Annex 5E

Hazard Identification Worksheets

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
. External Hazards	 Powered collision of the LNGC with another vessel 	Navigational error	Possible loss of LNG/natural gas containment leading to safety impacts.	LNGC will only enter Hong Kong (HK) waters within an agreed weather envelope
		Steering and/or propulsion equipment failure	2. Potential leakage of fuel oil from LNGC. Environmental impact.	2. LNGC will leave HK waters in event of impending bad weather
		3. Environmental factors (Refer to	3. Potential sloshing leading to boil off gas through vent. Potential safety impact if ignited.	3. Low marine traffic levels in the vicinity of the LNGC transit route
		Subsystem 2 Natural and Environmental		4. Pilot(s) onboard during transit
		Hazards)		5. Passive tug escort (for berthing only)
				6. Enforcement of speed limit
				7. Vessel Traffic System (VTS) (Hong Kong SAR and Mainland China)
				8. LNGC has double hull
				9. LNGC cargo area sub-divided
				10. LNGC equipped with advanced navigational aids
				11. Bow damage to LNGC unlikely to cause loss of storage
				containment due to configuration of cargo tanks
				12. Emergency response plan
	Drifting collision of the LNGC with another vessel	Steering and/or propulsion equipment failure	Possible loss of LNG/natural gas containment leading to safety impacts.	 LNGC will only enter HK waters within an agreed weather envelope
		2. Dragging anchor	2. Potential leakage of fuel oil from LNGC. Environmental impact.	2. LNGC will leave HK waters in event of impeding bad weather
			3. Potential sloshing leading to boil off gas through vent. Potential safety impact if ignited.	3. Bridge continuously manned in transit and when anchored.
				4. Vessel Traffic System (VTS) (Hong Kong SAR and Mainland China)
				5. Enforcement of speed limit
				6. Anchor break system onboard
				7. Automated anchor watch system (ARPA) alarm.
				8. LNGC has double hull.
				9. LNGC cargo area sub-divided.
				10. Emergency response plan.
	3. Collision of another vessel with the LNGC	Navigational error (by LNGC or by another vessel)	Possible loss of LNG/NG containment leading to safety impacts.	LNGC will only enter HK waters within an agreed weather envelope
		Failure to follow collision avoidance procedures (by LNGC or by another vessel)	2. Potential leakage of fuel oil from LNGC. Environmental impact.	2. LNGC will leave HK waters in event of impeding bad weather
		3. Environmental factors (Refer to	3. Potential sloshing leading to boil off gas through vent. Potential safety impact if ignited.	3. Low marine traffic levels in the vicinity of the LNGC transit route
		Subsystem 2 Natural and Environmental		4. Pilot(s) onboard during transit
		Hazards)		5. Passive tug escort (for berthing only)
				6. Enforcement of speed limit
				7. LNGC equipped with advanced navigational aids
				8. Vessel Traffic System (VTS) (Hong Kong SAR and Mainland China)
				9. LNGC has double hull
				10. LNGC cargo area sub-divided
				11. Emergency response plan
	4. Collision of the LNGC with a	Navigational error	1. Possible loss of LNG/NG containment leading to safety impacts.	1. Enforcement of speed limit
	fixed structure	Steering and/or propulsion equipment	2. Potential leakage of fuel oil from LNGC. Environmental impact.	2. Pilot(s) onboard during transit
		failure	3. Potential sloshing leading to boil off gas through vent. Potential safety impact if ignited.	3. No known structures in the vicinity of the LNGC route
			0 0 0 10 11 11 11 11 11 11 11 11 11 11 1	4. Emergency response plan
		Navigational error	1. Possible loss of LNG/natural gas containment leading to safety impacts.	LNGC transit route is not close to the grounding contour

ENVIRONMENTAL RESOURCES MANAGEMENT ANNEX 5E_HAZID.DOC

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Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	5. Powered grounding of the		2. Potential leakage of fuel oil from LNGC. Environmental impact.	2. Pilot(s) onboard during transit
	LNGC	failure	3. Potential sloshing leading to boil off gas through vent. Potential safety impact if ignited.	3. Passive tug escort (for berthing only)
				4. Vessel Traffic System (VTS) (Hong Kong SAR and Mainland China)
				5. LNGC has double hull
				6. LNGC cargo area sub-divided
				7. Emergency response plan
	6. Drifting grounding of the LNGC	Propulsion equipment failure	Possible loss of LNG/natural gas containment leading to safety impacts.	Pilot(s) onboard during transit
			2. Potential leakage of fuel oil from LNGC. Environmental impact.	2. Passive tug escort (for berthing only)
			3. Potential sloshing leading to boil off gas through vent. Potential safety impact if ignited.	3. Vessel Traffic System (VTS) (Hong Kong SAR and Mainland China)
				4. Automated anchor watch system (ARPA) alarm
				5. LNGC has double hull
				6. LNGC cargo area sub-divided
				7. Bridge continuously manned in transit and when anchored
				8. Emergency response plan
	7. LNGC anchor dropped onto	Equipment failure leading to	1. Possible loss of pipeline containment leading to safety impact if ignited by for instance passing	
	subsea pipeline, or dragging	unintentional anchor release	vessels.	0 0
	causing loss of pipeline containment	Intention anchor release but subsea pipeline presence not known		2. No anchoring envisaged during transit
		3. Dragging anchor		3. Pilot(s) onboard during transit
				4. Anchor break system onboard
				5. Automated anchor watch system (ARPA) alarm.
				6. Passive tug escort (for berthing only)
				7. Bridge continuously manned in transit and when anchored
				8. Emergency response plan
	8. Sinking or foundering of the	Other than the marine incidents defined above (e.g. cargo mismanagement at	1. Possible loss of LNG/natural gas containment leading to safety impacts.	1. LNGC is more likely to ground than sink due to shallow water
	LNGC			2. Vessel management
		departure, ballast system operational		3. Computerized cargo management system
		failure)		4. Ballast water transfer not anticipated during transit
	9. Aircraft crash	1. Aircraft crash due to proximity of airport	Possible loss of LNG/natural gas containment leading to safety impacts.	
	10. Helicopter crash	Helicopter crash due to proximity of helicopter flight path	Possible loss of LNG/natural gas containment leading to safety impacts.	1. No helipad on LNGC
	11. Dropped objects	1. Refer to anchor drop above		
	12. Oil or chemical spills in the vicinity	No additional concern identified		
	13. HV cables	No significant concern identified		
2. Natural and Environmental Hazards	High wind/high sea conditions and typhoon	High wind/high sea conditions and typhoon	1. Extreme high winds, high sea conditions and typhoon may make the LNGC more difficult to control.	1. Refer to Safeguards in Subsystem 1 - External Hazards above
			Collision or grounding incident may occur leading to possible loss of LNG/natural gas containment and safety impacts.	
	2. Heavy rainfall and flooding	Heavy rainfall and flooding	 Heavy rainfall will reduce visibility (making the LNGC more difficult to see and other vessels more difficult to be seen by the LNGC). 	1. Refer to Safeguards in Subsystem 1 - External Hazards above
			Collision or grounding incident may occur leading to possible loss of LNG/natural gas containment and safety impacts.	
	3. Fog with poor visibility	1. Fog with poor visibility	 Fogging will reduce visibility (making the LNGC more difficult to see and other vessels more difficult to be seen by the LNGC). 	1. Refer to Safeguards in Subsystem 1 - External Hazards above

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Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
			Collision or grounding incident may occur leading to possible loss of LNG/natural gas containment and safety impacts.	
	4. Lightning	1. Lightning strike	1. Ignition on vent can lead to potential localized safety impact.	1. Flame arrestors provided on vents
	5. Earthquakes	1. No significant concern identified		
	6. Landslide	No significant concern identified		
	7. Subsidence/ movement	No significant concern identified		
	8. Tsunami	1. Tsunami	1. Tsunami impact on LNGC during transit is not envisaged due to sufficient water depth.	
	9. Tidal waves/storm surge	1. Tidal waves/storm surge	Tidal waves/storm surge impact on LNGC during transit is not envisaged due to sufficient water depth.	
	10. Seawater - seasonal variations in salinity and suspended solids	No significant concern identified		
. Material Hazards	 Loss of LNG/natural gas - Marine Incidents 	Marine Incidents (Refer to Subsystem #1 External Hazards above)	1. Possible loss of LNG/natural gas containment leading to safety impacts.	1. Refer to Safeguards in Subsystem 1 - External Hazards above
	2. Loss of LNG/natural gas - Other Causes	1. Membrane and piping/flange failure due to degradation, construction/material defects, operational (human) errors and non-marine incident impacts (sloshing)	1. Possible loss of LNG/natural gas containment leading to safety impacts.	 Limited active cargo operational activity during transit Membrane material has very high corrosion resistance LNGC inspection, testing and maintenance (ITM)
		non marite incident impacts (stostinitg)		4. Annulus between membrane and ship structure monitored for hydrocarbon presence and vented to safe location
				5. Cargo tanks either full (inbound) or empty (outbound) so potential for sloshing is minimized.
				6. Leak detection system
				7. Fire and gas detection system
				8. Emergency shutdown system
				9. Spill containment system
				10. Water spray system for rapid vaporization
				11. Fire fighting system
				12. Emergency response plan
	3. Diesel oil	Refer to Subsystem 5 Layout Hazard below		
	4. Marine Fuel oil	Refer to Subsystem 5 Layout Hazard below		
	5. Lubricating oil	No significant hazard envisaged, considering the small quantity of lubricating oil for machinery		
	6. Urea	No significant hazard envisaged, considering the small quantity of urea generated		
	7. Nitrogen	Potential asphyxiation hazard, no off-site impact is expected.		
	8. CO ₂ - inert gas	Potential asphyxiation hazard, no off-site impact is expected.		
	9. Sodium Hypochlorite	Sodium Hypochlorite	1. Release of chlorine if subjected to fire. However, no significant hazard is envisaged given the limited quantity of generated chlorine expected.	
	10. Water Glycol	1. No significant issue		
Loss of Utilities	Loss of power supply	Loss of propulsion and/or steering	1. Marine Incidents (Refer to Subsystem #1 External Hazards above).	Refer to Safeguards in Subsystem 1 - External Hazards above
	2. Loss of instrument air supply	1. Not applicable		

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Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	3. Loss of nitrogen	1. No significant hazard identified		
	4. Loss of fuel gas supply	1. Refer to Loss of Power Supply above		
	5. Loss of fuel oil supply	1. Refer to Loss of Power Supply above		
	6. Loss of fresh water supply	1. No significant hazard identified		
5. Layout Hazard	1. Escalation of Engine Room Fire	1. Escalation of Engine Room Fire	1. Potential fire escalation to other areas.	Engine room separated from cargo storage area to prevent fire propagation
				2. Engine room designed to Class rules to minimize likelihood of fire and provide adequate fire-fighting and containment
	2. Escalation of Accommodation Fire	Escalation of Accommodation Fire	1. Potential fire escalation to other areas.	1. Accommodation separated from cargo storage area to prevent fire propagation
				2. Accommodation designed to Class rules to minimize likelihood of fire and provide adequate fire-fighting and containment
6. Interface with Existing Facility	1. Not applicable			

ENVIRONMENTAL RESOURCES MANAGEMENT ANNEX 5E_HAZID.DOC CLP Power Hong Kong Limited

System: 2. LNG Carrier (Approaching Jetty in HK waters)

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
External Hazards	Collision of the LNGC with the Jetty	1. Navigational error	 Collision with Jetty on approach may occur leading to possible loss of LNG/natural gas containment and safety impacts. 	 LNGC will only enter HK waters within an agreed weather envelope
		2. Tug error/failure	2. Collision with Jetty on approach may occur leading to potential high pressure natural gas	2. LNGC will leave HK waters in event of impeding bad weather
		3. Environmental factors (Refer to	release from pipeline risers.	3. Pilot(s) onboard during transit
		Subsystem #2 Natural and		4. Active tug control
		Environmental Hazards)		5. Extra tug redundancy
				6. Enforcement of speed limit
				7. Safety Zone
				8. LNGC has double hull
				9. LNGC cargo area sub-divided
				10. LNGC equipped with advanced navigational aids
				11. Vessel Traffic System (VTS) (Hong Kong SAR)
				12. Riser located within jetty structure
				13. Emergency response plan
	2. Collision of the LNGC with	Navigational error	Possible loss of LNG/natural gas containment leading to safety impacts.	LNGC will only enter HK waters within an agreed weather
	another vessel	1. Ivavigational circi	1. I ossible loss of Ervoy flutural gas containment leading to surety impacts.	envelope
		2. Tug error/failure	2. Potential leakage of fuel oil from LNGC. Environmental impact.	2. LNGC will leave HK waters in event of impeding bad weather
		3. Environmental factors (Refer to	3. Potential sloshing leading to boil off gas through vent. Potential safety impact if ignited.	3. Pilot(s) onboard during transit
		Subsystem 2 Natural and Environmental		4. Active tug control
		Hazards)		5. Extra tug redundancy
				6. Enforcement of speed limit
				7. Safety Zone
				8. Low marine traffic levels in the vicinity of the LNGC transit r
				9. Safety zone
				10. LNGC has double hull
				11. LNGC cargo area sub-divided
				12. LNGC equipped with advanced navigational aids
				13. Vessel Traffic System (VTS) (Hong Kong SAR)
				Bow damage to LNGC unlikely to cause loss of storage containment due to configuration of cargo tanks
				15. ISPS (Port Security) Plan
				16. Emergency response plan
	3. Collision of another vessel with the LNGC	Navigational error (by LNGC or by another vessel)	1. Possible loss of LNG/natural gas containment leading to safety impacts.	Pilot(s) onboard during approaching
		Failure to follow collision avoidance procedures (by LNGC or by another vessel)	2. Potential leakage of fuel oil from LNGC. Environmental impact.	2. Active tug control
		3. Environmental factors	3. Potential sloshing leading to boil off gas through vent. Potential safety impact if ignited.	3. Enforcement of speed limit
				4. Safety zone
				5. ISPS (Port Security) Plan
				6. Emergency response plan
	Collision of the LNGC with a fixed structure	Refer to Hazard #1 above - Collision of the LNGC with jetty		an a gray art a art a
	5. Grounding of the LNGC	Navigational error	Possible loss of LNG/natural gas containment leading to safety impacts.	LNGC will only enter HK waters within an agreed weather envelope
		2. Tug error/failure	2. Potential leakage of fuel oil from LNGC. Environmental impact.	LNGC will leave HK waters in event of impeding bad weather
			3. Potential sloshing leading to boil off gas through vent. Potential safety impact if ignited.	3. Pilot(s) onboard during approaching
				4. Active tug control

System: 2. LNG Carrier (Approaching Jetty in HK waters) [Applicable to FSRU Vessel approaching Jetty in HK waters]

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
				5. Extra tug redundancy
				6. Maintenance of sufficient water depth for berth access way an turning point
				7. LNGC equipped with advanced navigational aids
				8. Vessel Traffic System (VTS) (Hong Kong SAR)
				9. LNGC has double hull
				10. LNGC cargo area sub-divided
				11. Emergency response plan
	LNGC anchor dropped onto subsea pipeline	Equipment failure leading to unintentional anchor release	1. Possible loss of pipeline containment leading to safety impact if ignited by for instance passing vessels.	LNGC transit route is not close to the grounding contour
	• •	2. Intention anchor release but subsea		No anchoring activity envisaged during approaching
		pipeline presence not known		3. Pilot(s) onboard during transit
				4. Active tug control
				5. Anchor break system onboard
				6. Automated anchor watch system (ARPA) alarm
				7. Bridge continuously manned during approach and berthing
				8. Emergency response plan
	7. Sinking or foundering of the	1. Other than the marine incidents defined	Possible loss of LNG/natural gas containment leading to safety impacts.	LNGC is more likely to ground than sink due to shallow water
	LNGC	above (e.g. cargo mismanagement at	1. I ossible loss of ENO/ natural gas contaminent leading to safety impacts.	Vessel management
		departure, ballast system operational failure)		~
				3. Computerized cargo management system4. Ballast water transfer not anticipated during approach and
				berthing
	8. Aircraft crash	1. Aircraft crash due to proximity of airpor	1. Possible loss of LNG/natural gas containment leading to safety impacts.	
	9. Helicopter crash	Helicopter crash due to proximity of helicopter flight path	1. Possible loss of LNG/natural gas containment leading to safety impacts.	1. No helipad on LNGC
	10. Dropped objects	1. No additional concern identified		
	11. Oil or chemical spills in the vicinity	1. No additional concern identified		
	12. HV cables	No significant concern identified		
Jatural and Invironmental Jazards	High wind/high sea conditions and typhoon	High wind/high sea conditions and typhoon	1. Extreme high winds, high sea conditions and typhoon may make the LNGC more difficult to control.	1. Refer to Safeguards in Subsystem 1 - External Hazards above
iazaius			Collision or grounding incident may occur leading to possible loss of LNG/natural gas containment and safety impacts.	
	2. Heavy rainfall and flooding	1. Heavy rainfall and flooding	1. Heavy rainfall will reduce visibility (making the LNGC more difficult to see and other vessels	1. Refer to Safeguards in Subsystem 1 - External Hazards above
			more difficult to be seen by the LNGC).	2. Fog horn/bell system on LNGC and Jetty
			Collision or grounding incident may occur leading to possible loss of LNG/natural gas containment and safety impacts.	3. Operational procedure considering visibility limit
	3. Fog with poor visibility	1. Fog with poor visibility	Fogging will reduce visibility (making the LNGC more difficult to see and other vessels more	Refer to Safeguards in Subsystem 1 - External Hazards above
	o. Tog with poor visionity	1. Tog with poor visionity	difficult to be seen by the LNGC).	2. Fog horn/bell system on LNGC and Jetty
				Operational procedure considering visibility limit
			Collision or grounding incident may occur leading to possible loss of LNG/natural gas containment and safety impacts.	5. Operational procedure considering visionity mini
	4. Lightning	1. Lightning strike	1. Ignition on vent can lead to potential localized safety impact.	Flame arrestors provided on vents
		1. No significant concern identified		
	5. Earthquakes			4
	5. Earthquakes6. Landslide	No significant concern identified		
		No significant concern identified No significant concern identified		

ENVIRONMENTAL RESOURCES MANAGEMENT ANNEX 5E_HAZID.DOC

System: 2. LNG Carrier (Approaching Jetty in HK waters) [Applicable to FSRU Vessel approaching Jetty in HK waters]

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	9. Tidal waves/storm surge	1. Tidal waves/storm surge	 Tidal waves/storm surge impact on LNGC during approach is not envisaged (due to sufficien water depth). 	t
	10. Seawater - seasonal variations in salinity and suspended solids	1. No significant concern identified		
3. Material Hazards	Loss of LNG/natural gas - Marine Incidents	Marine Incidents (refer to Subsystem #1 External Hazards)	Possible loss of LNG/natural gas containment leading to safety impacts.	1. Refer to Safeguards in Subsystem 1 - External Hazards above
	2. Loss of LNG/natural gas - Other		1. Possible loss of LNG/natural gas containment leading to safety impacts.	1. Limited active cargo operational activity during transit
	Causes	to degradation, construction/material defects, operational (human) errors and		2. Annulus between membrane and ship structure monitored for hydrocarbon presence and vented to safe location
		non-marine incident impacts (sloshing)		3. Membrane material has very high corrosion resistance
				4. LNGC inspection, testing and maintenance (ITM)
				Cargo tanks either full (inbound) or empty (outbound) so potential for sloshing is minimized.
				6. Leak detection system
				7. Fire and gas detection system
				8. Emergency shutdown system
				9. Spill containment system
				10. Water spray system for rapid vaporization
				11. Fire fighting system
	3. Diesel oil	Refer to Subsystem 5 Layout Hazard		12. Emergency response plan
		below		
	4. Marine Fuel oil	Refer to Subsystem 5 Layout Hazard below		
	5. Lubricating oil	No significant hazard envisaged, considering the small quantity of lubricating oil for machinery		
	6. Urea	No significant hazard envisaged, considering the small quantity of urea generated		
	7. Nitrogen	Potential asphyxiation hazard, no off-site impact is expected.		
	8. CO ₂ - inert gas	1. Potential asphyxiation hazard, no off-site impact is expected.		
	9. Sodium Hypochlorite	1. Sodium Hypochlorite	1. Release of chlorine if subjected to fire. However, no significant hazard is envisaged given the limited quantity of generated chlorine expected.	
	10. Water Glycol	1. No significant issue		
4. Loss of Utilities	 Loss of power supply Loss of instrument air supply 	 Loss of propulsion and/or steering Not applicable 	Marine Incidents (Refer to Subsystem #1 External Hazards)	1. Refer to Safeguards in Subsystem 1 - External Hazards above
	3. Loss of nitrogen	No significant hazard identified		
	4. Loss of fuel gas supply	Refer to Loss of Power Supply above		
	5. Loss of fuel oil supply	Refer to Loss of Power Supply above		
	6. Loss of fresh water supply	No significant hazard identified		
5. Layout Hazard	Escalation of Engine Room Fire	Escalation of Engine Room Fire	Potential fire escalation to other areas.	Engine room separated from cargo storage area to prevent fire propagation
				Engine room designed to Class rules to minimize likelihood of fire and provide adequate fire-fighting and containment

System: 2. LNG Carrier (Approaching Jetty in HK waters) [Applicable to FSRU Vessel approaching Jetty in HK waters]

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	2. Escalation of Accommodation Fire	1. Escalation of Accommodation Fire	1. Potential fire escalation to other areas.	 Accommodation separated from cargo storage area to prevent fire propagation Accommodation designed to Class rules to minimize likelihood of fire and provide adequate fire-fighting and containment
6. Interface with Existing Facility	Not applicable			of the and provide adequate the-fighting and containment

System: 3. LNG Carrier (LNG Unloading at Jetty up to FSRU Storage)

Hazards/ Keywords 1. Collision of passing vesses	* *	Consequences	Safeguards
Collision of passing vessel, service vessel and support vessel	rt vessel	 Possible loss of LNG/natural gas containment due to breach of cargo, leading to safety impact (fire/explosion) with possible escalation. 	Enforcement of speed limit
(including refueling barg operation, maintenance b	arge, of the passing vessel	Possible loss of LNG/natural gas containment due to unloading arm failure, leading to safety impact (fire/explosion) with possible escalation.	2. Navigation aid system
supply vessel and tug) w LNGC/Jetty/FSRU Vesse		Possible loss of natural gas containment due to high pressure natural gas arm failure, leading to safety impact (fire/explosion) with possible escalation.	3. Safety zone
		4. Possible loss of natural gas containment due to higher pressure natural gas riser failure, leading	4. Bridge will be always manned
		to safety impact (fire/explosion) with possible escalation.	5. Jetty will be manned during unloading operation
			Standby tug (with impact characteristic less than the de criteria of LNGC and FSRU Vessel)
			Routing of high pressure natural gas pipework above is elevation for most vessels
			8. Standard SIGTTO ship to shore connections in place
			9. Provision of fenders with considering angled berthing
			10. LNGC cargo area sub-divided
			11. Emergency shutdown system with PERC activation
			12. Shut-off valves on loading arm connections
			13. Jetty designed to allow for emergency departure
			14. ISPS (Port Security) Plan
			15. Emergency response plan
2. Mooring line failure	1. Extreme loads	 Potential drifting of LNGC or FSRU Vessel leading to potential grounding, impact on structure, impact with another vessel. Ultimately release of LNG/natural gas and safety impacts. 	LNGC will only enter HK waters within an agreed werenvelope.
	2. Fatigue		2. LNGC will leave HK waters in event of impeding bad
	3. Corrosion and wear		3. Testing and maintenance program for mooring lines
	4. Improper selection of mooring lines		4. Line tension monitoring
			5. Vetting procedures for LNGC
			6. Vetting procedures by supplier
			7. Built in redundancy in the mooring configuration
			8. Load monitoring and mooring hooks
			9. DGPS
			10. Standby tug (with impact characteristic less than the criteria of LNGC and FSRU Vessel)
			11. Emergency response plan
3. Aircraft crash	 Similar to System 2 - LNG Carrier Approaching Jetty in HK waters 		
4. Helicopter crash	 Similar to System 2 - LNG Carrier Approaching Jetty in HK waters 		
Oil or chemical spills in to vicinity	he 1. No additional concern identified		
6. Grounding	1. No additional concern identified		
7. Dropped objects - from st crane operation	1. Swinging/dropped objects from crane operation	 Potential damage to high pressure natural gas pipeworks leading to safety impacts (fire/explosion). 	
8. Dropped objects - for jett maintenance	 Swinging/dropped objects during jetty maintenance due to for instance unloading arm maintenance 	Potential damage to high pressure natural gas pipeworks leading to safety impacts (fire/explosion).	
9. HV cables	1. No additional concern identified		
10. Anchor drop/ drag of s and support vessel (inc		1. Possible loss of subsea high pressure natural gas pipeline containment leading to safety impact if ignited by for instance passing vessels.	1. Safety zone
and support vessel (including refueling barge operation,			2. Automatic Identification System (AIS) to enable monitonearby vessels

System: 3. LNG Carrier (LNG Unloading at Jetty up to FSRU Storage)

	ier (LNG Unloading at Jetty up to FSR		T	
Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	maintenance barge, supply vessel and tug)	3. Extreme weather	_	3. Automated anchor watch system (ARPA) alarm.
	vesser and rug)	4. Improper anchoring		4. Emergency response plan
2. Natural and Environmental Hazards	High wind/high sea conditions	1. High wind/high sea conditions	 Extreme high winds and high sea conditions may create excessive movements and impact unloading arm operation. Refer to Material Hazard - LNG/natural gas above. Potential impact on mooring lines. 	1. Refer to Safeguards in Subsystem 1 - External Hazards above
			Refer to External Hazard - Failure of mooring lines.	
	2. Heavy rainfall and flooding	1. No significant concern identified		
	3. Fog with poor visibility	1. No significant concern identified		
	4. Tidal waves/storm surge	1. Tidal waves/storm surge	Tidal waves/ storm surge may create excessive movements and impact unloading arm operation. Refer to Material Hazard - LNG/natural gas above. 2. Potential impact on magning lines.	1. Refer to Safeguards in Subsystem 1 - External Hazards above
			2. Potential impact on mooring lines. Refer to External Hazard - Failure of mooring lines.	
	5. Lightning	1. Lightning strike	Ignition on vent at jetty can lead to potential localized safety impact. Potential gas release and possible fire if ignited leading to safety impact.	1. Flame arrestors provided on vents
	6. Earthquakes	1. Earthquakes of high intensity	1. Differential movement between the jetty and carrier (FSRU Vessel/LNGC) leading to potential disconnection of unloading arm. Refer to Material Hazard - LNG/natural gas above.	Basis of Design considers seismic activity
	7. Landslide	1. No significant concern identified		
	8. Subsidence/ movement	1. No significant concern identified		
	9. Tsunami	1. Tsunami	1. Tsunami impact is expected in the worst case of disconnection of unloading arm. No further impact is envisaged due to sufficient water depth.	
	10. Seawater - seasonal variations in salinity and suspended solids	No significant concern identified		
3. Material Hazards	1. LNG/natural gas	Excessive LNGC/FSRU Vessel movement	1. Possible loss of LNG/natural gas containment due to unloading arm failure, leading to safety impact (fire/explosion) with possible escalation.	Terminal, FSRU Vessel, LNGC inspection, testing and maintenance (ITM).
		2. Loading arm failure	Possible loss of natural gas containment due to high pressure natural gas arm failure, leading to safety impact (fire/explosion) with possible escalation.	2. Unloading operation is supervised and bridge is always manned
		3. Flange failure	3. Possible loss of natural gas containment due to higher pressure natural gas riser failure, leading to safety impact (fire/explosion) with possible escalation.	Jetty structures would be provided cryo bar to withstand any cryogenic impact
		4. External corrosion	4. Potential cryogenic impact leading to safety issue. However this will be localized.	4. Operation procedure will be in place
		5. Process upset due to equipment failure/ human error	5. Potential rapid phase transition when LNG comes in contact with water.	5. Process control systems and alarms (DCS)
		6. Vessel collisions (Refer to Subsystem 1 - External Hazards above)		 Emergency shutdown system to trip the unloading system including pumps shutdown valves to initiate the closing of PERO valves
		7. Dropped Objects		7. Pressure safety devices
				PERC system provided for unloading arms for quick disconnection and isolation, in case of excessive movement
				9. Fire and gas detection
				 Water spray curtain provided at manifold, which is in operatio during unloading operation to minimize cryogenic impact on the jetty structure
				11. LNG spill tray system under the manifold
				12. Fire fighting system (hydrants, monitors)
				13. Standby tug with fire fighting equipment
				14. Emergency response plan
	Fuel oil/ lubricating oil/ hydraulic oil	Refer to Subsystem 5 Layout Hazard below		

System: 3. LNG Carrier (LNG Unloading at Jetty up to FSRU Storage)

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	3. Calibration gas for analyzers	 No significant hazard envisaged. Only localized hazard envisaged due to small inventory. 		
	4. Urea	 No significant hazard envisaged, considering the small quantity of urea generated 		
	5. Nitrogen	 Potential asphyxiation hazard, no off-site impact is expected. 		
	6. CO ₂ - inert gas	 Potential asphyxiation hazard, no off-site impact is expected. 		
	7. Sodium Hypochlorite	1. Sodium Hypochlorite	1. Release of chlorine if subjected to fire. However, no significant hazard is envisaged given the limited quantity of generated chlorine expected.	
	8. Water Glycol	1. No significant issue		
	9. Pressurized air	No significant concern identified		
4. Loss of Utilities	Loss of power supply	No significant concern identified, since all systems will revert to safe conditions.		
	2. Loss of hydraulic system	Unable to operate unloading arms. No significant concern identified		
	3. Loss of instrument air supply	 Unable to operate unloading arms. No significant concern identified 		
	4. Loss of nitrogen	1. Loss of nitrogen for prolonged duration	1. Potential impact on unloading arm joints leading to minor leakage of LNG/natural gas	1. Redundant compressor system
			2. Potential impact on compressor seals leading to minor leakage of gas	2. High reliability of nitrogen generation package (membrane type)
			3. Loss of nitrogen will lead to potential vacuum in the inter space between the membranes. This will lead to air ingress with moisture ingress. Moisture can freeze leading to potential loss of mechanical integrity of the membranes.	3. FSRU Vessel tanks can tolerate days without any impact in case of loss of nitrogen
	5. Loss of fuel gas supply	1. Refer to Loss of Power Supply above		
	6. Loss of fuel oil supply	1. Refer to Loss of Power Supply above		
	7. Loss of fresh water supply	No significant hazard identified		
5. Layout Hazard	1. Escalation of Engine Room Fire	1. Escalation of Engine Room Fire	1. Potential fire escalation to other areas.	Engine room separated from cargo storage area to prevent fire propagation
				2. Engine room designed to Class rules to minimize likelihood of fire and provide adequate fire-fighting and containment
	2. Escalation of Accommodation Fire	1. Escalation of Accommodation Fire	1. Potential fire escalation to other areas.	Accommodation separated from cargo storage area to prevent fire propagation
				2. Accommodation designed to Class rules to minimize likelihood of fire and provide adequate fire-fighting and containment
6. Interface with Existing Facility	1. Not applicable			

Schemic Lander Keywords Collision of strong and an experiment Collision of s	System: 4. FSRU Vess	sel (HP Gas Send-out, FSRU Vessel Pro	ocess and Non-Process Systems)		
Service work and import votable for chairing services and import votable for chairing services and many desired properties of the chairing	Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
Proposition of a strategy of processing registering transport for the processing of the processing o	1. External Hazards		Navigational error of the passing vessel		1. Enforcement of speed limit
Self-Vicent Self-Vicent Security (Security Security		(including refueling barge operation, maintenance barge, supply vessel and tug) with		2. Possible loss of LNG/natural gas containment due to unloading arm failure, leading to safety	2. Safety zone
Particular of the properties			3. Environmental factors (See Subsystem #2 Natural and Environmental Hazards)		3. Navigation aid system
Secondary to grow the possible resolution Secondary to grow th			, i		4. FSRU Vessel will be always manned
elevation for more vessels and many of more vessels and many of tenders with connections in place Potential directing of FSEU Vessel leading to potential grounding, impact on structure, impact plants of the structure of the st					5. Standby tug (with impact characteristic less than the design
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		3. Fog with poor visibility	No significant concern identified		
		4. Tidal waves/storm surge	Refer to High wind/high sea conditions above		

ENVIRONMENTAL RESOURCES MANAGEMENT ANNEX 5E_HAZID.DOC CLP POWER HONG KONG LIMITED System: 4. FSRU Vessel (HP Gas Send-out, FSRU Vessel Process and Non-Process Systems)

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	5. Lightning	1. Lightning strike	 Ignition on vent can lead to potential localized safety impact. Potential gas release and possible fire if ignited leading to safety impact. 	1. Flame arrestors provided on vents
	6. Earthquakes	1. No significant concern identified		
	7. Landslide	1. No significant concern identified		
	8. Subsidence/ movement	1. No significant concern identified		
	9. Tsunami	1. Tsunami	 Tsunami impact is expected in the worst case of disconnection of unloading arm. No further impact is envisaged due to sufficient water depth. 	
	10. Seawater - seasonal variations in salinity and suspended solids	1. No significant concern identified		
Material Hazards	LNG/natural gas - Process Equipment	Excessive LNGC/FSRU Vessel movement	1. Possible loss of LNG/natural gas containment, leading to safety impact (fire/explosion) with possible fire escalation.	1. Terminal, FSRU Vessel, LNGC ITM
		2. High pressure gas arm connection failure	2. Potential cryogenic impact leading to safety issue. However this will be localized.	2. Operation procedure will be in place
		3. Flange/piping failure	3. Potential rapid phase transition when LNG comes in contact with water.	3. Check valve provided on HP gas send-out line to prevent rever flow
		4. Valves/seals failure		4. Process control systems and alarms (DCS)
		5. Internal corrosion/ erosion (in vaporizer area and send-out system)		Emergency shutdown system to trip the unloading system including pumps shutdown valves to initiate the closing of PER valves
		6. External corrosion		PERC system provided for unloading arms for quick disconnection and isolation, in case of excessive movement
		7. Process upset due to equipment failure/ human error		7. Pressure safety devices
		8. Loss of structural integrity of piping, process equipment support		8. Fire and gas detection with automatic actuation of ESD system
		Cargo mismanagement affecting hull integrity		9. LNG spill tray system (cargo area and regasification process are and reliquefyer area)
		10. Excessive vibration (compressor area and pumps)		10. Fire fighting system (hydrants, monitors)
		11. Dropped Objects		11. Standby tug with fire fighting equipment
				12. Emergency response plan
	LNG/natural gas - Storage Containment	1. Flange/piping failure	 Possible loss of LNG/natural gas containment, leading to safety impact (fire/explosion) with possible escalation. 	Terminal, FSRU Vessel, LNGC inspection, testing and maintenance (ITM)
		2. External corrosion	Possible roll over leading to overpressure and loss of LNG/natural gas containment, leading to safety impact (fire/explosion) with possible escalation.	2. Operation procedure will be in place
		3. Process upset due to equipment failure/ human error	3. Potential cryogenic impact leading to safety issue. However this will be localized.	3. Process control systems and alarms (DCS)
		4. Dropped Objects	4. Potential rapid phase transition when LNG comes in contact with water.	4. LNG eductor system to allow transfer of LNG in case of power failure and emergency condition
		5. Containment failure (membrane)		5. Emergency shutdown system
				6. Pressure safety devices
				7. Fire and gas detection
				8. Secondary barrier for spill containment for full inventory (applicable for each storage compartment)
				9. Fire fighting system (hydrants, monitors)
				10. Standby tug with fire fighting equipment
				11. Emergency response plan
	Fuel oil/ lubricating oil/ hydraulic oil	Refer to Subsystem 5 Layout Hazard below		
	4. Calibration gas for analyzers	Only localized hazard envisaged due to small inventory		

System: 4. FSRU Vessel (HP Gas Send-out, FSRU Vessel Process and Non-Process Systems)

		ocess and Non-Process Systems)	_	
Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	5. Hydrogen	No significant hazard envisaged, considering the small quantity of hydrogen generated, which will be diluted before venting to the atmosphere		
	6. Urea	No significant hazard envisaged, considering the small quantity of urea generated		
	7. Nitrogen	Potential asphyxiation hazard, no off-site impact is expected.		
	8. CO ₂ - inert gas	Potential asphyxiation hazard, no off-site impact is expected.		
	9. Sodium Hypochlorite	Sodium Hypochlorite	 Release of chlorine if subjected to fire. However, no significant hazard is envisaged given the limited quantity of generated chlorine expected. 	
	10. Water Glycol	No significant issue		
	11. Pressurized air	No significant concern identified		
4. Loss of Utilities	1. Loss of power supply	1. Power failure	 Potential warm up of LNG within pipeworks leading to overpressure and release of LNG/natural gas. 	1. Operating procedures
			2. Potential overpressure of storage system.	2. Ability to vent pressure manually
				3. DCS system with alarm (provided with UPS)
				4. Emergency power generator available
		4 17 11		5. Pressure relief device provided at suitable locations
	2. Loss of hydraulic system	Unable to operate unloading arms. No significant concern identified		
	3. Loss of instrument air supply	Instrument air compressor failure	 Potential warm up of LNG within pipeworks leading to overpressure and release of LNG/natural gas. 	Operating procedures
				2. DCS system with alarm (provided with UPS)
				3. Redundant instrument air system available
	1. Logg of mitmograp	Loss of nitrogen for prolonged duration	Potential impact on unloading arm joints leading to minor leakage of LNG/natural gas.	 Thermal relief valves provided at suitable locations Redundant compressor system
	4. Loss of nitrogen	1. Loss of futrogen for prolonged duration	Potential impact on unloading arm joints leading to minor leakage of LNG/ natural gas. Potential impact on compressor seals leading to minor leakage of gas.	Nedundant compressor system High reliability of nitrogen generation package (membrane type)
				FSRU Vessel tanks can tolerate days without any impact in case of loss of nitrogen
	5. Loss of fuel gas supply	Refer to Loss of Power Supply above		
	6. Loss of fuel oil supply	Refer to Loss of Power Supply above		
	7. Loss of fresh water supply	No significant hazard identified		
5. Layout Hazard	1. Escalation of Engine Room Fire	1. Escalation of Engine Room Fire	Potential fire escalation to other areas.	Engine room separated from cargo storage area and process equipment to prevent fire propagation
				Engine room designed to Class rules to minimize likelihood of fire and provide adequate fire-fighting and containment
	2. Escalation of Accommodation Fire	Escalation of Accommodation Fire	1. Potential fire escalation to other areas.	Accommodation separated from cargo storage area and process equipment to prevent fire propagation
				Accommodation designed to Class rules to minimize likelihood of fire and provide adequate fire-fighting and containment
	3. Escalation of Terminal fire	Handling of LNG and high pressure gas	 Possible loss of LNG containment leading to greater fire and resulting in further fatalities to people in the vicinity. 	 Shut-off valves on loading connections. FSRU Vessel/LNGC can move away from jetty (subject to MD
				approval)
6. Interface with Existing Facility	1. Not applicable			3. Emergency response plan

Subsystem	ea Pipelines to BPPS & LPS Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
. External Hazards	Aircraft crash	No significant concern identified	сопосущенесь	ouicgunus
1. External Fluzures				
	2. Helicopter crash	No significant concern identified		
	3. Anchor Drag/ Drop from third party vessels onto new pipelines	 Emergency anchoring for vessel underway due to loss of steerage, power or control, either due to mechanical problems or due to collision events 	Possibility of damage to external coating, damage to pipe requiring remedial action.	Engineered rock protection with respect to anchor size of different vessel types
		2. Drag from anchorage areas	Potential loss of containment leading to natural gas release. Impact on passing vessels and shore population. Vessel involved in the incidents may sink due to loss of buoyancy cause by the gas bubbling.	2. Depth of cover
			3. Disturbance to the rock cover protection. Possible exposure of the pipe.	3. Route avoiding anchorage areas
				4. Concrete external coating
				5. Marking marine charts of the pipeline route
	4. Anchor Drag/ Drop from construction vessels near the landing point onto existing CLP pipelines	1. Emergency anchoring for vessel underway due to loss of steerage, power or control, either due to mechanical problems or due to collision events	1. Possibility of damage to external coating, damage to pipe requiring remedial action.	Engineered rock protection for existing pipelines with respect to anchor size of different vessel types
		2. Drag from anchorage areas	Potential loss of containment leading to gas release. Impact on passing vessels and shore population. Vessel involved in the incidents may sink due to loss of buoyancy cause by the gas bubbling.	2. Proper anchoring procedures during construction
			3. Disturbance to the rock cover protection. Possible exposure of the pipe.	3. Anchor position monitoring
				4. Cofferdam near the shore to further protect the existing pipelines
	5. Anchor Drag/ Drop from construction vessels near the landing point onto existing HKE pipelines	Emergency anchoring for vessel underway due to loss of steerage, power or control, either due to mechanical problems or due to collision events	1. Possibility of damage to external coating, damage to pipe requiring remedial action.	Engineered rock protection with respect to anchor size of different vessel types
		2. Drag from anchorage areas	Potential loss of containment leading to natural gas release. Impact on passing vessels and shore population. Vessel involved in the incidents may sink due to loss of buoyancy cause by the gas bubbling.	Proper anchoring and construction procedures during construction
			3. Disturbance to the rock cover protection. Possible exposure of the pipe.	3. Anchor position monitoring
				 Cofferdam near the shore to further protect the existing pipelines, or tie-in with existing pre-installed section of the pipe
	6. Dropped Object	 Refer to Anchor Drag/ Drop above. No other relevant dropped objects identified 		
	7. Dumping	Dumping of construction waste and other bulk materials outside of	1. Minor surface damage.	Engineered rock protection with respect to anchor size of different vessel types
		designated dumping grounds		2. Depth of cover
				3. Concrete external coating
	8. Grounding	 Navigation error, loss of control due to mechanical or adverse weather 	1. Same as consequence 1,2 & 3 of anchor drag hazard.	Burial depth appropriate to the type of shipping activities based on Marine Department and CEDD guidelines
			2. Displacement of the pipeline leading to exposure.	2. Pipeline is buried below the seabed with rock cover flush with seabed
	9. Vessel Sinking	1. Vessel Sinking	1. Same as consequence 1, 2 & 3 of anchor drag hazard but less severe.	1. Depth of cover
				2. Concrete external coating
				3. Burial depth appropriate to the type of shipping activities based on Marine Department and CEDD guidelines
	10. Fishing & Trawling	 Operation of trawl board and other fishing/trawl gear 	1. No damage to the pipeline.	Pipeline is buried below the seabed with rock cover flush with seabed
	11. Dredging	1. Impact from dredge bucket or drag head	1. Same as consequence 1, 2 & 3 of anchor drag hazard but less severe.	Burial depth appropriate to the type of shipping activities based on Marine Department and CEDD guidelines
				Engineered rock protection with respect to anchor size of different vessel types
				3. Depth of cover

System: 5. Two Subsea Pipelines to BPPS & LPS

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	12. Service crossing or other services in the vicinity	Cable crossing - repair of cables potentially impacting pipeline	1. Potential loss of containment leading to natural gas release. Impact on passing vessels and shore population. Vessel involved in the incidents may sink due to loss of buoyancy cause by the gas bubbling.	 Utility crossing agreement (between pipeline operator and utility supplier) ensures that there is an adequate mechanism to prevent damage to the pipelines in case of repair activities and the risk is acceptable
	13. HV cables	1. No significant concern identified		
	14. Oil or chemical spills in the vicinity	No significant concern identified		
2. Natural and Environmental Hazards	1. Scouring	1. Current and wave actions	1. Possible reduction of cover.	 Pipeline is buried below the seabed with rock cover flush with seabed Engineered rock cover
	2. High wind and typhoon	No significant concern identified		
	3. Heavy rainfall and flooding	Not applicable		
	4. Fog with poor visibility	Not applicable		
	5. Lightning	No significant concern identified		
	6. Earthquakes	No significant concern identified considering the pipelines are located in low seismic activity area		
	7. Landslide	1. Not applicable		
	8. Subsidence/ movement	1. No significant concern identified		
	9. Tsunami	1. No significant concern identified		
	10. Seawater - seasonal variations in salinity and suspended solids	1. No significant concern identified		
	11. Tidal waves	No significant concern identified		
3. Material Hazards	1. Internal corrosion	No issue for non corrosive, clean and dry gas	y	
	2. External corrosion	1. Sea-water; corrosive environment	1. Loss of wall thickness leading to potential leak.	1. Coating system
				2. Sacrificial anode system
	2 Duana 1:	1 Discline and a sill and a sill time of	1. Matal fations leading to small	3. Designed for intelligent pigging
	3. Pressure cycling	1. Pipeline pressure will vary with time of day, loads etc.	1. Metal laugue leading to crack.	Design will consider pressure cycles
	4. Material defect/ construction defect	1. Material defect/ construction defect	1. Possible leaks.	Quality control during manufacture and construction
4. Loss of Utilities	1. Loss of power supply	1. No concern identified		
	2. Loss of instrument air supply	1. No concern identified		
	3. Loss of nitrogen	1. No concern identified		
	4. Loss of fuel gas supply	1. No concern identified		
	5. Loss of diesel supply	1. No concern identified		
5. Layout Hazard	1. Refer to Subsystem #1 - External Hazard above			
Interface with Existing Facility	1. Refer to Subsystem #1 - External Hazard above			

	ing Station (GRS) at BPPS and LPS			
Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
1. External Hazards	1. Aircraft crash	1. During take-off / landing / approach	1. Damage to the facility and fire/explosion hazard.	BPPS and LPS site not directly under the flight path
	2. Helicopter crash	Helipad at BPPS and at the radar station	1. Damage to the facility and fire/explosion hazard.	Helipad at the radar station near BPPS used for specific purpose and not frequent (about once per week)
l				2. Helipad about 500 meter away from the BPPS GRS
	3. Dropped objects	Lifting of objects over operational equipment	1. Damage to existing equipment. Potential fire/explosion hazard.	Lifting plans need to comply with operating plant procedures and guidelines (e.g. weight limits for lifting over operational plant)
l				2. Procedures (Brownfield and constructability workshops)
l	4. Neighbouring facilities - Existing		1. Potential domino impacts leading to fire escalation.	1. Fire and gas detection system
l	GRS at BPPS	BPPS		2. Emergency shutdown system
l				3. Fire fighting system
	5. Neighbouring facilities - Existing GRS at LPS	1. Gas leak from nearby existing GRS and LPS	1. Potential domino impacts leading to fire escalation.	Sufficient separation distance of about 60 meters away from existing GRS
l				2. Fire and gas detection system
l				3. Emergency shutdown system
l				4. Fire fighting system
l	6. Neighbouring facilities - BPPS	1. Gas leak at BPPS	1. Potential escalation to the new GRS facility leading fire/explosion. Impact on new GRS facility	1. Fire and gas detection
l		2. Fuel oil fire at BPPS	is considered less likely due to the separation distance of more than 200 meter.	2. Fire fighting system
l		3. Hydrogen fire/explosion at BPPS		
	7. Neighbouring facilities - ash lagoon	1. Ash lagoon to be developed in future (landfill site). Any development at this site has to take into account the risk to the existing facilities at BPPS/GRS		
l	Neighbouring facilities - Yacheng system	1. Gas leak from the Yacheng system 2. Gas leak from the GRS impacting	1. Fire and /or explosion; possible escalation to BPPS GRS/Yacheng.	1. Blast wall
				2. Fire and gas detection
		Yacheng		3. Fire fighting system
	9. HV cables	1. No significant issue identified		
l	10. Fuel oil spills in the vicinity	Leakage of fuel from diesel tank system	1. Potential fire and fire escalation.	1. Bund wall provided
l	(BPPS)			2. Fire detection system
				3. Fire fighting system
l	11. Fuel oil spills in the vicinity (LPS)	Leakage of fuel from diesel tank system	1. Potential fire and fire escalation.	1. Bund wall provided
l				2. Fire detection system
l				3. Fire fighting system
	12. Hikers in the vicinity	1. No issue identified		
2. Natural and	1. High wind and typhoon	1. No significant issue identified		
Environmental	2. Lightning	Lightning strike on piping and equipment	1. Damage to equipment and fire/explosion.	1. Lightning conductors
Hazards			2. Ignition of fugitive emission.	2. Fire and gas detection
l				3. Flame arrestor/snuffing system on vents
l				4. Fire fighting system
	3. Earthquakes	1. Seismic activity	1. Damage to equipment and fire/explosion.	1. Area of low seismic activity
				Design basis in compliance with local regulation for seismic activity
				3. Fire and gas detection
				4. Fire fighting system
	4. Heavy rainfall and flooding	1. Heavy rainfall and flooding	1. Damage to equipment.	Storm water drainage system
				2. Site at a minimum of +6 mPD
I	5. Fog with poor visibility	1. No significant issue identified		

ENVIRONMENTAL RESOURCES MANAGEMENT ANNEX 5E_HAZID.DOC CLP Power Hong Kong Limited

5E-17

System: 6. Gas Receiving Station (GRS) at BPPS and LPS

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	7. Boulders	1. No significant issue identified	1. No consequence expected on GRS given the boulders are located far away from GRS.	
	8. Subsidence/ movement	1. Subsidence/ movement	1. Damage to equipment and fire/explosion.	1. Design basis in compliance with local regulation for subsiden
				2. Fire and gas detection
				3. Fire fighting system
	9. Tsunami	1. Waves higher than predicted	1. Possible damage to structures / facilities due to high wave and associated flooding.	1. Black Point not susceptible to tsunami
				2. LPS site not susceptible to tsunami
				3. Site at a minimum of +6 mPD
	10. Tidal waves	1. Same as Tsunami above		
	11. Seawater - seasonal variations in salinity and suspended solids	1. No significant issue identified		
	12. Hill fire	1. Hill fire	1. Potential fire escalation.	Vegetation control to prevent hill fire escalation
Material Hazards	1. Leak from tapings, flanges,	1. Corrosion, mechanical failure, etc.	Potential loss of containment leading to fire/explosion.	Operating and maintenance procedures
	valves and piping	2. Misoperation		2. Area classification
		3. Maintenance error (including dropped		3. Fire and gas detection
		object and pigging)		4. Shutdown system
				5. Fire fighting system
	2. Fugitive emission	Leaks from seals / valves / analysers, operational losses	Environmental emission, potential ignition and fire	1. Well ventilated area
				2. Area classification
				3. Fire and gas detection
				4. Fire fighting system
	3. Overpressure downstream of letdown valve	1. Control valve malfunction	1. Potential overpressurization and loss of containment leading to fire/explosion.	1. Active/monitor and slam shut system
				2. HIPPS provided
				3. Fire and gas detection
				4. Shutdown system
				5. Fire fighting system
	4. Pigging operations	1. PIG stuck in the pipeline	1. Operational interruption.	1. Operating procedures
			2. Possible damage to facility.	2. Pigging is not a frequent operation, 1 in 5 years
	5. Ignition of gases from vent / PSVs	1. Lightning strike	1. Fire/explosion.	Stack height will be determined based on thermal radiation threshold on adjoining equipment
		2. Sparks / static / smoking	2. Potential thermal radiation effects on adjoining equipment.	2. Snuffing system
				3. Area classification
				4. Enforcement of protocol (no smoking on site)
				 Operating and maintenance procedures Area classification Fire and gas detection Shutdown system Fire fighting system Well ventilated area Area classification Fire and gas detection Fire fighting system Active/monitor and slam shut system HIPPS provided Fire and gas detection Shutdown system Fire fighting system Operating procedures Pigging is not a frequent operation, 1 in 5 years Stack height will be determined based on thermal radiation threshold on adjoining equipment Snuffing system Area classification
	6. Metering section including Gas Analyzer	Regular discharge of small quantity of gas	1. Potential localized fire. No offsite consequence possible.	1. Area classification
				2. Well ventilated area
				3. Piping design vent to safe locations / vent header
				3. Fire and gas detection 4. Fire fighting system 1. Active/monitor and slam shut system 2. HIPPS provided 3. Fire and gas detection 4. Shutdown system 5. Fire fighting system 1. Operating procedures 2. Pigging is not a frequent operation, 1 in 5 years 1. Stack height will be determined based on thermal radiation threshold on adjoining equipment 2. Snuffing system 3. Area classification 4. Enforcement of protocol (no smoking on site) 5. All PSV releases are routed to vent stack 1. Area classification 2. Well ventilated area 3. Piping design vent to safe locations / vent header 4. Fire and gas detection
				5. Fire fighting system
	7. Calibration gas	1. Leakage	1. Potential localized fire. No offsite consequence possible.	
	8. Carrier gas	1. Leakage	1. Potential localized fire. No offsite consequence possible.	
	9. Nitrogen	1. No significant hazard identified		
	10. CO ₂	No significant hazard identified		
	11. Corrosion Inhibitor (minor quantity)	Use of corrosion inhibitor in BPPS GRS (water bath heater)	Potential localized fire. No offsite consequence possible.	
	12. Pressurized air	No significant hazard identified		

System: 6. Gas Receiving Station (GRS) at BPPS and LPS

Subsystem	Hazards/ Keywords	Description/ Causes	Consequences	Safeguards
	13. Dry chemical powders	1. No significant hazard identified		
4. Loss of Utilities	1. Loss of Power supply	No significant concern identified, since all systems will revert to safe conditions		
	2. Loss of Instrument air supply	No significant concern identified, since all systems will revert to safe conditions		
	3. Loss of nitrogen	1. No significant hazard identified		
	4. Loss of fuel gas supply	1. No significant hazard identified		
	5. Loss of diesel supply	1. No significant hazard identified		
	6. Loss of fresh water supply	1. No significant hazard identified		
5. Layout Hazard	1. Layout	1. No significant hazard identified.		
6. Interface with Existing Facility	1. Tie-ins	1. Unplanned events during tie-in	1. Loss of containment leading to fire/explosion.	Procedures and emergency response plan (Brownfield and constructability review)
	 2. Access for installation / construction/ Brownfield activities/ General construction hazards 1. Possible interference with existing equipment 	1. Possible interference with existing	1. Damage to existing equipment. Potential leaks and fire/explosion.	1. Procedures (Brownfield and constructability review)
				Permit to work, procedures need to comply with operating plant procedures and guidelines (e.g. weight limits for lifting over operational plant)
				3. Construction safety plan (PPE, training, briefings, etc.)
	3. Dropped objects	Lifting of objects over operational equipment	1. Damage to existing equipment. Potential fire/explosion.	Procedures (Brownfield and constructability review)