

Annex 5C

Summary of Industry Incidents Review

A review of the past industry incidents at similar facilities worldwide has been conducted to further investigate the possible hazards from the Project's facilities. This *Annex* summarises the findings on the past industry incidents based on the review of comprehensive incidents/ accidents database.

5C.1 INCIDENTS RELATED TO LNGC AND FSRU VESSEL

Incidents/ accidents related to LNGC are summarised in *Table 5C.1*.

Based on the listed sources in the table below, no safety incident has been recorded for FSRU Vessels since the world's first FSRU Vessel began operation more than 10 years ago.

Table 5C.1 Summary of Incident Review for LNGC

Date, place	Cause	Description	Source
Negeshi, Japan (1970)	External Event	A few hours out of Japan heavy seas caused sloshing of cargo tanks in LNG ship steaming from Japan to Alaska. A thin membrane wall bent in four places and a half inch crack formed in a weld seam.	MHIDAS
Boston, Massachusetts, USA (1971)	Mechanical-Failure	LNG ship "Descartes" had gas leak from tank, faulty connection between tank dome and membrane wall, crew reportedly tried to conceal leak from authorities.	MHIDAS
Terneuzen; Algeria (1974)	Collision	LNG ship "Euclides" sustained contact damage with another vessel, causing damage to bulwark plating and roller fairlead.	MHIDAS
Canvey Island; Essex; UK (1974)	Collision	The coaster "Tower Princess" struck the "Methane Progress" as it was tied up at the LNG jetty tearing a 3 ft gash in its stern. No LNG was spilled & no fire	MHIDAS
El Paso Paul Kayser (1979)	Grounding	While loaded with 99,500 m ³ of LNG, the ship ran at speed onto rocks and grounded in the Straits of Gibraltar. She suffered heavy bottom damage over almost the whole length of the cargo spaces resulting in flooding of her starboard double bottom and wing ballast tanks. Despite this extensive damage, the inner bottom and the membrane cargo containment maintained their integrity. Five days after grounding, the ship was refloated on a rising tide by discharge of	SIGTTO (Society of International Gas Tankers Terminal and Operators Ltd.)

Date, place	Cause	Description	Source
		ballast by the ships' own pumps and by air pressurisation of the flooded ballast spaces.	
Libra (1980)	Mechanical Failure	While on passage from Indonesia to Japan, the propeller tail shaft fractured, leaving the ship without propulsion. The Philippine authorities granted a safe haven in Davao Gulf to which the ship was towed. Here, with the ship at anchor in sheltered water, the cargo was transferred in thirty two (32) hours of uneventful pumping to a sister ship moored alongside. The LNG Libra was then towed to Singapore, gas-freeing itself on the way and was repaired there. In this casualty, there was, of course, no damage to the ship's hull and no immediate risk to the cargo containment.	SIGTTO (Society of International Gas Tankers Terminal and Operators Ltd.)
Taurus (1980)	Grounding	Approaching Tobata Port, Japan to discharge, the ship grounded in heavy weather with extensive bottom damage and flooding of some ballast tanks. After off-loading some bunkers and air pressurising the ruptured ballast spaces, the ship was refloated four days grounding. Despite the extent of bottom damage, the inner hull remained intact and the spherical cargo containment was undistributed. After a diving inspection at a safe anchorage, the ship proceeded under its own power to the adjacent LNG reception terminal and discharged its cargo normally.	SIGTTO (Society of International Gas Tankers Terminal and Operators Ltd.)
Thurley, United Kingdom (1989)	Human Error	While cooling down vaporisers in preparation for sending out natural gas, low-point drain valves were opened. One of these valves was not closed when pumps were started and LNG entered the vaporisers. LNG was released into the atmosphere and the resulting vapor cloud ignited, causing a flash fire that burned two operators.	Cabrillo Port Liquefied Natural Gas Deepwater Port Final EIS/EIR
Bachir Chihani (1990)	Mechanical Failure	Sustained structural cracks allegedly caused by stressing and fatigue in inner hull.	Cabrillo Port Liquefied Natural Gas Deepwater Port Final EIS/EIR

Date, place	Cause	Description	Source
BOSTON, MASSACHUSETTS, USA (1996)	External Fire Event	Loaded LNG carrier sustained electrical fire in main engine room whilst tied up alongside terminal. Fire extinguished by crew using dry chemicals. Cargo discharged at reduced rate (over 90 h instead of 20 h) & vessel sailed under own power.	MHIDAS
SAKAI SENBOKU, Japan (1997)	Collision	LNG tanker sustained damage to shell plating on contact with mooring dolphin at pier. No spillage or damage to cargo system.	MHIDAS
BOSTON, MASSACHUSETTS, USA (1998)	Human Factor	LNG carrier was discharging cargo when arcs of electricity shorted out two of her generators. The US coast guard removed the vessel's certification of compliance as this incident was the latest in a series of deficiencies on the vessel.	MHIDAS
POINT FORTIN, TRINIDAD (1999)	Collision	A LNG carrier collided with a pier after it suffered an engine failure. There was no pollution or any injuries. The pier was closed for 2 weeks. \$330,000 of damage done.	MHIDAS
EVERETT, MASSACHUSETTS, USA (2001)	Mechanical	Suspected overpressurisation of No. 4 cargo tank resulted in some cracking of the outer tank dome. A minor leakage resulted in offloading being temporarily suspended. The tank itself was not damaged and offloading was completed. Vessel not detained.	MHIDAS
East of the Strait of Gibraltar (2002)	Collision	Collision with a U.S. Navy nuclear-powered attack submarine, the U.S.S Oklahoma City. In ballast condition. Ship suffered a leakage of seawater into the double bottom dry tank area.	Cabrillo Port Liquefied Natural Gas Deepwater Port Final EIS/EIR

5C.2 INCIDENT RELATED TO SUBSEA PIPELINES

The representative incidents/ accidents related to the subsea pipelines are summarised in *Table 5C.2*.

Table 5C.2 Summary of Incident Review for the Subsea Pipelines

Date, place	Cause	Description	Source
2006, St. Mary Parish, Louisiana	Dropped object	In a recent accident, a ruptured high-pressure natural gas pipeline was struck by a 5-ton mooring spud, dropped from a towing vessel Miss Megan. The uninspected vessel was pushing two barges, a construction barge, Athena 106, and the unmanned deck barge,	National Transportation Safety Board (2007)

Date, place	Cause	Description	Source
		<p>IBR 234, through the West Cote Blanche Bay oil field in St. Mary Parish, Louisiana. The aft spud on Athena 106 was released from its fully raised position and struck the buried gas pipeline in the northwest area of the oil field. (Spuds were used to keep the barges stationary and hold them in place during marine construction work). The released gas was ignited and the subsequent fire engulfed both the towing vessel and the two barges. Five out of eight people onboard, including the master and four barge workers were killed and one barge worker was reported missing.</p> <p>Following the investigation conducted by NTSB, the cause of the accident was ascribed to the failure of the owner of Athena 106, Athena Construction and the master and owner of Miss Megan, Central Boat Rentals to ensure the spuds were pinned securely on its barges before getting under way</p>	
1996, Tiger Pass, Louisiana	Dropped object	<p>On 23 October 1996, in Tiger Pass, Louisiana, the crew of the dredge Dave Blackburn dropped a stern spud (a spud is a large steel shaft that is dropped into the river bottom to serve as an anchor and a pivot during dredging operations) into the bottom of the channel in preparation for continued dredging operations. The spud struck and ruptured a 12" diameter submerged natural gas steel pipeline. The pressurised (about 930 psig) natural gas released from the pipeline enveloped the stern of the dredge and an accompanying tug. Within seconds of reaching the surface, the natural gas ignited and the resulting fire destroyed the dredge and the tug. All 28 crew members from the dredge and tug escaped into water or onto nearby vessels. No fatalities resulted.</p> <p>The incident occurred due to incorrect information on the location of the gas pipeline that was passed on by the gas company to the dredging operator. The investigation report on the incident (by the NTSB) recommended that all pipelines crossing navigable waterways are accurately located and marked permanently.</p>	National Transportation Safety Board (1998)
1989, Sabina Pass, Texas	Dropped object	<p>The menhaden vessel Northumberland struck a 16" gas pipeline in shallow water near Sabina Pass, Texas. The vessel was engulfed in flames; 11 of the 14 crew members died. The pipeline, installed in 1974 with 8 to 10 feet of cover, was found to be lying on the bottom, with no cover at all.</p>	National Research Council (1994)

Date, place	Cause	Description	Source
1987, Louisiana	Unknown	In July 1987, while working in shallow waters off Louisiana, a fishing vessel, the menhaden purse seiner Sea Chief struck and ruptured an 8" natural gas liquids pipeline operating at 480 psi. The resulting explosion killed two crew members. Divers investigating found that the pipe, installed in 1968, was covered with only 6" of soft mud, having lost its original 3-foot cover of sediments.	National Research Council (1994)

5C.3

INCIDENT RELATED TO NATURAL GAS FACILITIES

Incidents/ accidents related to natural gas facilities, which are similar to the GRSs at the BPPS and LPS, are summarised in *Table 5C.3*.

Table 5C.3 Summary of Incident Review for Natural Gas Facilities

Date, place	Cause	Description	Source
25/06/2001, Kazakhstan	Corrosion	Six metres of a one metre diameter pipe was thrown forty metres in the blast. Corrosion of the pipeline is thought to have led to the leak that caused the blast. Fire quickly extinguished and supplies resumed through an alternative pipe after three hours.	MHIDAS
10/04/2001, USA	Mechanical failure	Residents were evacuated for about three hours after a volatile gas cloud formed over a natural gas facility. The source of the leak was tracked down to a section of pipe, which was repaired.	MHIDAS
28/12/2000, Canada	Unknown	Explosion at a natural gas pumping station rattled windows 1.5 miles away. There was no rupture of the pipeline itself and the cause of the incident remains unknown. One man severely injured and gas pressure to customers affected	MHIDAS
28/05/2000, Canada	Mechanical failure	A section of the forty two inches pipeline ruptured during pressure-testing of the pipe.	MHIDAS
18/11/1998, UK	Impact	Workmen caused a main gas pipeline to fracture, sending a 30 ft plume of gas into the air. Local residents were evacuated and roads sealed off. It was	MHIDAS

Date, place	Cause	Description	Source
		several hours before the pressure had dropped enough for the pipe to be sealed off. No one was injured.	
14/08/1998, USA	External events	Lightning strike set fire to a natural gas compressor station. The resulting explosions sent a fireball 600 ft into the air. Five people were injured. Gas supplies to the whole of the Florida peninsula were shut off. Residents within two miles were evacuated.	MHIDAS
02/04/1998, Russia	Unknown	The metering unit of the natural gas distribution station was rocked by an explosion. A fire also occurred.	MHIDAS
27/06/1997, USA	Human factor	Gas escaped from a pipeline when equipment being used to take a metering station out of commission fractured a valve. No injuries were reported. People within a mile of the rupture were evacuated. No fire or explosion occurred.	MHIDAS
18/12/1995, Russia	Mechanical failure	Section of pipeline exploded due to high pressure in pipe.	MHIDAS
19/03/1995, USA	Unknown	Thirty six inches gas pipe ruptured. Leak caught fire & damaged reported 300 ft section. Gas rerouted to two parallel lines	MHIDAS
29/07/1993, UK	Impact	1,000 workers were evacuated as building contractors ruptured a mains pipe sending 40 ft gas into the air. Roads were sealed off for about an hour while the leak was brought under control.	MHIDAS
18/05/1989, Germany	General maintenance	Repairs to product pipeline possibly caused explosions/fires which destroyed refinery pumping/mixing station. Blaze burned for four hours as fire fed by 100 tonnes of fuel leaking from broken pipe system.	MHIDAS
10/10/2012, EU	Operation Error	The explosion occurred on 10 October 2012, just before midday, when the unit was being restarted. Earlier that morning, we had switched over to oil fuel in order to scan for defective non-return valves on the water-injection purging circuit. A transfer from	eMARS

Date, place	Cause	Description	Source
		natural gas to oil fuel takes place every 15 days in the period mid-October to March to prevent problems with fuel solidifying in ducts due to colder external temperatures. After the test we switched back to natural gas and proceeded to restart the unit at approximately 11:48. During each start-up, the gas valves (regulating valve SRV and on-off valves VS4, GCV1, GCV2 and GCV4) are tested for tightness. The test did not detect any problems. We therefore proceeded with the start-up by opening the gas supply and activating the spark plugs. At approximately 11:58, excessive vibrations were detected, corresponding to the time of the explosion (methane deflagration) in the boiler. This triggered the shutdown of the gas turbine and the whole unit.	
13/10/2008, EU	Operation Error	Explosion and fire caused by an unexpected and incidental flow of unburned Syngas in the room of the waste-heat boiler of the "Module 1" unit, for a wrong operation during the procedures of stop and purging for the maintenance of the turbogas (TG) of "Module 1". The operation was controlled by subcontracted person and directed and coordinated by a shift head in the control room.	eMARS
15/11/2007, USA	Unknown	An explosion occurred at around 11.30 am in a natural gas treatment facility. It resulted in four injuries, two of them were severe.	ARIA
23/09/2002, USA	Unknown	In a natural gas treatment facility, a flash fire like event occurred in the central part where the raw natural gas is washed to remove impurities. Four of the nearby employees are injured, three suffered severe burns and intoxication.	ARIA
28/05/2000, Canada	Overpressure	A forty two inches pipe transporting natural gas	ARIA

Date, place	Cause	Description	Source
		ruptured during a pressure test. Authorities indicated that the gas inlet was promptly shut down; environmental effects were therefore assumed to be zero.	
04/01/1999, USA	Unknown	In a substation of a natural gas pipeline, a leakage led to an explosion and a fire destroying a house and workshop. The incident, visible from thirty kilometres was taken care of by firemen and controlled within four hours. Two firemen suffered mild injuries.	ARIA
08/02/1997, USA	Unknown	A leakage occurred on a natural gas pipeline of 660 mm diameter. The gas cloud exploded and a 100 m high flame occurred. Nearby houses were shaken by the deflagration.	ARIA
01/01/1997, Turkey	Human error	A natural gas leak occurred on a badly closed valve on a pipe (pressure= 20 bar). This incident led to death by asphyxiation of the two employees who entered in the room, one equipped with an inappropriate mask and the other without equipment.	ARIA
22/11/1995, Russia	Corrosion	An explosion followed by a fire occurred on a 0.5 m diameter natural gas pipe. Corrosion is at the origin of the accident. 240 m of pipes were destroyed.	ARIA