Ministry of Commerce & Industry
Government of India

Confederation of Indian Industry

Standards and Conformance Cooperation Programme

Interactive Session on

US-India Cooperation in Standards & Conformance in LNG, LPG & CNG Equipment

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BACKGROUND PAPER

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Introduction

The Standards Conformance and Cooperation Programme (SCCP) between India and US aims at diluting the roadblocks to cross-border trade and infusing harmony in the standards of trade between the two countries. The SCCP is an initiative taken by the US Trade and Development Agency (USTDA) in conjunction with the American National Standards Institute, the Confederation of Indian Industry (CII) and the Bureau of Indian Standards (BIS), to tackle the non-tariff barriers to trade on various products.

In this regard, the Liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG) and Compressed Natural Gas (CNG) sector has been identified as a critical sector for bilateral trade between India and US. The SCCP will work towards sustaining a dialogue and finding solutions to complex issues faced by exporters from both countries in this sector.

The meet is expected to give an overview on the US experience in safe practices in the LNG, LPG and CNG industry. With this in view, this background paper is being put together that captures through case studies US industry's experiences and learnings in safe practices as an

overall view of the Indian natural gas industry and the storage needs and opportunities. Even though in the Conference we will discuss about the natural gas industry as a whole, for purpose of an in depth study, this paper takes the case of US LNG operations.

LNG Operations Safety and Regulations: A Case Study of the US Industry

Liquefied natural gas, or LNG, is natural gas that has been cooled to minus 160° C (minus 260° F) at atmospheric pressure and reduced to a liquid state that is 1/600th its original volume. LNG is clear, colourless, odourless, non-corrosive and non-toxic.

The potential hazards of LNG are the result of its basic properties -- its cryogenic nature and dispersion and flammability characteristics. Due to its cryogenic nature, LNG will freeze any material it comes in contact with. As a liquid, LNG cannot explode and is not flammable. It's only when LNG is warmed and returns to its gaseous state and comes in contact with an ignition source, that the mixture become flammable. However, the LNG industry uses advanced safety technologies and procedures. These are enforced and maintained through numerous standards, codes and regulatory supervision.

Worldwide, very few countries viz. EU, US and Canada have their own LNG standards. In US, LNG standards are made by the Technical Standard Committee of NFPA (National Fire Protection Association) which is recognized by various US state governments.

LNG Operations: History And Reliability

The first LNG plant was built in West Virginia in 1912 and began operations in 1917. In January 1959, the world's first LNG vessel, the Methane Pioneer, delivered an LNG cargo from Lake Charles, Louisiana to the United Kingdom. Worldwide, there are over 30 LNG export (liquefaction)

terminals with liquefaction capacity exceeding 250MTPA , 55 LNG import (re-gasification) terminals with total regasification capacity of around 500MTPA, and more than 300 LNG vessels (including Coastal Carriers) in operation. Since the industry's inception in 1959, there is commendable safety record in this industry in port or on the high seas. LNG vessels, which are double hulled and specially designed for storage in special containment systems a, have made more than 80,000 LNG shipments worldwide, covering more than 160 million kilometres.

Safety Hazards from LNG Terminals

The safety hazards associated with LNG terminals have been debated for decades. A 1944 accident at one of US's first LNG facilities which killed 128 people, initiated public fears about LNG hazards and these persist even today. Technology improvements and standards since the 1940's have made LNG facilities much safer, but serious hazards remain since LNG is inherently volatile and is usually shipped and stored in large quantities. A January 2004 accident at Algeria's Skikda LNG terminal killed and injured over 100 workers and has added to the current debate over the safety of LNG facilities.

Hazards of LNG

Natural gas is combustible, so an uncontrolled release of LNG poses a hazard of fire or, in confined spaces, explosion. It is also hazardous because it is so cold. While questions remain about the credible impact of specific LNG hazards, there appears to be consensus as to what the most serious hazards are:

Pool Fires: If LNG spills near an ignition source, the evaporating gas in combustible and will burn above the LNG pool. The resulting "pool fire" would spread as the LNG pool expands away from its source and keeps evaporating. A pool fire is intense and burns more hotly and rapidly than oil or gasoline fires, and may injure people and damage property a considerable distance from the fire itself. It cannot be extinguished — all the LNG must be consumed before it goes out. Many experts agree that a large pool fire, especially on water, is the most serious LNG hazard.

Other Hazards: LNG spilled on water could (theoretically) regasify almost instantly in a "flameless explosion," but an Idaho National Engineering Laboratory report concluded that "transitions caused by mixing of LNG and water are not violent." LNG vapor clouds are not toxic, but they could cause asphyxiation by displacing breathable air. Such clouds may begin near the ground (or water) when they are still very cold, but rise in air as they warm, diminishing the threat to people on the ground. Extremely cold LNG could injure people or damage equipment through direct contact. However, the extent of such contact is likely be limited as a major spill would result in a more serious fire. The environmental damage associated with an LNG spill would be confined to fire and freezing impact near the spill as LNG dissipates completely and leaves no residue.

Terrorism Hazards: LNG tankers and land-based facilities could be vulnerable to terrorism. Tankers might be physically attacked in a variety of ways to destroy their cargo — or used as weapons against coastal

targets. LNG terminal facilities might also be physically attacked with explosives or through other means. Some LNG facilities may also be indirectly disrupted by "cyber attacks" or attacks on regional electricity grids and communications networks which could in turn affect dependent LNG control and safety systems.

North American Safety Regulations and Standards

The Department of Transportation (DOT) and the Federal Energy Regulatory Commission (FERC) are the federal agencies primarily responsible for the regulation of onshore LNG facilities in the US. Codes related to LNG such as for storage facilities (example: NFPA 59A) have been developed by the National Fire Protection Association (NFPA). These are technically balanced, open consensus standards, representing technical input from the following groups: Special experts, regulators/enforcers, insurance industry, manufacturers, users, (import terminals, peak shavers, base loaders), fire fighters, builders and non-pipeline LNG users and, the public.

NFPA 59A is a Living Code. This standard is constantly revised, so it represents the best technology, performance and safety requirements. It represents a balance between cost, engineering excellence, risk and regulations. The code is updated, every 3-5 years.

The Canadian Standards Association (CSA), a national standards organization for developing public safety standards in Canada, has a specific standard for LNG production, storage and handling (CSA Standard CAN/CSA Z276-01). This standard establishes essential requirements and minimum standards for the design, installation, and safe operation of LNG facilities.

The Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990 was formulated to regulate marine facilities in order to minimize the possibility of discharge of oil, and to protect public health, safety, and the environment. The authority for this regulation is contained in Sections 8755 and 8756 of the California Public Resources Code. This act defines "oil" as any kind of petroleum, liquid hydrocarbons, or petroleum products or any fraction or residue thereof, including but not limited to, crude oil, bunker fuel, gasoline, diesel fuel, aviation fuel, oil sludge, oil refuse, oil mixed with waste, and liquid distillates from unprocessed natural gas. This act also provides for the regulation of marine facilities that are used for the offloading, storage, or processing of Liquefied Natural Gas (LNG).

Indian Natural Gas Landscape: Emerging Opportunities

In India, it is a commodity in short supply. Natural, considering its demand has been growing in India. As domestic gas production falls short of demand, India has set up elaborate infrastructure for the import and storage of Liquified Natural Gas (LNG), Liquified Petroleum Gas (LPG), crude oil and petroleum products. India has emerged as a substantial Asian consumer of LNG and presently in fourth position after Japan, Korea and Taiwan. If you refer to the Natural Gas future scenario in the country as projected by the Ministry of Petroleum and Natural Gas, you will easily find that inspite of Reliance major gas find (80 mmScd), there will be substantial shortfall between Natural Gas demand

in the country in the future years which can only be made up by LNG import. India has presently two operating LNG terminals, third one will be commissioned by this year. A fourth one is under construction and at least three more are in advance planning stage. Rough estimate of investment of each is around USD 500 million. Further there will be large investment on transportation and distribution infrastructure.

LNG Import and Storage Terminals

LNG is the preferred fuel for power, fertilizer, transport and industry and its demand has been growing in India. India's natural gas supply from domestic fields was about 89 million standard cubic metres per day (mmscmd). That seems woefully inadequate when compared to what various sectors need.

In the power sector, it's expected to increase from 91 mmscmd to 148 mmscmd by 2011-12, while in the fertilizer sector, it's likely to increase by 36 mmscmd. Even city gas distribution is expected to increase rapidly.

The main producers for LNG are Oil and Natural Gas Corp Ltd, Oil India Limited (OIL); a joint venture of the BG Group, Reliance Industries and ONGC for the Panna/Mukta and Tapti fields; and Cairn Energy and ONGC in the Ravva field. With the entry of Reliance Industries and Niko

Resources, which have started pumping gas from the Krishna Godavari area off India's east coast since April 2, 2009, supply has increased dramatically and is expected to nearly double India's supply. Presently, Reliance Industries can produce 40 mmscmd, but it plans to increase production to 80 mmscmd by the year end. Full production is expected to last seven years.

Out of the 40 mmscmd it can produce, 15.3 mmscmd has been given to fertilizer plants, 18 mmcmd to gas-based power plants, three mmscmd to GAIL's LPG extraction units and five mmscmd to city gas projects. These are meant for retailing CNG for automobiles and piped cooking gas and are supplied at the government approved rate of $4.20 per mmbtu.

Existing LNG terminals

To augment its domestic supplies, India plans to import 25-27 MMTPA (million tonnes per annum) of LNG over the next 5-6 years and is trying to do so from Australia, Qatar, Papua New Guinea, Russia and Iran. Currently, there are two LNG terminals with about 7.5 mmbtu capacity, operational at Dahej and Hazira in Gujarat.

Incidentally, Petronet LNG, a joint venture of ONGC, GAIL, IOC, Bharat Petroleum Corporation (BPCL) and Gaz de France was the first to import LNG into the country from Ras Laffan Liquefied Natural Gas Company Ltd, Qatar. About five million tons a year are imported. This was regassified at Dahej and resold as Reliquified Natural Gas (RLNG) to customers in northern and western India. The terminal has a total capacity of 10 MMTPA. During 2008-09, 104 LNG cargoes were unloaded, equivalent to 9.6 million tonnes. Shell has set up the second LNG Import terminal in Hazira with a capacity of 3.6MTPA.In fact, this LNG terminal has been one of the largest greenfield foreign direct investments in the energy sector in India.

Expansion of existing terminals

To meet the growing demand for gas, India is expanding existing terminals and setting up new ones on the west coast.

- LNG Petronet has just doubled the capacity of its first re-gasification plant from five mmtpa to 10 mmtpa at Dahej. It'll be further enhanced to 12.5 mmtpa. Ras gas QATAR will be supplying an additional 2.5 million tons a year. For transporting this additional volume, a third LNG ship is being constructed at Samsung Shipyard in South Korea.
- A second Petronet LNG plant with a capacity of 2.5 mmtpa is being constructed by Petronet LNG at Kochi, in Kerala. This can be expanded to five mmtpa. The terminal consists of two storage tanks, vapourization systems, utilities and marine systems. The engineering, procurement and construction (EPC) contract for the Rs 25 billion terminal has been awarded to Japan-based Ishikawajima-Harima Heavy Industries (IHI) Each storage tank has a capacity of 188,000 cu m. The terminal will be complete by December 2011. An Australian subsidiary of Exxon Mobil Corporation and Petronet LNG Limited has signed a Sales and Purchase Agreement (SPA) for

long-term supply of LNG from the proposed Gorgon LNG Project in Western Australia of approximately 1.5 mtpa of Exxon Mobil's share of LNG over a 20-year term.

- The Hazira LNG terminal, jointly owned by Shell Gas B.V, and Total Gaz Electricité Holdings, represents an investment of Rs 30 billion. The terminal, within the newly built protected harbour, started operations in 2005. Though the initial throughput capacity is of the order of 2.5 million tonnes per annum (mtpa), the LNG terminal together with infrastructure is laid out for a capacity of five mtpa. With marginal incremental investments in equipment, the capacity can be enhanced to five mtpa. The terminal is now interconnected with the GAIL pipelines at Mora, enabling Shell, which procures LNG in the international spot market, to supply gas to all of north-west India and Maharashtra.
- India's fourth LNG import facility is being readied at the GAIL-led Ratnagiri Gas and Power Project Ltd (RGPPL). The Dabhol LNG Receiving Terminal on the west coast of India was incomplete when construction work stopped in June 2001 after the Dabhol project -- formerly owned by US energy major, Enron -- ran into contractual problems.

  The terminal, with an LNG regassification capacity of 5 mmtpa, forms part of the integrated Dabhol Power Project that has an installed capacity of 2,150MW, but has been scaled down to 1,950MW. Since then, the Government of India has entrusted the revival of the project to Ratnagiri Gas and Power Private Ltd (RGPPL). However, the commissioning of the terminal has been delayed due to dredging of the channel to allow LNG ships enter the port.

  Part of the terminal – about 1 million tonnes capacity -- is expected to be operational in early 2010. The terminal will be fully operational only after the completion of the breakwater facilities in 2011 and will then supply 2.1 mt regassified LNG for captive use and 2.9 mt for merchant sale.

- A fifth terminal is being planned at Mundra by Gujarat State Petroleum Corp Ltd (GSPC), Hindustan Petroleum and the Adani Group with an initial capacity of 6.5 mmtpa. The Brussels-based Tractebel is acting as the technical advisor for the project and has bagged an order worth $10 million for conducting the front-end engineering and design (FEED) study. It is expected to submit its reports in two phases over a period of nine months. Construction work is likely to begin in the second half of 2010.
- Meanwhile, British Gas had proposed a terminal at Pipavav in Gujarat and Tatas and Total at Trombay, but both were abandoned after initial studies.

All of India's LNG import terminals presently are on India's west coast. Though terminals were planned on the east coast – at Ennore, Kakinada. Paradeep, Visakhapatnam and Tuticorin – they didn't materialize. However, IOC remains undettered. Even though Reliance Industries Ltd (RIL) has added about 60 million standard cubic metres a day of gas to Indian production from its discovery

LNG TERMINALS – IN OPERATION AND UNDER CONSTRUCTION

COMPANY /PROMOTER	LOCATION	CAPACITY mtpa	REMARKS
PetronetLNG (IOC, BPCL, ONGC, GAIL, Gaz de France)	Dahej, Gujarat	10	To be 12.5 mtpa
PetronetLNG	Kochi , Kerala	3.6	Will be ready by Dec 2011
Hazira LNG (Shell/ Total)	Hazira , Gujarat	2.5	In operation
Ratnagiri Gas and Power Ltd (NTPC/GAIL)	Dabhol, Maharashtra	5.0	Commissioning in 2010
Gujarat State Petroleum, HPCL and Adani	Mundra, Gujarat	6.5	Tractebel is preparing report

in the Krishna Godavari basin, the state owned IOC sees enough demand for gas in the eastern region.

It has decided to commission a detailed feasibility report (DFR) on a 2.5-million tonne a year LNG import terminal at Ennore, on the outskirts of Chennai. The company is also exploring the possibility of setting up a power plant with the terminal and is scouting for partners. It's likely to approach NTPC, Tamil Nadu Electricity Board and Larsen & Toubro, besides Petronet LNG.

LPG Storage Terminals

India is a huge LPG retail market. Annual sales are close to 13 million tons and growing at 5-6 percent. The number of domestic LPG customers increased from 77.2 million to 94.3 million from April 2004 to April 2007. And the number of registered customers crossed 100 million in April 2008.

Production has been rising steadily from 3.44 million tonnes in 1997-98 to 8.868 million tones in 2007-08 and 9.170 million tonnes in 2008-09.

LPG is produced both by state-run companies and private ones. The main producers are state-run – Indian Oil, Hindustan Petroleum and Bharat Petroleum. Private refiners supply one fourth of the demand. RIL had at the beginning of 2009 said it would supply 2.693 million tonnes of LPG to state refiners, but shortly thereafter, raised it to 2.965 milllion tonnes, including supplies from the new refinery. Essar after expanding its capacity at its Vadinar refinery is in a position to supply 0.54 million tonnes of LPG.

LPG Import Terminals

However, this domestic production is insufficient to meet the full demand of over 13 million tonnes per annum and India has to import LPG. The LPG import capacity is close to 5 million tons per year. A LPG import facilities at Ennore is being planned and the capacity at Visakhapatnam is being augmented.

State-owned HPCL has two of the largest import facilities in the country -- at Mangalore with capacity of 1.0 mmtpa and another at Visakhapatnam with capacity of 0.6 mmtpa. These facilities receive imported LPG as well as the coastal input.

Meanwhile, Indian Oil, along with Petronas, operates a 300,000 tonnes per year import facility at Haldia and a 600,000 tonnes per year facility at Ennore Kandla.

Another LPG bulk terminal is likely to come up in Tamil Nadu, designed to handle a throughput of 400,000 MTPA. As part of its refinery expansion programme, Chennai Petroleum Corporation Ltd (CPCL) has entrusted Indian Oil with setting up of an LPG bulk terminal with world class operating systems, including automation, fire fighting, safety and health standards. Pollution and environmental control measures too will be in place. The fire protection system includes a water sprinkler system with deluge valves. CCTV for surveillance to ensure the highest level of security

has been provided. LPG is transferred through a four km cross-country pipeline from the CPCL refinery.

Several Indian and foreign parallel marketers of LPG – Aegis Logistics, SHV, Total, Shell, Caltex and Petronas – too have set up import terminals. Aegis Logistics was the first Indian Co.and in private sector to set up a 300,000 MTTPA state of art Refigerated Import Terminal in Mumbai port. Others were global major eg Totalgaz, SHV, Caltex who too set up LPG terminals.

In 2008, South Asia LPG Company Limited (SALPG), TOTAL's equal partnership 50:50 joint venture with HPCL commissioned a first-of-its-kind 60,000 MT capacity LPG underground cavern storage facility in Visakhapatnam in the southern state of Andhra Pradesh. The cavern, an engineering marvel, has been dug in solid hard rock to store LPG at 162m below mean sea level (MSL). The deepest portion of the cavern is 196m below MSL. The storage facility has two caverns of 19m height, 20m base width and 160m in length with interconnections. It's designed on the "water containment principle" and is jacketed with a water curtain. Besides being safe from natural calamities and hazards like sabotage, and aerial bombings, they are leak and fireproof.

The cavern facility is expected to ease storage constraints on the eastern coast and will enable the oil industry meet the ever-growing demand of LPG in the country. Large ocean liners are expected to bring-in the freight. Further, large parcels with higher tanker discharge rates will reduce the berth occupancy by LPG vessels at Visakhapatnam Port.

One of the country's leading private sector LPG players is SHV Energy, a 100% owned subsidiary of the family-owned Dutch business group. It started operations in India in 1996 with Gujarat and Andhra Pradesh. SUPER Gas now has operations spanning 17 states in all four regions of the country and has import terminals at Mumbai, Porbandar and Visakhapatnam.

Meanwhile, Shell has set up terminals at Kakinada in Andhra Pradesh and Porbander in Gujarat. Petronas and IOC have set up a terminal at Haldia in West Bengal and at Ennore in Tamil Nadu. In April 2009, IOC awarded the contract for design and engineering of an LPG import terminal at Kochi to Pyramid Consulting Engineers.

Crude Oil Storage: An Overview

India, Asia's third-largest oil consumer, currently imports nearly 70 percent its crude oil requirement. It imported 69.6 million tonnes for $31.6 billion in the first six months (April-Sept) of 2009-2010. India's current total crude oil storage capacity can meet the country's oil requirement for 19 days. Its 7.3 million tonnes of crude tankage is considered dangerously low. To cater to situations like wars and natural calamities, India plans to create a five million tonne strategic petroleum reserve by 2012, raising the country's total storage capacity to meet 90 days of consumption.

Indian Strategic Petroleum Reserves Limited (ISPRL), a Special Purpose Vehicle, owned by the Oil Industry Development Board (OIDB) of the

Government of India is setting up 5 million metric tones (MMT) strategic crude oil storages -- considered the safest means of storing hydrocarbons -- at three locations, namely, Visakhapatnam, Mangalore and Padur (near Udupi). The proposed storages would be in underground rock caverns near east and west coasts so that they are readily accessible to the refining sector.

The estimated cost of the project is around Rs 24 billion, excluding the cost of crude oil for filling the caverns. While the cost of the Mangalore project is Rs 7.32 billion, that of the Visakhapatnam one is Rs 6.72 billion and the Padur project is Rs 9.93 billlion. Their storage capacities also vary -- Visakhapatnam will have a capacity of 1.33 MMT, the Mangalore one, 1.5 MMT and Padur, 2.5 MMT.

Expertise for these plants is of the top range. While Engineers India Limited (EIL) is the project management consultant for all three projects, Hindustan Construction Company (HCC), a leading infrastructure construction and development company, has bagged the contract for construction of underground rock caverns at Vishakhapattanam and Padur. The order, worth Rs 3.75 billion, includes detailed engineering and design, underground excavation, access tunnels, water curtain galleries, main storage cavern, shafts and associated underground civil works, including geological mapping. The project will be completed in 36 months.

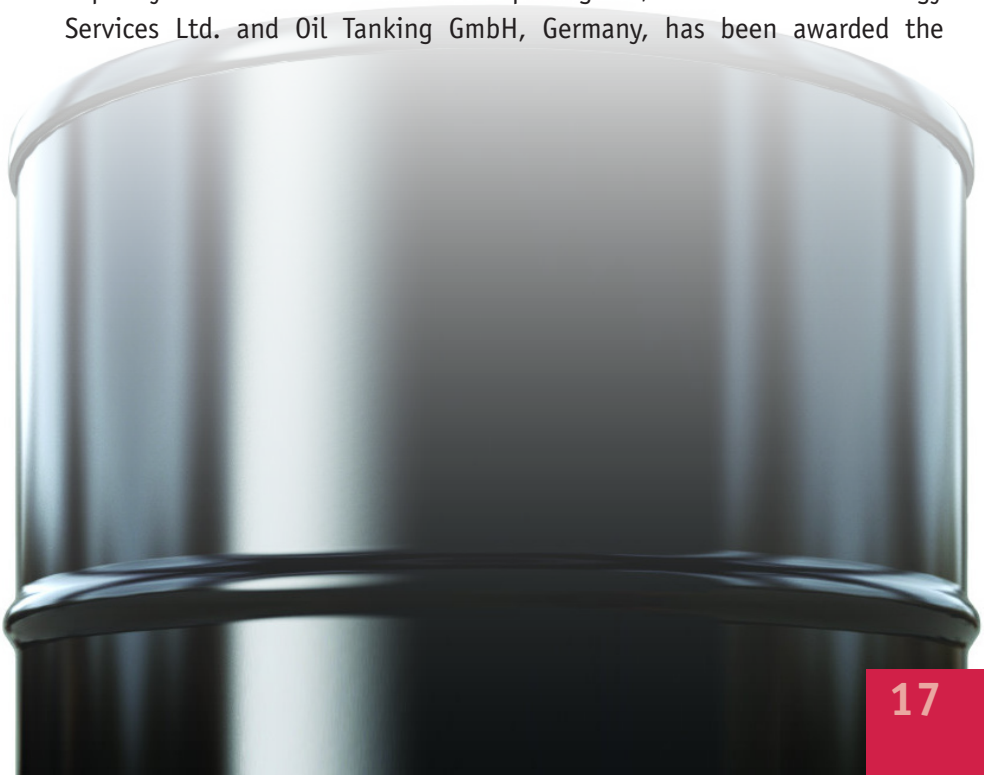
STRATEGIC CRUDE OIL STORAGE

Owner .promoter	Location	Capacity mtpa
Indian Strategic Petroleum Reserves	Visakhapatnam, Andhra Pradesh	1.33
Indian Strategic Petroleum Reserves	Padur (Udupi), Karnataka	2.5
Indian Strategic Petroleum Reserves	Mangalore, Karnataka	1.5

The Key Oil Players In India

Three state-owned oil companies -- Indian Oil, Hindustan Petroleum and Bharat Petroleum – have a vast infrastructure for storage of petroleum products. In fact, there's been a 4.5 percent rise in the domestic demand for petroleum products. It increased from 118.8 million tonnes during 2008-09 to 124.1 million tones. India imported 7.16 million tonnes of petroleum products, mainly diesel and naphtha, in the first six months (April-Sept) of 2009-10. Fuel exports were 14.3 million tonnes ($7.29 billion) during the same period. India has a 40-day demand cover of tankage for all petroleum products, i.e, about 6.8 million tonnes product tankage capacity. Development of tankage for 45 days has been planned.

Indian Oil Tanking Ltd. (IOT), is a 50:50 joint venture between Indian Oil Corporation Limited, and Oil Tanking GmbH. IOT owns terminals in Navi Mumbai and Chennai and has more than a million kilolitres of tankage capacity in India. A consortium comprising IOT, Infrastructure & Energy Services Ltd. and Oil Tanking GmbH, Germany, has been awarded the



concession for development of crude/product tankage facilities at Paradip Refinery Project, Paradip, Orissa, on a Build, Own, Operate and Transfer (BOOT) basis by IOC. IVRCL Infrastructures & Projects Limited (IVRCL) will be the joint venture partner in the special purpose vehicle. The project involves installation, operation and maintenance of approx. 1.4 million kilolitres of tankages for crude oil and petroleum products, LPG, sulphur and associated facilities at Paradip Refinery Project. It's expected to go onstream in 2012. The concession period will be 15 years after commissioning. Indian Oil Tanking Ltd. has formed a 50:50 joint venture with Mundra Port & Special Economic Zone Ltd., promoted by the Adani Group, to own, operate and develop a liquid product terminal there. The new JV company, named Mundra Indian Oiltanking Ltd. (MIOL), operates as an independent liquid storage provider and its terminal is located at Mundra Port on the northern shore of the Gulf of Kutch in Gujarat. It lies in the midst of one of India's first private port based multi-product SEZ complexes. The terminal has a total capacity of 342,000 m3 tank storage facilities. It can provide services to leading domestic and multinational companies from the refining/marketing, trading and manufacturing sectors for petroleum products, including bunker fuel, biofuels, vegetable oils and liquid chemicals. The Gulf of Kutch handles a significant amount of India's crude oil imports and planned refinery expansions as well as trading possibilities.

Meanwhile, Hindustan Petroleum Corporation Limited (HPCL) is building an oil terminal in Ennore at a cost of Rs 1240 million as part of a decision to shift its facility from Tondiarpet, north Chennai. The facility is expected to have state-of-the-art equipment, including a fully automated bay gantry to load 24 tanker trucks simultaneously. The tankage capacity will have 40,000 kilo litres of petrol, 60,000 kilo litres of diesel and 20,000 kilo litres each of kerosene and ATF. HPCL plans to lay a pipeline from the Ennore port and Chennai Petroleum Corporation to the new terminal.

Two private sector refiners -- Essar Oil and Reliance Industries – have

both set up petroleum products storage and handling facilities. Vadinar Oil Terminal, a subsidiary of the Essar Group, has invested in an all-weather, deep-draft port, providing a crude oil and petroleum products storage, handling and terminal facilities to support a 10.5 million tonnes per annum (MTPA) refinery capacity at Vadinar. The terminal has crude receiving capacity of 32 million tpa and sea-based product dispatch capacity of 14 million tpa. This facility possesses a crude oil tankage capacity of 5.79 million barrels and product intermediate tankage capacity of 6.81 million barrels. Phase I expansion of the oil terminal, for which financial closure is being completed, envisages expanding capacity from the present 10.5 to 16 million tpa by December 2010.

Reliance Industries, which operates two mega-refineries at Jamnagar on the west coast of India, that have a combined crude processing capacity of 1.24 million barrels per day (bpd), has been scouting the globe for oil terminals to bring itself closer to the marketplace for crude and refined end-products. Reliance recently leased 500,000 barrels storage for gasoline at the Borco oil terminal in the Caribbean. Earlier, the company had leased 100,000 cubic metres (cu m) of clean oil products storage

in Singapore from Dutch oil and chemicals storage operator Royal Vopak NV. The company already has storage in the Mediterranean.

Reliance Industries Ltd has also acquired majority stake and management control of Gulf Africa Petroleum Corporation (GAPCO), a company which has a significant presence in East Africa in the petroleum downstream sector. GAPCO, an entity based in East and Central Africa with headquarters in Mauritius, owns and operates large storage large storage terminals in Dar Es Salaam (Tanzania), Mombassa (Kenya) and Kampala (Uganda).

East India Petroleum (P) Limited is the first company in the private sector, to set up a port-based world-class facility for receipt, storage and handling of POL products, petro-chemicals and LPG. The terminal is constructed on 50 acres of land located at Visakhapatnam Port, on the east coast of India. Global Infrastructure Partners (GIP), a private equity firm backed by Credit Suisse and General Electric, has acquired 74 percent stake in Vizag-based East India Petroleum Ltd.

Aegis Logistics, Indian Oiltanking , IMC, Friends Terminal, CRPL and Kesar Industries are the major Port Storage Terminal operators for import and export of Petroleum products.

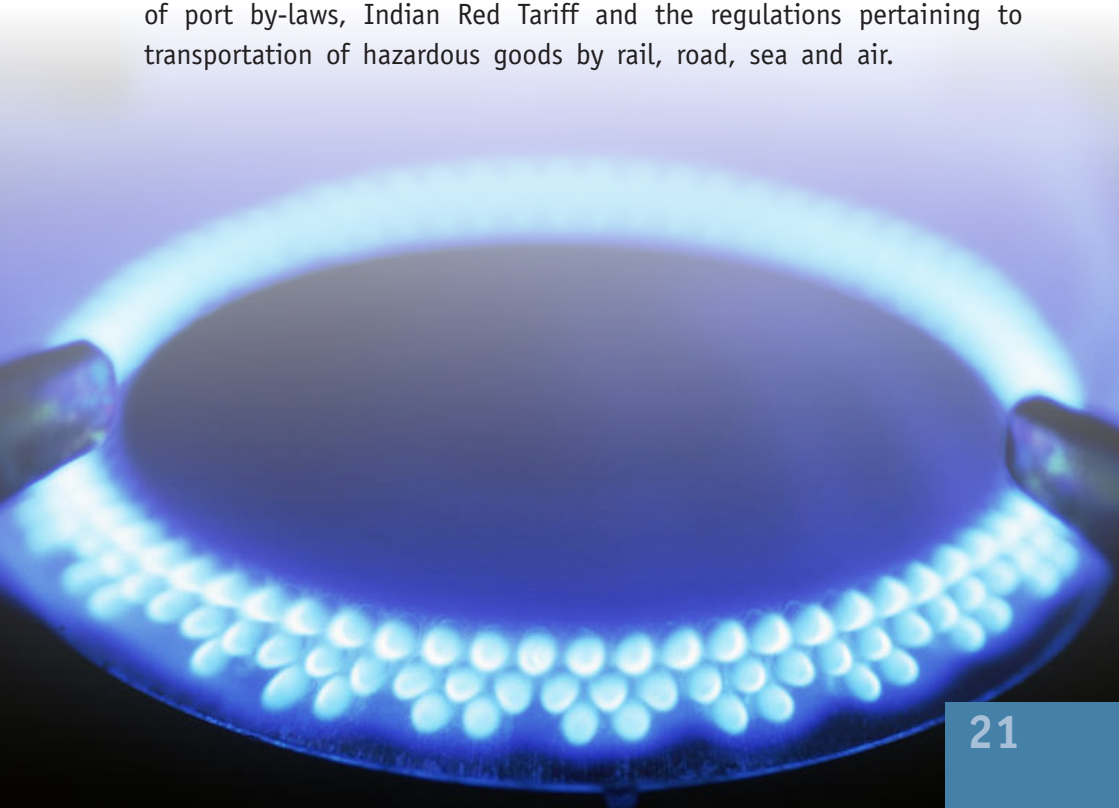
Safety Standards and Regulations in the Indian Context

LNG and LPG in India come under the purview of the Petroleum & Explosives Safety Organisation (PESO), earlier called Department of Explosives. The Indian standards focus on LPG largely, with LNG standards virtually non-existent here. The codes and rules are coined by PESO under the directive of the Chief Controller of Explosives. Safety standards for government oil companies are set by the Oil Industry Safety Directorate (OISD); the latter is a body made up of public sector oil and gas companies. Oil companies in the private sector follow applicable global standards like API, IP and NFPA.

According to PESO, its key objectives include:

- Regulating and monitoring the manufacture, import, export, transport, possession, sale and use of explosives, petroleum products and compressed gases as envisaged under the Explosives Act 1884 and Petroleum Act 1934.
- Providing operational and technical advice and assistance to the central government, states, local bodies, law enforcement agencies, industry, trade and end users of these products.

With the expertise to prevent fires and explosions of petroleum products, calcium carbide, gas cylinders, pressure vessels and other hazardous substances, PESO acts as a unique advisory body not only to industry but also to government and semi-government bodies like Ports, Railways, Defence establishments, Ministries of Surface Transport, Environment & Forests, Petroleum & Natural Gas and pollution control authorities. The organisation plays an important role in the formulation of port by-laws, Indian Red Tariff and the regulations pertaining to transportation of hazardous goods by rail, road, sea and air.



The Chief Controller of Explosives is the member of the Central Crisis Group constituted by the Ministry of Environment. There is adequate representation in the state and district-level crisis management groups as well.

Additionally, PESO is involved in the formulation and revision of standards for BIS, Indian Standards, Oil Industry Safety Directorate and the National Safety Council.

Some of the important rules in the LNG, LPG and CNG sectors include:

Explosive Rules, 2008: It relates to grant of approvals, licences for manufacture of explosives, authorisation of explosives, storage of explosives, import/export of explosives, packaging and transport of explosives by road. The focus is also on prescribing safe procedures and methods for manufacture of various types of explosives including tools and machinery. PESO investigates accidents involving explosives and looks into the destruction of unserviceable/seized explosives in the interest of public safety and security.

Gas Cylinder Rules, 2004: Rules were first published in 1940 after a Government of India notification (No. M-1272 (1), dated 28th September, 1938), declaring that any gas contained in any metal container in a compressed or liquefied state is an explosive under the Explosives Act, 1884. The Gas Cylinders Rules, 1981, succeeded the old set of rules, after a review of the development of the gas industry post-Independence. The 1980's and 1990's saw massive expansion in the gas and related industries triggered by economic liberalisation and globalisation, use of LPG as industrial and domestic fuel, introduction of CNG and LPG as environmental-friendly automotive fuels and the entry of new technologies. This necessitated another round of review and the new Gas Cylinders Rules, 2004.

Static and Mobile Pressure Vessels (unfired) Rules, 1981: The functions of the organisation relating to administration of these rules

cover grant of approval for shops manufacturing pressure vessels/fittings, their design, licenses for storage of compressed gas installations and transportation of compressed gas in vessels by road, permission for import of vessels, recognition of inspecting agencies and certification for the manufacture/repair of vessels.

Conclusion

Oil and gas continue to be a major source of energy with the majority of the energy needs being met by this sector. This has necessitated adoption of new technologies in exploration, refining and storage of the hydrocarbon in the oil and gas industry. A lot of technological improvements have taken place in the upstream and downstream sectors of oil and gas to enhance oil recoveries, reduce the bottom of the barrel and introduce environment-friendly products.

The hydrocarbon industry is subjected to high safety risk on account of the potential hazard from fires and explosions while handling, processing

and the storage of the highly inflammable liquid with low flash point, as well as the operation of gas and vapour at elevated temperatures and pressures.

In recent past, the industry has seen major upgradation in its value chain and petroleum refining, coupled with induction of new technologies like Catalytic Hydro-treating, Isomerisation for improved product quality and value addition through technologies like Hydro-cracking, Fluidised Catalytic Cracking, Delayed Coking to extract maximum from the bottom of the barrel and diversification towards petrochemicals. In recent years, storage and safety have gained added importance because of growing awareness of environmental degradation. In that sense, the upgradation and clean technological innovations that the industry is witnessing is an important step in right environment management.

Clearly, safety management in the hydrocarbon industry is a multi-disciplinary function and every organization and individual has to keep a vigil. It is hoped that this Conference will take us one step in that direction.

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