

R.A. Cox Risk Management

**Review of:
“Milford Haven Port Authority: Approach to and
use of Risk Assessments”**

by

Eur.Ing. Raymond Anthony Cox MBE MA PhD FIMechE

07 September 2008

This report has been prepared at the request of *Safe Haven* (an association of residents concerned about LNG operations in Milford Haven) with particular reference to their Petition to the European Parliament, No.354/2006.

The report represents the independent opinion of its author and the author declares that he has no financial nor other conflict of interest regarding the subject matter.

R.A. Cox Risk Management

20 Pollard Road
Morden
Surrey SM4 6EG
United Kingdom

Tel: 020 8648 5012
Fax: 020 8648 4652
email: riskman@safetycraft.com

Review of: “Milford Haven Port Authority: Approach to and use of Risk Assessments”

Contents

1.	Introduction	1
2.	The Nature and Scale of the Risk due to LNG Operations in Port Areas	2
3.	The approach by which these risks should be controlled	5
4.	The Normal Format of a Risk Assessment of LNG Marine Operations	6
5.	Evaluation of the MPHA’s “Risk Assessment”	7
6.	Conclusions	10
ANNEX 1:	References	12
ANNEX 2:	Annotated Copy of Statement by the Milford Haven Port Authority	13

1. Introduction

1.1 This review has been prepared by Eur. Ing. Dr. Raymond Anthony Cox, an expert in risk assessment of technological systems, who served as President of the European Section of the Society for Risk Analysis in 1992. He was also an independent member (for one year, Acting Chairman) of the UK Health & Safety Executive’s (“HSE”) Advisory Committee on Dangerous Substances from 1993 to 2005, which provided HSE with technical advice on the UK implementation of the Seveso-2 Directive.

1.2 He was, during the 1970’s and 1980’s, the developer of one of the first mathematical models of the atmospheric dispersion of LNG vapour clouds from accidental spills, on behalf of British Gas, and he later served as the leader of the technical teams undertaking risk assessments of:

- (i) LNG production and export terminal in Western Australia,
- (ii) LNG production and export at Sakhalin Island (Russia)
- (iii) LNG import terminal at Zeebrugge, Belgium, and

(iv) LNG peak-shaving plant in Europoort, Rotterdam.

1.3 Further details of the author's qualifications are available on request.

1.4 The objectives of this report are:

- (i) To summarise the nature and scale of the risk posed to on-shore populations by the potential spillage onto the sea of LNG from gas carriers in transit, manoeuvring or at berth in ports.
- (ii) To summarise the approach by which these risks should be controlled through: site selection, port/terminal conceptual design, risk assessment and operational safety measures.
- (iii) To summarise the usual scope, format and results of risk assessments of LNG operations.
- (iv) To evaluate the published statements by the Milford Haven Port Authority ("MHPA") concerning their discharge of their duties to the neighbouring public in respect of their assessment of the risk to them from LNG ships in connection with the project for two LNG terminals at Milford Haven.

1.5 I address the last of these partly in the form of an annotated copy of the statement made by MHPA by publication on their web site [Ref.1], and I draw summary conclusions from that review in the main report below.

2. The Nature and Scale of the Risk due to LNG Operations in Port Areas

2.1 Natural gas, such as we burn in our homes, is typically a mixture of two flammable gases—about 90% methane and 10% ethane. LNG is simply natural gas that has been cooled so much that it condenses into a liquid, which happens at about 162 degrees below zero Celsius (i.e., -162°C), which is extremely cold by any ordinary standards.

2.2 In the event of an accidental spillage of LNG, whether onto the ground or onto water, this cold liquid will pick up heat from its surroundings and will start to boil and vaporise, just as water does when heated to its boiling point. When the LNG vaporises, it does so at the very low temperature of the liquid, so that the gas emerging into the air is natural gas at -162°C (sometimes referred to as "LNG vapour"). Such cold LNG vapour is about 50% more dense than air, and therefore tends to hug the ground or water surface.

- 2.3 When the spill is onto land, the rate of vaporisation of the LNG reduces rapidly, because the ground acts as a thermal insulator. On land, it is possible to engineer channels and catchments so that the LNG spill can be contained and the generation of flammable vapour controlled. However, for spills on water, such containment is impossible. Moreover, the fluidity of the water means that it does not act as a thermal insulator and therefore the rate of vaporisation of the LNG is sustained at a higher rate than is the case on land. Overall, this means that, for the same size of spill, the cold, dense, LNG vapour is generated must faster on water than it is on land.
- 2.4 In the event of immediate ignition of the escaping LNG, the result would be an intense fire, located around the release point. The thermal radiation from natural gas fires is the most intense of all common hydrocarbon fuels because the flame is not very smoky. Such a fire would be highly dangerous to any nearby people, whether on board a ship or in a storage terminal; in the case of very large ignited spills, dangerous heat effects might be found in the order of 1 kilometre distant. For marine spills, these effects are very unlikely to harm the shore population, although they can affect passing vessels such as commercial ships and leisure craft.
- 2.5 However, there is a very significant risk if the LNG does not ignite immediately (which could happen, to give just one example, when it is released under water). In this case, the hazard is caused by the drifting LNG vapour, which may reach populated areas and then ignite at some later time.
- 2.6 The drifting of a vapour cloud in the air is influenced strongly by its density, which determines whether it lifts off the ground, or stays in contact. As cold LNG vapour mixes with the warm atmosphere, the LNG vapour warms up— but the admixed air cools down. The net effect for the mixture as a whole is that the mixed vapour-air cloud is always colder and denser than the surrounding atmosphere. For this reason, cold LNG vapour clouds remain denser than air as they disperse, and therefore stay in contact with the surface.
- 2.7 The preceding description has been confirmed in large scale spill tests with LNG, such as the marine discharges of LNG during the commissioning trials of the SS “Gadila” in 1973 and later experimental spill trials (e.g., Maplin Sands, UK, 1980, and at China Lake and Frenchman Flat by Lawrence Livermore National Laboratory, USA 1978 - 82).
- 2.8 The “Gadila” discharges included the largest ever deliberate spill of LNG, at 193m³, and the resulting cloud had a depth of only 10-12m, while its visible length was over 2000m and it was over 500m wide. It is obvious from this that the cloud was denser than the surrounding air, and that its general shape was long, broad and shallow.

- 2.9 Potential spills from an LNG carrier due to a breach of a cargo hold following a ship collision or grounding, or a striking by a passing vessel while at berth, could easily be in the order of several thousand tonnes, up to, say, the capacity of a single tank, i.e. of the order of 10,000 tonnes. The hazard of an unignited vapour cloud from such a spill could easily extend for many kilometres in the downwind direction.
- 2.10 The likelihood of such a spill can be reduced by sound engineering and operational practices. The nature of this risk will therefore be “low probability/high consequence” and therefore there is a duty upon the proponents to show that their proposals include sufficient safeguards to ensure that the probability of such an event is sufficiently low in relation to the potential consequences of an accident. That demonstration can only be provided by a risk assessment.
- 2.11 Throughout Europe, assessments of this kind are carried out under the EU “Seveso-2” Directive [Ref.2] (implemented in the UK by the “COMAH” Regulations 1999 [Ref.3]) for all shore-based industrial establishments holding more than certain threshold quantities of hazardous substances. All LNG terminals are subject to this Directive. The Competent Authority for the UK COMAH Regulations is a joint authority comprising the Health and Safety Executive (HSE), the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA), and in respect of fire and explosion hazards, HSE has the required expertise and would usually assume the primary regulatory responsibility.
- 2.12 For the onshore side of the Milford Haven LNG projects, such risk assessments were carried out under the supervision of HSE for the shore-based facilities of the Milford Haven LNG terminals. However, nothing comparable was done for the marine side because, as stated by an official of HSE: *“My staff did not complete an assessment of the tanker risks because we sought and obtained advice from the Office of the Deputy Prime Minister (ODPM) about whether this was ‘in scope’ for our role as a statutory consultee in Planning (Hazardous Substance) Consent. They advised us that, contrary to our previous understanding, it was not.”*
- 2.13 In effect, this meant that the technical expertise relating to the risks due to hazardous cargoes, that resided within HSE and was used in their assessment of the shore-based installations, was not made available to the Planning Authority, in respect of such risks that arose from ships’ cargo tanks.
- 2.14 The risks to shore-based populations due to the marine side of such projects will usually exceed those from the shore side facilities for three reasons:
- (i) The size of credible spills is generally larger,

- (ii) The spills of liquid cannot be contained or controlled on water,
- (iii) The rate of LNG vaporisation from water is higher,
- (iv) The probability of a marine accident, such as a serious collision or grounding, or a striking by a passing vessel, is much higher than broadly comparable scenarios on land facilities.
- (v) Land-based LNG storage tanks can be designed with very robust structures, and secondary spill containment systems, that are not feasible on ships.

3. The approach by which these risks should be controlled

- 3.1 There is no logical reason why the risks to local populations, arising from the marine side of an LNG port operation, should not be managed in the same way as the risks from the onshore elements of the same port operation. In practice, most LNG industry operators look upon them in the same way, because they recognise that a major disaster, involving fatalities to the public, would have equally serious consequences, whether it arose from the ship or from the shore terminal.
- 3.2 For these reasons, in the absence of a regulatory framework comparable to that on-shore, the sector has produced guidance through its association, the Society of International Gas Tanker and Terminal Operators (“SIGTTO”) [Refs.4 & 5].
- 3.3 In the present case, HSE carried out a comprehensive risk analysis of the land based facilities and all LNG operations on the terminals up to the unloading arms on the berths. Those assessments included consideration of a suitably comprehensive and representative selection of accidental releases for the purpose of assessing the risk to neighbours. Their assessment results are expressed in terms of “chances per million years” (“cpm”) of a potentially fatal effect on people, at various onshore locations. These estimates summarise both the likelihood and the consequences of all potential accident scenarios, in a way that can be used as a basis for advice to the planning authorities and for other safety regulatory purposes.
- 3.4 It is essential to assess these risks thoroughly and in a manner that is open to scrutiny, in order to provide the required assurance that the risks involved are reasonable in relation to the benefits that the projects will bring and in relation to any safer alternatives that may be available. Such an assessment would also provide a firm basis for any control measures that may be deemed necessary.

4. The Normal Format of a Risk Assessment of LNG Marine Operations

4.1 In my own experience, the usual contents of a risk assessment for an LNG project are as follows:

- (i) **Project definition** (input data to the assessment - description, assumptions, etc.)
- (ii) Identification of accident **scenarios** - in the case of LNG the important ones are all LNG spill scenarios - from different parts of the system, at different locations, and under different operating conditions.
- (iii) Estimation of the **frequencies** of each scenario.
- (iv) Mathematical modelling of the **consequences** of each scenario (liquid spill spreading, vaporisation, vapour cloud dispersion, ignition, combustion, and effects on the population).
- (v) Calculation of the **risk profile** - for example risk levels (in units such as HSE's "cpm") at specific locations, or "risk contours" which show the risk levels around the facility on a map.

4.2 All risk assessments of major hazard facilities and operations must be site-specific. In the case of LNG terminals, where the potential fire and explosion effects can extend over large distances, local factors such as the positioning of storage tanks and ship berths, the navigational hazards and the proximity of shore populations, all have a significant effect on the level of risk. The SIGTTO recommendations on site selection and design of LNG ports and jetties [Ref.4] recognise these factors and state how risks should be assessed for port operations with LNG. The elements of this include:

- port and jetty layout,
- traffic frequencies,
- vessel collision resistance,
- collision and grounding probabilities,
- population locations and densities,
- gas dispersion,
- fire and explosion modelling,
- personnel exposure estimates and
- fatality risk calculations. [Ref.4, Section 2.3 on page 8]

4.3 This a framework analogous to that used for the onshore facilities, under the Seveso-2 Directive.

- 4.4 A similar framework appears in a US government sponsored set of guidelines on risk assessment for LNG spills on water [Ref.9] in the following terms:
- (i) Evaluating the potential for an event that could cause a breach or loss of LNG from a ship;
 - (ii) Establishing the potential damage to a cargo tank or other system from these events and the potential spills that could occur;
 - (iii) Estimating the volume and rate of a potential LNG spill based on the dimensions and location of the breach, properties and characteristics of the LNG, ship construction and design, and environmental conditions (e.g., wind, waves, currents, etc.);
 - (iv) Estimating the dispersion, volatilization, and potential hazards of a spill based on physical and environmental conditions; and
 - (v) When necessary, identifying prevention and mitigation approaches and strategies to meet risk management goals.”
- 4.5 These guidelines are authoritative and reflect the view among risk analysts concerning the logical structure of a risk assessment for dangerous goods and cargoes, which has become settled after some 30 years of such work in the oil, gas and chemical industries. In my evaluation of the work done by the Milford Haven Port Authority, I have used the above catalogue of assessment tasks as the standard.

5. Evaluation of the MPHA’s “Risk Assessment”

- 5.1 Annex 2 contains my commentary on the MHPA statement on “Approach to and use of Risk Assessments”. This commentary shows that the Authority has carried out many studies relating to ship navigation issues in the port, but they have exaggerated the scope and findings of the various studies they have commissioned, to make it appear that a proper risk assessment of LNG cargo spills, to the onshore population, has been carried out on their behalf.
- 5.2 Most of the studies referred to by MHPA (listed in Annex 2 at p.19, under the title “What actual information have we made available”) have not, in fact, been released by them and for this reason I have had to infer their scope from their titles, and their findings from the published statements of MHPA. The following table lists these studies, and more detailed comments are found in Annex 2 from page 19 onwards.

Studies listed by MHPA (Annex 2 p.19 etc.)	Comment
(a) Marico Marine - marine traffic analysis	Not released. Does not deal with cargo hazards.
(b) South Hook LNG - concept risk assessment, 9-10 December 2002	Severely redacted extracts have been released by MHPA, which show that this study was superficial and qualitative, and did not include estimates of risks to the shore population from LNG marine spills.
(c) Maritime Research Institute Netherlands: navigation simulations, 14 February 2003	Not released. Does not deal with cargo hazards.
(d) Marico Marine: navigational risk assessment of Dragon LNG's proposals, March 2003	Not released. Does not deal with cargo hazards.
(e) Maritime Research Institute Netherlands: fast time simulations for large LNG ships, 19 May 2003.	Not released. Does not deal with cargo hazards.
(f) Det Norske Veritas (USA) Inc.: report on marine risk associated with vessel manoeuvres in respect of South Hook LNG's proposal 13 October 2003	Not released. Not clear whether cargo risks were considered. In any case, no results released.
(g) ABS Consulting Inc., report on potential damage to LNG tankers due to ship collisions, 20 February 2004 for South Hook LNG.	Not released. This is relevant to the size of holes that might be caused in ships' cargo tanks. Results not released or referred to elsewhere.
(h) Burgoyne Consultants: potential consequences of fires and explosions involving ships carrying petroleum products (including LNG) March 2005.	Not released. These calculations, which could be highly relevant to the local population, have not been released, nor are they referred to in the Lloyds Register reports (j).
(i) HR Wallingford: report on mooring safety and the possibility of disturbance caused to moored vessels for South Hook LNG, November 2003	Not released. Does not deal with cargo hazards.
(j) Gordon Milne, Senior Risk Analyst at Lloyd's Register of Shipping, assessment of the risk of explosion and gas release from LNG carriers.	Released. This is a generic paper on LNG risks and is not specific to Milford Haven.

(j) Lloyd's Register: "Milford Haven Event Statistics" report, 13 April 2005	Released. This is based on world statistics and all fuel cargoes. It contains no analysis specific to LNG, only some assertions, and the only Milford Haven specific data are the traffic volumes.
------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

- 5.3 In some of their other public statements, MHPA have also referred to QRA studies by Royal Haskoning, carried out on behalf of Petroplus, one of the LNG terminal operators. I have seen reports from Royal Haskoning as follows:
- (i) Quantitative Risk Assessment - Petroplus Tankstorage Milford Haven LNG Terminal dated September 2002
 - (ii) Quantitative Risk Assessment - Petroplus Tankstorage International - LNG Terminal Milford Haven, Wales - Draft Report, dated 28 January 2003
 - (iii) Dragon LNG Terminal - Environmental Statement for Revised Layout and Use of Alternative Jetty - Final Report January 2004
This contains a QRA report in Appendix 6.1.
 - (iv) Quantitative Risk Assessment - Petroplus Tankstorage International Dragon LNG Terminal Milford Haven, Wales - Draft Report, dated 9 January 2004
- 5.4 In all of these reports, the consultants have treated the LNG marine risks solely by two cargo spill cases -
- (i) External impact, large spill: Continuous release of 126 m³ in 1,800s;
 - (ii) External impact, small spill: Continuous release of 32 m³ in 1,800s.
- 5.5 These spill cases are completely inadequate to describe the hazard presented by LNG carriers with individual cargo tanks of 25,000 m³ volume. There is very little explanation in the Royal Haskoning reports as to the actual form of the release. It could be a breach of a cargo tank (in which case, it would have to be an extremely small breach) or it could be a failure of the unloading arm, due to movement of the LNG ship along the berth. These two cases also fail to treat ship collisions, sinkings or groundings while in transit or manoeuvring. Moreover, if the spill were from a cargo tank breach, it could not be stopped in 1800s, which is 30 minutes. More realistic spill scenarios from a cargo tank breach due to external impact would be in the order of thousands of m³ in volume.

- 5.6 In short, these studies by Royal Haskoning fall far below what should be expected of a proper risk assessment of marine cargo spills (and, in fairness to the authors, were probably not intended to fulfil that function). If MHPA relied upon them, they were wrong to do so, not only because the studies were not independent of the operator, but also because the results did not address the greater part of the marine cargo risk.
- 5.7 Whilst I would have preferred to have seen the whole of all the original documents on which MHPA are relying, I am confident, from their titles and the statements made by MHPA upon them, that no proper risk assessment, for example one meeting the recommendations of SIGTTO, nor one broadly equivalent to that undertaken by HSE for the landward side, has been undertaken by or for the MHPA for the risks of marine spills of LNG.
- 5.8 The MHPA therefore gave its advice to the local planning authorities concerning the planning applications for construction of the terminals without having found out what risks were entailed for the onshore population, still less determining that these were so low as to be acceptable.

6. Conclusions

- 6.1 For most LNG projects, the risks due to spills on the sea are the highest risks involved in such projects, due to the particular difficulties in controlling a spill of LNG on water, the size of ships' cargo tanks, and the relatively high likelihood of a marine accident compared to a similarly large spill onshore.
- 6.2 The regulatory framework for project approval for marine operations involving large quantities of hazardous cargo, is seriously deficient. There is an obvious disparity between the regulatory control of dangerous cargoes in the shore-based facilities and that for the marine side.
- 6.3 In particular, the risks to the onshore population, due to marine LNG operations at Milford Haven, have fallen through a regulatory gap. The EU Seveso-2 Directive does not extend to port areas, and the authorities did not elect to use their other powers to evaluate this risk to an equivalent standard. For example, the planning authorities (which, in granting approvals for the terminals, relied in this respect on the Port Authority) could have required the relevant information under the EU environmental impact assessment (EIA) process. Alternatively, either the planning authorities or the Port Authority could have requested the information in any event, before deciding their respective positions in relation to the applications.

- 6.4 As to EIA, I refer in this report to Royal Haskoning's QRA work which formed part of the EIA for the Dragon terminal. That work was not sufficient by a long way, yet there was nothing equivalent, even to that, in the EIA in relation to the South Hook terminal.
- 6.5 The LNG import projects involve several government approvals: the land-use planning for the shore terminals and jetties; the consents for the onshore cross-country gas pipeline; and the acceptance of the proposed marine shipments by the port authority. These are, in reality, inseparable parts of a single infrastructure project. The necessary scientific expertise and sector-specific knowledge exists within different branches of government to assess the public risks to a consistent standard. However, there has been no proper analysis of the risks to the shore-based population due to marine LNG spills that was made available to the decision making authorities. Approvals were therefore granted to the terminals without this critical information.

ANNEX 1: References

1. Milford Haven Port Authority: "Approach to and use of Risk Assessments", undated, published on Internet at:
http://files.mhpa.co.uk/lng/risk_assessment_use.pdf
2. EEC Council Directive 96/82/EEC of 9 December 1996 "Seveso-2 Directive" on the control of major-accident hazards involving dangerous substances, Official Journal No. L 10/13, 14.1.97
3. Statutory Instrument 1999 No. 743 "The Control of Major Accident Hazards Regulations 1999", UK HSE, SEPA and the Environment Agency, 1999
4. SIGTTO - Society of International Gas Tanker and Terminal Operators: "Site Selection and Design for LNG Ports and Jetties", Information Paper No. 14, ISBN: 1 85609 129 5, January 1997
5. SIGTTO - Society of International Gas Tanker and Terminal Operators: "LNG Operations in Port Areas", First Edition, ISBN 1 85609 256 9, 2003
6. Lloyd's Register EMEA, Consultancy Services Group: "Event Statistics", Ref: CSG 05-252-1-1, 13 April 2005
7. Gordon Milne, Senior Risk Analyst, Lloyd's Register of Shipping: "Explosion & Gas Release from LNG Carriers", a conference paper or a scientific journal paper, unknown where published.
8. Royal Haskoning (Netherlands): Quantitative Risk Assessment - Petroplus Tankstorage International Dragon LNG Terminal Milford Haven, Wales - Draft Report, dated 9 January 2004
9. Sandia National Laboratories: "Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water", commissioned by the U.S. Department of Energy, SAND2004-6258, December 2004

ANNEX 2: Annotated Copy of Statement by the Milford Haven Port Authority

MILFORD HAVEN PORT AUTHORITY

Approach to and use of Risk Assessments

[Note: The original text of this paper is presented in Arial Font while the annotations are in italic bold Times Roman font between square brackets. All annotations have been made by the author of the report to which this is an Annex.]

In 1982, the Authority (then the Milford Haven Conservancy Board) commissioned Burgoyne Consultants Limited to produce a report into the potential consequences of fires and explosions involving the significant amount of hazardous cargo being handled by the port including LPG (Liquefied Petroleum Gas).

The outcome was used to assist in the development of both the Port Emergency Plan and provision of moving exclusion zones around certain vessels.

In 1997, a Quantified Risk Assessment (QRA) was undertaken by Bomel Consulting Engineers. The study, the first of its kind in the UK, included the specific traffic pattern experienced by the port including LPG tankers. This study formed the basis on which MHPA devised and introduced its Safety Management System (SMS) which in compliance with the Port Marine Safety Code is the basis on which all the Authority's operations and planning are approached. *[Comment: this work uses judged consequence categories of which the highest is ">5 fatalities", rather than a consequence analysis based on LNG spill sizes and vapour travel distances, shore population numbers at risk, etc. It covers all vessel types, but makes no distinction between them, relevant to LNG. "Gas carriers" are included, often with other types of vessel, and it is unspecific whether "gas" means LPG or LNG, which have very different cargo tank sizes and physical characteristics. Moreover, this work was done before there was any intention to import LNG at Milford Haven. The "hazards" listed are mostly aimed at marine navigation concerns; cargo spills are not included in the list. Accordingly, there is no consequence analysis of any cargo spill. Therefore, this assessment cannot be considered to be a QRA in the sense in contention here, i.e. a risk assessment of the risks due to LNG spills for the neighbouring population.]*

In 2004 and due to the impending arrival of LNG (Liquefied Natural Gas) from the end of 2007 onwards, the Authority required Burgoyne's to update their report to include such LNG vessels.

It is important to note that the report commissioned and provided considers the consequences of events without giving any consideration to the adequacy of the precautions in place to prevent or minimise the consequences of each incident type.

In short, the report is a “HAZID” (hazard identification). *[Comment: MHPA do not reveal what the results of this consequence analysis were, in respect of LNG or the other cargoes considered. This report has not been published nor disclosed, nor has the earlier Burgoyne report of 1982. The consequence results have not been combined with frequency estimates to generate estimates of risks to the local population.]*

To take this further it was decided to commission Lloyds Register to consider the Burgoyne report's findings and produce a QRA for the port, set against worldwide statistics and convert those findings into readily understandable, layman's terms - e.g. “Any explosion (including fire) large enough to potentially injure people nearby is only slightly more likely per year as being struck by lightning.”

[The Lloyds' study](#) further concluded “The likelihood of an LNG incident is extremely low. There has never been a recorded incident of a major release of LNG from a ship to external atmosphere.” Similarly, “No member of the public has ever been injured by LNG from a ship.”

[Comment: There are two pieces of work by Lloyd's Register, to which MHPA make reference in different places:

LR(i) “Event Statistics”, Ref: CSG 05-252-1-1, prepared by: Lloyd's Register EMEA, Consultancy Services Group, Date: 13th April 2005

LR(ii) “Explosion & Gas Release from LNG Carriers”, by Gordon Milne, Senior Risk Analyst, Lloyd's Register of Shipping, which from its style and content appears to be a reprint of a conference paper or a scientific journal paper, but the copy I have does not indicate where it was published.

The hyperlink in the MHPA text points to LR(i). The quotation “Any explosion (including fire) large enough to potentially injure people nearby is only slightly more likely per year as being struck by lightning” is a paraphrase from this report, however, examination of the report shows that this is not a finding of an assessment for LNG or even LPG gas carriers, but relates to general ship fires, which by their nature are unlikely to affect shore-based neighbours.

The quotations: “The likelihood of an LNG incident is extremely low. There has never been a recorded incident of a major release of LNG from a ship to external atmosphere.” and “No member of the public has ever been injured by LNG from a ship.” also come from LR(i) but are not supported by any assessment. They are simply assertions.

LR(i), in fact, is merely the application of worldwide port accident statistics to the traffic volumes at Milford Haven, and is neither specific to that Port (except for the traffic volumes), nor is it specific to LNG, still less the particular LNG terminals being built here.

LR(i) in any case is not a QRA, and furthermore it is highly misleading to say that it “takes further” the Burgoyne report, since it makes no reference to the latter, nor uses any of its results concerning the consequences of LNG spills.

LR(ii) is not a study that is specific to Milford Haven, nor was it commissioned by MHPA. I refer to this document again below.]

For more than twenty years Milford Haven has been the largest Gas handling port in the UK with approximately 1,000,000 tonnes of LPG handled annually. Although there have been a number of minor incidents with LPG vessels, no uncontrolled loss of containment has been recorded.

The arrival of LNG will dovetail well with the existing procedures for handling hazardous vessels including exclusion zones within the main channels enforced by Port Control and patrol boat. However, additional resource in the form of a shadow tug will be made available to further ensure that vessels are correctly separated from each other.

In addition, and in compliance with SIGTTO (Society of International Gas Tanker & Terminal Operators Ltd) guidance the Authority has further widened the channel in the vicinity of the South Hook terminal and opposite the Dragon terminal to provide a larger separation distance for certain vessels (e.g. ferries) whilst passing LNG ships which are alongside at either facility.

[Comment: MHPA may have complied with SIGTTO guidance on channel widths, but has not complied with SIGTTO guidance on site selection and design for LNG ports and jetties - Ref.4]

June 2005

Milford Haven Port Authority's Approach to Planning for the Management of LNG Shipping

In common with all other UK ports, we have a duty to accept all those who wish to enter the port. We do not have the ability to deny entry to any vessel except in very specific circumstances. Thus, our whole approach is to determine the way in which we manage ships and other uses of the Waterway so as to identify risks and in the way in which we regulate water movements, mitigate or remove such risks entirely.

[Comment: The Port Authority has more than one role. In their role as a statutory consultee to the planning process, they had a duty to advise the Council about the marine cargo risks to the shore based public. They also have a duty as the safety regulator to address that risk properly in their management of the port. They did not do this - in contrast to HSE who did undertake the equivalent job for the shore side of the same project.]

Thus, given the fact that LNG ships will be using the Waterway from the third quarter of 2007 our whole approach has been to work alongside the technical teams of both developers so that we get an understanding of what their shipping requirements are, and also feed into them our own comments and approach so that they can be incorporated into their planning. We have identified a wide range of

scenarios which we have then tested within the framework of our Safety Management System, the basis of which is that all activities are underpinned by a comprehensive risk assessment. Such scenarios and risks have been tested in a variety of ways through both internal and external discussions and analyses ; the use of simulators at MARIN in Holland and also Fleetwood ; visits that members of our Marine team have made to various LNG facilities and ships ; the commissioning of various reports from specialists and a detailed and continuing dialogue with all those involved.

In particular we have researched, assessed and identified such factors as the capacity of the Haven to accommodate traffic increases, the stages of tide at which LNG ships will be allowed to move; the circumstances relating to the number and size of tugs, the number of Pilots, and weather conditions that will allow or prevent movements; the need for any modifications or changes to the navigation marks or facilities that we have in the Haven; any changes required to the navigation channels with deepening or widening ; and a similar approach to turning areas. We have also taken into account the appropriateness of current security provisions under the Security Plans that we have for controlling our facilities which are approved by the security arm of the Department for Transport (TRANSEC), and will be making modifications to these where necessary to meet TRANSEC's own assessment. We have also identified the need to revise and update our emergency response plans, and have entered into dialogue with the Fire Service, the terminal operators and the emergency response division of Pembrokeshire County Council among others.

We would wish to emphasise that this is very much an iterative process which is constantly being refined to ensure the optimum procedures are in place to facilitate the safe and efficient handling of LNG vessels, indeed all vessels utilising the Haven.

September 2005

Summary of some of the Risk Assessments and Analyses undertaken to assist in planning for the continuing safe and efficient management of shipping with the advent of LNG Ships from 2007

Introduction

MHPA have been on a continual path to assess the risks and prepare for arrival of these vessels which will bring the port traffic up to the levels previously handled safely in the Haven. This path of assessment uses our Safety Management System (SMS) approach which was developed through a quantified risk assessment and provides for detailed assessment of risks and the identification of the most appropriate management strategies. This complies with the requirements of the

Port Marine Safety Code which applies to all UK ports and for which the policy is laid down by the Department for Transport in consultation with the industry and monitored by the Maritime and Coastguard Agency.

This process has included navigation and engineering studies, ship simulations and risk assessments using the Authority's pilots and technical staff, information and studies from the LNG project teams and the commissioning of a number of studies and risk assessments (both quantitative and qualitative) from independent, professional experts. In co-ordination with the developers we continue to evaluate and assess all potential threats as part of the planning and preparation process for LNG operations.

[Comment: none of these assessments included an assessment of the consequences and probabilities of spills of LNG from ships affecting the local populations, and in particular the level of risk borne by the neighbours. As such, they do not constitute a risk assessment, neither as separate studies, nor as a collection of studies.]

As part of this continuing preparation several studies have been conducted to determine ways to reduce the risk of LNG marine traffic. As a consequence of these studies, a number of measures will be implemented. For example, the channel is to be widened to provide greater separation of ships in the Haven ; while LNG carriers are unloading the traffic speed of passing ships in the Haven is to be reduced ; a minimum of two pilots are to be aboard LNG vessels entering the Haven ; the existing fleet of tugs is to be augmented with new state-of-the-art tugs equipped with the latest technology.

[Comment: these are being presented as special measures, derived from the studies of risk, but in fact they are nothing more than standard practice for LNG operations. They are presented as “reducing the risk” but there is no demonstration what that risk level was before and after these measures were adopted, not whether the residual risk is acceptable.]

Making detailed Information Publicly Available

The broad scope of these studies mean that certain scenarios are assessed which, if generally publicised, might be sensitive from a national or local security perspective. These considerations combined with ongoing legal challenges prompt an understandable reluctance on the part of the Port Authority and the developers to release these documents into the public domain.

We are also concerned that our experience is that when detailed rather than summary and conclusive information is made available then it is misused by those opposing the projects by information taken out of context and used for scaremongering, unjustified allegations and superficial challenging of the conclusions. Examples of this include the decrying of Royal Haskoning QRA by

misquoting the HSE, misuse of SIGTTO guidelines, and taking out of context a piece of information in the comprehensive assessment undertaken and published by Dragon LNG.

[Comment: The Royal Haskoning QRA, [Ref.8], was undertaken under contract to one of the two LNG terminal proponents, Petroplus (later, Dragon LNG). It contains all the elements of a proper QRA, however its scope does not include LNG ships in transit or manoeuvring. Its treatment of releases from ships' cargo tanks while at berth is extremely superficial and grossly understates the quantities that could be spilled. In general, there are several serious technical objections that can be raised against this QRA, in that its calculations of both the sizes of the spills and the consequence distances are underestimated.]

Thus our policy, agreed as a common approach with all those involved in these developments, is to outline and describe what has been undertaken and why, together with the results and how they have been used, but not to make publicly available the large amount of detail of the work done.

[Comment: the cited documents, purporting to be the MPHA's "risk assessment" do not at all reflect a "large amount of detail of the work done"; they show that no work relevant to the risk to shore populations was done. In particular, the Lloyds Register work, which MHPA portray as a "QRA", is, in fact, nothing of the kind, and its conclusions regarding LNG risks are totally unsupported by any analysis specific to this site or the specific LNG traffic and terminal locations.]

However we do accept that we have both a duty and a business need to be as open as possible and explain our position as widely as we can. Thus we have made many presentations, had many discussions and offered to meet many individuals so as to fully explain the approach we are taking and will continue to develop as the introduction of LNG shipping draws near. We have also carried summaries of what we have done and will be doing in our Annual Reports, press releases, interviews to the media and many other ways, including keeping our politicians fully informed and placing a priority on responding to any questions that they have of us.

What actual information have we made available.

One of the accusations is that we have not made any information available especially about our approach to managing LNG shipping. This is far from the truth as a considerable amount of such information has been, and will continue to be put into the public domain. Some examples of the information and mechanism of its public promotion are given below. *[Comment: Despite the title of this section, and the one immediately following, the information items listed at subparas. a to j below have, for the greater part, NOT been made publicly available. Of the 10 listed items, only (j) and a severely redacted extract from (b) have been released publicly. To the casual reader, this*

section gives a totally misleading impression that the port authority has been very open with information, when, in fact, the opposite has been the case. A summary is given in my table on page 8 above.]

Formal Public Information

The following summary of our approach was included in the bundles available to Safe Haven and their legal team in MHPA's Summary Grounds as part of the judicial Review :-

The Authority has undertaken and/or participated in and/or considered many risk assessment reports as part of its continuing work with each developer. The range of risk assessment analysis undertaken includes the following (as an illustration for the purpose of these summary grounds of the extent of the Authority's active participation in what has been and continues to be a thorough process of evaluation and risk assessment) :-

- a. Marico Marine, a well established and reputable Marine and Risk Consultant, was commissioned to conduct a marine traffic analysis of vessel movements through the port during a 25 day period in November 2002.
- b. South Hook LNG submitted a concept risk assessment dated 9-10 December 2002 to identify hazards, consequences and possible mitigation measures relating to the potential use of the port of Milford Haven for the importing of LNG. The Authority participated in the assessment process.

[Comment: An extract from this document has been released by the MHPA. This indicates that the assessment used the judgmental "Risk Matrix" approach which is often used for comparative assessment at the concept definition stage, but is not capable of providing an estimate of the degree of risk to neighbouring populations, and does not reflect the final design. There is no indication in the extracted results that any estimate of the geographical extent of the consequences of LNG spills was included in the work. This does not constitute a risk assessment suitable for regulatory purposes.]

- c. Marin, the Maritime Research Institute Netherlands, produced a report, dated 14 February 2003, on simulations to check the nautical consequences of future 200,000 m³ LNG carriers (in respect of the South Hook LNG's proposal).
- d. In March 2003 Marico Marine produced a navigational risk assessment in respect of the Dragon LNG's proposal. The report concluded that the risks inherent in the movement of LNG tankers in the Haven are manageable and tolerable. It identified a number of additional risk management measures to further reduce residual risk. An addendum to this report was produced in March 2004 and assessed the use of Berth 1 for LNG vessels. The report reflects the continuing dialogue

between the Authority and Dragon LNG in respect of marine risk assessment.

- e. Marin reported on fast time simulations for large LNG ships in a report issued on 19 May 2003.
- f. Det Norske Veritas (USA) Inc. (“DNV”), a major classification society, produced a technical report dated 13 October 2003 in respect of South Hook LNG's proposal assessing the marine risk associated with vessel manoeuvres in the channel and around the South Hook terminal for discharging cargo from LNG carriers. The report recommended mitigation measures which have been accepted by the authority and developer.

[Comment: MHPA do not indicate whether this study considered the risks associated with the cargo, or only “marine” risks - which often means ship navigation risks only. If they did consider cargo-related risks, what were the levels of risk to the shore populations? No indication is given.]

- g. ABS Consulting Inc., an international consulting operation experienced in the analysis of shipping collisions, produced a report dated 20 February 2004 for South Hook LNG dealing with potential damage to LNG tankers due to ship collisions.

[Comment: The conclusions of this study are not mentioned. They should have included estimates of the likelihood of holes being created in LNG cargo tanks, and the sizes of those holes. Note that the US DOE Guidelines, Ref.9, indicate holes sizes in the order of 1 to 5 m² in area, depending on the severity of the collision. Such breaches would lead to very large spills of LNG, in the order of thousands of cubic metres.]

- h. The Authority commissioned a report from Burgoyne Consultants, International Consulting Engineers and Risk Consultants, dealing with the potential consequences of fires and explosions involving ships carrying petroleum products (including LNG), which updated a similar report obtained in the early 1980's. The Authority used the findings in the earlier report to develop procedures for regulating and managing shipping movements, and, in the light of the proposal to handle LNG, commissioned the latest report dated March 2005. It confirmed the continuing relevance of the current systems and procedures that applied to ships carrying petroleum products to those that would convey LNG.

[Comment: This report has not been released, either to the public or even to the local planning authority. It is the only report, commissioned by MHPA, that may have included the potential consequences to the public from large LNG spills, but these consequences have not been published, nor (apparently) communicated to the local planning authority (March 2005 was after the permissions had been granted), nor used in any of the other studies that MHPA claim constitute their assessment of risks.]

- i. South Hook LNG commissioned a report in November 2003 from HR Wallingford, the former research establishment for the Ministry of Defence, dealing with mooring safety and the possibility of disturbance caused to moored vessels and made this available to MHPA.
- J. A report by Gordon Milne, Senior Risk Analyst at Lloyd's Register of Shipping, was commissioned by the Authority to assess the risk of explosion and gas release from LNG carriers. It concludes that : "LNG has specific parameters which make the likelihood of a major explosion remote. These features combined with the high standards of design and operation throughout the industry mean that compared to other chemicals LNG poses one of the lowest threats to the general public and property".

[Comment: this is the paper referred to in my page 14 as LR(ii). It must be noted here that the occurrence of "explosion" in an LNG vapour cloud is not the only hazard. A fire in such a cloud would be very nearly as devastating as an explosion, and most analysts consider that it would cause a similar numbers of casualties. It is strange that the Lloyds Register report LR(i) is not included on this list and I suspect that in drafting this table, MHPA were confusing them.]

[General comment: of these studies, items (a), (c), (d), (e), (f), (g) and (i) are useful but narrow studies of specific operational matters, in particular ship navigation, which could provide input to a comprehensive risk assessment but do not include cargo spill risks and thus do not constitute a risk assessment of the sort that is in contention here.]

Other Public Information

The above is a description of the actual assessments and studies. We have also explained our approach in more general terms to a wide range of enquirers over the past six months including Safe Haven, local residents, politicians, Lord Crickhowell, and in press releases etc.

We have explained that we have researched, assessed and identified such factors as:

- the capacity of the Haven to accommodate traffic increases
- the way in which LNG ships will be allowed to move according to the state of tide;
- the number and size of tugs they will need;
- whether those tugs should provide active escorting (coming in with the tanker with a line attached);
- the number of pilots per movement, the number of pilots to be employed in total;

- identifying the training programme required for our pilots and others;
- weather and tidal conditions that will allow or prevent movements;
- where ships will swing to get onto a berth;
- the need for any modifications or changes to our navigation aids such a buoys or other facilities;
- any changes required to the navigation channels or turning areas themselves.
- we have fully taken into account any implication from LNG shipping with the security plans that we now have in place in compliance with the ISPS code (International Ship and Port Facility Security code)
- we have assessed the need to update our various response plans and capabilities, and the need for and process of consultation and working with other authorities and agencies.

Summary

From the above it is quite clear that the Authority has undertaken and facilitated a detailed assessment of marine risks involved in the LNG proposals. It gave informed advice to the LNG developers, to the Planning Authorities and to the HSE in respect of the decisions which they took. Pursuant to its continuing duties to operate a safe port, the Authority is continuing work in respect of risk assessment and mitigation measures to ensure that the port continues to operate safely and efficiently.

[Comment: None of that work addresses the magnitude of the risk to the shore population, due to the marine side of these LNG projects. By using the phrase “marine risks” the MHPA appears to claim that it has considered cargo spill risks, whereas the truth is that it has only assessed the marine navigation risks. Its consideration of cargo spills has been restricted to one confidential report (Burgoyne) and the results of that work have not been taken up in the other studies that MHPA claim constitute “risk assessments”.]

October 2005

PLANNING FOR LNG SHIPPING (Article for Coastal Forum Public Newsletter)

When the first ship carrying LNG (Liquified Natural Gas) arrives in Milford Haven in 2007 it will not be the first time that the pilots, bridge team and tugs involved will have brought the ship into the port - they will have done so on many occasions before, under a variety of testing conditions on the simulators in the Marine Research Institute in Holland and the Nautical College in Fleetwood. The use of

these simulators is just one of the ways in which Milford Haven Port Authority is preparing for this new development.

There have been calls for the Authority to publish the risk assessment that has been undertaken that confirms that LNG ships will be allowed into the port. There is no single such document however but rather a series of processes, assessments and scenario testing, such as the use of the simulator, that define the way in which the Authority will continue to safely and effectively manage the port with LNG ships added to the variety of other users that currently make Milford Haven the fourth largest cargo port in the UK and one of the largest oil and gas ports in Northern Europe.

[Comment: The concept that a risk assessment may be constructed from several separate studies is not entirely wrong, but usually there is a single over-arching document that pulls together the results of sub-studies. For example, it is impossible to assess the risks being borne by the onshore population without bringing together the estimates of frequency of spills with the estimates of the consequences of LNG dispersion and combustion. Such an over-arching report is simply missing here (and, in any case, the sub-studies are not sufficient to support it).]

This misunderstanding that unlike say a Planning Authority we do not come to a yes or no decision as to whether LNG ships will be allowed into the port arises from the fact that in common with all other UK ports, we have a duty to accept any ships who wish to enter the port. We do not have the ability to deny entry to any vessel except in very specific circumstances. Thus, our whole approach is to determine the way in which we manage ships and other users of the Waterway so as to identify risks and in the way in which we regulate water movements, mitigate or remove such risks entirely.

So, starting from the fact that LNG ships will be using the Waterway from the third quarter of 2007 our whole approach has been to work alongside the technical teams of both developers so that we get an understanding of what their shipping requirements are, and also feed into them our own comments and approach so that they can be incorporated into their planning. We have identified a wide range of scenarios which we have then tested within the framework of our Safety Management System which itself is underpinned by a comprehensive quantified risk assessment. Such scenarios and risks have been tested in a variety of ways through both internal and external discussions and analyses ; the use of simulators as mentioned above ; visits that members of our Marine team have made to various LNG facilities and ships ; the commissioning of various reports from specialists and a detailed and continuing dialogue with all those involved.

In particular we have researched, assessed and identified such factors as the capacity of the Haven to accommodate traffic increases, the stages of tide at which LNG ships will be allowed to move ; the circumstances relating to the number and size of tugs, the number of Pilots, and weather conditions that will allow or prevent movements; the need for any modifications or changes to the navigation marks or facilities that we have in the Haven ; any changes required to the navigation channels with deepening or widening ; and a similar approach to turning areas. We have also taken into account the appropriateness of current security provisions

under the Security Plans that we have for controlling our facilities which are approved by the security arm of the Department for Transport (TRANSEC), and will be making modifications to these where necessary to meet TRANSEC's own assessment. We will revise and update our emergency response plans, and have entered into dialogue with the Fire Service, the terminal operators and the emergency response division of Pembrokeshire County Council among others.

One of the risk assessments that we initiated was from the Risk Analysis team at Lloyd's Register of Shipping. They were commissioned by the Authority earlier this year to assess the risk of explosion and gas release from LNG carriers in Milford Haven. [Their report](#) concludes that:

“LNG has specific parameters which make the likelihood of a major explosion remote.These features combined with the high standards of design and operation throughout the industry mean that compared to other chemicals LNG poses one of the lowest threats to the general public and property.”

[Comment: the statement by MHPA does not appear to be true. The commissioned report was LR(i), which is the report found through the hyperlink. However, it was LR(ii), the paper by Gordon Milne, which addressed the risk of explosion and gas release from LNG carriers (but not specifically in Milford Haven) and contained the cited text. LR(ii) does not appear to have been commissioned by MHPA. Moreover, as I have discussed elsewhere in this report, neither of the two LR papers came anywhere near to being a risk assessment of the sort that should have been done.

Moreover, the conclusion by Gordon Milne concerning “explosion” is liable to be misunderstood and appears to have been misunderstood by MHPA. As mentioned above, the risk that is of importance is the risk of a drifting unignited vapour cloud, which may reach population and then ignite - the consequences of the resulting fire would be devastating—regardless of whether or not an explosion (i.e. blast effects) occurred. Finally, there is no scientific basis for his claim that LNG is among the least hazardous of chemicals. It is very volatile, its vapour is denser than air (and remains so during atmospheric dispersion), its energy content per tonne is similar to LPG and other fuels.]

It is important to emphasise that this is very much an iterative process which is constantly being refined to ensure the optimum procedures are in place to facilitate the safe and efficient handling of LNG vessels, indeed all vessels utilising the Haven.

September 2006

Brief to Staff and the Public

LNG and Leisure Craft on the Haven

No significant extra restrictions will be enforced on leisure craft as a result of the LNG ships expected to call regularly at the Haven's two terminals from the end of 2007.

Around 300 will be arriving each year, a relatively small increase on the 3,500 ship calls already handled in the port. Milford Haven is the fifth busiest port in the UK, and the Port Authority is skilled at handling the movements of all shapes and sizes of vessels, some of which are as large, or larger, than those that will be carrying LNG.

Only minor modifications will be needed to accommodate the handling of LNG ships within the current mix of oil and gas tankers, ferries, fishing and general cargo vessels and the increasing number of recreational craft.

Thus there will continue to be restriction zones in the shipping channels within 100 metres of the jetties, as well as a moving restriction zone of one mile in front and behind a loaded LNG vessel, as is currently the case for loaded gas tankers. Leisure users navigating outside the main channel are unlikely to be affected at all. The small boat passages through the existing jetties will remain open, unless their temporary closure is required because the port is operating at higher than normal security levels. The existing Codes of Conduct outlined in the Recreation Plan and the annually published Leisure Guide will continue to apply.

As a Port Authority, we are fully committed to securing and developing the recreational role the Haven plays, including accommodating certain racing events and regattas. Whilst a new energy era is being embraced, so too is the continued use of the Haven as a safe and enjoyable leisure environment.

Any queries or comments on this should be sought from any MHPA manager or from

Ted Sangster
Chief Executive
Milford Haven Port Authority
Gorsewood Drive, Milford Haven, SA73 3ER
Tel : 01 646 6961 00 e-mail : tedsangster@mhpa.co.uk

Milford Haven Town & Marina Guide 2006/7

Liquefied Natural Gas...

The Haven's new energy era

With two LNG receiving terminals being built on the Haven we can expect specialist LNG ships to start using the port from the end of 2007. There has been much publicity surrounding these developments and unfortunately much misunderstanding of the true situation as a result of the way in which some opponents of LNG terminals have inaccurately portrayed their view of how this will impact on the users of the port and the local community.

Whilst Milford Haven Port Authority would be pleased to respond to any questions or concerns about any aspect of LNG shipping (contact the Chief Executive on

01646 696100 or e-mail enquiries@mhpa.co.uk) a brief summary as to how we are planning for LNG ships to successfully co-exist with all recreational users of the Waterway is given below.

LNG shipping has been operating successfully and safely across the world for over 40 years. In over 45,000 loaded voyages whilst there have been some incidents none has resulted in a loss of any cargo. LNG shipping has an exemplary safety record and Milford Haven Port Authority has been working closely with both local projects in terms of the studies and risk assessments to ensure that the Port will continue to operate safely and efficiently. For the Haven's Leisure community, very little will in fact change - just the more regular sightings of quite spectacular commercial craft on the waterway!

No significant extra restrictions will be enforced, as a result of the 300 LNG ship calls expected each year once the terminals are fully operational - a relatively small increase on the 3,500 ship calls already handled in the port. In fact as the fourth largest port in the UK the Port Authority is skilled at handling the movements of all shapes and sizes of vessels - some of which are at present, as big, or larger than those that will be carrying LNG.

The independent research and risk assessments which have been commissioned by the Authority have confirmed both that there is sufficient capacity to accommodate the increase and that the current procedures, with some minor modifications are equally appropriate to handling LNG ships within the mix of current oil and gas tankers, ferries, fishing and general cargo vessels and the increasing number of recreational craft.

Thus there will continue to be restriction zones within 100 metres of the jetties, but this already applies as do the moving restriction zones of 1 mile in front and behind a loaded gas tanker. The small boat passages through the existing jetties will remain open following comprehensive risk assessments - (the point to note here is the possible temporary restriction on their use if the port is required to operate at a higher than normal security level) and the existing codes of conduct outlined in the Recreation Plan, the annually published Leisure Guide and indeed within this Guide will continue to apply.

What is clear is that for the many people who use the waterway for leisure use, no significant changes will occur. The Port Authority is fully committed to securing and indeed developing the recreational role that the Haven plays. Thus whilst a new energy era is being embraced, so too is the continued use of the Haven as a safe and enjoyable leisure environment.

LNG is methane (Natural Gas) which is liquefied by cooling it to temperatures of minus 160 degrees Celsius. The chilled liquid is then stored in insulated storage tanks, until such time as it is pumped into specially built tankers and shipped as a liquid at this temperature. Discharged into insulated tanks onshore it is then sent to vaporisers where it is re-gasified by warming the cold liquid until it reverts to a Gas.