APPENDIX C

SAFOP REVIEW OF DIFFERENT PIPE DISPOSAL OPTIONS

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C1. INTRODUCTION

The SAFOP was performed on February 18. Tor Egil Nielsen from Scandpower facilitated the study with Don Eckert and Glen Duhon from Global Solutions participating as experts on pipeline removal operations.

The review focused on personnel risk. However, a check list usually applied for marine operations, which also covered operational aspects and potential equipment damages, was used for the review. This was done to reveal operational problems, which could lead to situations with increased risk for personnel. The list is presented below. The last five guidewords, those which identify potential harm to personnel, are the ones included in the SAFOP sheets. In addition to the risks dealing with energy release and exposure to toxic substances, diving is an activity that contributes to personnel risk.

Operational review check list

PREOP.CHECKS	:	Necessary equipment, tugs not available on schedule Necessary equipment checking/testing not performed
WEATHER	:	Unclear weather restrictions or unexpected deterioration of weather (abortion of operation). Weather forecasting, low temperatures
CURRENT	:	Problems related to strong, unexpected currents
POSITION	:	Object, grillage, tugs or vessel not in correct position
POWER	:	No power or insufficient power (tugs, electrical, hydraulic, air)
EQUIPMENT	:	Malfunction or lack of equipment
INSTRUMENTS	:	Malfunction or lack of instruments
RESPONSIBILITY	:	Undefined/unclear responsibilities (tugs, vessel, port)
COMMUNICATION	:	Malfunction or lack of communication equipment. Communication lines, noise, shift changes
EXECUTION	:	A work task is executed in a wrong way, timing, speed
PROCEDURES	:	Missing or unclear procedures
VISIBILITY	:	Can the operator(s) see sufficiently?
MOVEMENT	:	Objects, tugs or vessels move in an uncontrolled way
STABILITY	:	Unstable conditions
TOLERANCES	:	Tolerances for positioning, etc.
INTERFACES	:	Wrong, contamination, corrosion, marine growth, etc.
STUCK	:	Movement cannot be performed
RUPTURE	:	Rupture of critical equipment, overloading
ACCESS	:	Insufficient access/space on tugs, vessel, port
ESCAPE ROUTES	:	Sufficient, checked against requirements, protected
CONTINGENCY	:	Back-up procedures/equipment not available
OTHER	:	Other items not covered by the above guidewords

IMPACT	:	Impact between objects, squeezing (personnel)
DROP	:	Drop of objects from a higher level
FALL	:	Fall of personnel to lower level
ENERGY RELEASE	:	Electric, pressure, heat, cold, radioactive
TOXIC RELEASE	:	Release of hazardous substances

For the SAFOP review, each method for pipeline disposal was split in different main activities, see Appendix B. For each of these main activities, the check list above was applied. The results are given in the tables on the following pages. It was assumed that all pipelines were flushed at the start of the operation.

C2. SAFOP SHEET LEAVE IN PLACE

SAFOP Leave in place

Main Step 1: Cut turn tube and rock dump pipe ends (if pipeline is buried).
No. of vessels in operation: 2 (Tug + Rock dumping vessel)
No. of divers involved/share of time: : Min. 5 (1 in water at anytime)

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact	In rough weather, divers can get impacts while going through the splash zone. In rough water, excessive surge can cause unexpected movements of equipment etc. lowered to the diver, which can be hit. Also, high currents can slam the diver into the subsea structures	Proper application of sea state limitations will minimize the risk. Also monitoring of weather forecasts is important	Crane handling etc. poses a risk for swinging loads and dropped objects at the barge when the tube turn(s) are lifted out of the water and onto the barge. This risk increases in rough seas/high winds					
Drop	The turn tube can snag on the jacket structure while being retrieved by the barge crane. Can cause unexpected movements or snapping of slings or nylon straps. Lines or turn tube can hit diver. Poor visibility will increase the risk	Communication between diver and barge/crane operator is critical for safe handling of the equipment subsea. Also, procedures for location of diver relative to retrieved/ deployed equipment is important						
Fall								

Energy release	If the pipeline is in tension, it can swing out and hit the diver when it is cut	The diver needs not to be close to the cutting device during the cutting and a procedure is in place to keep the diver out of the potentially dangerous area						
Toxic release								

C3. SAFOP SHEETS BURY/TRENCHING

SAFOP Bury/Trenching

Main Step 1: Cut tube turn.
No. of vessels in operation: 1 (Tug)
No. of divers involved/share of time: Min. 5 (1 in water at anytime)

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact	In rough weather, divers can get impacts while going through the splash zone. In rough water, excessive surge can cause unexpected movements of equipment etc. lowered to the diver, which can be hit. Also, high currents can slam the diver into the subsea structures	Proper application of sea state limitations will minimize the risk. Also monitoring of weather forecasts is important	Crane handling etc. poses a risk for swinging loads and dropped objects at the barge when the tube turn(s) are lifted out of the water and onto the barge. This risk increases in rough seas/high winds					
Drop	The turn tube can snag on the jacket structure while being retrieved by the barge crane. Can cause unexpected movements or snapping of slings or nylon straps. Lines or turn tube can hit diver. Poor visibility will increase the risk	Communication between diver and barge/crane operator is critical for safe handling of the equipment subsea. Also, procedures for location of diver relative to retrieved/ deployed equipment is important						
Fall								

Energy release	If the pipeline is in tension, it can swing out and hit the diver when it is cut	The diver needs not to be close to the cutting device during the cutting and a procedure is in place to keep the diver out of the potentially dangerous area						
Toxic release								

SAFOP Bury/Trenching

Main Step 1: Bury pipeline.

No. of vessels in operation: 2 (Tug + rock dumping vessel)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact								
Drop								
Fall								
Energy release								
Toxic release								

C4. SAFOP SHEETS REVERSE LAY RECOVERY

SAFOP Reverse Lay Recovery

Main Step 1: Set up of barge

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			In heavy seas, excessive movement of the barge can cause equipment to move or topple, also equipment can drop Poor communication between tug and barge can cause impacts between vessels, fall of personnel, and potentially snapping of lines or wires, which can injure personnel	Proper procedures for sea-fastening/securing of equipment, proper attention to weather forecast and weather restrictions Lack of communication during set-up is not seen as a major hazard with proper procedures etc. in place, but good communication is deemed critical for a safe operation	Handling of anchors and anchor buoys can cause squeezing and snapped lines	Anchor and anchor buoy handling are standard operations performed through the whole removal procedure and are not considered high risk operations		
Drop								
Fall			Personnel can fall off barge, considered low probability		Personnel can fall off tug, considered low probability			
Energy release								
Toxic release								

SAFOP Reverse Lay Recovery

Main Step 2: Cut and Remove Tube Turn(s)

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: min. 5 off which 1 in water at anytime

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact	In rough weather, divers can get impacts while going through the splash zone. In rough water, excessive surge can cause unexpected movements of equipment etc. lowered to the diver, which can be hit. Also, high currents can slam the diver into the subsea structures	Proper application of sea state limitations will minimize the risk. Also monitoring of weather forecasts is important	Crane handling etc. poses a risk for swinging loads and dropped objects at the barge when the tube turn(s) are lifted out of the water and onto the barge. This risk increases in rough seas/high winds	Proper lifting procedures, communication and application of weather/sea state limitations will minimize this risk				
Drop	The turn tube can snag on the jacket structure while being retrieved by the barge crane. Can cause unexpected movements or snapping of slings or nylon straps. Lines or turn tube can hit diver. Poor visibility will increase the risk	Communication between diver and barge/crane operator is critical for safe handling of the equipment subsea. Also, procedures for location of diver relative to retrieved/ deployed equipment is important						
Fall								

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Energy release	If the pipeline is in tension, it can swing out and hit the diver when it is cut	The diver needs not to be close to the cutting device during the cutting and a procedure is in place to keep the diver out of the potentially dangerous area						
Toxic release								

SAFOP Reverse Lay Recovery

Main Step 3: Recover Pipeline with a A&R Winch

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 1 (attaching A&R cable only)

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact								
Drop								
Fall								
Energy release			Overloading of A&R cable for any reason can cause it to snap. This can cause the cable end to swing out on the barge deck hitting personnel. The cable can also snap without being overloaded	With the A&R winch pull capacity and the cable rating this is considered low probability. Also, the tension in the cable can be monitored continuously				
Toxic release								

SAFOP Reverse Lay Recovery

Main Step 4: Retrieval of Pipe

No. of vessels in operation: 3 (Tug+Barge+Material Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			Crane operations for handling of the cut pipe sections pose the same risks as handling of the turn tube	As for handling of the turn tube	As for setting up, the tug will move anchors continuously		Material handling risk as for personnel at the recovery barge	
Drop								
Fall			Personnel may move between recovery barge and material barge, can fall into the water	Hand rails and securing lines will minimize this risk				
Energy release			Cutting of pipe sections at the barge can cause eye injuries, cuts	Safety glasses shall be used				
Toxic release								

SAFOP Reverse Lay Recovery

Main Step 5: Cutting and transport of pipeline onshore

No. of vessels in operation: 3 (Tug+Barge+Material Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			Struck by moving Equipment? NORM release? Chemicals?					
Drop			Drop of pipe due to poor integrity in pipe?					
Fall								
Energy release								
Toxic release								

C5. SAFOP SHEETS REVERSE REEL BARGE RECOVERY

SAFOP Reverse Reel Barge Recovery

Main Step 1: Set up of barge

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			In heavy seas, excessive movement of the barge can cause equipment to move or topple, also equipment can drop Poor communication between tug and barge can cause impacts between vessels, fall of personnel, and potentially snapping of lines or wires, which can injure personnel	Proper procedures for sea-fastening/securing of equipment, proper attention to weather forecast and weather restrictions Lack of communication during set-up is not seen as a major hazard with proper procedures etc. in place, but good communication is deemed critical for a safe operation	Handling of anchors and anchor buoys can cause squeezing and snapped lines	Anchor and anchor buoy handling are standard operations performed through the whole removal procedure and are not considered high risk operations		
Drop								
Fall			Personnel can fall off barge, considered low probability		Personnel can fall off tug, considered low probability			
Energy release								
Toxic release								

SAFOP Reverse Reel Barge Recovery

Main Step 2: Cut and Remove Tube Turn(s)

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: min. 5 off which 1 in water at anytime

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact	In rough weather, divers can get impacts while going through the splash zone. In rough water, excessive surge can cause unexpected movements of equipment etc. lowered to the diver, which can be hit. Also, high currents can slam the diver into the subsea structures	Proper application of sea state limitations will minimize the risk. Also monitoring of weather forecasts is important	Crane handling etc. poses a risk for swinging loads and dropped objects at the barge when the tube turn(s) are lifted out of the water and onto the barge. This risk increases in rough seas/high winds	Proper lifting procedures, communication and application of weather/sea state limitations will minimize this risk				
Drop	The turn tube can snag on the jacket structure while being retrieved by the barge crane. Can cause unexpected movements or snapping of slings or nylon straps. Lines or turn tube can hit diver. Poor visibility will increase the risk	Communication between diver and barge/crane operator is critical for safe handling of the equipment subsea. Also, procedures for location of diver relative to retrieved/ deployed equipment is important						
Fall								

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Energy release	If the pipeline is in tension, it can swing out and hit the diver when it is cut	The diver needs not to be close to the cutting device during the cutting and a procedure is in place to keep the diver out of the potentially dangerous area						
Toxic release								

SAFOP Reverse Reel Barge Recovery

Main Step 3: Recover Pipeline with a A&R Winch

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 1 (attaching A&R cable only)

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact								
Drop								
Fall								
Energy release			Overloading of A&R cable for any reason can cause it to snap. This can cause the cable end to swing out on the barge deck hitting personnel. The cable can also snap without being overloaded	With the A&R winch pull capacity and the cable rating this is considered low probability. Also, the tension in the cable can be monitored continuously				
Toxic release								

SAFOP Reverse Reel Barge Recovery

Main Step 4: Wound pipe onto reel and transport reel to shore

No. of vessels in operation: 3 (Tug+Barge+Material Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			Pipe might brake while wounded on reel	Inspection of pipe integrity				
Drop								
Fall			Personnel may move between recovery barge and material barge, can fall into the water	Hand rails and securing lines will minimize this risk				
Energy release								
Toxic release								

C6. SAFOP SHEETS LONG SECTION BARGE RECOVERY

SAFOP Long Section Barge Recovery

Main Step 1: Set up of barge
No. of vessels in operation: 2 (Tug + Barge)
No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			In heavy seas, excessive movement of the barge can cause equipment to move or topple, also equipment can drop Poor communication between tug and barge can cause impacts between vessels, fall of personnel, and potentially snapping of lines or wires, which can injure personnel	Proper procedures for sea-fastening/securing of equipment, proper attention to weather forecast and weather restrictions Lack of communication during set-up is not seen as a major hazard with proper procedures etc. in place, but good communication is deemed critical for a safe operation	Handling of anchors and anchor buoys can cause squeezing and snapped lines	Anchor and anchor buoy handling are standard operations performed through the whole removal procedure and are not considered high risk operations		
Drop								
Fall			Personnel can fall off barge, considered low probability		Personnel can fall off tug, considered low probability			
Energy release								
Toxic release								

SAFOP Long Section Barge Recovery

Main Step 2: Cut and Remove Tube Turn(s)

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: min. 5 off which 1 in water at anytime

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact	In rough weather, divers can get impacts while going through the splash zone. In rough water, excessive surge can cause unexpected movements of equipment etc. lowered to the diver, which can be hit. Also, high currents can slam the diver into the subsea structures	Proper application of sea state limitations will minimize the risk. Also monitoring of weather forecasts is important	Crane handling etc. poses a risk for swinging loads and dropped objects at the barge when the tube turn(s) are lifted out of the water and onto the barge. This risk increases in rough seas/high winds	Proper lifting procedures, communication and application of weather/sea state limitations will minimize this risk				
Drop	The turn tube can snag on the jacket structure while being retrieved by the barge crane. Can cause unexpected movements or snapping of slings or nylon straps. Lines or turn tube can hit diver. Poor visibility will increase the risk	Communication between diver and barge/crane operator is critical for safe handling of the equipment subsea. Also, procedures for location of diver relative to retrieved/ deployed equipment is important						
Fall								

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Energy release	If the pipeline is in tension, it can swing out and hit the diver when it is cut	The diver needs not to be close to the cutting device during the cutting and a procedure is in place to keep the diver out of the potentially dangerous area						
Toxic release								

SAFOP Long Section Barge Recovery

Main Step 3: Cut pipe subsea

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 5 (1in the water all time)

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact								
Drop								
Fall								
Energy release								
Toxic release								

SAFOP Long Section Barge Recovery

Main Step 4: Lift pipeline with crane, transport onshore

No. of vessels in operation: 3 (Tug+Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			Crane operations for handling of the cut pipe sections pose the same risks as handling of the turn tube Lifting operation might interfere with diving operations.	As for handling of the turn tube Establish procedures, and make sure diver is out of the water during lift	As for setting up, the tug will move anchors continuously		Material handling risk as for personnel at the recovery barge	
Drop								
Fall			Personnel may move between recovery barge and material barge, can fall into the water	Hand rails and securing lines will minimize this risk				
Energy release								
Toxic release								

C7. SAFOP SHEETS TOW RECOVERY

SAFOP Tow Recovery

Main Step 1: Set up of barge

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			In heavy seas, excessive movement of the barge can cause equipment to move or topple, also equipment can drop Poor communication between tug and barge can cause impacts between vessels, fall of personnel, and potentially snapping of lines or wires, which can injure personnel	Proper procedures for sea-fastening/securing of equipment, proper attention to weather forecast and weather restrictions Lack of communication during set-up is not seen as a major hazard with proper procedures etc. in place, but good communication is deemed critical for a safe operation	Handling of anchors and anchor buoys can cause squeezing and snapped lines	Anchor and anchor buoy handling are standard operations performed through the whole removal procedure and are not considered high risk operations		
Drop								
Fall			Personnel can fall off barge, considered low probability		Personnel can fall off tug, considered low probability			
Energy release								
Toxic release								

SAFOP Tow Recovery

Main Step 2: Cut and Remove Tube Turn and pipe sections subsea

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: min. 5 off which 1 in water at anytime

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact	In rough weather, divers can get impacts while going through the splash zone. In rough water, excessive surge can cause unexpected movements of equipment etc. lowered to the diver, which can be hit. Also, high currents can slam the diver into the subsea structures	Proper application of sea state limitations will minimize the risk. Also monitoring of weather forecasts is important	Crane handling etc. poses a risk for swinging loads and dropped objects at the barge when the tube turn(s) are lifted out of the water and onto the barge. This risk increases in rough seas/high winds	Proper lifting procedures, communication and application of weather/sea state limitations will minimize this risk				
Drop	The turn tube can snag on the jacket structure while being retrieved by the barge crane. Can cause unexpected movements or snapping of slings or nylon straps. Lines or turn tube can hit diver. Poor visibility will increase the risk	Communication between diver and barge/crane operator is critical for safe handling of the equipment subsea. Also, procedures for location of diver relative to retrieved/ deployed equipment is important						
Fall								

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Energy release	If the pipeline is in tension, it can swing out and hit the diver when it is cut	The diver needs not to be close to the cutting device during the cutting and a procedure is in place to keep the diver out of the potentially dangerous area						
Toxic release								

SAFOP Tow Recovery

Main Step 3: Attach flotation buoyancy to the pipe

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 5 (1 in water at anytime)

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact								
Drop								
Fall								
Energy release								
Toxic release								

SAFOP Tow Recovery

Main Step 4: Tow of pipe to shore

No. of vessels in operation: Multiple (Tugs)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact								
Drop								
Fall								
Energy release								
Toxic release								

C8. SAFOP SHEETS SHORT SECTION RECOVERY

SAFOP Short Section Recovery

Main Step 1: Set up of barge

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			In heavy seas, excessive movement of the barge can cause equipment to move or topple, also equipment can drop Poor communication between tug and barge can cause impacts between vessels, fall of personnel, and potentially snapping of lines or wires, which can injure personnel	Proper procedures for sea-fastening/securing of equipment, proper attention to weather forecast and weather restrictions Lack of communication during set-up is not seen as a major hazard with proper procedures etc. in place, but good communication is deemed critical for a safe operation	Handling of anchors and anchor buoys can cause squeezing and snapped lines	Anchor and anchor buoy handling are standard operations performed through the whole removal procedure and are not considered high risk operations		
Drop								
Fall			Personnel can fall off barge, considered low probability		Personnel can fall off tug, considered low probability			
Energy release								
Toxic release								

SAFOP Short Section Recovery

Main Step 2: Cut and Remove Tube Turn and cut short sections subsea

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: min. 5 (1 in water at anytime)

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact	In rough weather, divers can get impacts while going through the splash zone. In rough water, excessive surge can cause unexpected movements of equipment etc. lowered to the diver, which can be hit. Also, high currents can slam the diver into the subsea structures	Proper application of sea state limitations will minimize the risk. Also monitoring of weather forecasts is important	Crane handling etc. poses a risk for swinging loads and dropped objects at the barge when the tube turn(s) are lifted out of the water and onto the barge. This risk increases in rough seas/high winds	Proper lifting procedures, communication and application of weather/sea state limitations will minimize this risk				
Drop	The turn tube can snag on the jacket structure while being retrieved by the barge crane. Can cause unexpected movements or snapping of slings or nylon straps. Lines or turn tube can hit diver. Poor visibility will increase the risk	Communication between diver and barge/crane operator is critical for safe handling of the equipment subsea. Also, procedures for location of diver relative to retrieved/ deployed equipment is important						
Fall								

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Energy release	If the pipeline is in tension, it can swing out and hit the diver when it is cut	The diver needs not to be close to the cutting device during the cutting and a procedure is in place to keep the diver out of the potentially dangerous area						
Toxic release								

SAFOP Short Section Recovery

Main Step 3: Attach lifting slings

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 1 (attaching lifting sling)

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact								
Drop								
Fall								
Energy release								
Toxic release								

SAFOP Short Section Recovery

Main Step 4: Lift pipe to barge, and transport to shore

No. of vessels in operation: 2 (Tug+Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			Crane operations for handling of the cut pipe sections pose the same risks as handling of the turn tube	As for handling of the turn tube	As for setting up, the tug will move anchors continuously		Material handling risk as for personnel at the recovery barge	
Drop								
Fall			Personnel may move between recovery barge and material barge, can fall into the water	Hand rails and securing lines will minimize this risk				
Energy release								
Toxic release								

C9. SAFOP SHEETS J-LIFT RECOVERY

SAFOP J-Lift Recovery

Main Step 1: Set up of barge
No. of vessels in operation: 2 (Tug + Barge)
No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			In heavy seas, excessive movement of the barge can cause equipment to move or topple, also equipment can drop Poor communication between tug and barge can cause impacts between vessels, fall of personnel, and potentially snapping of lines or wires, which can injure personnel	Proper procedures for sea-fastening/securing of equipment, proper attention to weather forecast and weather restrictions Lack of communication during set-up is not seen as a major hazard with proper procedures etc. in place, but good communication is deemed critical for a safe operation	Handling of anchors and anchor buoys can cause squeezing and snapped lines	Anchor and anchor buoy handling are standard operations performed through the whole removal procedure and are not considered high risk operations		
Drop								
Fall			Personnel can fall off barge, considered low probability		Personnel can fall off tug, considered low probability			
Energy release								
Toxic release								

SAFOP J-Lift Recovery

Main Step 2: Cut and Remove Tube Turn(s)

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: min. 5 off which 1 in water at anytime

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact	In rough weather, divers can get impacts while going through the splash zone. In rough water, excessive surge can cause unexpected movements of equipment etc. lowered to the diver, which can be hit. Also, high currents can slam the diver into the subsea structures	Proper application of sea state limitations will minimize the risk. Also monitoring of weather forecasts is important	Crane handling etc. poses a risk for swinging loads and dropped objects at the barge when the tube turn(s) are lifted out of the water and onto the barge. This risk increases in rough seas/high winds	Proper lifting procedures, communication and application of weather/sea state limitations will minimize this risk				
Drop	The turn tube can snag on the jacket structure while being retrieved by the barge crane. Can cause unexpected movements or snapping of slings or nylon straps. Lines or turn tube can hit diver. Poor visibility will increase the risk	Communication between diver and barge/crane operator is critical for safe handling of the equipment subsea. Also, procedures for location of diver relative to retrieved/ deployed equipment is important						
Fall								

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Energy release	If the pipeline is in tension, it can swing out and hit the diver when it is cut	The diver needs not to be close to the cutting device during the cutting and a procedure is in place to keep the diver out of the potentially dangerous area						
Toxic release								

SAFOP J-Lift Recovery

Main Step 3: Recover Pipeline with a A&R Winch

No. of vessels in operation: 2 (Tug + Barge)

No. of divers involved/share of time: 1 (attaching A&R cable only)

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact								
Drop								
Fall								
Energy release			Overloading of A&R cable for any reason can cause it to snap. This can cause the cable end to swing out on the barge deck hitting personnel. The cable can also snap without being overloaded	With the A&R winch pull capacity and the cable rating this is considered low probability. Also, the tension in the cable can be monitored continuously				
Toxic release								

SAFOP J-Lift Recovery

Main Step 4: Retrieving of Pipe

No. of vessels in operation: 3 (Tug+Barge+Material Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact			Crane operations for handling of the cut pipe sections pose the same risks as handling of the turn tube	As for handling of the turn tube	As for setting up, the tug will move anchors continuously		Material handling risk as for personnel at the recovery barge	
Drop								
Fall			Personnel may move between recovery barge and material barge, can fall into the water	Hand rails and securing lines will minimize this risk				
Energy release			Cutting of pipe sections at the barge can cause eye injuries, cuts	Safety glasses shall be used				
Toxic release								

SAFOP J-Lift Recovery

Main Step 5: Cutting and transport of pipeline onshore

No. of vessels in operation: 3 (Tug+Barge+Material Barge)

No. of divers involved/share of time: 0

Type Exposure	Safety Concern, Cause and Safeguards							
	Divers		Personnel at Recovery Barge		Personnel at Tug(s)		Personnel at Material Barge	
	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards	Risk	Safeguards
Impact								
Drop								
Fall								
Energy release								
Toxic release								