

ANNEX E

RISK CONTROL MEASURES Expansion of Annex D Initial Risk Control Measures and Possible Mitigations

NOTE

The following risk control measures, and suggested mitigations, were initially created by Marico Marine in advance of the risk control mitigation meeting.

Initially the existing controls were identified and discussed to ensure these were being utilised and were effective. This was to avoid suggesting a future control that was already in place.

The measures found within this annex were discussed at length and from this set of controls, a set of suggested control measures were derived. This finalised set of controls can be found in the main text of the report.

This was a working set of suggested controls, some were discounted, some were expanded upon/improved and some additional controls were added.

For this reason this annex is for reference only.

Blue measures are existing controls; Red and suggested controls.

Grounding Control Measures

Commercial Vessels

The following existing controls are in place to manage risks related to grounding hazards on commercial vessels.

• Compulsory pilot	Pilotage is compulsory for large vessels
• Experienced pilots (SIGTTO)	Experience and training of SFPC pilots – Master/Pilot Information Exchange – adjusting passage plan accordingly.
• Pilots portable laptop available	Although a portable navigation system is available, its use by pilots is generally limited to berthing manoeuvres only.
• Pilotage Advice by VHF	Approaching vessels without an embarked can occasionally be given advice from the pilot station and/or pilot cutter
• Lead-in with pilot cutter	Vessels are occasionally talked-in through the entrance channel prior to boarding a pilot. The pilot cutter is able to closely monitor the vessel during transit. Note: Whilst both VHF advice and Talk-in procedures reduce the risk to an unpowered vessel, they nevertheless retain a significant risk of grounding, and should only be used in exceptional circumstances
• Environmental constraints	If conditions are adverse for pilot embarkation, a vessel can be delayed until conditions improve, thereby eliminating the risk on grounding
• Navigational buoyage and leading lights	Navigational buoyage and leading lights play a critical role in preventing grounding.
• Bridge team competence	Navigational competence in the context of a grounding is a primary method of reducing risk. It is, however, not a control within the gift of a port authority.
• Width and depth of estuary	The width and depth of the Shannon Estuary compares favourably with other similar ports and makes a significant contribution to safe navigation.
• Underkeel Clearance software	Existing underkeel clearance software allows SFPC to determine whether there will be enough water to permit a safe passage throughout the passage. Existing procedures ensure that where the software does not so indicate, the transit is delayed.

The following possible mitigation measures could be implemented to further reduce these hazards to commercial vessels:

<ul style="list-style-type: none"> • VTS traffic organisation and information service (SIGTTO) 	VTS to oversee the movement of all vessels within the port limits and to give timely information to vessels of pending traffic movements.
<ul style="list-style-type: none"> • VTS surveillance (SIGTTO) 	VTS can monitor vessels. They are able to monitor vessels movements and notify them of any unusual deviations from expected tracks.
<ul style="list-style-type: none"> • VTS navigational assistance (SIGTTO) 	Second level assistance where a VTS service is able to give advice to vessels within the port limits.
<ul style="list-style-type: none"> • GPS Datum 	Update existing charts to the WGS 84 datum. Most international charts use WGS84 and ships GPS navigation system set by default to this. Possible mismatch in datum sources leading to incorrect transit and LNGC standing into danger (visual navigation does not have this error).
<ul style="list-style-type: none"> • Embark pilot to seaward of Ballybunnion Buoy 	LNGC's can be boarded at Kilstiffen Buoy under present rules. The boarding area could be moved to the same position as deep-draught vessels. LNGC vessels would thereby be under the control of an experienced pilot prior to entering restricted waters.
<ul style="list-style-type: none"> • Bridge team management training (SIGTTO) 	Pilots to attend bridge team management courses so that they are fully conversant with, and understand, bridge team management techniques and communications. This will create a more effective bridge team.
<ul style="list-style-type: none"> • Develop generic LNG Carrier passage plan (SIGTTO) 	This will standardise the Master/Pilot information exchange and also standardise the expected approach. Passage Plans increase the quality of service delivered by SFPC licensed pilots.
<ul style="list-style-type: none"> • Optimum track 	Ensure optimum transit track (including speed of transit) is assessed properly to enhance safety. This will include reassessing navigational marks as described in other options.
<ul style="list-style-type: none"> • Mobile Control Zone (SIGTTO) 	The use of a Mobile Control Zone around a manoeuvring LNGC vessel will ensure the LNGC is not hampered in her manoeuvre by other vessels thereby eliminating the need for her to take avoiding action which could lead to an LNGC standing into shallow water.
<ul style="list-style-type: none"> • Environmental operating limits (SIGTTO) 	Set maximum environmental operating limits to ensure the transit can be undertaken safely (part of passage planning)
<ul style="list-style-type: none"> • Escort tugs 	Utilise escort tug/s prior to transit as this may reduce grounding hazards in the event of a failure. Escort tugs can also stabilise an incident more quickly thereby reducing damage incurred thereafter.
<ul style="list-style-type: none"> • Designated channel (SIGTTO) 	LNG Carriers to use same deep-water designated deep water channel as per bulk carriers to Money Point.
<ul style="list-style-type: none"> • Increase clearance over Doonaha wreck - remove buoy 	Increasing the depth over the Doonaha wreck would reduce/eliminate this hazard. The removal of the buoy would also allow greater room for the turn onto the leads.
<ul style="list-style-type: none"> • Reposition Beal Bar Buoy 	Repositioning Beal Bar Buoy to the South would increase the manoeuvring room for a vessel turning from the leads into the main channel.
<ul style="list-style-type: none"> • Improved navigational marks 	Consider utilising starboard lateral mark and/or improving visibility of North Carrig Buoy to ensure Carrig Shoals are well marked.
<ul style="list-style-type: none"> • Reposition Carrigaholt Buoy 	Consider removing Carrigaholt buoy or moving it to new position on 14.9m patch on leads to West of Doonaha Buoy. This could be done in conjunction of sweeping Doonaha wreck and removing the Doonaha buoy. This option would ensure vessels turn into the estuary correctly and not 'overshoot' the turn thereby standing into shallower water to the North. The present buoy is in 30m+ water and not considered to be useful.
<ul style="list-style-type: none"> • Consider navigational mark on West Point of Glencloosagh Bay shallows 	A mark will highlight the shallow area. The actual usefulness of this mark will be determined by the final position and heading of the proposed LNG terminal. It could also mark the Eastern boundary of any control zone.
<ul style="list-style-type: none"> • Tug procedures 	Implement procedures regarding tugs, where they are to attend and when to be made fast, as well as connecting up procedures. Tugs fast prior to berthing
<ul style="list-style-type: none"> • Review of Limits 	Limits and operating procedures to be reviewed once details and simulator models available, with a further review once LNGC's are in service.

Grounding Control Measures

Service Craft

The following existing controls are in place to manage risks related to grounding hazards on service craft.

• Width and depth of estuary	The width of the Estuary is a natural control the majority of which is wide and deep allowing for safe navigation and manoeuvring, especially for service craft.
• Experienced coxswains	SFPC employ experienced coxswains for the pilot cutter. These coxswains presently monitor approaching vessels and, in conjunction with the pilot, decide whether it is safe to proceed out to board a vessel.

The hazards to service craft are well managed and specific mitigation measures are unlikely to increase safety. Suggested mitigation measures for commercial vessels will indirectly benefit service craft and other vessels.

Contact - Navigation Control Measures

Commercial Vessels

The following existing controls are in place to manage risks related to contact-navigation hazards on commercial vessels.

• Pilot embarkation positions	There are four designated pilot boarding positions dependant on the size of vessel. An LNGC vessel would be required to be boarded no closer than Kilstiffen Buoy.
• Compulsory pilot	Pilotage is compulsory for large vessels
• Experienced pilots (SIGTTO)	Experience and training of SFPC pilots - Master/Pilot Information Exchange - adjusting passage plan accordingly.
• Pilots portable laptop available	Portable navigation system independent of ships systems is available and utilised by pilots.
• Pilotage Advice by VHF	Approaching vessels can be given advice from the pilot station and/or pilot cutter
• Lead-in with pilot cutter	Vessels can be lead-in to calmer waters to board a pilot.
• Environmental constraints	If conditions adverse for the pilot cutter to proceed out the vessel can be delayed until conditions improve or lead-in to calmer waters. Delaying a vessel eliminates contact hazards, and indirectly reduces contact hazards when transiting under pilotage as conditions will be inherently more favourable for a safer transit.
• Anchorage	Designated Anchorages are clear of the main channel.
• Bridge team competence	Competence of the bridge team, who monitor a vessels track and bring to the ship handler's attention any deviations. Bridge Resource Management ensuring effective communications.
• Width and depth of estuary	The width of the Estuary is a natural control the majority of which is wide and deep allowing for safe navigation and manoeuvring.
• Vetting procedures	Vessels calling at Shannon are subject to inspection and periodic re-inspection to ensure compliance with proper safety and environmental standards by charter companies.

The following possible mitigation measures could be implemented to further reduce these hazards to commercial vessels:

• VTS traffic organisation and information service (SIGTTO)	VTS to oversee the movement of all vessels within the port limits and to give timely information to vessels of pending traffic movements.
• VTS surveillance (SIGTTO)	VTS can monitor vessels. They are able to monitor vessels movements and notify them of any unusual deviations from expected tracks. VTS can monitor anchored vessels to ensure that they maintain position

	and alert a vessel if it appears to be dragging anchor.
<ul style="list-style-type: none"> Embark pilot to seaward of Ballybunnion Buoy 	LNGC's can be boarded at Kilstiffen Buoy under present rules. The boarding area could be moved to the same position as deep-draught vessels. LNGC vessels would thereby be under the control of an experienced pilot prior to entering restricted waters.
<ul style="list-style-type: none"> Bridge team management training (SIGTTO) 	Pilots to attend bridge team management courses so that they are fully conversant with, and understand, bridge team management techniques and communications. This will create a more effective bridge team.
<ul style="list-style-type: none"> Develop generic LNG Carrier passage plan (SIGTTO) 	This will standardise the Master/Pilot information exchange and also standardise the expected approach. Passage Plans increase the quality of service delivered by SFPC licensed pilots.
<ul style="list-style-type: none"> Berthing and escort tugs 	Ensure berthing and escort tugs are in attendance and fast before manoeuvring onto the berth. Tugs will also reduce the chance of contact if the LNGC suffered a failure.
<ul style="list-style-type: none"> Environmental operating limits (SIGTTO) 	Set maximum environmental operating limits to ensure the transit can be undertaken safely (part of passage planning)
<ul style="list-style-type: none"> Designated channel (SIGTTO) 	LNG Carriers to use same deep-water designated deep water channel as per bulk carriers to Money Point.
<ul style="list-style-type: none"> Remove/reposition small ship anchorage at Glencloosagh Bay 	This will remove/ reduce the risk of small coastal vessels coming close to the proposed LNGC terminal.
<ul style="list-style-type: none"> Increase clearance over Doonaha wreck - remove buoy 	Increasing the depth over the Doonaha wreck would reduce/eliminate the requirement for a buoy. It would also remove any grounding hazard. The removal of the buoy would also allow greater room for the turn onto the leads.
<ul style="list-style-type: none"> Reposition Beal Bar Buoy 	Repositioning Beal Bar Buoy to the South would increase the manoeuvring room for a vessel turning from the leads into the main channel.
<ul style="list-style-type: none"> Control zone of 150m when LNG Carrier alongside 	The use of a control zone would ensure smaller transiting vessels and other craft to keep clear of a berthed LNGC thereby eliminating the risk of contact.
<ul style="list-style-type: none"> Standby tug in vicinity when LNG berth occupied 	A standby tug would enforce the control zone mentioned in point above.
<ul style="list-style-type: none"> Marine guidelines for handling LNG Carrier - towage 	Create Marine Guidelines for Handling LNG Carriers developed for numbers of tugs used for berthing / unberthing at Shannon. This ensures sufficient tugs are utilised for safe berthing / unberthing, taking into account the size of the vessel and fitted manoeuvring aids.

Contact - Navigation Control Measures

Other Vessels

The following existing controls are in place to manage risks related to contact-navigation hazards for other vessels such as service craft and commercial leisure craft.

<ul style="list-style-type: none"> Experienced coxswains 	SFPC employ experienced coxswains for the pilot cutter. These coxswains presently monitor approaching vessels and, in conjunction with the pilot, decide whether it is safe to proceed out to board a vessel.
<ul style="list-style-type: none"> Experienced tug masters and crew 	The tugs utilise experienced tug masters and crew.
<ul style="list-style-type: none"> Licensed/inspected vessels 	Small commercial vessels, such as the dolphin watch are licensed and inspected to ensure compliance with operating rules.

The following possible mitigation measures could be implemented to further reduce these hazards to commercial and service craft:

<ul style="list-style-type: none"> • Maintain safe distance from structure 	SFPC can implement bye-law or operating procedure, or the commercial operator to show evidence of own procedures, for commercial leisure craft to ensure they maintain a safe distance of the LNGC terminal; this could be extended to other terminals.
<ul style="list-style-type: none"> • Impose 150m control zone around berthed vessel (SIGTTO) 	The use of a control zone would ensure commercial leisure craft and other craft to keep clear of a berthed LNGC thereby eliminating the risk of contact.
<ul style="list-style-type: none"> • Standby tug on patrol 	A standby tug would enforce the control zone mentioned in point above.
<ul style="list-style-type: none"> • VTS surveillance (SIGTTO) 	VTS can monitor vessels within the vicinity of an LNGC. They are able to monitor vessels movements and notify them if they breach the control zone.

Collision Control Measures

Commercial Vessels

The following existing controls are in place to manage risks related to collision hazards on commercial vessels.

<ul style="list-style-type: none"> • Compulsory pilot 	Pilotage is compulsory for large vessels. Vessels over 13.0m have compulsory pilotage seaward of Ballybunnion Bar. The pilot would be aware of other movements.
<ul style="list-style-type: none"> • Experienced pilots (SIGTTO) 	Experience and training of SFPC pilots – Master/Pilot Information Exchange – adjusting passage plan accordingly.
<ul style="list-style-type: none"> • Bridge team competence 	Competence of the bridge team, who monitor a vessels track and bring to the ship handler's attention any deviations. Bridge Resource Management ensuring effective communications.
<ul style="list-style-type: none"> • Vessel Movements 	There are relatively few simultaneous large vessel movements thereby reducing the likelihood of two vessels meeting, especially at a navigation pinch point.
<ul style="list-style-type: none"> • Width and depth of estuary 	The width of the Estuary is a natural control the majority of which is wide and deep allowing for safe navigation and manoeuvring. The majority of the estuary would allow two vessels to pass safely.
<ul style="list-style-type: none"> • Port Byelaws 	Port byelaws control aspects of navigation. e.g. Bye-law 85 requires the ferry to keep out of the way of a commercial transiting vessel
<ul style="list-style-type: none"> • Simulator Training and Emergency Procedures 	Pilots undergo simulator training incorporating emergency procedures.
<ul style="list-style-type: none"> • Cruise Ship Frequency 	Cruise ships are infrequent visitors. The likelihood of a cruise ship being involved in a collision is remote due to this infrequency.

The following possible mitigation measures could be implemented to further reduce these hazards to commercial vessels:

<ul style="list-style-type: none"> • VTS traffic organisation and information service (SIGTTO) 	VTS to oversee the movement of all vessels within the port limits and to give timely information to vessels of pending traffic movements. The movement and progress of vessels can be promulgated to other vessels thereby allowing passage plans to be adapted to avoid meeting other vessels at critical points.
<ul style="list-style-type: none"> • VTS surveillance (SIGTTO) 	VTS can monitor vessels. They are able to monitor vessels movements and notify them of any unusual deviations from expected tracks.
<ul style="list-style-type: none"> • VTS navigational assistance (SIGTTO) 	Second level assistance where a VTS service is able to give advice to vessels within the port limits.
<ul style="list-style-type: none"> • Bridge team management training (SIGTTO) 	Pilots to attend bridge team management courses so that they are fully conversant with, and understand, bridge team management techniques and communications. This will create a more effective bridge team.
<ul style="list-style-type: none"> • Develop generic LNG Carrier passage plan (SIGTTO) 	This will standardise the Master/Pilot information exchange and also standardise the expected approach. Passage Plans increase the quality of service delivered by SFPC licensed pilots.
<ul style="list-style-type: none"> • Mobile Control Zone (SIGTTO) 	The use of a Mobile Control Zone around a manoeuvring LNGC vessel will ensure the LNGC is not hampered in her manoeuvre by other

	vessels thereby eliminating the likelihood of collision.
<ul style="list-style-type: none"> • Embark pilot to seaward of Ballybunnion Buoy 	LNGC's can be boarded at Kilstiffen Buoy under present rules. The boarding area could be moved to the same position as deep-draught vessels. LNGC vessels would thereby be under the control of an experienced pilot prior to entering restricted waters.
<ul style="list-style-type: none"> • Escort tugs 	Utilise escort tug/s prior to transit as this may reduce collision hazards in the event of a failure.
<ul style="list-style-type: none"> • Designated channel (SIGTTO) 	LNG Carriers to use same deep-water designated deep water channel as per bulk carriers to Money Point.
<ul style="list-style-type: none"> • Define 'narrow channel' (SIGTTO) 	Designate the deep water channel as a 'narrow channel' within byelaws. This will allow full implementation of the Colregs and the requirement of other vessels not to impede the passage of a vessel that can only safely navigate in the channel.
<ul style="list-style-type: none"> • Tug procedures 	Implement procedures regarding tugs, where they are to attend and when to be made fast, as well as connecting up procedures.
<ul style="list-style-type: none"> • Second passive tug in attendance 	A second passive tug could enforce control zone.

Collision Control Measures

Service Craft and Commercial Leisure Craft

The following existing controls are in place to manage risks related to collision hazards on service craft and commercial leisure craft.

<ul style="list-style-type: none"> • Experienced coxswains 	SFPC employ experienced coxswains for the pilot cutter. These coxswains presently monitor approaching vessels and, in conjunction with the pilot, decide whether it is safe to proceed out to board a vessel.
<ul style="list-style-type: none"> • Experienced tug masters and crew 	The tugs utilise experienced tug masters and crew.
<ul style="list-style-type: none"> • Licensed/inspected vessels 	Small commercial vessels, such as the dolphin watch are licensed and inspected to ensure compliance with operating rules.
<ul style="list-style-type: none"> • Width and depth of estuary 	The width of the Estuary is a natural control the majority of which is wide and deep allowing for safe navigation and manoeuvring. The majority of the estuary would allow two vessels to pass safely.

The following possible mitigation measures could be implemented to further reduce these hazards to commercial vessels:

<ul style="list-style-type: none"> • VTS traffic organisation and information service (SIGTTO) 	VTS to oversee the movement of all vessels within the port limits and to give timely information to vessels of pending traffic movements. The movement and progress of vessels can be promulgated to other vessels thereby allowing passage plans to be adapted to avoid meeting other vessels at critical points.
<ul style="list-style-type: none"> • VTS surveillance (SIGTTO) 	VTS can monitor vessels. They are able to monitor vessels movements and notify them of any unusual deviations from expected tracks.
<ul style="list-style-type: none"> • Mobile Control Zone (SIGTTO) 	The use of a Mobile Control Zone around a manoeuvring LNGC vessel will ensure the LNGC is not hampered in her manoeuvre by other vessels thereby eliminating the likelihood of collision.
<ul style="list-style-type: none"> • Define 'narrow channel' 	Designate the deep water channel as a 'narrow channel' within byelaws. This will allow full implementation of the Colregs and the requirement of other vessels not to impede the passage of a vessel that can only safely navigate in the channel.
<ul style="list-style-type: none"> • Dolphin Watch procedures 	SFPC to develop procedures to ensure Dolphin Watch craft do not hamper LNGC
<ul style="list-style-type: none"> • Second passive tug in attendance 	A second passive tug could enforce control zone.

These mitigation measures could be implemented for the proposed tugs that are being considered:

<ul style="list-style-type: none"> • Tug construction 	<p>Use specially designed escort-notated tugs. These have better sea-keeping capabilities than normal harbour tugs and are designed to work in a seaway. Consequently the fendering systems are designed for escort work.</p> <p>Tugs fender systems should be designed to avoid point loadings above the maximum tonnes/metre of the proposed vessels</p>
<ul style="list-style-type: none"> • Dual redundancy with tug systems 	<p>Dual redundancy of tug systems reduces likelihood of total tug failure.</p>
<ul style="list-style-type: none"> • Joint bridge simulation 	<p>Tug masters to attend joint bridge simulation trials with pilots and/or masters to gain better awareness of each others roles and understanding of problems.</p>
<ul style="list-style-type: none"> • Bridge team management training 	<p>Tug masters to attend bridge team management so that they are fully conversant with, and understand, the bridge team (and pilot) anticipated manoeuvre. It will ensure that tug masters will also alert/question the pilot if the tug has a problem or the tug master sees a potential problem or deviation.</p>
<ul style="list-style-type: none"> • Tug procedures 	<p>Implement procedures regarding tugs, where they are to attend and when to be made fast, as well as connecting up procedures.</p>
<ul style="list-style-type: none"> • Tug connecting up procedures 	<p>Implement connecting up procedures and training to enhance safety.</p>

Contact-Berthing Control Measures

The following existing controls are in place to manage risks related to contact berthing hazards with existing commercial vessels.

<ul style="list-style-type: none"> • Compulsory pilot 	<p>Pilotage is compulsory for large vessels. Vessels over 13.0m have compulsory pilotage seaward of Ballybunnion Bar. The pilot would be aware of other movements.</p>
<ul style="list-style-type: none"> • Experienced pilots (SIGTTO) 	<p>Experience and training of SFPC pilots – Master/Pilot Information Exchange – adjusting passage plan accordingly.</p>
<ul style="list-style-type: none"> • Bridge team competence 	<p>Competence of the bridge team, who monitor a vessels track and bring to the ship handler’s attention any deviations. Bridge Resource Management ensuring effective communications.</p>
<ul style="list-style-type: none"> • Marine Operation Staff 	<p>Marine Operations Staff attend berthing and sailing of vessels to ensure shore readiness and pass information on tides etcetera to the Pilot.</p>
<ul style="list-style-type: none"> • Simulator Training and Emergency Procedures 	<p>Pilots undergo simulator training incorporating emergency procedures.</p>
<ul style="list-style-type: none"> • Pilots portable laptop available 	<p>Portable navigation system independent of ships systems is available and utilised by pilots.</p>
<ul style="list-style-type: none"> • Environmental constraints 	<p>If conditions are adverse for the pilot cutter to proceed out the vessel can be delayed until conditions improve. Delaying a vessel indirectly eliminates contact-berthing hazards due to adverse weather.</p>
<ul style="list-style-type: none"> • Berthing Tugs 	<p>The three existing tugs have approximately 150t bollard pull available designed to safely handle cape sized vessels at Money Point.</p>

The following possible mitigation measures could be implemented to further reduce these hazards to LNGC Carriers:

<ul style="list-style-type: none"> • VTS information service (SIGTTO) 	<p>VTS can update pilot with weather and tidal information if requested.</p>
<ul style="list-style-type: none"> • Bridge team management training (SIGTTO) 	<p>Pilots to attend bridge team management courses so that they are fully conversant with, and understand, bridge team management techniques and communications. This will create a more effective bridge team.</p>
<ul style="list-style-type: none"> • Develop generic LNG Carrier passage plan (SIGTTO) 	<p>This will standardise the Master/Pilot information exchange and also standardise the expected approach. Passage Plans increase the quality of service delivered by SFPC licensed pilots.</p>
<ul style="list-style-type: none"> • Doppler docking system 	<p>Doppler docking system can give real time approach data to the ship handler (pilot) independent of the ships systems. This will enhance the assessment of approach speed for bow and stern.</p>

• New tug fleet	New tugs with increased bollard pull and escort notated tugs will allow increased control of the vessel in adverse conditions.
• Joint bridge simulation	Tug masters to attend joint bridge simulation trials with pilots and/or masters to gain better awareness of each others roles and understanding of problems.
• Bridge team management training	Tug masters to attend bridge team management so that they are fully conversant with, and understand, the bridge team (and pilot) anticipated manoeuvre. It will ensure that tug masters will also alert/question the pilot if the tug has a problem or the tug master sees a potential problem or deviation.
• Tug procedures	Implement procedures regarding tugs, where they are to attend and when to be made fast, as well as connecting up procedures.

Mooring Breakout Control Measures

The following existing controls are in place to manage risks related to mooring breakouts on commercial vessels.

• Compulsory pilot	Pilotage is compulsory for large vessels. The pilot would be aware of other vessels alongside.
• Experienced pilots (SIGTTO)	Experience and training of SFPC pilots – Master/Pilot Information Exchange – adjusting passage plan accordingly.
• Bridge team competence	Competence of the bridge team, who monitor a vessels track and bring to the ship handler’s attention any deviations. Bridge Resource Management ensuring effective communications.
• Vessel movements	There are relatively few large vessel movements which reduces the likelihood of a large vessel causing a breakout.
• Width and depth of estuary	The width of the Estuary is a natural control the majority of which is wide and deep allowing for safe navigation and manoeuvring. This avoids the necessity of a transiting vessel to pass close by to another berthed vessel.
• Port Byelaws	Port byelaws 25 and 26 stipulate the requirements for moorings and tending of moorings.
• Existing mooring plans	Existing mooring plans have proven reliability in keeping vessels alongside. There has not been a breakout of any vessels at Money Point and Tarbert terminals.

The following possible mitigation measures could be implemented to further reduce these hazards to commercial vessels:

• VTS surveillance (SIGTTO)	VTS can monitor vessels. They are able to monitor vessels movements and notify them of any unusual deviations from expected tracks and possible encroachment on another berthed vessel.
• Develop generic LNG Carrier passage plan (SIGTTO)	This will standardise the Master/Pilot information exchange and also standardise the expected approach. This would also ensure a LNGC does not transit too close to another berthed vessel at Money Point.
• Environmental Operating Parameters (SIGTTO)	Have operating parameters in place at the LNG terminal with procedures to stop cargo and/or possible disconnection of loading arms in the event of adverse weather.
• Environmental Monitoring Equipment and Display	Real-time display of environmental data on the berth that the LNGC can readily view. This will allow the LNGC to also determine whether conditions are unsafe to continue operations.
• Control zone of 150m when LNG Carrier alongside	The use of a control zone would ensure smaller transiting vessels and other craft to keep clear of a berthed LNGC thereby eliminating the risk of interaction.
• Load cells on Mooring Equipment	Utilise load cells on the berth mooring equipment that can allow a jetty supervisor to identify either: lines coming under undue tension or lines being slack. This will allow the supervisor to pro-actively ensure lines are optimally maintained at all times.

<ul style="list-style-type: none"> • Effective design (SIGTTO) 	<p>Ensure the design of the terminal, fender systems and mooring points are optimised for the environmental conditions.</p> <p>Optimoor Software can be used to verify safe environmental limits of and optimise mooring retention of large vessels.</p>
<ul style="list-style-type: none"> • Trained jetty supervisors 	<p>Train the jetty supervisors so that they are fully aware of the requirements to maintain lines at all times.</p>
<ul style="list-style-type: none"> • Proximity of second tug in extreme weather 	<p>Have procedures in place to ensure second tug available in the event of extreme weather.</p>
<ul style="list-style-type: none"> • Standby tug in vicinity when LNG berth occupied 	<p>A standby tug would enforce the control zone mentioned in point above.</p>
<ul style="list-style-type: none"> • Marine guidelines for handling LNG Carrier - towage 	<p>Create Marine Guidelines for Handling LNG Carriers developed for numbers of tugs used for berthing / unberthing at Shannon. This ensures sufficient tugs are available in the event of adverse weather.</p>
<ul style="list-style-type: none"> • Vetting Procedures (SIGTTO) 	<p>LNG Carriers can be vetted by Shannon LNG (or charterer) prior to arrival to ensure mooring equipment and layout is satisfactory for the terminal.</p>

Fire/Explosion, Cargo Release and Port Security Incident Control Measures

Commercial Vessels

The following existing controls are available to manage risks related to fire/explosion, cargo release and port security incident hazards on commercial vessels.

<ul style="list-style-type: none"> • IMO Gas Codes 	<p>LNG Carriers are built to stringent rules, known as the IMO Gas Codes. This covers: construction, equipment, fire and detection, cargo systems etcetera and has been the primary key to an enviable safety record within the industry.</p>
<ul style="list-style-type: none"> • SIGTTO procedures 	<p>The Internationally recognised SIGTTO procedures outline the essential best practices for LNGC's and terminals. It describes all aspects of LNG operations.</p>
<ul style="list-style-type: none"> • Shannon Foynes Emergency Procedures 	<p>SFPC have emergency procedures in place to deal with incidents within their jurisdiction.</p>
<ul style="list-style-type: none"> • ISPS Code 	<p>ISPS Code is a required international standalone document that sets down procedures and obligations with International Ship and Port Facility Security.</p>
<ul style="list-style-type: none"> • Shore fire services 	<p>Shore fire services are available to assist in ship fires and have joint procedures with SFPC.</p>
<ul style="list-style-type: none"> • Ship staff procedures and training (SIGTTO) 	<p>Ships staff are trained under international standards and all vessels have emergency procedures that are part of the ISM code.</p>
<ul style="list-style-type: none"> • Shipping Vetting for charter vessels (SIGTTO) 	<p>LNG Carriers are often vetted prior to charter to ensure they meet the charterer's exacting safety requirements.</p>
<ul style="list-style-type: none"> • Experienced pilots (SIGTTO) 	<p>Experience and training of SFPC pilots – Pilots can implement SFPC emergency procedures and be able to liaise with emergency services.</p>
<ul style="list-style-type: none"> • Detection Systems (SIGTTO) 	<p>LNG Carriers have sophisticated detection and alarm systems for fire and gas (vapour) release.</p>
<ul style="list-style-type: none"> • Auto-shut down systems (SIGTTO) 	<p>LNG Carriers and terminals have auto-shut down systems that will shut down, and cease cargo operations, in the event if a failure within the cargo system.</p>

The following possible mitigation measures could be implemented to further reduce these hazards to commercial vessels:

<ul style="list-style-type: none"> • VTS information service (SIGTTO) 	<p>VTS can promulgate emergencies to other vessels. They can be used to co-ordinate any actions required by other vessels and/or shore assistance.</p>
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• VTS surveillance (SIGTTO)	VTS can be used to monitor traffic and other activities as part of the ISPS code.
• Jetty fire fighting equipment (SIGTTO)	Fire fighting equipment to be fitted to meet SIGTTO and terminal fire fighting standards.
• ISPS Code	The ISPS Code to be updated to reflect LNG operations.
• FiFi 1 escort tug	The escort tug could be fitted with FiFi 1 equipment to assist the Carrier in the event of a fire.
• Second FiFi 1 tug in attendance in transit	Second tug increases the coverage and also allows escort tug to continue towing if required. Dual coverage allows increased flexibility in fire fighting and boundary cooling.
• Standby FiFi 1 Tug	The utilisation of a standby tug when a Carrier is alongside would benefit from having FiFi 1 equipment as it can be in attendance and assist with minimum delays.
• Develop joint emergency plan (SIGTTO)	SFPC and Shannon LNG, together with shore fire services and tug services to develop joint emergency plan, which incorporates training and exercises.
• Ship/Shore Interface (ISGOTT & SIGTTO)	Full ship shore interface as per ISGOTT guide prior to any cargo operations commencing. Also pre-arrival information plans notifying SFPC and Shannon LNG of any defects.
• Shore services fire fighting training	Shore services to be trained in LNG fire fighting procedures
• High level of physical security throughout LNG site	In conjunction with the ISPS Code: the terminal needs to incorporate best security practices that are at other LNG terminals.

Fire/Explosion, Cargo Release and Port Security Incident Control Measures

Service Craft

The following existing controls are in place to manage risks related to fire/explosion hazards on service craft.

• Experienced coxswains and crew	SFPC employ experienced coxswains and crew for the pilot cutter.
• Experienced tug masters and crew	The tugs utilise experienced tug masters and crew.
• Crew training	Both tugs and crew are trained with onboard fire fighting.
• Onboard fire fighting systems	Tugs and pilot cutters have onboard fire fighting systems.

The hazards to service craft are well managed and specific mitigation measures are unlikely to increase safety. Suggested mitigation measures for commercial vessels will indirectly affect service craft, especially with any updated emergency plans.

Personal Injury Control Measures

The following existing controls are in place to manage risks related to personal injury hazards identified with all vessels, but primarily service craft.

• Experienced pilots	SFPC pilots are experienced and trained in boarding vessels in adverse conditions, reducing personal injuries during transfer.
• Experienced tug masters and crew	The tugs utilise experienced tug masters and crew.
• Experienced coxswains and crew	SFPC employ experienced coxswains and crew for the pilot cutter.
• Experienced ship crews	Ship crews are normally experienced and work to ISM Code of Safe Working Practices.
• Experienced Mooring Boat Operators	The present mooring boat crews are experienced operators and have procedures in place regarding mooring operations.
• Personal Protective Equipment	Personal Protective Equipment is used by most parties and is one of the primary controls in reducing personal injury hazards.
• Environmental conditions	If conditions are detrimental to safety, the pilot and pilot cutter coxswains can abort and delay a movement. The decision to delay can also apply to ship masters if they feel it is too dangerous to undergo the proposed manoeuvre.
• Vetting procedures	Vessels calling at Shannon are subject to inspection and periodic re-inspection to ensure compliance with proper safety and environmental standards by charter companies.

The following possible mitigation measures could be implemented to further reduce hazards to tug and mooring boat personnel:

• Effective design (SIGTTO)	Ensure the design of the terminal, fender systems and mooring points are optimised for the environmental conditions and for the safety of personnel, such as mooring gangs. Optimoor Software can be used to verify safe environmental limits of and optimise mooring retention of large vessels.
• Berthing Master or Mooring Supervisor	Consider utilising a berthing master or mooring supervisor who can oversee the mooring operations and ensure correct procedures are being utilised.
• Trained Mooring Personnel	SFPC should ensure only trained mooring personnel are employed in mooring operations.
• Training and HSE	SFPC should ensure there are training programs in place for all SFPC operational personnel and that Health and Safety in Employment (HSE) is effective and understood by all.
• Correct and properly maintained mooring ropes	Only correct and properly maintained mooring ropes should be used (part of vetting procedures).
• Line boats built for purpose	Line boats should be built for purpose and in keeping with current legislation and best practices.
• Marine guidelines for handling LNG Carrier - towage	Create Marine Guidelines for Handling LNG Carriers developed for numbers of tugs used for berthing / unberthing at Shannon. This ensures sufficient tugs are utilised for safe berthing / unberthing, taking into account the size of the vessel and fitted manoeuvring aids.
• Environmental operating limits (SIGTTO)	Set maximum environmental operating limits to ensure the transit can be undertaken safely (part of passage planning)
• Tug procedures	Implement procedures regarding tugs, where they are to attend and when to be made fast, as well as connecting up procedures. Procedures should include water-tight integrity procedures which stipulate what vents and doors are required to be closed when operating.
• Freewheel/quick release facilities for winches	Freewheel and quick release facilities increases safety as it allows tow master to release high load if required. Also allows ease of connecting up as freewheel winch can allow rope to run freely when vessel dropping into position.

• Towline configuration	The towline configuration can increase safety and should be assessed during the design phase, which should include the use of quick connection units (Foslink), LNGC dedicated towing points etcetera.
• Tug construction	Use specially designed escort-notated tugs. These have better sea-keeping capabilities than normal harbour tugs for escort work and are designed to work in a seaway.
• Effective Communications	SFPC should ensure there are effective communications between all parties (Pilot, Cutter, Tugs, Mooring Gangs/Boats and Terminal)

Foundering Control Measures

The following existing controls are in place to manage risks related to foundering hazards identified with service craft.

• Experienced coxswains	SFPC employ experienced coxswains for the pilot cutter. These coxswains presently monitor approaching vessels and, in conjunction with the pilot, decide whether it is safe to proceed out to board a vessel.
• Experienced tug masters and crew	The tugs utilise experienced tug masters and crew.
• Compliance with Pilot Cutter regulations	Pilot cutters are licensed and inspected to ensure compliance with operating rules.
• Environmental operating limits	The pilot cutter has maximum operating limits as stipulated under the licence.
• Pilot Cutter coxswain has power to suspend operations	The pilot cutter coxswains have the power to suspend operations, or abort a transit in adverse weather. This is normally done in conjunction with a licensed pilot.
• SFPC Operating Procedures	SFPC have operating procedures in place for the Pilot Cutters.
• Tug QMS	The tug is required to be run under a Quality Management System (QMS or ISM) as per Port Byelaw 87(4).
• Experienced Mooring Boat Operators	The present mooring boat crews are experienced operators and have procedures in place regarding mooring operations.

The following possible mitigation measures could be implemented to further reduce these hazards to these vessels:

• Environmental operating limits (SIGTTO)	Set maximum environmental operating limits to ensure the transit by Carrier and service craft can be undertaken safely.
• Upated Pilot Cutter for rough weather operations	Consider the use of uprated Pilot Cutter for rough weather operations to west of Ballybunnion Buoy. This is to ensure pilot cutter can proceed to boarding ground safely within the maximum environmental operating limits.
• Improved Pilot Cutter reliability of service	Increase reliability of service of the Pilot Cutter with effective planned maintenance systems. This may require the consideration of a second boat to ensure maintenance can be planned rather than when required.

The following mitigation measures could be implemented for the proposed tugs that are being considered:

<ul style="list-style-type: none"> • Tug construction 	<p>Use specially designed escort-notated tugs. These have better sea-keeping capabilities than normal harbour tugs for escort work and are designed to work in a seaway.</p>
<ul style="list-style-type: none"> • Dual redundancy with tug systems 	<p>Dual redundancy of tug systems reduces likelihood of total tug failure.</p>
<ul style="list-style-type: none"> • Joint bridge simulation 	<p>Tug masters to attend joint bridge simulation trials with pilots and/or masters to gain better awareness of each others roles and understanding of problems.</p>
<ul style="list-style-type: none"> • Bridge team management training 	<p>Tug masters to attend bridge team management so that they are fully conversant with, and understand, the bridge team (and pilot) anticipated manoeuvre. It will ensure that tug masters will also alert/question the pilot if the tug has a problem or the tug master sees a potential problem or deviation.</p>
<ul style="list-style-type: none"> • Freewheel/quick release facilities for winches 	<p>Freewheel and quick release facilities increases safety as it allows tow master to release high load if required. Also allows ease of connecting up as freewheel winch can allow rope to run freely when vessel dropping into position.</p>
<ul style="list-style-type: none"> • Tug procedures 	<p>Implement procedures regarding tugs, where they are to attend and when to be made fast, as well as connecting up procedures. Procedures should include water-tight integrity procedures which stipulate what vents and doors are required to be closed when operating.</p>