TECHNOLOGY & MANAGEMENT SYSTEMS, INC.

Mr. RAJ. Thank you, Mr. Chairman. Mr. Chairman, members of the committee, it is a privilege and high honor for me to be invited to testify before this committee.

I come before you to share some of my knowledge on issues concerning liquefied natural gas, or LNG, and the public's concern on its hazards.

My research, both experimental and modeling of the behavior of hazardous materials, including LNG, have been funded by U.S. government agencies.

The LNG industry, to whom I have provided and continue to provide consulting services, has recently funded some LNG fire research jointly with the United States Department of Transportation.

The testimony I am presenting today is based on my professional and scientific experience and was entirely prepared by me.

However, I wish to acknowledge for the record that my professional time and expenses for preparation and appearance before this committee is being underwritten by the Center for Liquefied Natural Gas, CLNG, which is a coalition of entities active in the LNG industry.

Mr. Chairman, in regard to LNG issues, I wish to make the following six observations. One, the LNG industry is one of the safest industries, very enviable record of safety for over 40 years.

Worldwide, there have been over 40,000 shipments of LNG to ports that have high marine traffic, and many of which are also near populated areas.

In the U.S., millions of gallons of LNG have been transported, imported, handled, gasified, and have provided energy to the public, all with the industry's exemplary record of safety.

In the 40 years that this activity of supplying the vital energy needs of the country has been going on, not a single person of the public has been injured or suffered a fatality by any LNG incident.

Also, the total number of worker casualties in the LNG industry in the entire world over the last 40 years of operation can perhaps be counted on one's fingers.

Number two, LNG, propane, gasoline, jet fuel and other hydrocarbon fuels, are all members of the hydrocarbon fuel family. The combustion properties of LNG and other hydrocarbons have more in common than in their differences.

A large LNG fire will be very similar in radiant heat emission characteristics to a large fire of propane, gasoline, jet fuel, et cetera, all of them forming very smoky fires.

Currently used LNG hazard assessment models have layer upon layer of conservative calculations, making the predicted distances to hazard substantially more than what it would likely be in reality.

This is due to lack of information on how large spills, and especially large fires, behave. All we have now are data from small tests.

Our confidence in extrapolating these large spill phenomena is low, and this leads to variations in predictions by different researchers.

Larger LNG pool fire tests that are being planned will provide the necessary framework for the development of realistic fire models.

Number four, other research that are equally important as pool fire tests and modeling should be undertaken to determine the type and magnitude of other hazards which may, under certain circumstances, become the more important hazard scenarios rather than the pool fire.

These include, for example, water-LNG interaction, water intrusion into LNG tanks, and considerations of a fireball type of burning. The overall combined hazard may be, however, smaller than predicted if only the pool fire is considered.

Focusing only on the consequences of a perceived worst case rather than the overall risk from an activity will result in poorly utilized and improperly allocated resources, not to speak of the economic penalties that may result.

Risk analysis as a tool is being increasingly utilized in the U.S. for decision making, but only in bits and pieces. The single important reason for the lack of universal adoption of risk-based decision making is the lack of standards for the levels of risk that are acceptable to society.

Mr. Chairman, in summary, the LNG industry operates very safely. Further research and its results will lead not only to enhancing our knowledge for better evaluations of safety but also help to educate the public on the real issues.

Mr. Chairman and members of the committee, I thank you for this opportunity to testify before your committee. I will be happy to answer any questions.

[The statement of Mr. Raj follows:]

PREPARED STATEMENT OF PHANI RAJ, PHD

Mr. Chairman, Mr. King, Members of the Committee, it is a privilege and high honor for me to be invited to testify and share my knowledge on liquefied natural gas (LNG) safety related to accidental or intentional breach of cargo tanks in a LNG vessel.

Introduction

I come before you as a researcher in the field of LNG safety with over 30 years of experience in conducting experiments, analyzing the test results and developing mathematical models for the behavior of LNG upon its release into the environment and the hazards it may pose. My research projects related to LNG have been funded primarily by US Federal agencies (US Coast Guard and US Department of Transportation) and to a lesser extent by the LNG industry. I was one of the members of the research team (and the principal author of the technical report) that conducted the field experiments in mid 1970s to understand the different behavior phenomena associated with the release of LNG on water, including that of the pool fire on water and its radiant heat emission characteristics. This series of tests, which to this day remains as the only comprehensive set of experiments on water, was funded by the United States Coast Guard, and conducted in the US Navy testing facility in China Lake, CA. Many of the mathematical models used today are in one way or other based on the findings from this series of tests, though the test sizes were of a modest scale compared to sizes of postulated spills to which the models are being applied now. My recent research, sponsored jointly by the Pipeline & Hazardous Materials Safety Administration (PHMSA) of the US Department of Transportation and Distrigas of Massachusetts, LLC (DOMAC), has been to evaluate the data from the largest LNG fire experiment to date and model the characteristics of very large LNG pool fires and their radiant heat effects. This research and the model developed are based on the data from larger size LNG fire tests conducted in France in 1987. The model and the findings, which have been published in a peer reviewed technical journal, indicate that large LNG fires behave quite differently than the smaller scale fires (used in China Lake tests) and, in fact, radiate less heat per unit fire area. Other research that I am currently involved in includes the determination of the tolerance (without injury) of human beings to LNG fire radiant heat exposure, and the degree of protection provided by ordinary civilian clothing and other intervening objects to the public from the effects of radiant heat from a large LNG fire.

In my capacity as a scientist and researcher in the field of LNG behavior modeling, I have (i) provided consulting support to the Government agencies, the LNG industry, Standards setting bodies, (ii) testified before administrative and regulatory proceedings, (iii) presented many scientific research findings before peer groups, re-

sponded to the safety questions from the public in public hearings, (iv) trained firemen and first responders on the properties and behavior of LNG, and (v) authored a number of technical publications in reputable journals. I also serve on the LNG Standards Committee of the National Fire Protection Association (NFPA), which has developed a consensus standard on LNG facility design, LNG handling and storage, and personnel training requirements. Parts of this standard, especially on LNG fire hazard assessment and protection, have been incorporated in federal regulations.

I review below some of the important questions that have been raised in scientific forums and public debate on LNG behavior and safety and provide my views on the subject. My testimony below will:

(i) Comment on the exemplary safety record of the LNG industry both in the US and worldwide

(ii) Highlight some of the LNG properties that have an impact on potential hazards and compared them with properties of other common fuels,

(iii) Discuss the knowledge related to what is known and unknown in mathematical modeling to predict adverse public impact distances from LNG releases,

(iv) Identify immediate and near term research needs to fill the gaps in our knowledge, and,

(v) Argue that results based on risk analyses and not those based on the consideration of a single scenario (however large the hazard) should form the basis of policy decision-making related to LNG activities. This discussion includes, briefly, the current LNG regulatory requirements in the U.S. and potential for improvements in assessment techniques that may lead to a more balanced and efficient use of resources.

Safety Record of the LNG Industry

LNG industry has operated safely both in the US and worldwide for over six decades. There is no technical or operational reason why this exemplary record will not continue. New technologies, application of results of careful research, and continued personnel training are expected to contribute to the enhancement of the safety record.

In the U.S., LNG has been used in peak shaving operations (liquefying pipeline natural gas during periods of low demand, storing the liquid, and re-gasifying it to meet peak demand, generally during winter months) for over 60 years. Trans-continental shipments of LNG in ocean-going tankers started in 1959. The worldwide demand for LNG has grown significantly since the 1960s and today over 150 LNG ships safely deliver the liquid to ports in many countries (including the US, Japan, France, et al) in some of the busiest and most congested ports of the world near population centers. The safety record of the LNG industry is enviable and unmatched by any other comparable industry—not a single injury or fatality to a member of the public for over 50 years and extremely low rates of injury even among the workers in the industry. Over 45,000 tanker shipments have occurred world wide to date, without any significant LNG spills (other than very minor leaks through pipe gaskets, overfilling of tanks, and spills during make and break of the unloading arms).

The industry is highly regulated in the US and has to meet very strict mechanical design, personnel training and low public impact standards. The ships are built to international standards, are of double hull design (and have been from the very beginning of the industry). The US Coast Guard inspects every LNG vessel that visits a US port before it enters the port. This inspection includes a check of safety emergency systems, interview with personnel, review of ship's records and a security assessment. In addition, the US Coast Guard (specifically, USCG Sector Boston) has mandated certain exclusion zones in the fore, aft and sides of an LNG ship in transit to minimize collision risks with other vessel traffic in the port. The shore-based operations and facilities of LNG terminals come under the purview of the US DOT regulations and are inspected annually for safety. In addition, the design of storage tanks and other systems in the facility have to conform to the industry consensus standard, namely, the National Fire Protection Association's "Standard for the production, Storage, and Handling of Liquefied Natural Gas, (NFPA 59A)." The DOT regulations also stipulate the training requirements for industry personnel. Last but not the least, every one of the LNG terminal facilities in the US has to prepare and follow a security plan to thwart any potential sabotage or terrorist acts. This level of scrutiny and regulatory oversight, in addition to the industry's self interest to operate extremely safely, has been the principal cause of the safety success story. As mentioned earlier, no other energy industry has such an outstanding safety record. However, the price for an exemplary safety record is eternal vigilance, personnel training and implementation of advanced technologies.

LNG properties that have an impact on potential hazards and comparison with properties of other common fuels

LNG burning properties are not very different compared to similar properties of other commonly used hydrocarbon fuels. Large LNG fires will be very similar in radiant heat emission characteristics to large fires of propane, gasoline, jet fuel, etc.

LNG is natural gas cooled at atmospheric pressure to a low temperature of —260 °F. It consists, mainly, of methane and few percent by volume of ethane and propane and traces of other hydrocarbons and nitrogen. Methane is a member of the saturated hydrocarbon group of chemicals, which includes ethane, propane, butane, pentane, octane (the principal constituent of gasoline). Each molecule of a hydrocarbon fuel consists of carbon and hydrogen atoms combined in specific proportions. The combustion properties of all hydrocarbon fuels are very similar. For example, the heat produced when a pound of any one of these saturated hydrocarbons is burned in air [1] is the about the same, namely 20,000 Btu (within ± 5%). Also, the pounds of air required to burn completely one pound of any of these fuels are also about the same, namely, 15.5 (± 3%), except for methane, which requires a larger quantity of air. The consequence of the similarity in combustion properties is that the fires all of these fuels should have, within ± 100 oF, the same temperature, methane fires being the least hot. This observation has been demonstrated by carefully conducted laboratory experiments with different fuels.

The implication of the above observation is that methane (LNG) fires are no different in temperature than other fuels that the industrial society uses. All fires emit heat in the form of radiant heat ("infrared radiation") and the amount of energy emitted is dependent on the fire temperature. The question, therefore, is why methane (or LNG) fires are considered to be more "hazardous" or "hot?" This has to do with one additional phenomenon that occurs in burning, namely, production of soot particles (unburned carbon) in a fire. The higher the number of carbon atoms in the fuel molecule (as in gasoline or diesel fuel) the greater is the production of soot particles during the process of burning. That is, a methane fire will, all other conditions being the same, produce a smaller amount of soot in a given size fire than in a fire burning a heavier oil. The soot particles produced tend to form a mantle or shroud around the fire. The larger the density of the soot particles in the mantle, the higher is the absorption of the radiant heat emitted from inside the fire and the lower is the magnitude of the heat emitted to the surroundings. The soot layer acts as a "heat blocker" much the same way as a smoked glass does to visible light. In the case of smaller fires, this blocking of heat emission is smaller because of the lower soot amount produced. The fire from the burning of methane -which has a single carbon atom in the fuel molecule and which produces the least amount of soot- will therefore appear "brighter" or "hotter" to an observer outside the fire. However, as the methane fire size increases a lot more soot is produced, forming a black shroud around the fire, like fires of "heavier" hydrocarbons.. This reduces the overall radiative heat emission to the outside. Therefore, when the fire sizes become large (such as hundreds of feet in diameter), the distinction between fires of different hydrocarbon fuels tends to diminish and they all look about the same (with small differences in the amount of radiant heat emitted to the outside). That is, LNG is clean burning in relatively small size fires but as its size becomes large it burns "dirty." Exhibit 1 shows a 13 m diameter LNG fire on water observed in the tests conducted at China Lake. The smoky aspects of a large LNG fire is seen in Exhibit 2, which shows the 35 m diameter LNG fire in the tests conducted in 1987 at Montoir, France. The latter fire is the largest LNG fire tested to date.

4. Immediate and near term research needs to fill the gaps in our knowledge

4A. What is known and unknown in mathematical modeling to predict adverse public impact distances from LNG releases

The models that are being currently used in LNG hazard assessment have layer upon layer of conservative calculations, making predicted distance to hazard substantially more than what it may be in reality. New sets of larger LNG pool fire tests and other equally important research will provide the necessary framework for the development of realistic models with which to assess the hazards from potential LNG release scenarios from ships.

To a large extent the fire hazard assessment models used currently are based on the data and findings from tests such as China Lake experiments. These test sizes were of a modest scale compared to sizes of postulated spills to which the models are being applied now. There is considerable uncertainly in the scale-up and applicability to larger LNG releases.

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[1] In sufficient quantity of air which contains the chemically required amount of oxygen to react with the hydrocarbon for complete combustion (called the "stoichiometric" amount).

The extent of the potential hazard zone surrounding a LNG release depends upon a number of factors including the quantity and rate of LNG release, the location of release (onto water or land), the environmental conditions and mitigating circumstances and the type of behavior of interest (dispersion and subsequent ignition of a vapor cloud, a pool fire, or other type of behavior of concern). Our knowledge of and confidence in modeling some types of LNG behavior, even in the case of very large spills, are good and in other cases they are very limited or lacking. The gaps in our knowledge of applicability to larger LNG releases make it difficult to model the entire sequence of events as a system and estimate the magnitude of the final consequence.

There are four distinct steps in modeling the consequences of release of any hazardous material, including LNG. These steps include, (i) the quantitative description of the details of the source and the modification that the released material may undergo in the immediate vicinity of release location due to its interaction with air or water. (ii) the description of behavior of the released material in the environment (burning as a pool fire, dispersion of vapor in the atmosphere and later burning as a vapor fire, rapid phase transition-RPT, etc) and quantification of the hazardous effects caused by the behavior, (iii) the enhancement or reduction of the hazardous effects due to interaction with the atmosphere and, finally, (iv) calculation of the effects on people or structures using the appropriate susceptibility criteria for such hazards (or alternatively, calculating the distance from the release where the hazards are below acceptable levels).

In the case of scenarios of potential LNG release from tankers, there are significant uncertainties and unknowns in the first step itself, namely source modeling. This has a significant impact on the overall hazard prediction. The calculation of the rate of discharge of LNG from a specified size hole on the side of a ship's tank is relatively straight forward, when such a hole is above the water line. Other phenomena may also occur, which substantially reduce the overall flow rate. One such is the creation of a vacuum condition in the tank leading to intermittent discharge ("glug-glug" type of flow as from an inverted bottle). Our knowledge to calculate the LNG outflow and the water inflow rate in the case the hole is either at or below the water line should be supplemented. The physics of mixing of LNG outflow with the water inflow, and mixing of water entering the tank with the LNG inventory in the tank (causing rapid evaporation and exacerbating the tank pressure condition), are some of the potential phenomena that have not been studied carefully. The calculations of how fast LNG comes out and in what form (liquid, vapor, liquid drops) are extremely difficult and full of uncertainties. Currently, there are no experiments to guide us to model the flow when the hole is at or below water line. Performing a chain of calculations using only a single scenario of release cannot be the last word on the extent of the public hazard, however conservative the assumptions may be. A whole spectrum of events and their consequences needs to be considered.

The GAO report has identified cascading tank failures due to heat or the contact of cryogenic liquid and carbon steel as another issue. The conditions under which these cascading tank failures may occur and resultant effects on the hazards are not clearly understood. Therefore, there are considerable uncertainties in describing the rate and quantity of LNG released and the form in which it may be released depending upon the locations and sizes of holes in the two hulls of the ship.

The vapor formed by the release of LNG (into or on water) is most likely to be ignited, close to the ship, from hot metals or electrical sparks (static or cut cables). In all current generation models it is assumed that all released LNG will form an expanding-vaporizing pool on the water surface sustaining a pool fire. Modeling the spread of the pool given the volume of the liquid LNG in the pool (or the rate of volume entering the pool) is reasonably well established. However, what is not known precisely is how much of the LNG flowing out of the tank actually pools on the surface. A large jet of LNG pouring out from an elevated hole plunging into water can penetrate the water column to a significant depth, fragment by both mechanical and thermal interaction with water, form small droplets of LNG most of which will vaporize[2] by the time they rise to the surface leaving only a fraction of the release to form a floating liquid pool. There are two main consequences of this. One is that the large vapor volume released could burn as a fireball near the ship. (A fireball puts out significantly higher heat (per unit area) but for a considerably shorter duration than a pool fire). The second possible outcome is that the vapor

[2] My own recent analysis of the phenomenon of a LNG jet plunging into deep water indicates that depending upon the LNG plunging velocity into the water surface 50% or higher fraction of the released liquid could vaporize in the immediate vicinity of the release leaving only a smaller volume of liquid to spread on the water surface.

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produced within the water column together with the vapor produced by the spreading LNG pool on water burns in a pool fire. The diameter of this pool fire would be far less than if all released liquid pooled on the water surface. Both of these phenomena have direct effect on the calculated hazard distance. No experiments have been conducted to understand the effects of LNG jet plunging into the water and the consequent fireball, pool fire or other types of burning.[3]

A fire poses hazards due to the emitted radiant heat. Radiant heat is the heat felt by a person (or an object) outside the fire and at some distance from the fire so that the heat is not due to direct contact with the hot gases in the fire. This is the "heat" that one experiences when facing a fire in a home fireplace. The radiant heat emission from a fire is generally quantified by a parameter called the "emissive power," which is the average amount of heat energy "leaving" a unit nominal surface area of the fire and is expressed in units of kW/m^2 or $Btu/hr\ ft^2$. The higher the emissive power the brighter a fire will appear and the farther one needs to be from the fire to be safe. The emissive power of LNG fires has been measured in relatively small-scale field tests. Most of these small fires burn bright (as seen in Exhibit 1). It is known that emissive power value is fire size dependent. A large body of current generation models used for LNG fire hazard distance evaluations assume that irrespective of the fire size the emissive power remains essentially the same (and high), leading to the prediction of uncomfortably large hazard distances from large spills of LNG.

As argued earlier (and shown in Exhibit 2), large LNG fires become smoky, very similar to other fuel fires. All smoky fires have a region close to the bottom where the smoke mantle has not formed and where the hot "bright" parts of the fire are visible from which can emanate high radiant heat fluxes. The height of this region decreases as the size of the fire increases. The black (cold) smoke mantle enveloping the fire absorbs the radiant heat emission from the inner regions of the fire resulting in substantially less radiant heat energy being released to the areas outside the fire. In the case of large LNG pool fire on water the burning regions close to the water could be hot but the overall emissive power will be less than that from a smaller size fire. In addition, the hot region close to the water will result in inducing high vaporization of water, locally. The water vapor thus formed just around the base of the fire may contribute to absorbing the radiant heat emission in addition to, being sucked into the fire and affecting the combustion chemistry to make the fire cooler and less radiative. None of these phenomena have been studied quantitatively in any controlled, large-scale experiments. We do not know how smoky very large LNG fires will be and what the height of the lower "bright" burning zone would be or what the mean emissive power will be. A theoretical model developed using the principles of combustion physics and validated against the best available data from the 35 m LNG fire experiments (the largest fire to date) seems to indicate that the mean emissive power of large LNG fires from ship spills may be only about a 1/3 as radiative as smaller fires. If this is true, the hazard distances predicted from current models will have to be reduced by almost a factor of 2. Certainly, more research and large pool fire experiments on water are needed to get definitive data. I concur with the GAO recommendation on the need for this research.

Some people analyzing LNG hazards from ship releases are concerned with cascading failures of tanks due to external fires or interactions of the cryogenic LNG with metal structure of the ship. In fact, the GAO report recommends that research be conducted on this potential failure phenomenon. I agree with this recommendation, in principle, provided the types of research performed are realistic representations of the conditions following LNG release from a single tank. The heat from a pool fire may not result in further tank failures. The potential for cryogenic liquid-carbon steel interaction will depend upon a number of variables including the extent to which water is present, the location of contact between the hull plate and the liquid, whether such a contact will result in the immediate fracture of a part of the plate and the draining of the cryogenic liquid reducing the possibility of further contact, the engineered naval architectural designs that maintain the integrity of the ship structure even when a part of the structure fails, etc.

It is my opinion that heat from even a LNG pool fire impinging on the outer hull plate of the ship will be insufficient to cause further tank failures. This opinion is based on the following reasons; (i) there are at lest two historical records of incidents involving ships carrying refrigerated liquefied fuels which were exposed to intense and very long duration (hours) hydrocarbon fires impinging on the hulls and deck plates, yet suffered no failures of the cryogenic liquid tanks, (ii) the ships were of smaller size than current day LNG vessels; because of shorter dimensions, the

[3] I, however, noticed in the China Lake tests that the higher the spill rate (in gpm) of LNG the higher was the burning rate, the taller was the fire and the quicker it went out.

smaller vessels are relatively more vulnerable to heat transfer from the fire to the tanks (and yet the tanks did not fail), (iii) the calculated lifetime of a LNG pool fire is of the order of minutes within which the total heat transfer to a massive ship structure would not affect the hull integrity (especially since the outer hull is also cooled by sea water), and (iv) the LNG and hydrocarbon fires have the same temperature as discussed earlier. The cases I cite are the incidents with "Yuyo Maru # 10" and the "Gaz Fountain."

In November 1974 the Yuyo Maru No10, a 47,300 m^3 tank capacity ship carrying refrigerated LPG in insulated tanks with ballast tanks filled with naptha (a fuel very similar to gasoline) was underway in Tokyo harbor. It was hit broadside by 15,500dwt steel products carrying ship "Pacific Ares," The collision resulted in one of the wing tanks of Yuyo Maru being punctured and releasing naptha on to both the water and the deck of the colliding ship.[4] The naptha pool ignited immediately and the resulting fire caused damage to both the LPG carrier and the colliding vessel. The naptha fire on the sea engulfed the ships for more than 4 hours. The LPG vapors were released through the normal relief valves and no boiling liquid expanding vapor explosion (BLEVE) occurred nor did a leak of liquid propane occur nor any tank failure.

The other incident refers to Gaz Fountain. This ship, designed to carry both LNG and LPG, was hit in the Persian Gulf during the Iran/Iraq war in October 1984 by three air-to-surface Maverick missiles, which caused extensive damage on the deck of the ship.[5] The ship at that time was carrying LPG. Intense and long lasting fire resulted on the deck. Propane vapors burned through a gash in the tank roof as a large vent fire. No tank failure or release of refrigerated liquid propane resulted nor did any of the tanks undergo a BLEVE type of failure.

Other researchers have postulated the failure of LNG ship tanks due to fire heat exposure leading to a LNG tank explosion (due to BLEVE). As indicated above, no such explosions have occurred in tanks of ships carrying refrigerated liquefied petroleum gas (LPG) even after being subjected to intense fires on the outside. For a BLEVE to occur the liquid in a tank must be heated to temperatures well beyond its normal boiling temperature (and therefore higher pressure in the tank) and the tank has to be suddenly depressurized by, say, the sudden rupture of the tank wall. The rapid depressurization results in the production of large volumes of vapor, which may ignite and form a large fireball and the pressure waves created may hurl pieces of the tank to some distance. The higher the pressure in the tank at rupture the worse will be the effect of a BLEVE including the throw of the pieces of the tank to distances up to 10 mile. BLEVE incidents have occurred in pressurized (LPG) rail tank cars or relatively small LPG storage tanks in which the pressure is normally about 105 psig and the tank will withstand pressures up to 375 psig before rupturing. Large tanks have not exhibited the BLEVE type of explosive rupture;The smaller the tank and the higher the pressure it can withstand the greater is the likelihood for the occurrence of a BLEVE.

One can conclude that a BLEVE is extremely unlikely in a LNG ship tank when one considers the conditions necessary for such an event to occur. First, the volume of liquid in each tank of a LNG carrier is large (25, 000 m3). To heat such a massive amount of liquid to any temperature significantly higher than its normal boiling temperature requires significant amount of heat to be input. The calculated lifetime of a LNG pool fire (caused by the rupture of another tank) generally ranges from a few minutes to, at best, 15 minutes. Over this burning time it is difficult to transfer significant quantity of heat to the LNG in the tanks. Second, the LNG tanks are well insulated and separated from the outer hull by a large (at least 2 m wide) inter-hull ballast space, which impedes heat transfer from the fire to the tank wall. Third, the tanks are provided with relief valves, which will ensure that no significant rise in the pressure occurs. Further more, because of the size of the LNG tank the roof of the tank will not be able to withstand any significant increase in pressure () before being damaged. Last but not the least, actual experience with large ships carrying refrigerated fuels (LPG and butane) in tanks similar to those in LNG carriers indicates that even though they were subject to fires lasting several hours no BLEVE resulted. Therefore, in my opinion, the consideration of BLEVE as a potential public hazard phenomenon in the scenario of an accidental or intentional release from a LNG ship is addressing a non-problem.

4B. ***Areas that require additional research and why***

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[4] William de Barry Thomas, *Spectacle Blurs Issues,* Hazardous Cargo Bulletin, p 23, October 1984.

[5] J.A. Carter, *Salvage of Cargo from war damaged Gaz Fountain,* paper presented at the 1985 Gastech Conference, Nice, France, 1985.

Other research that may be as important as pool fire tests and modeling needs to be performed to determine the type and magnitude of other hazards, which may, under certain circumstances, become the dominant hazard scenario(s) rather than a pool fire. These include water-LNG interaction, water intrusion into LNG tanks and considerations of a fireball type of burning.

There are two most likely scenarios resulting from a large release from a LNG ship. These are (i) the formation of a LNG pool fire on water (initially expanding but reaching later a steady size) and, (ii) the potential formation of a large fireball type burning due to the immediate ignition of the large volume of vapor produced rapidly and locally from the LNG jet-water interaction. Whether such interaction could lead to localized and flameless rapid phase transition explosions, (RPT), should be investigated. A RPT together with LNG jet penetration into the water column together with the occurrence of a RPT can result in a very large volume of vapor bring thrown high up in the air leading to the formation of a fireball if ignited. The recent GAO report has recommended the investigation of the radiant heat emission and smoke production characteristics of large LNG pool fires on water. I am in agreement with GAO on this recommendation. However, the results of a pool fire test series alone will not provide all of the knowledge required to perform a credible public safety assessment. Therefore, I recommend the conduct of the following types of experiments followed by modeling to properly estimate the potential hazard areas from different types of similar magnitude phenomena. (These recommendations are complementary to those of the GAO).

1. Large LNG pool fire of sizes up to 100 m in diameter on (deep) water? the objective of these tests should be to understand the variation of the fire dynamics, smoke production characteristics and radiant heat emission change from bottom to top of LNG fires as the fire size increases.
2. Plunging LNG jet interaction with water (of significant depth) to understand the phenomenon of depth of penetration, jet fragmentation, rate of vaporization and fraction of liquid spilled that will eventually pool on the water surface. This is an equally important phenomenon to consider since in some situations most of the spilled LNG may evaporate in the water column and the pool formed may be so small as to not pose significant pool fire hazard compared to, perhaps, other phenomena like a fireball type of burning.
3. Ignition tests with a plunging LNG jet into water to see if a fireball results (and if so the conditions under which it happens) or whether a fire similar to a pool fire but with substantially large fire plume results due to very high gas release rates in the "pool."
4. Viewing a LNG Pool fire (or even a large natural gas fire) from a distance of several hundreds of meters up to 2 km on a very large expanse of water and measuring the absorption of the radiant heat in the atmosphere. Current calculations of LNG heat absorption by the intervening atmosphere are based on the assumption that the fire radiates like an ideal black body. However, LNG fires are known to be band emitters of radiation in exactly the right frequency where the water vapor (and to some extent the carbon dioxide) in the atmosphere absorbs. Such a definitive test conducted on water will provide a basis for taking into consideration the beneficial (and mitigative) aspects of the atmosphere. Unfortunately, some of the models used in calculating hazard distances either incorrectly model the atmospheric absorption or do not consider it at all. Such omission is not excusable when the predicted hazard distances are in hundreds of meters (up to 2 km).
5. The interaction of the LNG outflow and the water inflow (simultaneously) to understand what may happen if the postulated hole location in the ship's tank is at or below the water line. The flow situation and the effects of large quantity of water intrusion into a tank filled with LNG are complex and need to be studied. Such a phenomenon may need to be considered in hazard calculations.

5. *Results from risk assessments rather than from a single postulated scenario should be the basis of policy decision making.*

Risk analysis as a tool is being increasingly utilized in the US for decision-making, but only in bits and pieces. The single important reason for the lack of universal adoption of risk-based decision making is the lack of standards for the levels of risk that are acceptable to society.

It is my opinion that policy decisions should be made after evaluating all possible scenarios of releases, their likelihood of occurrence, the levels of consequences associated with each scenario and considering the effects of either natural mitigation processes or man made technological or procedural systems. Absent such an approach, the focus will always be on the largest, most incredible types of releases, whether they have ever a chance of occurrence or not. Preparing for and managing

resources required to respond to emergencies involving events that occur with very low probabilities is a misapplication of resources.

It is very commendable that the report by Sandia[6] recognizes that risk analysis must be the basis of overall assessment rather than the consequences of a single worst-case event. In fact, this report has provided a template on how one should perform a risk assessment; unfortunately, since the process has not been quantified with a specific example, the public seems to be focusing on the results from the theoretical assessment of the consequences only. Many other federal agencies have long recognized the usefulness of risk-based approach. However, it has been slow in "permeating" to the LNG industry regulations. The US Coast Guard requires the performance of Waterway Suitability Assessment, for LNG ship passage to a port, based on a risk consideration approach. The US DOT has in its Pipeline Integrity Management regulations the requirements for performing risk based assessments. The NFPA LNG Committee is considering providing, as an alternative Standard for compliance, a risk based standard.[7] The European regulators have successfully used the risk-based approach to permitting LNG and other petrochemical facility siting for over a decade.

One of the important recommendations I would offer this august body is to consider setting up acceptability standards for levels of risk that are suitable for siting industrial activities and for continuing such operations. Risk cannot be considered in a vacuum; it has to be based on comparative scales. There is substantial body of literature on this topic.

Conclusions

1. LNG industry has operated safely both in the US and worldwide for over six decades. There is no technical or operational reason why this exemplary record will not continue. New technologies, application of results of careful research, and continued personnel training are expected to contribute to the enhancement of the safety record.
2. LNG burning properties are not very different compared to similar properties of other commonly used hydrocarbon fuels. Large LNG fires will be very similar in radiant heat emission characteristics to large fires of propane, gasoline, jet fuel, etc.
3. The models that are being currently used in LNG hazard assessment have layer upon layer of conservative calculations, making predicted distance to hazard substantially more than what it would likely be in reality. New sets of larger LNG pool fire tests will provide the necessary framework for the development of realistic models with which to assess the fire hazards from potential LNG release scenarios from ships.
4. Other research that may be as important as pool fire tests and modeling needs to be performed to determine the type and magnitude of other hazards, which may, under certain circumstances, become the dominant hazard scenario(s) rather than a pool fire. These include water-LNG interaction, water intrusion into LNG tanks and considerations of a fireball type of burning.
5. Focusing only on consequences of perceived worst cases rather than on the overall risk from an activity will result in poorly utilized and improperly allocated resources, not to speak of the economic penalties that may result.
6. Risk analysis as a tool is being increasingly utilized in the US for decision-making, but only in bits and pieces. The single important reason for the lack of universal adoption of risk-based decision making is the lack of standards for the levels of risk that are acceptable to society.

Mr. Chairman and Members of the Committee, I thank you for the opportunity to testify before your Committee.

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[6] Hightower M., L. Gritzo, A. Luketa-Hanlin, J. Covan, S. Tieszen, G. Wellman, M. Irwin, M. Kaneshige, B. Melof, C. Morrow, and D. Ragland, *Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water,* Sandia National Laboratory Rep.# SAND2004–6258, U.S. Department of Energy, Washington, DC, Dec 2004.

[7] The full membership of this NFPA 59A Committee is considering this recommendation and verbiage provided by its sub-committee. If approved, this alternative standard would be incorporated into the 2009 edition of the NFPA 59A Standards.

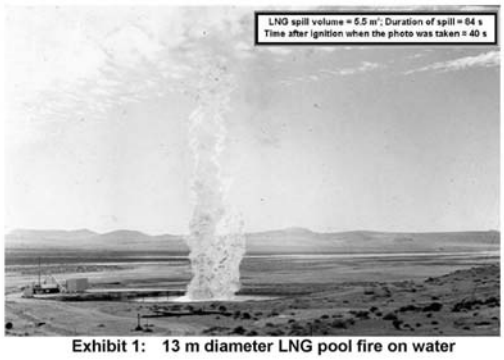

Exhibit 1: 13 m diameter LNG pool fire on water

Exhibit 2: 35 m diameter LNG pool on an insulated concrete dike

Comparison of two LNG fires showing the effect of size on smoke formation (and consequent reduction in the magnitude of the emitted heat flux in the larger fire)

Chairman THOMPSON. Thank you very much.

I thank both of you gentlemen for offering your testimony, and I remind each member that he or she will have 5 minutes to question the panel.

I now recognize myself for the first 5 minutes.

Mr. Davis, there were some questions earlier about the maritime administrator's initiative to increase the number of U.S. mariners on LNG tankers. Just for the record, do you support that?

Mr. DAVIS. Absolutely. I think that the maritime administrator is doing a fantastic job. I think he recognizes that this is an important part of homeland security.

And I think that he believes, as I do, that what better people to be watching out for the United States than U.S. citizens.

Chairman THOMPSON. If this committee recommended to Congress that the administrator's initiative becomes law, requiring LNG tankers to have a certain minimal percentage of U.S. mariners, could we over time be able to provide those qualified persons to work on those LNG facility ships?

Mr. DAVIS. Yes, Chairman Thompson. As it currently stands—we had a fleet of vessels, LNG vessels, operating for over 20 years with the American flag on it, which MEBA was on board and were the officers on board, and the Seafarers International Union was the crew on board.

And those ships were taken and put a foreign flag on them for economic purposes, and we eventually lost all of our jobs on them.

We still have a pool of mariners that essentially could walk on board the ships today—they would need a little bit of recency training and to get familiarized with any new vessels that are out there.

But in a very short period of time—and I am talking weeks, not months—we could essentially start crewing up vessels. So my answer to that is yes, as well as the absolutely wonderful schools that we have around the country.

We have the federal maritime school at Kings Point. We have the state schools at various states around the country, as well as the union schools, including my own in eastern Maryland.

Chairman THOMPSON. Thank you very much.

Dr. Raj, the GAO report highlights the fact that experts still disagree on the consequences of an LNG spill. Why do you think that disagreement exists? And kind of share that with the committee, if you would.

Mr. RAJ. Certainly, Mr. Chairman. The disagreement arises simply because of lack of knowledge. We have so far done tests on water, especially back in the 1970s, in which I was involved myself, spills on water where the size of the fire was about 50 feet maximum diameter.

But we are postulating scenarios based on ship spills that will go something like 1,000 feet in diameter, so there is a tremendous scale-up of the information from a 50-feet size experiment to a 1,000-feet diameter fire.

We have recently come across, for example, information when the size of the fire is doubled from 50 feet to 100 feet it behaves completely differently. It completely becomes smoky fire and seems very much—looks very much like a gasoline fire.

What has happened is people who know of those have used those models, whereas the people who do not know about this have used the older models, thinking that the fire is very bright. So we come up with substantially different estimates of the hazard.

So I think it is a matter of lack of knowledge of really the behavior of LNG as we increase the size. And we are applying some very limited information that we have at the moment.

Chairman THOMPSON. Has any of your research looked at potential economic consequences of spills? Or you just limited the research to just what would happen in the spill area?

Mr. RAJ. I have personally not undertaken any economic assessments. My field of research has been limited to understand the science part of it. But I am sure there are people who can understand the economic impacts if any such accidents do occur.

Chairman THOMPSON. Well, and I think one of the things we want to consider is obviously the danger, but you know, terrorists would just as well like to keep a port out of business for a week or two, and that would be an absolute significant incident also associated with a spill or that particular incident.

So I think part of our challenge is how do we look at all the consequences associated with the handling of LNG. Clearly, we want to know the hazards initially, but we also want to look at economic conditions that relate to it also. But I thank you for that.

The other point that I want to talk to you, Mr. Davis, about is you have heard testimony that over time we will be bringing more LNG facilities online. And that will also require more and more people working in the facilities.

So just like if the administrator's philosophy of more people on board ships become American, if we somehow can codify that, what happens if we bring 10 new facilities online and we will need additional ships for that?

Do you see a problem with getting the necessary American citizens to work at those facilities also?

Mr. DAVIS. Well, first, I think that the simple answer is no. If there are jobs for Americans, we will train them. We will fill the jobs when we have competent people to do that.

But what I would like to say is in regards to land-based facilities that right now, there is no oversight on the vessel crewing issue for any ships to come into a land-based facility. MARAD has no say in that.

It is interesting that MARAD has some input into the permitting process with the ships going to an offshore location, to a buoy set up offshore, but as far as the land-based, for example, you can have a terminal right in the middle of a city, for example, which is certainly exposure to a lot of people.

Now, the Coast Guard has 96 hours to essentially make sure that Joe Smith or whoever the name is that is given to them—that they are supposedly cleared through their database.

But basically, what they are not able to do is they are not able to—what MARAD is not able to do is have any say whatsoever in the crewing on board the ships that come into a land-based facility as it stands right now under the law.

Chairman THOMPSON. Thank you, because that distinction was not made in testimony from the other panel. And I think that is absolutely beneficial.

I will yield now to the gentleman from Houston, Texas, which, as you know, has a significant port operation going on there.

Mr. Green?

Mr. GREEN. Thank you, Mr. Chairman. And I want to thank you for hosting this important meeting.

I thank the witnesses for taking the time to be with us today. And I have been gratified and edified by what you have said.

So let me start by asking first, for my edification, how does the process work of having our mariners actually get to the ships? I am concerned about the logistics in that. What happens such that we can place our people on their ships? I am new to this. I am a neophyte on the committee.

Mr. DAVIS. Well, as far as—you are talking on current ships, foreign-flag ships right now, American ships? I am not quite sure—

Mr. GREEN. Well, you indicated that you thought that our mariners would be better suited because of their training to be on these vessels. So how do we get them there logistically speaking, if you don't mind?

Mr. DAVIS. Well, logistically, a company—if a company's ship right now comes into the United States, we can—wherever it comes in and docks, we can just go ahead and put our people on there. Or if they are out at anchorage, we could send them out by boat.

Or it is not uncommon at all for Americans to fly overseas and board a vessel overseas, and that is where they join the vessel.

Now, what is going on in this industry is that there is a tremendous amount of new construction that is taking place. Many, many ships, well over 100 ships, which is a tremendous amount of ships, are being manufactured in other parts of the world.

The best way to familiarize people with these ships and to become trained on these ships is to actually participate—toward the end of the shipyard period as the ship nears completion, to actually go to that shipyard and participate at that point in time in the operations, because all the systems on board the ship are then tested and all before the ship is put into commission.

That is the best way. But I mean—logistically, for new ships, the very best way. Older ships, all you have to do is fly people over to—fly Americans that are trained in LNG, which we do have—fly them overseas and put them on ships and they will take the ship to the United States and back to load again, discharge, and back and forth.

And third case scenario is the ship is already here in the United States at an LNG facility or at an anchorage or a dock—is we make the proper arrangements essentially to take people down to the ship either by boat or take them down in the car.

Mr. GREEN. And is this process something that is employed in other places in the world, or would we be the first to initiate it?

Mr. DAVIS. No, as far as putting people on board vessels—Mr. Green, you are from Houston.

Mr. GREEN. Yes.

Mr. DAVIS. And I am very familiar with the Houston Ship Channel down there, and this is just standard procedure that we would do with any of the ships that—we are not on any of the international ships—international flag ships that come into Houston.

But the American flag ships that come into Houston—this is all our standard procedure of what we do there.

And if an American flag ship that was overseas in a port overseas—say it was in South America getting some oil, and they essentially came up a crew member short because an American on there got sick, we would fly a crew member down from Houston,

put him onboard the ship in South America, and then he would bring the ship up to Houston, to the refinery in Houston.

Mr. GREEN. If we imposed this type of requirement, could other ports, seeing this, conclude that because we now have ships coming to our port from the United States perhaps we would want to have some of our people on their ships?

Mr. DAVIS. That is certainly possible, but right now, the United States—97 percent of all the shipping that comes into and out of the United States is carried on flags other than United States flag ships.

So out of every 100 ships that comes into the United States, three of them are manned by Americans with a United States flag. The other 97 are foreign-flagged from some other country.

Many of them are what we call flags of convenience, which are essentially flags that are licensed to a state that may not even have a port in it, but it has essentially big monetary tax breaks for a shipping company.

Mr. GREEN. Dr. Raj, are you commenting at all, or are you in disagreement with what Mr. Davis is saying? Or are you just here to help us to understand the consequences of having the LNG handled inappropriately such that we have an explosion of some type?

Mr. RAJ. I am not competent, Mr. Green, to respond or—you know, I have not studied the problem. I am not an expert in this, and I don't have the background.

So my expertise is really to understand what happens when LNG gets released.

Mr. GREEN. All right. Are you familiar with the Houston Ship Channel?

Mr. RAJ. No, I have not been to the Houston Ship Channel. I am aware of it and heard many things about it.

Mr. GREEN. Well, let's just take this hypothetical. In a ship channel, which is usually fairly narrow, if we have an explosion, how long—what is the duration, generally speaking—the chairman got into this with you—for cleanup such that that ship channel will be traversable again from the point of the explosion, assuming that it is one that will incapacitate the vessel?

Mr. RAJ. I do want to mention that I agree with the GAO in their report that explosion from an LNG ship is a perhaps extremely unlikely scenario. LNG as a liquid does not explode.

And LNG spills—if there is a fire, the fire is fairly short-lived and everything that gets released will be burned away or just literally go up in smoke. So there would be nothing left in the water as a cleanup of the material that got spilled.

There may be other debris from the ship itself, or so on, and my expectation—and, you know, I don't have background in that area, but I will just expect that the port will be operational within hours, if not a day or two, because there is no cleanup kind of things that is required which would shut the port down.

Mr. GREEN. Thank you, Mr. Chairman. I yield back.

Chairman THOMPSON. Thank you.

Just taking off from Mr. Green's comment, has your research, Doctor, taken in any potential acts of terrorism associated with an LNG tanker?

Mr. RAJ. No, sir. I have not specifically looked at terrorism. My expertise starts when there is a release, however the release is caused.

Chairman THOMPSON. So if, say, as we had to happen in Yemen, where terrorists ran into the side of a ship with a lot of explosives, do you have any research or do you know of any research as to what the results of those kinds of terrorist acts potentially could be up on an LNG ship?

Mr. RAJ. I can only speculate, because—engineering judgment and science-based speculation, for two reasons. One is I can formulate what will happen to LNG when it gets released from tat kind of a situation where there is an explosive breakage of the hulls of the ships.

But I also want to refer you to the information I have provided in my testimony on two actual incidents that happened in years past with large ships which were not hit by a terrorist but nevertheless they were subject to very high heat from flames.

This happened in Tokyo Harbor where a ship carrying material called LPG, which is liquefied petroleum gas or liquefied propane, which is pretty similar to LNG, was involved in a t-bone collision accident with another ship, and there was no explosion or anything.

In fact, what was released was a material similar to gasoline which was held in the side tanks of the ship, and the ships—both ships were cooked in the fire caused by the gasoline, the naphtha, released for 4 hours, and there were no explosions of any kind, other than burning. And the Japanese, in fact, had to tow that ship after 3 days and sink it with a lot of effort.

The other incident that I am aware of is the one that—a ship that was hit by a maverick missile, surface-to-air missile—air-to-surface missiles in the Iran–Iraq war. And even there, when the missiles penetrated the hull of the ship, the deck of the ship, there were really no explosions or anything.

So that is about all the knowledge we have at this time. We do not have experiments to really simulate exactly the situation that you have asked.

Chairman THOMPSON. Well, do you think it would be worthwhile for us to have the experiments and the modeling that could probably give us some answers to some of these questions?

Mr. RAJ. Some of them, yes, indeed. I think it would be very worthwhile, and I have alluded to them in my testimony.

Chairman THOMPSON. Thank you. Because part of it is the safety of LNG as it is, but the other is whether or not we can secure that LNG from a potential terrorist attack. And if we can, how do we do it? And heaven forbid, if we don't, what are the consequences?

And how do we marshal the resources to respond to it in a manner that is coordinated and part of the strategic plan that we found out we don't have at the agency right now? And I will assume we will have it shortly. But we just keep our fingers crossed until we do.

But that is part of the dilemma, and I can appreciate the testimony. I was not real happy with the Coast Guard and DHS's testimony that more assets and equipment is at this point not needed.

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I can't for the life of me see how, with the potential for these many facilities coming online—for us not to have need for more men and equipment.

I know the Coast Guard is good, but I don't think you can be two places at one time. And that is kind of my thought. And Ranking Member King and others have kind of indicated similar opinions. And so we will be looking at that.

I now yield to the gentlelady from Texas.

Ms. JACKSON LEE. Thank you, Mr. Chairman.

And let me thank the witnesses on the second panel. This has been an important dialogue.

One of the comments that I make and will continue to make in these hearings is that we have been lucky since 9/11. We have certainly made substantial improvements. We have awakened.

But I can assure you, as the dust settles on any potential tragic incident, if they look to the lawmaking body, certainly this committee will be in the eyesight of those who will ask the question why.

So we may be not finger pointing, but we may be looking under the hems of garments, and behind cracked doors, and turning on lights, and people will scratch their head and say, "We have been doing it this way for a long time. Why?"

And I think it is simply because before the Yemen boat incident, if you will, who would have ever thought? A little, small boat—sounds like a fantasy story—goes up to a big, huge ship and 19 or so sailors are dead.

So, Mr. Davis, let me ask you to speculate, because frankly, some would say, "Well, he hasn't looked at the recent accounting pluses and minuses of the Coast Guard."

But just because you represent those who are a part of this marine industry, and I imagine you have encountered the Coast Guard and looked at the vastness of the area in which they operate—because your, if you will, members are probably engaged in a lot of what the Coast Guard is involved in.

If you had to just look, would you think that there are enough resources in the Coast Guard—and I am going to ask you some other questions about—I think you made a point in your testimony that there should be more of your membership on ships.

But just tell me, if you had to speculate, would you—could you feel comfortable in analyzing whether there is seemingly the Coast Guard—or the Coast Guard seemingly is doing all the work they need to do and could stand more resources? Mr. Davis?

Mr. DAVIS. I am happy to answer that question. Thank you for asking it. I have, I guess, two ways that I would like to answer the question.

The first kind of dovetails into a little bit of the previous question that the chairman had asked, and that is essentially the—I just feel it is my obligation at this point in time to state to this committee that in regards to terrorism with a ship, whether it be an LNG ship or any other type of ship, the most vulnerable place that you have on the ship is the crew.

It is the crew that controls the ship. One or two engineers down in the engine room can take control of the ship, can control the steering of the ship, can control the speed of the ship, can have the

ship going 20 knots up the Houston, ship channel or into New York Harbor or places in confined areas.

They can ram the ship into bridges, Golden Gate Bridge. You name it—Verrazano Bridge, down in Houston. Anywhere they want, they can point this thing.

Terrorists are not going to start some small fire that these tests and such have taken on. Terrorists are going to look for the most damage they can possibly do.

They are going to direct—if they are going to use a ship for a weapon, it is going to be directed to do the absolute worst amount of damage, which will be stationary objects as well as perhaps other ships.

And probably none of these studies have done a study of an LNG ship being deliberately smashed into another ship of highly flammable explosive types of materials.

The barges that are down in the—coming up the Houston Ship Channel—unbelievable, some of the things that are in those barges.

So to answer your—I just felt I needed to tell homeland security about this. It is the people on board the ship who ultimately control that ship. That is number one, and that is why—

Ms. JACKSON LEE. Could you hold your point for 1 second? So that means, in addition to the point you have made, to accept Mr. Raj's limitations by being encouraged that more research needs to be done in a vast area, because obviously terrorists are not going to pinpoint to us what they might do.

Mr. DAVIS. Absolutely. There is no doubt about it. And you can't look at it as an isolated ship. You have to look at all the surrounding possible targets around there, how this could be done in such a matter.

I mean, we do have nuclear power plants that are on rivers and bays and such. So there are certainly many possibilities, yes.

Ms. JACKSON LEE. It is my understanding that your organization and Excelerate Energy have entered into a memorandum of understanding. Can you provide us with information about the MOU?

Mr. DAVIS. Yes. We have entered into an agreement between MEBA and Excelerate Energy that we will supply American officers for the Excelerate vessels.

They made a commitment—Excelerate made a commitment to the maritime administrator, I believe, for 25 percent of the crews basically to be American, and that they intend to crew these ships up with American officers. That is deck officers and engineering officers.

And we will integrate—right now, apparently, the ships have Belgian officers on board them, and we will integrate in there and take our experienced people that have LNG experience and integrate them onto these ships and get their recency and get their familiarization with this particular—each ship has its own idiosyncracies—and become familiar with that, and work together with the Belgian officers.

And as Excelerate's fleet expands, perhaps at some point in time it may be all Americans on one ship and all Belgium on another, or something like that. I don't know.

The final details of that I don't really know, because we are still in an exploratory process, because this is new for both Excelerate and for MEBA. But I would like to commend them. This is a major step forward, and we are very pleased that they have done this.

Ms. JACKSON LEE. You have got a little piece of paper next to you. Do you need to check on that?

Or, Mr. Chairman, would you indulge me to finish my question? I am sorry.

Do you need to——

Mr. DAVIS. Well, just that Excelerate has made a commitment for their ships worldwide and not just for their ships that come into the U.S.

Ms. JACKSON LEE. Well, let me just say that being one that appreciates internationalism and working with our foreign allies, I am sensitive that we work worldwide.

But I like what you have just indicated, and we might want to look at, as long as it is not proprietary, this MOU, because I think you are asking for more of our officers to be on foreign ships, to have a more integrated system, if you will, which can also play into this whole idea of security.

And I don't know why we would be afraid of that. We have to do it in a way that speaks to our internationalism. But I think it would be a valuable approach to take. This MOU seems to be an advanced idea.

In my last hearing, I asked about more training for your officers or for officers and I need your voice on that.

I think it is important that we get on the same page, that we give more training as it relates to security, terrorism, prevention thereof to our officers and have the resources to do so.

Would that be helpful to the individuals you represent?

Mr. DAVIS. Yes. We have our own school, but most of our people have come from one of the state schools or the federal maritime academy, including Texas A&M.

Ms. JACKSON LEE. I am glad you said that, in Texas, and near Houston.

Mr. DAVIS. In fact, I have been speaking with Texas A&M recently about some joint projects, joint training projects, between MEBA and them. We haven't come to any agreement or finalized anything, but we are discussing it.

The maritime administrator has also been proactive with this. He asked all the CEOs of all the schools, federal, state, and the presidents of the labor unions that have training schools to please come to MARAD and sit down with him and discuss how we can train Americans for this specialized LNG training.

And we did meet, and we have an ongoing committee meeting, and we are all working together and cooperating together to fill the possibility of jobs that we see coming down the road of putting Americans on these ships. So, yes.

Ms. JACKSON LEE. I appreciate it.

Mr. Raj, let me bring my questioning to a close by posing two combined questions to you. And I heard you discuss research, and you made the very, I think, forward-thinking point that additional research is required.

And I think it is, because you have talked about safety, but as I said to you, the question why will be asked, and I would say God forbid, were we to see a terrorist act.

And so can you tell us why research has not been done and what approach we can—well, I think there should be sort of a firm approach to homeland security that this needs to be done and the appropriate researchers need to be engaged.

But while you are answering that question, though you have noted the exemplary record that the LNG tankers have had, some 60 years or so, couldn't you envision, as I have just heard Mr. Davis give us a wake-up call with some scenarios that he has offered, that it is vulnerable to terrorism, and that we should be mindful and watchful, and research would be warranted so that we can be prepared?

Mr. RAJ. Congresswoman, yes, I think you really hit the point. Research is needed to understand really what happens, and how it happens is an equally important part, as the chairman pointed out. And those are the areas that really need attention.

One of the questions you asked is why was not research done all these years. I think the answer to that—research was done in the mid 1970s when LNG was considered to be one of the energy resources for this country, and for a variety of reasons the industry did not take off. In fact, a couple of them almost went bankrupt.

And the revival of the industry is fairly recent in a sense, in the last 10 years or so. And with that, there is a lot more traffic in the world, a lot more traffic in the United States. And certainly, of course, 9/11 has added a new perspective and concern.

I do want to mention one other thing. In my testimony, I have gone into great length to compare some of the other hydrocarbons that we deal with every day—gasolines, propane and so on.

In my opinion, LNG is no different from them in the properties and, you know, hazardous properties. So we do not only have to be concerned with LNG—you know, our assessments, but also with the other materials which have similar properties.

Ms. JACKSON LEE. And you would think that we should not ignore the fact that a terrorist act could happen, but we need to generate the research, not only LNG but some of the other of the gases—propane, et cetera—that would be as susceptible to some act.

Mr. RAJ. Absolutely, because, you know, the price for freedom, as we all know, is eternal vigilance, and vigilance in this case includes understanding what would happen and prevent it from happening, and if it happens be responsive in emergency response.

Ms. JACKSON LEE. Mr. Chairman, profound eternal vigilance, I think, is a good not for me to yield back.

But I just want to offer on the record—and it may sound redundant, but let me just offer it in any event. Before 9/11, none of us could imagine individuals learning to take off in planes and not have any training to land.

And our first response for any of us who were looking awake or looking at the T.V. or seeing the reruns and hearing the initial responses as we listened to the tapes coming back was that it was an accident, that there must be a plane crash. Isn't it a little plane going into the towers initially?

We had no understanding of that. And then my recollection is that we had a tragedy with an Egyptian pilot, if I recall, that has never been explained, I think, that flew one of the planes in New York and either wanted to commit suicide or—whatever, but it was a human act.

So things that we have never heard of have happened, and we need to get the vulnerability assessment studies, more research, more training.

And, Mr. Davis, I think you have gotten hold of a good idea, and I would hope that if your document is not proprietary, I would like to have an opportunity to review it and begin to look at it as a model.

Mr. Chairman, I yield back. Thank you for this hearing.

Chairman THOMPSON. Thank you very much, Ms. Jackson Lee.

I want to thank the witnesses both for their expert testimony as well as their response to the question. We are just beginning the process of looking into this area. We will have more hearings on this.

So I hope you won't feel that we will be imposing on you from time to time to come back and share your information with us.

It is the new kid on the block. It is coming. We have to be able to respond to whatever the challenge is, both if it is manpower, if it is safety. As you know, permitting of these facilities is question one, and it is always around safety. But now we have to add security to it.

And the notion is whether or not from a government standpoint we can inspect them in real time, or are we going to have LNG tankers lined up, because we only have so many people around to do inspections.

So those are some of the questions that this committee will have to grapple with.

I want to compliment our MARAD administrator for being forthright in trying to negotiate putting American citizens on these particular ships. Hopefully we can move a little faster now that we know we can, over time, train the people to manage the facilities. So we will look forward to it.

Again, let me thank the witnesses for their testimony.

Hearing no further business, the committee stands adjourned.

[Whereupon, at 3:54 p.m., the committee was adjourned.]

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APPENDIX A

FOR THE RECORD

PREPARED STATEMENT OF THE HONORABLE BOB ETHERIDGE, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NORTH CAROLINA

I want to thank Chairman Thompson for convening this important and timely hearing. As energy prices have skyrocketed, alternative sources of energy and means of transportation for that energy. Liquid natural gas (LNG) will increasingly be used to diversify America's energy use, as shown by the recent upswing in applications for LNG facilities. As this gas will be transported under pressure in tankers traveling close to our shoreline, it is important that we ensure the public's safety as we increase the use of this fuel. This hearing is part of the Committee on Homeland security's vital work to make sure that the technologies and procedures in place are protecting the public.

Last week's Government Accountability Office (GAO) report on the possible effects of a terrorist attack on a LNG tanker is a useful first step in identifying the threat and putting procedures in place to counter that threat. I look forward to hearing the testimony from the GAO experts today. I also will listen with interest to the officials from the Maritime Administration (MARAD) and Federal Energy Regulatory Commission (FERC) who are charged with licensing safe and secure LNG facilities. I want to be certain that the procedures in place take the possibility of a terrorist attack into account and require planning and security against that threat. I am pleased to see that the Director of Inspection and Compliance of the U.S. Coast Guard is here to give testimony as well, as the role of the Coast Guard in siting and approving LNG facilities includes emergency response planning and operational command in the event of an accidental or intention disaster.

Again, I thank Mr. Thompson for his leadership, and our witnesses for their time in coming to speak with the Committee on this important issue. I look forward to the testimony and discussion as we work together to keep America Safe.

Appendix B

ADDITIONAL QUESTIONS AND RESPONSES

QUESTIONS FROM HONORABLE BENNIE G. THOMPSON, CHAIRMAN, COMMITTEE ON HOMELAND SECURITY

RESPONSES FROM RON DAVIS

Question 1: Do you support the Maritime Administrator's initiative to increase the number of U.S. mariners on LNG tankers? What else should be done?

MEBA fully supports Administrator Connaughton's initiative to increase the number of American mariners on LNG tankers. His efforts have been a major factor in persuading LNG vessel operators to begin using United States merchant mariners on their vessels.

We believe that the primary reason he has been successful is because plays a role in the permitting process of all deepwater LNG ports. However, does not play a role in the permitting process for land based terminals, which is overseen by the Federal Energy Regulatory Commission and the Coast Guard, neither of whom have a statutory duty to promote the U.S. maritime industry, as MARAD does.

We believe that should play a role in the permitting process for on-shore (land based) terminals similar to the one they play with deepwater terminals.

We also believe that the federal government should look into the feasibility of legislating a minimum crewing standard for LNG Tankers, including a requirement that 50% of the Officers be U.S. Merchant Mariners within a five-year period.

Question 2.: How will the increase of mariners improve the security of the LNG tankers?

Thanks to the in-depth vetting process that currently exists for US mariners, having them present on LNG tankers will help lower the threat of deliberate sabotage of the vessel by a knowledgeable member of the crew. This kind of an intentional incident is, in our opinion, the greatest threat to LNG tankers, and the most likely scenario that would result in loss of life or property. We can be sure that US mariners are who they say they are, and that they are adequately trained and loyal. This is not something we can be certain of with foreign crews.

In addition, with U.S. Mariners the LNG vessels they will have a stake in the security of the vessel while it is overseas loading LNG. All shipboard LNG is delivered from foreign countries and sometimes from politically unstable nations. U.S. Mariners care about their country and will have a vested interest in keeping a keen "watch" on the gangway, mooring lines and other areas that stowaways or terrorists could attempt to board.

The actual security vetting that U.S. Mariners undergo is extensive:

- U.S. Merchant Mariners receive their credentials to work from the U.S. Coast Guard;
- U.S. Merchant Mariners undergo extensive background checks performed by the Federal Bureau of Investigation;
- U.S. Merchant Mariners are background checked through a National Driver (vehicle) Record database;
- U.S. Merchant Mariners will also be subject to jurisdiction of the Transportation Safety Administration (TSA) where they will be vetted through a terrorist watch database in order to receive a Transportation Worker Identification Card (TWIC).
- U.S. Merchant Mariners are citizens of the United States or aliens lawfully admitted for permanent residence.

As I wrote in my written testimony, foreign seafarers are not held to these standards.

Question 3.: It is my understanding that the MEBA Calhoon Engineering School already has LNG training available for U.S. mariners. Please provide us with information about this training.

The Marine Engineers' Beneficial Association operates a world renowned training facility, the Calhoon MEBA Engineering School (CMES), in Maryland. The school is fully accredited and certified by the U.S. Coast Guard and Det Norske Veritas (DNV), one of the world's leading classification societies.

The MEBA training facility trains both deck and engineering officers and has recently installed a edge Bridge Simulation System designed and built by USA. The simulator is one of the newest and most sophisticated systems of its type in the world.

The interactive program allows students to simultaneously control simulated ships utilizing any of 56 different types of vessels in over 20 different ports. In addition to the ten ships that can be controlled within one scenario, instructors can further intensify the simulation by implanting multiple controlled ships into the scenario. Unlike many existing bridge simulators, each station, operating a different type of vessel (including LNG vessels), can interact with every other station simultaneously. The LNG cargo simulation program allows students to dock, load and discharge LNG vessels.

Moreover, the computerized system even encompasses the terminal-side operations of an LNG facility. It accommodates upgrades to adapt to ever-evolving Coast Guard and International Maritime Organization training and testing requirements.

The Calhoon MEBA Training School prides itself in developing and offering courses before the need becomes apparent in the U.S. maritime industry. Relevant courses meeting today's LNG training needs include Liquefied Gases (LNG). This course has been part of the MEBA training core since 1975. It provides U.S. Coast Guard Licensed Deck and Engine Officers with the knowledge to safely and efficiently transport LNG. This LNG course is a USCG prerequisite for employment aboard LNG carriers. The class includes comprehensive lecture, lab work, and computer training as well as LNG science, engineering systems, cargo systems, stability, and safety. This course complies with the IMO Code for the LNG Vessels.

Our school provides comprehensive lecture and computer-based cargo handling simulator training, including LNG science, engineering systems, cargo systems, interfaces, rules and regulations, and safety.

I have provided a copy of a presentation that fully outlines our LNG instruction at CMES along with this testimony.

Question 4.: How are U.S. mariners regulated versus foreign mariners?

Under international law, each flag state is permitted to regulate mariners sailing on vessels documented under their flag. Generally speaking, many states claim to adhere to the minimum standards set by the lnternational Maritime Organization. Their regulations are reviewed and supposedly enforced by their own equivalent of the Coast Guard. However, because of the large number of "flags of convenience", which offer little or no oversight or regulation, there is a large discrepancy between how mariners are regulated in the United States and how they are regulated elsewhere.

While foreign mariners may be required to comply with their government's regulations as well as international standards, the validity of some of the credentials is suspect. A few years ago, lnternational Transport Workers Federation President David Cockroft purchased an authentic Panamanian first officers certificate and sea book despite no practical maritime experience. The Seafarers' lnternational Research Centre at the University of Wales investigated the issue of fraudulent qualifications and in its preliminary findings revealed 12,653 cases of forgery in 2001.

Federal and state government, local municipalities and the communities surrounding LNG import terminals can rest assured that with American mariners the LNG vessels are manned by professional seafarers who have the integrity and the training necessary for the safe transport of LNG.

Question 5.: Is there a worldwide shortage of LNG mariners? If so, what can be done to close this gap?

Yes. According to a variety of sources, as I mentioned in my written testimony, there is a worldwide shortage of LNG mariners. And with over one hundred vessels expected to enter the trade in the next few years, it will only get worse.

We believe that an easy way to close the gap is to use the available pool of mariners in the United States. At the same time, we must do our best to entice young men and women to join the ranks of the maritime industry by going to sea. This means increased attention to our federal and state maritime academies and promotion of the industry.

There are numerous articles cited in my written testimony regarding the international crewing crisis as it relates to LNG. To illustrate some of the concerns and the frequency with which the subject of the worldwide shortage is reported, the international trade journal Daily News published an article on April 4, 2007 that states:

SINGAPORE—04 April—Rapid growth of LNG shipping has forced vessel operators to cream off senior officers from other ship types, causing a serious shortage of trained and quality crew, warned Anglo Eastern Ship Management quality and training director Chawla today. Speaking after a presentation at the Sea Asia conference in Singapore, Chawla said monthly wages for masters of LNG ships now stand at $18,000—20,000, with some even being offered $22,000. "There is no fresh pool of officers to man LNG vessels. The entire LNG crew today have been recruited from other ships (mainly LPG vessels) and re-trained," he told Fairplay. Anglo Eastern manages four LNG vessels and is set to take on more. However, Chawla noted that the manager has an average crew retention rate of 10 years. The vicious circle of shortage has seen rapid promotions with the result that many senior on-board personnel have no hands-on experience, he said. Training methods have to change to adapt to this worrying position, Chawla observed."

In the end, shipping companies by nature traditionally wait until the very last minute to make appropriate changes to their crewing modules. This should not and cannot be the practice for LNG importation.

Question 6.: According to Mr. Lesnick's written testimony, an additional 133 LNG vessels are scheduled for delivery to service the global LNG trades by 2010. This expanded fleet will require as many as 10,000 additional seafarers. Where will the companies find this additional personal if there is already a shortage? What impact will this shortage have on security?

This is a good question. The answer is unclear at this time. The likeliest scenario is that the companies will put increased pressure on their crewing agents, who will in turn begin to accept poorly trained or unqualified seafarers to crew the ships. This represents a significant threat to both safety and security. As the high standards that have always existed in the LNG sector begin to slip because of the shortage, the likelihood of an accident or intentional incident increases.

This scenario is unacceptable, especially considering that there are qualified Americans available for employment, and the United States is a leading producer of entry-level mariners. The international maritime community's deeply engrained prejudice and preconceived notions about US merchant mariners remains a major impediment to getting our mariners these jobs.

Question 7.: Do you support the Maritime Administrator's initiative to increase the number of U.S. mariners on LNG? If so, what else should be done?

Question 8.: It is my understanding that MEBA and Excelerate Energy have entered into a Memorandum of Understanding. **Please provide us with information about this MOU.**

On Tuesday, March 14, 2007, MEBA President Ron Davis signed a Memorandum of Understanding (MOU) with Excelerate Energy for the utilization of M.E.B.A. deck and engineering officers their liquefied natural gas (LNG) carriers. The MOU, which recognizes MEBA as the exclusive supplier of U.S. officers, involves Excelerate opening its vessels and terminals worldwide to our members in order to achieve recency qualifications to serve as officers in the LNG trade. In addition, once qualified, MEBA officers will begin to mix into the fleet as shipboard deck and engineering officers.

Excelerate has two partners related to its LNG shipping. One is the Belgium based NV that operates the LNG tankers and the other is the Norway based Skaugen Petro Trans that operates LNG Terminals. MEBA will be providing officers for both shipboard and terminal side operations.

There are still details that are being worked out. For instance, we are currently working with appropriate government agencies and embassies for the purpose of licensing acceptance for U.S. Coast licenses and qualifications international flag LNG vessels. In addition, we are working with Excelerate's partner NV on taxes, benefit structure, and qualification documentation.

On May 8, 2007, Excelerate, and Skaugen will be visiting our training facility in Maryland. We expect that MEBA members will be on Excelerate's vessels operating worldwide before the end of the year.

The following is an article from the April issue of Lloyd's List, one of the leading maritime industry trade publications regarding the deal:

Excelerate Energy's "landmark" US crewing agreement will apply to all the company's vessels, the innovative US liquefied natural gas shipping operator has confirmed, writes Tony Gray. Last month, Excelerate reached an agreement with the Marine Engineers' Beneficial Association union under which it would employ US citizens as deck and engineering officers. Excelerate vice president Jonathan Cook said the intention was "to integrate US mariners on all our ships". The company's fleet comprises three regasification vessels and one newbuilding. Mr. Cook said Excelerate planned to integrate US mariners into the crews of the vessels, and not undertake a complete replacement. Existing crews comprise European officers and Filipino ratings.

Mr. Cook said the decision was not taken because Excelerate considered US seafarers to be superior, "We believe there will be a shortage of mariners, especially officers, and think that the US is an excellent source for qualified mariners." He explained that the US had "excellent training facilities" from maritime academies to union training schools. "We believe the competency of the existing crews is excellent and have been very impressed with their capabilities and Mr. Cook said. "We expect that all of our crew will perform to the highest standards regardless of nationality." Mr. Cook said Excelerate's partner, Belgian gas shipping specialist was "very supportive" and "happy to be working together with us on this There were no plans at this time to change the flag—Belgium—under which the vessels sailed. Cook said it would be "premature" to comment on the cost of employing US officers compared with existing arrangements as "details are being discussed and worked out."

QUESTIONS FROM THE HONORABLE PETER T. KING, RANKING MEMBER, COMMITTEE ON HOMELAND SECURITY

Question 9.: As you know, the Maritime Administration has begun providing priority licensing to platforms that promise to provide training opportunities for U.S. merchant mariners. How long does it take for a merchant mariner to become truly proficient in LNG systems? What does the qualification process involve?

To be considered truly proficient in LNG systems we must specify at what level the officer will be working. A junior officer may be deemed to have met the standards of training after completing a combination of classroom and practical training. This may only take months to achieve. However, it could take as long as 1—2 years of experience working with expert senior officers to demonstrate the expertise to be considered truly proficient. Additionally, to build a senior officer through USCG License upgrades, specific specialized training and practical experience it would require approximately 7—10 years time.

Question 10.: Where are merchant mariners trained on LNG systems? Are there currently any training facilities in the United States?

At this time, all six of the state maritime academies and the federal maritime academy at King's Point all provide basic LNG training courses for their students. In addition, union training schools such as the Calhoon School have extensive training programs for LNG. MEBA has been teaching and training LNG technologies since the mid-1970's.

Question 11.: You mention in your written testimony that younger junior officers are leaving the industry prematurely. We see this in government from time to time, including within the Department of Homeland Security. **Why are these talented young seafarers leaving? Is it a generational phenomenon? How can we keep this talent?**

My testimony addressed the issues international fleet (foreign flag) junior officers leaving the industry before they reach senior level officer status thereby exacerbating the crisis. I placed this in the testimony to show that if the United States does not address the international crewing pinch now, then we are leaving ourselves open for a disaster later. All of my testimony and citations to reports and articles were based on what is going on in the international fleet. The international community did not take into consideration that the United States has a vibrant and growing pool of U.S. mariners ready, willing and able to sail in the LNG trade. Basically, until recently, the international maritime community forgot that the United States still has a merchant marine.

Question 12.: If we required all LNG vessels calling on U.S. ports to be crewed by U.S. merchant mariners, what happens if a ship, not originally destined for the United States, wants to come to the U.S. because of market demands on LNG? Should we turn them away?

It is quite common in the maritime industry to replace or add crew members while the vessel is between final destinations. Generally, the company would fly the replacement crew to a port somewhere along the route the vessel is taking before it reaches its final destination, and exchanges the crews as necessary.

Right now, many of the vessels operating in the LNG trades are plying established routes, so the likelihood of their being diverted is low. For those ships operating on the "spot" market, they generally expect scenarios like this and plan for them appropriately. There would be no need to turn away a vessel, because there would be multiple opportunities to get qualified US crews in a reasonable amount of time.

Question 13.: Can you perhaps give us some insight into the vetting process of some of the current LNG crews? I understand it varies from country to country. The actual security vetting that U.S. Mariners undergo is extensive:

- U.S. Merchant Mariners receive their credentials to work from the U.S. Coast Guard;
- U.S. Merchant Mariners undergo extensive background checks performed by the Federal Bureau of Investigation;
- U.S. Merchant Mariners are background checked through a National Driver (vehicle) Record database;
- U.S. Merchant Mariners will also be subject to jurisdiction of the Transportation Safety Administration (TSA) where they will be vetted through a terrorist watch database in order to receive a Transportation Worker Identification Card (TWIC).
- U.S. Merchant Mariners are citizens of the United States or aliens lawfully admitted for permanent residence.

Under international law, each flag state is permitted to regulate mariners sailing on vessels documented under their flag. Generally speaking, many states claim to adhere to the minimum standards set by the International Maritime Organization. Their regulations are reviewed and supposedly enforced by their own equivalent of the Coast Guard. However, because of the large number of "flags of convenience", which offer little or no oversight or regulation, there is a large discrepancy between how mariners are regulated in the United States and how they are regulated elsewhere.

While foreign mariners may be required to comply with their government's regulations as well as international standards, the validity of some of the credentials is suspect. A few years ago, International Transport Workers Federation President David Cockroft purchased an authentic Panamanian first officers certificate and sea book despite no practical maritime experience. The Seafarers' International Research Centre at the University of Wales investigated the issue of fraudulent qualifications and in its preliminary findings revealed 12,653 cases of forgery in 2001.

Question 14.: The Coast Guard and the rest of the intelligence community continue to tell us that the biggest threat to vessels is that of a small boat attack—a Cole or a scenario. You argue that it is the insider threat. What are your sources?

The United States Department of Energy commissioned a study which determined that one of the most likely threats associated with the carriage of LNG is an international (deliberate) act of terrorism by a crewmember working aboard and LNG tanker. See the report conducted by Sandia National Laboratories titled, "Guidance on Risk Analysis and Safety Implications of an LNG Spill Over Water." The report was issued to the public in January of 2005 and can be found at:

http://www.fossil.energy.gov/programs/oilgas/storage/lng/sandia_lng_1204.pdf

The Sandia report utilized available intelligence and historical data to establish a range of potential, intentional tank breaches that could be considered possible and credible. This included an evaluation of insider and hijacking attacks on ships and also external attacks, as well. The Sandia report is clear that the most devastating scenarios involving an LNG tanker are those occurring as a result of an intentional incident.

As a Licensed Chief Engineer for Steam, Diesel and Gas Turbine vessels, I know how a ship operates and the ease with which a knowledgeable crew member can take control of a vessel from remote locations Especially in today's world of automation and computer controls, which have reduced the crew needed to safely operate a vessel, it is relatively easy for a member of the crew, intent on causing a disaster and with no regard for his own personal safety, to cause an intentional incident like the one I described in my oral testimony.

Question 15.: The GAO, Coast Guard, and FERC have all testified this morning as to the excellent safety record of LNG vessels. **Does MEBA have reason to question this assessment?**

Not at all. In fact, the MEBA was instrumental in the establishment of this safety record in the earliest days of the LNG trade. We recognize that the LNG sector of the maritime industry has the best safety record. Our desire is to ensure that this remains the case.

With the increased number of vessels and the widely acknowledged crewing shortages, we believe that this excellent safety record is in jeopardy. This is why we feel it critical that we persuade the international maritime community to look to the United States as part of the solution to this ongoing problem. If we don't take steps now to address this looming problem, we make the possibility of a major accident or incident more likely, and that is a risk we cannot afford to take.

The point being is that transportation of LNG worldwide is a rapidly expanding marine service. This growth has never happened so quickly before, or in a segment of the maritime industry that is technically so different from other segments. The shipboard transportation of LNG has a great safety record. This is due in large part because of the 40 years it took for the international LNG fleet to reach 200 vessels. It may only take 5 more years for the LNG fleet to increase by 100 or more LNG tankers. Thus proper vetting and training are critical factors for consideration. The United States will most likely be importing LNG at a very increased rate over the next several years and we need to be prepared.

QUESTIONS FROM THE HONORABLE BENNIE G. THOMPSON, CHAIRMAN, COMMITTEE ON HOMELAND SECURITY

RESPONSES SUBMITTED BY MARK E. GRAFFIGAN

Question 1: According to your testimony, uncertainties still exist concerning the risks LNG spill would pose to the public. Why do these uncertainties still exist?

Response: A large LNG spill from a poses a number of potential hazards, the most likely of which is a large fire, which could potentially bum the public. Scientists measure the heat from such a fire by calculating the distance at which 30 seconds of exposure to the heat could cause second-degree burns (termed the heat hazard distance). The uncertainty surrounding this distance is evidenced by the range of estimates identified by the empirical studies conducted to date: from about 500 meters (less than mile) to more than 2,000 meters (about 1-114 miles). Since there have been no large-scale LNG spills or large spill studies have relied on models to determine the heat hazard distance. Researchers had to make numerous modeling assumptions including key fire properties, the size of the hole in the tanker, the number of tanks that fail (cascading failure), the volume of LNG spilled, and environmental conditions, such as wind and waves. Without data on large-scale LNG spills, different studies used different parameters for each of these assumptions, which resulted in different heat hazard distances.

Question 2: In your testimony you state that additional research to resolve some key areas of uncertainty could benefit federal agencies responsible for informed decisions when approving LNG terminals and protecting existing terminals. **Please provide us with information on this much needed additional research.**

GAO Response: Additional research resolve some key areas of uncertainty (particularly involving dangers from fire) could benefit federal agencies responsible informed decisions when approving LNG terminals and protecting existing and tankers, as well as providing reliable information to citizens concerned about public safety. Our panel of experts identified several areas of research needed. The highest-ranked research needs are listed in table 1 below:

Table 1: Expert Panel's Ranking of Need for Research on LNG

Rank	Research area	Description	Funded in DOE's study
1	Large fire phenomena	A large fire may behave differently than a small fire by breaking into several small, short flames, rather than remaining as a single, large fire. This behavior could reduce heat hazard distances by a factor of two or three. Research could this effect.	√
2	Cascading failure	Cascading failure is the sequential failure of multiple LNG storage tanks on an LNG tanker potentially due to cold, spilled LNG or the heat from an LNG fire. Research could determine the likelihood of cascading failure after an LNG spill.	
3	Large-scale spill testing on water	Self-explanatory	√
4	Large-scale fire testing	Self-explanatory	√
5	Comprehensive modeling: interaction of physical processes	Comprehensive modeling would model all phases of an LNG spill together, rather than creating separate models for each process (vapor dispersion, ignition of the vapors, etc.)	√
6	Risk tolerability assessments	An assessment of the level of risk the public would tolerate (potentially community specific)	
7	Vulnerability of containment systems (hole size)	An assessment of how vulnerable LNG tankers are to attack	
8	Mitigation techniques	Research into techniques that could be used to mitigate the consequences of an LNG spill	
9	Effect of sea water coming in as LNG flows out	Self-explanatory	
10	Impact of wind, weather, and waves	Research to determine how wind, weather, and waves would impact existing models of LNG spills and fires	

Source: GAO.

Although DOE has recently funded a study that will address LNG fires, study will address 3 of the top 10 issues—and not second-highest ranked issue-that our panel of experts identified as potentially affecting public safety. To provide the most comprehensive and accurate for assessing the public safety risks posed by tankers transiting to proposed LNG facilities, we recommended that DOE incorporate the key issues identified by the expert panel into its current LNG study. In particular, we recommended that DOE examine the potential for cascading failure of LNG tanks in order to understand the damage to the hull that could be caused by exposure to extreme cold or heat. DOE agreed with our and recommendation.

Question 3: You have recommended that the Department of Energy incorporate the key issues identified by the panel into their upcoming report. **What else should be done?**

GAO Response: We believe that a study which addresses the key issues identified by our panel of experts will significantly improve the understanding of the consequences of an LNG spill. DOE should ensure that the results of this research are available to and used by decision makers.

Question 4: Do you think that the Coast Guard, the Maritime Administration, and the Federal Energy Regulatory Commission have the personnel and assets needed to oversee the additional 32 LNG facilities?

GAO Response: As part of our work on the consequences of LNG spills, we did not analyze the personnel or assets of these three agencies.

Question 5: As part of the audit, you convened a Web-based panel of 19 experts. How did you select these experts?

GAO Response: We identified the 19 experts from a list of 51 who had expertise in one or more key aspects of LNG spill consequence analysis. In compiling this initial list, we sought to achieve balance in terms of area of expertise. In addition, we included at least one author of each of the six major LNG studies we reviewed, that is, studies by National Laboratories; Consulting; Quest Consultants Inc.; Pitblado, et al.; James Fay (Massachusetts Institute of Technology); and William (National Oceanic and Atmospheric Administration). In researching each candidate, we gathered and reviewed resumes, publication and major related publications from the experts identified on the initial list.

Specifically we sought: (1) broad experience in all facets of LNG spill consequence modeling (LNG spill from hole, LNG dispersion, vaporization and pool formation, vapor cloud modeling, fire modeling, and explosion modeling); (2) experience in conducting physical LNG experiments; and (3) specific experience with areas of particular importance, such as LNG explosion research.

Question 6 Do you think that the Coast Guard, the Maritime Administration, and the Federal Energy Regulatory Commission have the personnel and assets needed to oversee the requested 32 LNG facilities?

GAO Response: As part our work on the consequences of LNG spills we did not analyze the personnel or assets of these three agencies.

Question 7: According to your testimony, these experts did not agree on several key issues. It has been over 5 years since 9/11, why is there still disagreement amongst the experts concerning the security on LNG tankers?

GAO Response: Our expert panel members primarily included scientists and engineers who were experts in the areas of LNG experiments, modeling LNG dispersion, LNG vaporization, fire modeling, and explosion modeling. These experts do not have specific expertise in the area of security.

The key areas of disagreement on the consequences of LNG spills primarily involved heat hazard and cascading failure conclusions of the Sandia study. Specifically, 7 of 15 experts thought Sandia's heat hazard distance was "about right," and the remaining 8 experts were evenly split as to whether the distance was "too conservative" (i.e., too small to protect the pulic). Experts who disagreed with the distance in the Sandia study generally disagreed with some of the assumptions Sandia used in its models.

Only 9 of 15 experts agreed with Sandia's conclusion that only three of the five LNG tanks on a tanker would be involved in cascading failure. Many of the experts who disagreed with Sandia's conclusion on cascading failure noted that the Sandia study did not explain how it reached this conclusion.

QUESTIONS FROM THE HONORABLE PETER T. KING, RANKING MEMBER, COMMITTEE ON HOMELAND SECURITY

Question 1: Why is it important to study large pool fires? Why is the current data insufficient? How has the Department of Energy received your recommendations? Will you be following up with them following their 2008 tests?

GAO Response: No LNG spills resulting from a cargo tank rupture have occurred. In the 1970s and 1980s, experiments to determine the consequences of a spill examined small LNG spill of up to 35 meters in diameter. Following the terrorist attacks of September 11, 2001, however, many experts recognized that an attack on an LNG tanker could result in a large spill-a volume of LNG up to 100 times greater than studied in past experiments, with uncertain effects.

Since then, a number of studies have reevaluated safety hazards of LNG tankers in light of a potential terrorist threat. Because a major LNG spill has never occurred, studies examining LNG hazards rely on computer models to predict the effects of spills, often focusing on the properties of LNG vapor fires. Small-and large-

scale LNG fire experiments are needed to refine and validate existing models to accurately calculate the heat hazards of large LNG fires. Our panel of experts recommended new LNG tests for fires between 15 meters and 1,000 meters with a median recommended size of 100 meters. Some experts also raised the issue of whether large LNG fires will stop behaving like one single flame but instead break up into several smaller, shorter flames and whether large fires will produce sufficient smoke to partially shield the heat from the LNG fire.

DOE agreed with our and recommendation. GAO will follow up on the implementation of this recommendation.

Question 2: The GAO report refers to the possibility of a LNG explosion as "unlikely." **Would the GAO consider such an explosion more or less "likely" than gasoline?**

GAO Response: Our panel of experts agreed that (1) the most likely public safety impact of an LNG spill is the heat impact of a fire and (2) explosions are not likely to occur in the wake of an LNG spill, unless the LNG vapors are in confined spaces. For confined spaces, the experts agreed that it is possible, under controlled experimental conditions, to induce an explosion of LNG vapors; however, they agreed that a detonation—the more severe type of explosion—of confined LNG vapors is unlikely following an LNG spill caused by a terrorist attack. For unconfined spaces, such as a spill from a ship onto water, our experts were split on whether it is theoretically possible to induce such explosions; however, even experts who thought such explosions were possible agreed that explosions in unconfined spaces are unlikely to occur following an LNG spill caused by a terrorist attack.

We did not specifically ask our panel of experts about whether an LNG explosion is more or less "likely" than gasoline, or any other commodity, explosion. However, we did ask our panel of experts to rate the risk to public safety posed by an attack on tankers carrying various energy commodities. The results of their ratings are included in Table 2 below.

Table 2: Expert Panel Comparison of Risk Posed by Energy Commodities

Experts were asked ''In your opinion, what is the risk to public safety posed by an attack on tankers carrying each of the following energy commodities?'' The numbers in the table are a count of how many experts selected each possible response (i.e. ''little to none,'' ''little,'' etc.)

Answer	Liquefied natural gas	Crude oil	Diesel	Gasoline	Heating oil	Jet fuel	Liquefied petroleum gas
Little to None	1	2	1	0	1	1	0
Little	3	10	11	5	11	6	1
Medium	6	3	3	8	3	6	4
Large	3	0	0	2	0	2	5
Very Large	2	0	0	0	0	0	5
Did not answer this question	4	4	4	4	4	4	4

Ten of 15 experts identified a large to very large risk associated with an attack on a liquefied petroleum gas tanker; whereas, only 5 of 15 rated LNG as a large to very large risk. In comparison, only 2 of 15 experts rated gasoline as a large to very large risk.

QUESTIONS FROM THE HONORABLE BENNIE G. THOMPSON, CHAIRMAN, COMMITTEE ON HOMELAND SECURITY AND THE HONORABLE PETER T. KING, RANKING MEMBER, COMMITTEE ON HOMELAND SECURITY

RESPONSES FROM PHANI K. RAJ,PHD

Question 1: In your written testimony, you state additional research is required. **Why hasn't this research already been completed?**

Response: In any industry research is an ongoing activity simply because the nature, type of questions and underlying reasons for additional investigations change continually.

In the case of the LNG industry, there was considerable research and assessments conducted in the US in 1970s and in early 1980s because the industry was just beginning to grow. The research, while initially focused on understanding LNG hazards, quickly was refocused on prevention of accidents and mitigation. With this change in the emphasis, small-scale test results were deemed acceptable, especially since large releases were discounted as being engineered out or of such a low probability of occurrence as not to pose a risk to society. The US Coast Guard promulgated regulations to control vessel traffic in harbors and required safe separation distances between a LNG ship and other vessels. This virtually eliminated the possibility of accidents in LNG shipping in and around harbors. The promulgation of the consensus industry standard, NFPA in 1969 and the federal regulations in 49 CFR, part 193 in late 1970s and for designing and operating LNG facilities together with the safe *de facto* operation of LNG facilities and shipping (world-wide) provided an assurance of public safety. The same was true for LNG industry in Europe with the promulgation of the EN1473 regulations. Some additional experimental research was continued in England (on heavy gas dispersion) and in France (on pool fire). However, by the time of late 1980s and for the rest of the 1990 decade no funds were invested by either government agencies or the industry in conducting substantive research because of the reduced importance of LNG in the energy economy of the world. In fact, many of the data from late 1980s tests went un-reviewed and unpublished because of lack of research funding.

Since 9/11/2001 a new dimension of concern from LNG storage and transportation has been added to the public safety debate. Terrorism caused releases and their effects have opened up new concerns both in how much and how large a LNG spill may occur and on the consequences such releases pose to the public. Such concerns are expressed for releases from LNG ships in or near harbor entrances, more than for land-based terminals (thanks to successful terrorist attacks on ships like USS Cole and the crude oil tanker SS Limburg). Because of the possible scenarios of release caused by intentional acts, new potential hazards have been identified for LNG releases, which may or may not be larger than the hazards previously examined. These hazards, therefore, need to be investigated both mathematically and experimentally. That is, new research is therefore essential. In addition, the underlying premise of large holes being created by intentional attacks on LNG ships needs to be reviewed by a knowledgeable and cleared independent peer review panel to ensure that all aspects of the issue have been investigated and that the assumptions on which the hazard distance estimates have been developed are credible.

As indicated earlier, some of the data from tests conducted in late 1980s were not analyzed fully to understand the extent of hazards posed by large LNG (pool) fires. Only recently has it been realized that large LNG fires do not pose as large a threat as envisioned from the data of small fire tests of the 1970s. It is now known that large LNG fires burn with evolution of significant quantity of black smoke forming a shroud outside and around the burning inner core of the fire. The smoke layer prevents the heat from radiating out of the fire. However, the quantification of the extent of smoke production, the height of the burning zone, the variation of the heat emission from the various parts of the fire with height) are not all known with the degree of precision needed for proper estimation of the hazard area surrounding large LNG pool fires. Therefore, additional research in the form of conducting large LNG pool fires is needed.

In addition, the release scenario associated with a terrorist attack (involving the formation of large gaping holes on the two hulls and the tank of a LNG ship) leads to certain phenomena that have not been understood or researched before. These include (i) the potential leak of LNG into the hold space and the possible detrimental effect of the interaction of the cryogenic liquid with the ship's structural members leading to metal cracking and multiple tank failures, (ii) the rapid and very large rate of release of LNG onto the water surface, its plunging into the water column, its high evaporation locally and rising to the water surface of both a large volume of vapor and liquid. The un-evaporated liquid would then spread as a pool on the water surface, (iii) the effect of wind and waves affecting the motion and evaporation of the pool with and without sustaining a fire on top, (iv) the transient nature of the pool spread and the characteristics of the fire on top of it, etc. These phenomena also need be assessed by conducting experiments of the appropriate size.

In summary, while a considerable amount of LNG related research activities occurred in 1970s and the postulated circumstances and causes of potential releases in the 2000s are different and consequently their effects could be different. Hence, additional research is necessary.

Question 2: The GAO report highlights the fact experts still disagree on the consequences of a LNG spill. **What is the root of this disagreement? Will consensus reached on this important issue?**

Response: As discussed in response to question 1, there are a number of phenomena related to a LNG release that are incompletely understood and need additional research to provide information with which to make scientifically valid extrapolations to real situations.

The sizes of postulated LNG releases, either on land from storage tanks or on water from LNG ships, from accidents or deliberate terrorist actions are substantially larger (by factors of 20 to 30) than any controlled tests performed to date. For example the largest test performed to understand the behavior of LNG pool fires on water are of about [1]5 m in diameter, whereas the postulated sizes of LNG pool fires occumng from spills from ships (due to intentional acts) can range from 300 m to 450 m in diameter. Therefore, in order to the consequences of large spills, considerable extrapolation of the results from small scale tests need to be made. This is where the disagreements amongst the scientists occur, because, the mathematical models used by different groups describe the largsscale phenomena differently. Some include additional physical phenomena that have been observed in other fuels, some do not; one group makes very conservative assumptions (essentially to overcome scientific ignorance), while another group assumes it knows how to extrapolate from smaller scale test data to larger scale. That is, scientific extrapolation involves significant issues of interpretation of existing data, assumptions regarding changes in the behavior characteristics (for example, the characteristics of large LNG fires) and consideration or lack thereof of certain other phenomena of interest (atmospheric absorption of radiant heat, effect of obstructions, clothing in reducing heat effects).

In addition to the extrapolation of the effects of known phenomena with LNG behavior there are other causes for disagreements. The calculation of potential hazard (areas) from the release of LNG requires the consideration of three important elements, namely, (i) the *description of the source;* that is, the location, size and other characteristics of the hole, the rate of release of LNG given the hole characteristics, the interaction of LNG release with its immediate environment (water, land, etc), the sizes of pool or vapor cloud formed, (ii) *description of the behavioral mode pf the LNG;* that is, immediate ignition or not, burning as a pool fire, fire ball or unignited vapor cloud dispersion, probabilities of ignition of the dispersing vapor cloud with distance from the source, the type of burning of the vapor cloud, passive burning vs. energetic burning with the formation of a blast wave, etc, characteristics of the fires produced in terms of size, duration of existence, radiant energy output, etc, and (iii) description of the effects of fires or other hazards; including the radiant energy absorption in the atmosphere, its attenuation by intervening structures, clothing on persons; effects of radiant heat flux on a person, ability of a person to take corrective action and finally, the effects of any active mitigation activities instituted by the emergency responders. As can be seen, there are so many dimensions to evaluating the potential hazards. Therefore, depending upon what behavioral aspects are included in an analysis, how correct the description of the individual phenomenon is, and the correctness of extrapolation of small-scale test data (for those phenomena for which data exist), researchers can come up with different set of predicted areas of hazard.

Therefore, it can be surmised that the root causes of disagreement among experts are (a) the nature of the problem itself and the extent to which the details of various phenomena are considered in any analysis, (b) validity of scenarios and the underlying assumptions, which lead to prediction of large scale releases, and (c) the variability in the science of extrapolation of small test data to larger scale phenomena, especially when some of the behavioral aspects of nature that occur in the large scale do not show-up in the small scale tests. For example, a technical peer panel of experts with proper technical and classified credentials will need to validate the result that very large holes are created by intentional attacks and not by ship-to-ship collisions event though the latter involves substantial energies. The magnitude of the source represented by the hole size forms the very basis of all other hazard assessment results. As to the question of whether consensus will ever be reached among the experts on this important issue, I will have to say that while convergence of approaches to evaluating the hazards for a given set of specified scenarios may be achieved in the future (especially with additional experiments on several scenarios for which we have, at present, limited or not data at all), I would not say that consensus on all issues will ever be possible. This is just the nature of scientific debate. In addition, the external circumstances may change, dictated by unforeseen circumstances (as indeed happened between the 1980s and 2000s by the interjection of terrorism as a force to contend with), technological improvements that may ne-

gate some of the "scenarios" currently being considered by some experts and not by others, and changes in regulatory requirements. Therefore, it would be difficult to expect a 100 consensus among all experts on all issues in this field, or any other field for that matter.

Question 3: In your written testimony you state that the LNG industry has operated safely both in U.S and worldwide for over six decades and that there is no technical operational reason this record will not continue. There is one reason why this record could be broken and that is terrorism. **Do you believe that terrorists will be unsuccessful in targeting LNG ships? If so, why?**

Response 3: I want to address two aspects in my answer to the above question. The first is the presumption that LNG ships are attractive targets to terrorists. The second is whether LNG ships can be successfully targeted. I do not believe that on either of the above two criteria, LNG ships form attractive and successful targets.

It is my considered opinion, based entirely on commonsense judgment and scientific training, that an LNG ship does not form an attractive target to terrorists. If one studies the *modus operandi* of terrorism, it is clear that it is always based on the need to make a big "splash" either by affecting (injuring or killing) the largest number of people or attacking a target that represents a national "symbol" of some sort. The train and subway bombings in London, Madrid and Mumbai and the hotel bombings in Bali all represent the former type whereas US World Trade Center bombings in 1993 and the attack on represent both types of targets. A LNG ship or an installation is neither national symbol nor will a large LNG release from a ship cause mass casualties in nearby populations. The principal effect of concern in the case of LNG release is the radiant heat effects of the fire, whose effects can be, relatively easily, defeated or minimized by sheltering, hiding behind buildings or initiating other mitigation measures. That unfortunately, is not the case for a number of other soft targets where people gather in large numbers (sports arenas, big office buildings, mass transit, etc) or from chemical facilities that store or produce chemicals that once released can affect a large number of people.

LNG is a fuel very much like other hydrocarbon fuels that are used in the US in much larger quantities and transported in more numerous ships. The fire effects of all fuels are about the same, especially when one considers the characteristics of very large pool fires. We have to assume, with reasonable amount of certainty, that terrorists do considerable research (as was evident from the 9/11 tragedy) on the science required, technical outcome, and the or symbolism of the target before selecting a target. It is reasonable to assume that only a target, which promises to be vulnerable and successful in the attack will be selected; that is, a terrorist wants the best for the (the unfortunate pun is intended here). Having said that, it is evident that there are other less well protected energy and chemical targets that may be more susceptible and closer to population centers than a LNG ship. On a sheer opportunity, availability and comparative effects basis, it is my opinion that LNG ships do not form a target that would be high on the list of "attractive" targets for terrorists. In fact, my above conclusion is similar to the conclusion in a relatively recent report by the GAO.[1] To quote the GAO,

Flammable chemicals fewer people because the distance the substance travels tends to be shorter, and

. . . chemical facilities present an attractive target for terrorists intent on causing massive damage because facilities house toxic chemicals that could become airborne and drift to surrounding areas Alternatively, terrorists could steal chemicals, which could be used to create a weapon capable of causing harm.

The recent book[2] by Stephen Flynn has also pointed out how many vulnerable, high damage ratio targets of interest there are in the US, which if attacked can result in significant harm to the public, both physically and economically. It is therefore, my considered opinion that an LNG ship neither provides the opportunity nor forms an attractive target, either from the perspective of causing mass casualties or disrupting the nation's economic activity.[3]

The second part of the question is whether terrorists will be unsuccessful in targeting LNG ships. Sandia report[4] indicates that, *"Risks from intentional events,*

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[1] GAO Homeland Security, Voluntary Initiatives are Underway at Chemical Facilities, but the Extent of Security Preparedness is Unknown. U.S. General Accounting Office, GAO–03–439, March, 2003.

[2] Stephen Flynn, "The Edge of Disaster," Random House Publishers, New York, 2007.

[3] If a LNG ship is attacked and all its cargo is burned, a substantial loss will result to the owner of the ship and the cargo owner. But that will hardly disrupt the nation's long-term economic welfare. Short disruptions in port and natural gas supplies could occur, however.

[4] Hightower M., L. Gritzo, A. Luketa-Hanlin, J. Covan, S. tieszen, G. Wellman, M. Irwin, M. Kaneshige, B. Melof, C. Morrow, and D. Ragland, "Guidance on Risk Analysis and Safety Impli-

such as terrorist acts, can be significantly reduced with appropriate security, planning, prevention, and mitigation." Of course, what it does not say is that there are currently appropriate security, prevention, and mitigation regulations in place." The security planning, prevention and mitigation, are required to be implemented under the US Coast Guard regulations.[5]

With the current security regime that "surrounds" a LNG ship when it is underway or anchored in a port, I do not see how a terrorist can successfully attack the ship as to cause substantial damage. The US Coast Guard is on record[6] stating that shoulder fired missiles will not damage LNG ships. The only other way a LNG ship could be attacked is by a fast boat or a dinghy loaded with explosives that can actually approach the ship, and set off the explosives in very close proximity of the ship. [As pointed out in my written direct testimony presented to this Committee, a LNG ship has two hulls separated by at least a 2 m (6 ft) separation distance. Such a double hull construction provides considerable protection against LNG releases from scale attacks]. If the boat bomb scenario is credible, one expects this to occur in or near a port because a port represents a high population density (and that is what a terrorist may be interested in causing damage to). This scenario of attack, at least, in US may be an extraordinary feat to achieve. For example, every LNG ship that makes a port call into Boston Harbor is escorted by a flotilla of US Coast Guard and other law enforcement vessels manned by armed personnel. A terrorist boat must get through this gauntlet; the chance of success is therefore very small to essentially zero. As I argued earlier, a terrorist will seek to maximize his success for his efforts and, therefore, may redirect his attention towards other softer and less well guarded targets that will produce comparable, if not, greater casualties than those resulting from an attack on a LNG ship. While, I cannot state categorically that an attempt at a LNG ship will not be made or if made will not cause some damage to the ship, I can state with a good deal of certainty that the probability of a successful attack on a LNG ship in the harbor waters of any US port is extremely small. This statement is based entirely on my judgment as an engineer and my practical experience in conducting field experiments and suffering failures in best-laid test plans executed with cooperation and help from the best professionals. Success in any mission, however well planned, is not guaranteed under the best of circumstances, let alone when it is actively and vigilantly opposed.

Question 4: According to your written testimony, focusing only on consequences of perceived worst cases rather than on the overall risk from activity will result in poorly utilized improperly allocated resources. I disagree with this assessment. We should be concerned about the worst-case scenario. Why you recommending otherwise?

Response 4: Mr. Chairman, it was not my intent in the testimony to suggest that worst-case scenarios should not be considered in hazard assessment. My point was that a worst-case scenario alone, without consideration of its chances of occurrence (in comparison with other activities that our society is subject to involuntarily or accepts voluntarily), cannot and should not form the only basis of a regulatory decision-making. I will elaborate this contention below.

The true potential for harm by any activity, industrial or personal, can be gauged only by a process of comparing the range of detrimental effects of that activity with other similar activities undertaken either by the society at large or by an individual by own volition. This approach is termed the "Risk Analysis." Risk analysis, which presents a true measure of the both economic and physical problem, considers a spectrum of events, their probabilities of occurrence and their detrimental effects. This is in contrast to a worst-case analysis, which only highlights a situation where the ability of people to actively or passively manage the situation once it is very limited. In the case of an industrial plant when one focuses on the very worst case, one is not looking at the possibility of it occurring with any degree of certainty within the lifetime of a plant. Focusing only on the worst case and trying to obtain solutions to it tantamount to making the risk zero, which is impossible. In the words of late Sen. Moynihan, *The function of risk assessment, is not drive risks to zero, which would rarely be possible, but to illuminate choices, costs and priorities. The*

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cations of a Large Liquefied Natural Gas (LNG) Spill Over Water," Sandia National Laboratory Rep.# SAND2004–6258 U.S. Department of Energy, Washington, p 77, Dec 2004

[5] Waterway Suitability Assessment, Navigation and Vessel Inspection Circular 05–05, U.S. Coast Guard, Washington, June 2005.

[6] Testimony by Vice Admiral Solerno before the Homeland Security Committee of the US House of Representatives, March 21, 2007.

first discovery in applying risk assessment to the real world is that zero risk is not a prudent objective."[7]

If worst case scenarios were the only basis of public policy and regulatory regimes then many of the activities that we, as a human society and the US as an industrial society, would not be able to undertake. For example, there have been at least two major disasters involving explosives and detonable cargo transported in ships leading to many fatalities.[8] Yet explosives and other chemicals that explode do get transported every day in ships and vehicles that drive through populated areas. Similarly, airline disasters have killed many people over the past 100 years, yet billions of people have traveled and continue to travel in airplanes without fears. There have been dam bursts, chemical releases, and other industrial accidents, all of which can be termed "worst-case" occurrences resulting in associated public injuries and fatalities. After every disaster the safety systems are improved and systems to prevent future happenings are incorporated in the design. No single industry has been prevented from participating in the economic activity or has been stopped by regulations anywhere in the world because of these historical occurrences. This is because the regulatory process has understood that while the "risk" has to be minimized, and efforts must be made to reduce the chances of "worst-case" scenarios from occurring, there is no way to completely eliminate them.

If worst-case scenarios are the only guiding principles for a human society to function, all activities will have to stop and progress, as we know it, will not exist. In the context of the LNG industry and the associated activities, I provide the following examples of the impact of "worst-case" analysis.

- In a recent DFEISEIR[9] related to the siting of a LNG import facility in the Port of Long Beach (PoLB) it is stated (by considering only the worst case scenarios) that the best guess frequency of a terrorist attack on a LNG plant is of the order of once in 150,000 years. This conclusion is based on the statistics of all chemical facilities in the US and historically realized or thwarted attacks. Considering that LNG plant is well guarded and that the infrastructure (tanks) is much more robust compared to those in chemical plants, it can be argued that a successful attack on a LNG storage tank leading to the release of its entire inventory is smaller than once in 1– 1/2 million years. This scenario of the release of entire contents of the storage tank and its effect will constitute the worst-case condition.

The odds of a LNG release as described are about the same as the odds of a large asteroid (of size greater than 1 km in diameter) hitting the earth (approximately, once in one thousand to once in a million years).[10] The consequences of such an asteroid hitting the earth will spell a disaster of proportions that have never been experienced by human beings. However, the public does not seem to be concerned at all but is pursuing all activities, industrial, personal or political without much regard to this worst-case scenario.

- Consider another example a more probable and highly disastrous asteroid hitting the earth. In December 2004 scientists announced[11] that a space rock named 2004 (of diameter 1/4 mile or 400 m) had about a 1-in-40 or 2.6 % chance of striking Earth on April 13, 2029.[12] The asteroid is large enough to cause considerable local or regional damage were it to hit the planet. What are we doing about this potentially a very large catastrophe?—nothing. That is because the problem is so huge that unless a very large magnitude of resources are imposed nothing much can be done to prevent the accident. Fortunately, the situation with regard to LNG shipping is far better. Steps have been taken to minimize, with human innovativeness, with intelligence information and technology, the occurrence of such very large disasters.

The case of preparing and planning response procedures only on the basis of very large, catastrophic scenarios of LNG release without considering the evaluation of

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[7] Quotation attributed to US Senator Daniel Patrick Moynihan by William (past Administrator of EPA) in the foreword to the book "Human and Ecological Risk Assessment; Theory Practice, "Edited by Dennis Paustenbach, A John & Sons Publication, New York, 2002.

[8] The first one occurred in the port of Halifax in 1917 in an ammunition carrier, "Mount Blanc." The second incident occurred in 1947 in Texas City, involving two ships (*"Grandcamp" and "High Flyer" loaded with ammonium nitrate fertilizer, which exploded.*

[9] *http://elibrary.fere.gov/idmws/search/results.asp:* Draft Environmental Impact Report for the Long Beach LNG Import Project under CP04–58 et al., FERC, 10/07/2005,

[10] http://geo.arc.nasa.gov/sge/jskiles/fliers/all__flier__prose/asteroid__toon/asteroid__toon.html

[11] *http://www.space.com/scienceastronomy/astroid__*update__041227.html

[12] Recent news reports on the internet allude to other scientific assessments, which indicate that this asteroid will come close to the earth, but will not collide with the earth in 2029; the same asteroid will make another pass in 2035, but the risk of collision with the earth cannot be calculated at this time.

smaller "accidental" or other "smaller attack" scenario releases leads to misallocation of resources and leads to ineffectiveness. Should a relatively small incident occur, it is human nature to respond with the and only plan developed on the basis of the scenario, which will affect a very large number of people. Such a plan may call for massive evacuation or at the very least require informing a very large number of people on what to do, in a very short time. Such approaches will only exacerbate the problem resulting in physical as well as communication gridlocks, not to speak of the wrong information it conveys to people.

In my recent assessment of the consequences of potential release scenarios at the Everett, MA LNG facility, the emergency responders of the city of Everett (The Fire Chief and the Police Chief) requested me to consider only those scenarios that are realistic, credible and exclude the scenario of release of the entire contents of the LNG tanks (40 million gallons) because it represents an extremely incredible event (an event that had the probability of occurring, if at all, once in a million years or more). This is because of the realization that the release of the entire contents of even the smaller of the two tanks (15 million gallons) would be an incredible event, the response to which would take an extremely large amount of financial, equipment and manpower resources that neither the city of Everett nor the surrounding communicates could afford to tie up. Therefore, while the worst-case scenario may be considered for analysis, it cannot form the only basis of any decision-making including for emergency response.

Over the past 30 years of safely transporting LNG in highway trucks there have been three instances in which the LNG trucks overturned (due to traffic accidents) without leaking LNG. In all of these instances the local authorities chose to shut arterial highways for over 8 hours creating traffic havoc, inconvenience, lost economic opportunities and direct expenses, all on a scale completely The reason for this is simple; the emergency responders today are taught (incorrectly, in my opinion) that LNG is very dangerous and they are always taught to expect the "worst." As a scientist I can state that a gasoline road tanker in a similar situation will be far worse both from the perspective of the potential for a spill (gasoline tankers are less strongly built than LNG tankers), fire and explosion and other vehicles and people in the vicinity. Yet, I have never heard of highways being shut down for whole day due to a traffic accident involving a gasoline tanker without fire or spill.. This is because, gasoline is widely used and its hazards, normal or worst case, are accepted by the society.

A recent report by Sandia National Lab [4] recognizes the limitations of conducting just a worst-case analysis related to LNG shipping and concludes:

Because costs to prevent and mitigate the potential consequences of an extreme event such as an LNG spill can be extensive, performance-based risk management approaches can be used to ensure that public safety and property are effectively protected.

Therefore, Mr. Chairman, it is my considered opinion that analysis alone should not be the basis for any regulation or decision-making. It has to be considered in the context of other events associated with the activity of concern and has to be viewed from the perspective of the risk posed by a spectrum of events, their likelihood of occurrence and the hazards they cause.

QUESTIONS FROM THE HONORABLE PETER T. KING, RANKING MEMBER, COMMITTEE ON HOMELAND SECURITY

Ouestion 1: You mention in your written testimony that the mathematical modeling used today is based on data that is 30 years old, and that you're concerned about the "scale." **Can you explain why a smaller LNG spill or fire might behave differently than a larger LNG spill or fire?**

Response 1: There are a number of phenomena related to LNG release (especially from a ship) that have to be modeled before a calculation of the overall hazard from the release can accurately be made. The models applicable to these phenomena may be broadly as, (i) Source models, (ii) LNG behavior models, and (iii) Hazard-effect models. A majority of the experimental research conducted to date has focused on understanding and quantifying LNG behavior phenomena (such as the characteristics of pool fires, vapor fires, vapor cloud explosions, etc). Not much experimental work has been undertaken to model or describe either the "source" or the effects that constitute hazard to people and objects. To a very limited extent laboratory test data exist on radiant heat effects on the human skin. Only theoretical models exist for the source and characterizing hazard effects.

The principal concern in regard to hazards from a LNG spill is the effect of a fire. As the GAO has indicated in its report,[13] the formation of a large pool fire on water and the radiant heat emission (and its effect on people) is the single most important issue in LNG hazards analysis. A number of pool fire studies were conducted in 1970s in the US and up to 1987 in Europe. The largest sizes of pool fires tested in the US are, 6 m (20 ft) diameter on land and 15 m (50 ft) diameter on water. In Europe the largest pool fire on land tested was 35 m (115 ft) diameter on an insulated concrete dike.

The less than 50 ft diameter LNG fire tests showed a very clean burning, highly radiative yellow colored fire. These types of fires were found to radiate heat energy at a high level over[14] all of the visible size of the fire. However, as the size increased by just a factor of about 2 (from 15 m diameter to 35 m diameter) the fire characteristics were found to be completely different in that the larger fire produced copious amounts of black soot which shrouded much of the surface of the fire resulting in substantially reduced emission of heat from the fire. In addition, it was noticed that the heat output from the fire was not uniform from bottom to again due to the effects of smoke.

The conventional wisdom as to why large fires behave differently (and put out less net radiant heat than small fires) are based on the following observations:

(i) As the size of the fire increases, it becomes more and more difficult for air to diffuse to the center of the fire *in time* so that the fuel vapor burns efficiently and completely. The reduction in burning efficiency (or the burning chemistry) results in the formation of black soot in such an amount as to start shrouding the fire from the outside.

(ii) The fuel vapor emanating from the boiling liquid pool surface forms a bubble of gas in the bottom core of the fire. This gas bubble has the capacity to absorb the heat from the fire above and thus reduce the amount of heat that gets passed on to the liquid for evaporation. Both of these phenomena are size dependent phenomena that do not occur in smaller (less than 20 m) fires but are pronounced in fires larger than about 30 m.

(iii) Once the diameter of the fire increases above a certain critical value (and what this critical value is for LNG pool fires is at present unknown), the fire no longer bums as a single unit but instead breaks up into several individual and distinct collection of columns of fire. This phenomenon, which is observed in forest fires when a very large area is burning, is termed the "mass fire." The air for burning no longer comes from the sides but from the top in the form of downdrafts feeding individual columns. This is an extremely complicated phenomenon, which has not been observed in any of the largest LNG fire experiments to date (35 m diameter tests in France). If this should occur in LNG pool fires, the result would be a much shorter vertical extent of the fire and, hence, a much reduced hazard distance.

The significance of the large fire phenomena on the overall hazard distance can be described as follows.

- In general the larger the LNG fire diameter the larger is the distance from the fire to a specified level of hazard (in kW/m^2 in heat flux level). However, for a specified level of hazard the ratio of the hazard distance to the diameter decreases substantially for larger fires compared to the value for smaller fires. This is primary due to the less radiative characteristics of a larger sooty fire.
- Since hazard distances from large LNG pool fires result in large distances, the absorption of radiant heat by the intervening atmosphere becomes very important in reducing the radiant heat to the objects. The reduction in hazard distance to diameter ratio of larger fires is therefore due to both the sootiness of the fire as well as due to the significance of the atmospheric absorption.
- In large fires the emissive power varies significantly from the base to the top of the fire. The bottom parts of the fire are more radiative than upper parts of the fire. Hence, if the lower parts are masked (either by a wall or by some other obstruction), then the reduction in the hazard distance will be very significant.

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[13] "Public Safety Consequences of a Terrorist Attack on a Tanker Carrying Liquefied Natural Gas Need Clarification," Report GAO–07–316 to Congressional Requesters, US Government Accountability Office, Washington, February 2007.

[14] The radiant heat output from a fire is generally expressed as its "Emissive Power" or "Radiance" and is measured in units of energy radiated per unit "ideal" surface area of the fire and expressed in either kW/m^2 or $Btu/hr\ ft^2$. The fire is considered as a cylindrical body (even though the flame has many folded surfaces) and it is the surface of this cylindrical envelope that is considered in defining the emissive power.

• In the case of a larger LNG pool fire on water, the high radiative emission from the bottom parts of the fire will result in the water surface near the fire to be heated to such an extent that it produces significant amount of water vapor. The thus generated water vapor will act as an additional and significant absorber of radiant heat emission from the bottom parts of the fire resulting in substantial reduction in the hazard distance.

Question 2: As an expert in the study of LNG, can you take a moment to compare the different dangers between LNG and gasoline? Is LNG so much more dangerous than gasoline? Does it fire faster?

Response 2: Gasoline and LNG (methane) are fuels that belong to the saturated hydrocarbon chemical group. The combustion properties of all saturated hydrocarbon fuels are very similar. For example, the heat produced when a pound of any one of these saturated hydrocarbons is burned in air [15] is the about the same, namely 20,000 Btu (within ±5%). Also, the pounds of air required to bum completely one pound of any of these fuels are also about the same, namely, 15.5 (±3%) except for methane, which requires a larger quantity of air. The consequence of the similarity in combustion properties is that the fires all of these fuels have, within ± 100 °F the same temperature. (The laboratory measured fire temperature in a gasoline fire is 3580 °F and that in a methane fire is 3410 °F)

Itemized below are comparisons of important gasoline and methane properties that have a bearing on the extent of hazard that each fuel poses. Also included are discussions on the effect of each property on the overall hazard.

• ***Vapor flammabilitv limits in air:*** The gasoline limits are 1 % to 7.6 %, whereas the methane limits are 5% to 15%. This means that gasoline vapors are flammable even at very low concentrations posing a larger vapor area of hazard for a given mass of spill.

• ***Energy content per unit volume:*** Gasoline (liquid) has an energy content of 116 kBtu/gal whereas the LNG value 72 kBtu/gal. That is, a gasoline tanker of the same volume capacity as a LNG tanker has almost 60 % more energy content than the LNG tanker.

• ***Density of vapor:*** The density of vapor of gasoline emanating from the evaporation of a pool of spilled gasoline is 4.4 kg/m^3 (or 3.67 times heavier than air). The LNG vapor given off from a boiling pool of LNG is 1.84 kg/m^3 (or 1.53 times heavier than air). Therefore, for a given volume of vapor generated by the evaporation of the pools of gasoline and LNG, the gasoline vapor gets diluted at a much slower rate, lingers much longer and spreads to a much greater distance before becoming non flammable. That is, the dispersion of vapor generated by a gasoline spill poses a greater dispersion distance and flammable vapor area danger than from the release of an equivalent quantity of LNG vapor. Also, LNG vapor can get heated by the substrate (ground or water) or the sun and become neutrally buoyant further reducing the area of dispersion to lower flammability limit. This does not happen with gasoline vapors, which are essentially at ambient temperature during dispersion and therefore stay heavy and close to the ground.

• ***Ignition temperature:*** The ignition temperature of gasoline vapor in air is between 500 and 745 (440 °F and 880 °F) depending upon the gasoline blend. This is compared to methane, which has a higher ignition temperature of 660 K (1088 °F). The higher the ignition temperature, the more difficult it is to ignite a mixture of vapor and air. Therefore, a gasoline air mixture is more easily ignitable than methane air mixtures by hot surfaces.

• ***Flame/Fire temperature:*** The gasoline and methane fires have about the same temperature (3580 °F for gasoline and 3410 °F for methane fire). Therefore, it is expected that the radiant heat output from each would be about the same. For a given (small) diameter pool fire gasoline fire is sootier than an LNG fire of the same size. However, as the fire diameter increases and the shrouding effect of black soot produced in the fire becomes dominant it can be argued that both gasoline and LNG fires will show similar radiant heat output characteristics. Unfortunately, there are no experimental data for either large gasoline fires or large LNG fires (of sizes in the hundreds of meters in diameter).

The above facts clearly indicate that an LNG fire is no more dangerous than an equivalent size gasoline fire. I do wish to point out to the Committee that large gasoline pool (of tens of meters in diameter) are dangerous and no one, to the best of my knowledge, has successfully put out such size fires with any of the conventional

[15] In a quantity of air (called the "stoichiometric" amount), which contains the chemically required amount of oxygen to react with the hydrocarbon for complete combustion.

techniques used in Therefore, large LNG pool fires and gasoline pool fires pose similar dangers; neither is better or worse than the other.

Question 3: In your testimony you mention three missiles striking a LPG carrier and the resulting fire. **Did the cargo explode? Did the ship survive?**

Response 3: To the best of my knowledge the cargo carried by the Fountain at the time of its attack (October 12, 1984) in the Persian Gulf carried 18,850 tons of liquefied petroleum gas (LPG). The information I have is from the article presented in a conference.[16] According to this paper, the ship was hit by three air-to-ground, guided and armour-piercing Iranian "Maverick" missiles. The ship suffered extensive damage to the deck plate and to one of the LPG tanks. There was an extensive fire on the deck and in some of the crew quarters from the exploding missiles. However, the flammable cargo, LPG, did not explode. There was however, leak of propane gas through a gash in the roof of one of the tanks. The fire burned as a torch fire (similar to a flare normally seen in petrochemical refineries).

All of the crew abandoned the ship and were saved. The ship itself was towed Dubai, to the remainder LPG cargo unloaded safely and repaired. The ship not only survived the missile attack but also (after repair) is said to be back in the same service.

Question 4: The GAO report recommend the DOE (1) incorporate into its current LNG study the key issues identified by the panel of experts assembled GAO and (2) that DOE examine the potential for cascading failure of LNG tanks. **Will the two principal research recommendations in the GAO report, if implemented, provide sufficient knowledge you as an expert scientist need to perform an accurate prediction of the extent of the hazard?**

Response 4: The GAO has identified only two of the principal area for further research. I am of the opinion that there are a number of equally important issues that have not been highlighted in this report, which have considerable influence on the assessment of hazards. Therefore, my response to your question, Mr. King, is that while better assessments of the hazard can be performed with better confidence, if the research recommended by GAO is successfully carried out, it will not provide all of the answers to performing an "accurate" prediction of the extent of the hazard. I will elaborate my answer below.

- Hazard assessment is dynamic process in which many of the phenomena considered may change as technology and procedures change. For example, larger LNG ships than the ones in service now are being and in the near future will join the world fleet. What issues these ships (which in some cases have twice the carrying capacity of present day ships) may bring to the forefront in terms of potential hazards be envisioned at present.
- Focusing one or two phenomena for research to the abandonment (or reduction in emphasis) of other issues may not be a very good policy decision.
- In addition, what constitutes a significant hazard cannot be based on polling expert opinion only. It has to be worked out by a careful assessment of the various phenomena and their interplay with one another. In effect one needs conduct a thorough study of the failure modes and effects analysis.
- GAO ranks the study of cascading failures as the second highest priority. The statistical basis on which such a conclusion was arrived at is not clearly indicated by the GAO. Ten experts suggested a "great need" for conducting research on "Comprehensive modeling allowing different physical processes to interact" whereas only 5 experts said the same on "Cascading failure." Therefore, it is difficult to reconcile as to why this particular research need is ranked #2. The top six scores for the "research types" are relatively close and can be considered to have the same statistical significance. Votes of "experts" can be a guide to policy decision-making only when the "experts" have the relevant expertise in the technical matter of interest. Not all "experts" have expertise in all aspects of release and behavior of LNG. It is my recommendation, therefore, that prior to making any policy decisions experts in the field of metallurgy and ship design should be consulted and their views on the importance (or not) of this problem should be taken into consideration.
- It also is evident from the GAO report (and this shows the bias of some of the experts towards the very worst case scenario consideration) that the frequency of occurrence of events of different types and magnitudes was not considered in making the recommendations. As I have argued in response to a question from the Chairman, without performing a detailed risk assessment, making policy decisions using only one type of hazard or consequence size con-

[16] Captain J. A. Carter, *Salvage of Cargo from the War-Damaged Gaz Fountain,* Paper presented at the 1985 Gastech Conference held at Nice, France.

sideration leads to non-economic application of resources (in this case scientific resources).

There are a number of very important phenomena that GAO has not even alluded to in its report nor was discussed with the experts. These include the fate of LNG released into water and its rapid evaporation and production of very large volume of vapor close to the spill source and its possible ignition and burning in the form of a large fireball. The remaining un-vaporized liquid will spread on the water surface as a pool, and will sustain a pool fire. Because of the possible initial and substantial evaporation the volume of liquid remaining to spread is smaller thus posing a smaller pool fire hazard. Similarly, the GAO report has not identified research into the effects of winds and waves on the movement and expansion of the liquid pool. There are such numerous other phenomena, each of which affects to a great extent the calculation of the hazard.

Therefore, I submit that if the GAO report recommendations are implemented, and the research results are obtained without leading to the identification of additional phenomena of concern or complications, they will provide some but not all of the information for me as an expert scientist to perform an accurate prediction of the extent of the hazard from LNG releases from a ship.

QUESTIONS FROM THE HONORABLE BENNIE G. THOMPSON, CHAIRMAN, COMMITTEE ON HOMELAND SECURITY

RESPONSES FROM AJ. MARK ROBINSON

Question 1.: Does the Federal Regulatory Commission (FERC) have the personnel and assets needed to oversee the additional LNG facilities? If not, what will will FERC need?

T2Response: Yes. In 2004, the LNG Engineering Branch was formed to conduct engineering and safety review of the increasing number of proposed facilities. In 2006, the LNG Compliance Branch was created to provide oversight of construction and operation of LNG facilities under jurisdiction. Later that same year, the Office of Energy Projects hired six engineers for positions in the LNG Engineering and Compliance Branches to meet the current and expected workload from LNG import terminal applications and construction. Engineers in these branches ensure a thorough safety oversight through the three phases authorization; pre-construction, and pre-operation) of project review at the Commission.

Question 2.: It has been over 5 years since 9/11, why is there still disagreement amongst the experts concerning the security on LNG tankers?

Response: The GAO study reports substantial agreement among the expert panel concerning many of the potential public safety consequences of a terrorist attack on an LNG tanker including thermal radiation from a pool fire, unconfined vapor cloud explosions, burns, asphyxiation, and rapid phase transitions. The findings of the GAO expert panel are also consistent with those in the FERC staffs assessment of LNG facilities. With respect to the December 2004 Sandia report, eleven of the fifteen experts judged the distance calculations as either accurate or overly conservative.

The U.S. Coast Guard (Coast Guard), the lead federal agency responsible for waterway safety and maritime security, has issued nation-wide guidance to ensure that a uniform approach is taken in assessing security issues related to LNG vessel transit. The guidance issued in Navigation and Inspection Circular 05–05 is used by applicants, the Coast Guard, and port stakeholders to perform an objective review of whether a waterway is suitable with respect to navigation safety and maritime security. The conclusions of this port-and project-specific review are used by both the Coast Guard and the FERC in deciding whether to issue federal authorizations for the LNG vessel transit and the on-shore facility.

Question 3.: According to GAO, more research is needed. **Why hasn't this research been completed already?**

Response: Sandia National Laboratories has two research initiatives currently underway: one on threat, breach and hazard modeling and assessment for larger LNG ships; and the other on safety hazard testing and modeling of large LNG spills on water. These efforts are planned to continue through 2007 and 2008 with interim results at intermediate dates. Sandia has conducted periodic briefings for our staff and other federal agencies on the progress of each project. We fully support the research by Sandia and anticipate that the results will validate the conservatisms in our hazard modeling.

Question 4.: Please provide us with information about the measures FERC undertakes to ensure the security on the LNG facilities.

Response: As referenced in my March 21,2007 testimony, the Commission shares security responsibilities for these facilities with the Coast Guard, which has primary responsibility under the Maritime Transportation Security Act of 2002. The Commission has a role related to facility security at all phases of project development. During the pre-construction review, the preliminary plans to secure the facility intentional acts are evaluated and discussed at the cryogenic design and technical review conference for the proposal. Prior to starting commissioning activities, engineering staff confirms that all plant security systems are in place (personnel, cameras, and other equipment), and that the Facility Security Plan is current. During project operation, engineering staff reviews the facility security as part of the annual inspection to ensure sufficient levels of security provided by surveillance cameras; intrusion detection systems; security fencing; and on-site access control plans.

Question 5.: While there have been no major LNG incidents, there have been groundings. How does FERC use the lessons learned to improve the safety and security of all the facilities?

Response: Our environmental impact statements (EIS) disclose the more significant LNG ship incidents including several groundings in international waters that resulted in bottom damage but no cargo tank damage. We are aware of LNG vessel groundings in U.S. waters but they did not result in any damage.

Our EISs also disclose the accidents that occurred at Cove Point, Maryland in 1979 and at Skikda, Algeria in 2004. The lessons learned from these incidents have resulted in revising equipment design and adding hazard detection to improve the safety of all LNG facilities, both under review and in operation under FERC jurisdiction.

Question 6.: Five FERC approved LNG facilities are currently under construction—Louisiana; Freeport, Texas; Sabine, (two); and Cove Point Maryland. **Please provide us with an update at their construction. When will the construction be completed?**

Response: The LNG import terminals and expansions currently under construction have targeted in-service dates of: March 2008 for LNG (Phase I) in Freeport, Texas; April 2008 for Cheniere's Sabine Pass LNG (Phase I) in Sabine, Louisiana; October 2008 for Cameron LNG (Phase I) in Hackberry, Louisiana; November 2008 for the Cove Point Expansion in Cove Point, Maryland; and April 2009 for Golden Pass LNG in Port Arthur, Texas.

QUESTIONS FROM THE HONORABLE PETER T. KING, RANKING MEMBER, COMMITTEE ON HOMELAND SECURITY

Question 7.: Has FERC ever denied a LNG licensing request? If sO, when? how often do companies withdraw from the FERC process?

Response: In an Order issued on July 5,2005, the Commission denied a proposal by KeySpan to convert its existing LNG peak shaving facility in Providence, Rhode Island to an LNG import terminal.

In accordance with the Energy Policy Act of 2005, all LNG project applicants must participate in the mandatory prefiling process specified under 18 CFR 157.2 1. The prefiling process, as well as the subsequent formal filing of an application, requires a substantial commitment of resources by the project sponsor, thereby discouraging frivolous applications. We are aware of sponsors that have considered a project, but have never filed a proposal before the Commission. To date, project sponsors that have either filed applications or have entered the pre-filing process have not withdrawn their proposals.

Question 8.: How does the LNG industry compare with the oil industry in terms of safety records? Your testimony indicates that a LNG ship has never had a major spill. What constitutes a major spill of LNG?

Response: My testimony identified the commendable safety record of LNG shipping since its beginning in 1959, and explained the current process for coordinating reviews with the Coast Guard to ensure the safety and security of the LNG vessel transit to a proposed import facility. While our impact statements have not included a comparison with the oil industry, we are certainly aware of large cargo releases, fires and explosions involving petroleum tankers, both in U.S. and international waters, but note that these have not occurred with LNG vessels.

None of the LNG vessel incidents that are disclosed in our environmental impact statements resulted in a breach or failure of a cargo tank. In those incidents where an LNG release occurred, they were relatively small volumes that occurred during the cargo transfer. A major spill would require a large breaching of a cargo tank.

Question 9.: Has there ever been an explosion at a LNG facility? What is the relative risk of an explosion LNG when compared with gasoline?

Response: The Reliability and Safety Section of each EIS for an LNG import project describes an incident that occurred in 1979 at the Cove Point import terminal in a building in which one operator was killed and another injured. Nevertheless, we do not believe vapors an LNG spill would explode.

With the exception of the higher surface emissive power and larger flame heights estimated for LNG fires, the public hazards associated with LNG vapors are not markedly different than from other fuels such as gasoline. For example, while gasoline may ignite at a lower concentration, LNG vapors have a wider flammability range.

Question 10: Can you explain the Commission's role in enforcing the cost-sharingplans required by the Energy Policy Act of 2005?

Response: Both the Energy Policy Act of 2005 and Commission Orders authorizing LNG terminals require that we approve an Emergency Response Plan prior to authorizing any construction. Further, the Emergency Response Plan must include a cost-sharing plan. The plan must identify the mechanisms for funding all project-specific security costs and management costs that would be imposed on state and local agencies. The cost-sharing plan must what the LNG terminal operator will provide to cover the cost of the state and local resources required to manage the security of the LNG terminal and LNG vessel. Commission staff carefully reviews the plan to ensure that the state and local resources required for security and emergency management have been adequately addressed and that no resource gaps remain. The potential costs that are considered fall into three categories: (1) per-transit costs (for example, overtime for police or fire department personnel); (2) capital costs for equipment and personnel base (for example, patrol boats, fire fighting equipment); and (3) annual costs for specialized training and for conducting exercises.

QUESTIONS FROM THE HONORABLE BENNIE G. THOMPSON, CHAIRMAN, COMMITTEE ON HOMELAND SECURITY

RESPONSES FROM REAR ADMIRAL SALERNO

Question 1: From what countries do we receive LNG? Are all of these countries compliant with the International Ship and Port Facility Security Code?

Response: Our primary suppliers of LNG are Trinidad, Algeria, Egypt and Nigeria. Over the last ten years we've received cargoes from Malaysia, Oman, Qatar, UAE and even Australia.

The Coast Guard's International Port Security (IPS) Program has visited Trinidad, Algeria, Nigeria, Malaysia, Oman, Qatar, and Australia. With the exception of Nigeria, each of these countries was found to be substantially implementing the International Ship and Port Facility Security (ISPS) Code. When visiting Nigeria, the Coast Guard was only able to visit facilities in the port of Lagos. Thus, Nigeria was found to be provisionally implementing the ISPS Code. We have not completed an assessment of Nigeria because of political unrest and potential danger to Coast Guard personnel. When security conditions improve, another visit to Nigeria will be scheduled. Visits to Egypt and UAE are anticipated to be completed by March 2008. All the countries listed have reported their compliance with the ISPS Code to the International Maritime Organization in accordance with Safety of Life at Sea security regulations and the ISPS Code.

Question 2: Please outline for the Committee the additional safeguards placed upon U.S. mariners with the Transportation Worker Identification Card (TWIC).

Is it true that the additional security requirement of a TWIC is only to be applied to U.S. mariners? Why are foreign mariners not vetted in the same manner?

Response: The Maritime Transportation Security Act of 2002, 46 USC § 70105, requires a biometric transportation security card for U.S. mariners issued a license, certificate of registry, or merchant mariner document. The TWIC does provide additional safeguards for U.S. mariners by providing a biometric credential which is common to the maritime industry. Whereas the current mariner documents (MMD, license, Certificate of Registry) are only used by the population of individuals who work on certain vessels, the TWIC will be used by a larger population and will be more widely recognized. Having a common credential increases the chances that a security guard will be able to identify signs of tampering or forgery of the credential as well as easing access for the mariner. Inclusion of a biometric on the credential

provides the ability to ensure that the person who presents the TWIC for access is the person to whom the card was issued by matching their fingerprint to the biometric template on the card. This is not a feature currently available on mariner documents. The TWIC also has limited personal information printed on the face of the card than the MMD currently has; therefore, if the TWIC was stolen, the thief would be unable to retrieve as much information on the holder than if the MMD was stolen. Thus, presenting the TWIC as the preferred identification document protects mariners' personal information from theft.

Yes, it is true that the TWIC is only required for U.S. mariners. The TWIC is not required for foreign mariners.

Foreign mariners are already vetted prior to entering the United States. Foreign mariners must possess a visa issued by the Department of State in order to be eligible to enter the United States. The visa application process includes a face-to-face interview and vetting performed by the Department of State. Additionally, ninety-six hours prior to arrival to a U.S. port, a notice of arrival, including a list of all persons onboard a vessel, must be sent to the Coast Guard. The persons are then vetted through various databases. Finally, upon the vessel's arrival at a port facility, Customs and Border Protection conducts face-to-face interviews with those foreign mariners who request shore leave. Even with a visa, however, a foreign mariner will be required to be escorted through secure areas of MTSA regulated vessels or facilities, because he/she will not hold a TWIC.

It is also not clear that requiring foreign mariners to obtain a TWIC would provide any security benefit since it is unlikely that a foreign seafarer will have a criminal record in the United States. The additional background checks are done during the U.S. Department of State visa application and Customs and Border Protection screening processes, as outlined above. In addition to the uncertain security benefit, foreign mariners would not likely have the means to get to enrollment centers or to return to claim and activate their credentials, nor would any be able to present the appropriate identity documents, or meet the requirement for lawful presence under the TWIC program. Requiring foreign seafarers to obtain a TWIC would mean that before being allowed off of a foreign vessel, each foreign seafarer would need to come to the United States to enroll in the TWIC program, and then again to pick up their TWIC. Finally, placing such requirements on foreign seafarers could effect reciprocal requirements for U.S. mariners in other countries.

Question: To what extent can we improve communication between shore side first responders and a LNG ship's crew and officers if they are speaking in the same first language and have similar cultural backgrounds?

Similarly, would it not be beneficial for the safety of the vessel and its cargo if both officers and crew communicated in their native language?

Response: Current international standards satisfy the safety concern raised in this question. In accordance with Safety of Life at Sea (SOLAS) Regulation V/14.3, every foreign vessel, even those with multi-national, multi-cultural crews, is required to have a common working language that permits effective crew performance. Furthermore, every Master and Deck officer on vessels subject to SOLAS Chapter I that engage in ship to ship or ship to shore safety communications must speak English, unless both parties speak another common language.

Question: Are you concerned about the frequency and the nationality of stowaways that have been confirmed on international vessels, particularly from international ports that have been vetted by the U.S Coast Guard?

Response: The answer to this question is not releasable to the public and therefore must be provided via a secure venue. The Coast Guard is available to provide this information at your earliest convenience.

Question: We have heard today, that energy companies have submitted 32 applications to build additional LNG facilities. **Does the Coast Guard have the assets to protect the additional LNG tankers and facilities? If not, what will the Coast Guard need to successfully fulfill this new mission?**

Response: The Coast Guard continues to utilize a waterway suitability assessment and report process to identify safety and security measures required to mitigate the port-wide risk posed by new Liquefied Natural Gas (LNG) facilities. Based on the results of these assessments, resources may be identified from the Coast Guard, state and local agencies, or the private sector to mitigate that risk. The President's budget represents the Coast Guard's highest priority resource needs, including the continual evaluation of the assets required to mitigate the impact of Certain Dangerous Cargoes (such as LNG).

Question: Is it true that the additional security requirement of a Transportation Worker Identification Card is only to be applied to U.S. mariners? Why are foreign mariners not vetted in the same manner?

Response: The Maritime Transportation Security Act of 2002, 46 USC § 70105, requires a biometric transportation security card for U.S. mariners issued a license, certificate of registry, or merchant mariner document. The TWIC does provide additional safeguards for U.S. mariners by providing a biometric credential which is common to the maritime industry. Whereas the current mariner documents (MMD, license, Certificate of Registry) are only used by the population of individuals who work on certain vessels, the TWIC will be used by a larger population and will be more widely recognized. Having a common credential increases the chances that a security guard will be able to identify signs of tampering or forgery of the credential as well as easing access for the mariner. Inclusion of a biometric on the credential provides the ability to ensure that the person who presents the TWIC for access is the person to whom the card was issued by matching their fingerprint to the biometric template on the card. This is not a feature currently available on mariner documents. The TWIC also has more limited personal information printed on the face of the card than the MMD currently has, therefore, if the TWIC was stolen, the thief would be unable to retrieve as much information on the holder than if the MMD was stolen. Thus, presenting the TWIC as the preferred identification document protects mariners? personal information from theft.

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Question:: More specifically, will the Coast Guard have the assets to continue the following security measures for all of the new facilities including—Inspection of security and tanker loading at the port of origin.

Occasional on-board escort by Coast Guard "sea marshals."

96-hour advanced notice of arrival of an LNG tanker.

Advance notification of local police, fire, and emergency agencies, as well as the Federal Aviation Administration and the U.S. Navy.

Enforcement of security zones.

Suspension of overflights.

Inspection of adjacent piers for bombs by police divers.

Posting of sharpshooters on nearby rooftops.

Response: All of the activities listed above may not be necessary or appropriate for each new facility. The appropriate risk mitigation strategies necessary to ensure the safety and security of new shoreside LNG facilities, and the resources to carry out such activities, are determined on a case by case basis during the waterway suitability assessment and analysis process for each project. Unfortunately, due to the large number of potential projects, along with the expectation that only a fraction will actually be constructed, the Coast Guard is unable to estimate the overall needs associated with future LNG terminals until construction of each individual

terminal is actually approved by FERC. Once an applicant has received their construction permit from the Federal Energy Regulatory Commission (FERC), the Coast Guard is then able to look at the unique needs that will accompany that new facility, and whether the Coast Guard has the resources in place, balanced against our other legislatively mandated mission-programs, to meet those needs. If additional resources are necessary in that geographic area, the Coast Guard will determine whether those resources are available elsewhere in the Coast Guard or if a new resource request is necessary.

Question: How does the LNG industry compare with the oil industry in terms of safety records?

Response: Transportation of LNG by marine carriers has a long record of safe operation. Since 1959, when the commercial transportation of liquefied natural gas began, there has never been a shipboard death or significant incident involving liquefied natural gas. As of March 1, 2007, the world fleet of LNG tank ships consisted of 224 carriers which have safely delivered over 40,000 shiploads while covering more than 100 million miles. The outstanding LNG shipping safety record is attributable to continuous improvement of technology, safety equipment, comprehensive safety procedures, training, equipment maintenance by responsible ship owners/operators and effective government regulation and oversight.

Over the history of LNG shipping, there have been no collisions, fires, explosions or hull failures resulting in a loss of containment for LNG ships in ports or at sea. According to a Sandia National Laboratories 2004 report to DOE, over the 45-plus year life of the industry only eight marine incidents worldwide have resulted in accidental spillage of LNG and none of the spills have been as a result of a failure or breach of a containment system. In the cases of accidental spillage, no fires occurred and only minor structural damage was noted. Seven additional marine-related incidents have occurred with none resulting in release of cargo. No explosions or fatalities from a cargo spill have ever occurred aboard an LNG carrier.

By comparison, the number of marine carriers in the world fleet which carry oil is significantly larger, but marine carriers have been transporting oil for a much longer period of time. In 2006, the oil carrier industry was 120 years old. Since the first oil carrier set sail in 1886, the oil carrier fleet has grown dramatically in both size and volume of oil transported worldwide. According to a July 2006 report from the U.S. Maritime Administration (MARAD), there were approximately 4,454 oil and chemical carriers in the world fleet. The exact number of those which are oil carriers in operation is unclear, but the International Maritime Organization (IMO) places the number at over 3,500. Statistical data and information on the complete safety record of oil carriers since their entry into the world trade market is unknown. A recent paper submitted to IMO in December 2006 included an assessment which looked at casualties on the world fleet of oil carriers covering a period of 15 years (1990 to 2005). The paper reported that in the time frame studied, worldwide, there were a total of 564 lives lost on oil tankers due to various causes and 484 due to accidents caused by fire and explosion.

Using these comparison standards, the safety record associated with LNG marine carriers is much better than the safety record associated with marine carriers of oil.

Question: I understand that the Coast Guard requires crew manifests be submitted 96-hours prior to the arrival of a ship into port. Are U.S. mariners on these ships vetted against the same lists?

Response: Yes, U.S. Mariners are vetted against the same federal terrorism, immigration, and law enforcement databases as foreign mariners.

Question: The Coast Guard is frequently commended for their risk-based resource allocations. In the Coast Guard's opinion, would a ship crewed by U.S. mariners provide less a risk than a ship crewed by foreign citizens?

Response: The Coast Guard believes the existing screening process and security checks conducted for all crews on arriving foreign-flag vessels, combined with the employer vetting process, significantly reduce the likelihood that an unauthorized crewmember could surreptitiously join the crew of an LNG vessel.

While a U.S. crew on a U.S. flag LNG vessel could reduce the risk from internal sabotage, this measure would not mitigate the greatest risks to the vessel (i.e. a vessel-borne explosive device or an attack from a stand-off weapon).

Question: There has been some discussion as of late to require U.S. mariners to crew foreign-flagged LNG carriers offloading in the United States. Would the Coast Guard provide a ship crewed entirely by U.S. citizens less of a security envelope compared to a ship with some foreign citizens?

Response: While a U.S. crew on a U.S. flag LNG vessel could reduce the risk from internal sabotage, this measure would not mitigate the greatest risks to the vessel (i.e. a vessel-borne explosive device or an attack from a stand-off weapon).

Question: What actions or investments has the Coast Guard taken to prevent a USS Cole or T/V Limberg incident from occurring to a LNG vessel? Is the Coast Guard's Research and Development Center involved?

Response: The President's Fiscal Year 2008 Budget includes several items which contribute to improving the overall multi-mission capability of the Coast Guard. Specifically, the President's Fiscal Year 2008 budget request supports the following initiatives to increase specialized forces and intelligence capability to meet the small boat Improvised Explosive Device (IED) threats.

- Nationwide Automatic Identification System
- Maritime Security Response Team Shoothouse
- Response Boat-Medium
- Rescue 21
- Deployable Operations Group
- Coast Guard Counterintelligence Service

Addressing the threat of small vessel attacks in the U.S. requires continual review of security gaps and coordination with small vessel stakeholders, including commercial and recreational vessel operators in U.S. waters. To further such dialogue with these stakeholders, the Department of Homeland Security has scheduled a National Small Vessel Security Summit for June to begin a robust conversation to fully understand the gaps in maritime border security and collaboratively develop measures of closing those gaps. Additionally, the Coast Guard is vigorously exploring a number of ways to close existing gaps including: unambiguous warning capability to determine intent of small craft approaching high value assets; technologies appropriate for use within crowded ports to deter or stop small vessel attacks, including non-lethal options; regulations expanding current requirements for tracking of small vessels; and improved sensors (radars, offshore buoys, etc.).

The Coast Guard's Research and Development (R&D) Center is starting a new project to addresses challenges faced by Coast Guard boat forces units conducting waterside security operations. These include Level I Port, Waterway, and Coastal Security (PWCS) units such as Sectors, Maritime Safety and Security Teams (MSSTs), Port Security Units (PSUs), and Maritime Force Protection Units (MFPUs). This project directly supports the Coast Guard's Small Vessel Response Task Force Final Report recommendation to vigorously pursue technology to deter or stop small vessels threats within the port environment.

The R & D Center's Project Objective is to provide Coast Guard program managers with recommendations for the best short, mid & long term solutions to close capability gaps in domestic ports. The desired end-state is to ensure Coast Guard program managers have actionable information to select and implement changes to policy and procedures, and new use of force tools. This array of improvements to domestic port security capabilities will serve to mitigate and reduce risk in the maritime environment.

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