SCANDPOWER

MMS Report

”An Assessment of Safety, Risks and Cost Associated with Subsea Pipeline Disposals”

September 3rd 2004

Tor Egil Nielsen

Study Objectives

The objectives for this study are:

1. **Present the disposal options for subsea oil and gas pipelines that have reached the end of their useful life**
2. **Identify relevant regulations**
3. **Detail the safety hazards for each disposal option**
4. **Detail the costs for each disposal option**
5. **Detail potential environmental impacts for each disposal option.**

Report Table of Contents

US Regulations

Department of Transportation (DOT) Research & Special Programs Administration Office of Pipeline Safety (RSPA/OPS) and of the Minerals Management Service (MMS) of the Department of the Interior (DOI) have the jurisdiction in US waters.

- **30 CFR 250.1754** requires a pipeline to be removed when the Regional Supervisor of the MMS determines that the pipeline is an obstruction.
- MMS requirements to removal procedures in **30 CFR 250.1750 through 250.1754.**
- The type and scope of decommissioning work to be performed on a pipeline is dependant on the time the pipeline is scheduled to be out of service. These requirements are found in **30 CFR 250.1006.**

International Regulations/Guidelines

International rules/laws do not specifically cover pipelines, but the pipelines are either indirectly included, or in the process of being included.

- **The 1958 Geneva Convention and the Nations Convention on the Law of the Sea (UNCLOS)** says removal shall be done to ensure safety of navigation and consider fishing and marine environment
- **IMO** is the competent international organization pursuant to Article 60.3 of the UNCLOS. The IMO Guidelines are not formally binding and are thus advisory in nature.
- **The London (Dumping) Convention** "Guidelines for the Assessment of Wastes and Other Matter that may be Considered for Dumping" provide specific guidance for different classes of waste, including platforms and other man-made waste.
- The Commission on the Convention for the protection of the marine environment in the North East Atlantic (**OSPAR**) has reached an agreement on banning dumping of disused offshore installations at sea. Requirements can be waived based on assessments.

Pipeline data

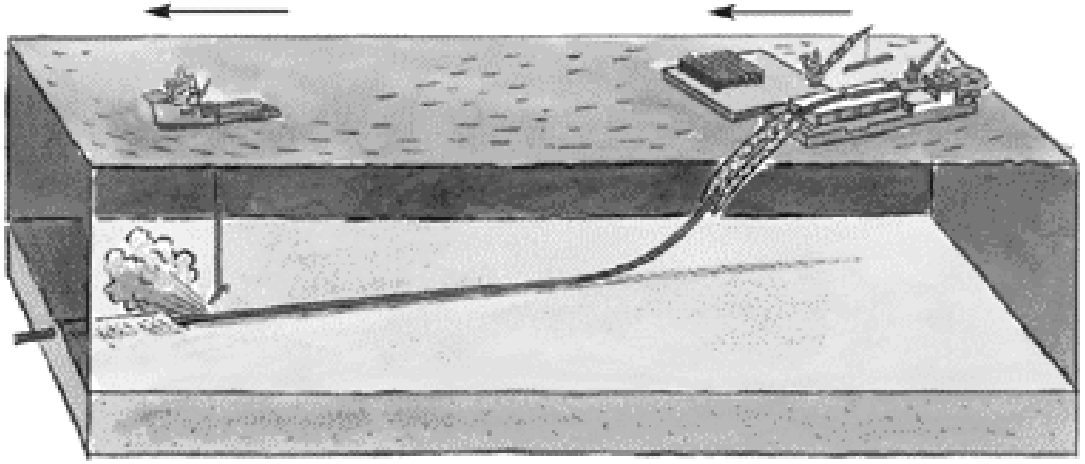
- **Length**
  - GOM - 32,900 miles
  - West Coast - 231
  - Alaska - 160
- **Dimensions**
  - < 4” - 2,683 miles
  - 4” to 12” - 20,213 miles
  - 14” to 16” - 2,982 miles
  - 18” to 24” - 4,674 miles
  - 26” to 30” - 1,684 miles
  - > 30” - 1,055 miles

Pipeline disposal options

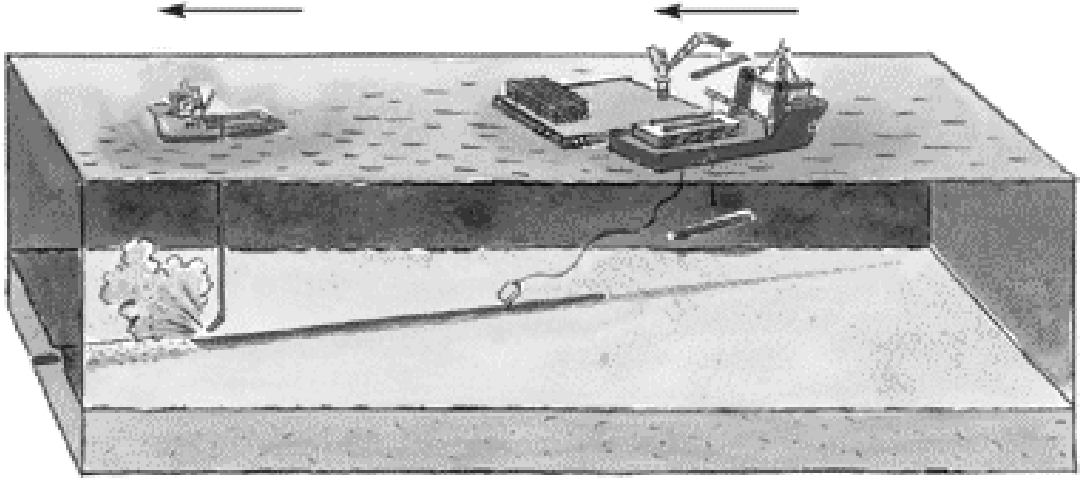
(from John Brown HSE report)

1. **Leave in Place**
2. **Burying or Trenching**
3. **Reverse Lay Recovery**
4. **Reverse Reel Barge Recovery**
5. **Long Section Barge Recovery**
6. **Tow Recovery**
7. **Short Section Recovery**
8. **J-Lift Recovery**

Reverse lay



Cutting on seabed



Personnel hazards associated with pipe retrieval operations include the following:

- Being struck by moving equipment such as the pipe reel or joints of pipe rolling across the racks on the back of the vessel
- Being caught between moving joints of pipe or pipe racks being moved across the deck of the vessel
- Falling from a height of 4 or more feet from walkways or work platforms on the equipment
- Potential exposure to ultraviolet radiation from welding operations on the deck of the boat or barge during retrieval operations
- Potential exposure to NORM from pipe scale
- Potential exposure to any chemicals being used in a pipe retrieval operation.
- Diving risks, impacts, drops, squeeze, etc.

Hazard Identification

SAFOP: Systematically review the sequences of the different disposal options to identify possible hazards and unsolved issues.

Guidewords:

- **WEATHER**
- **IMPACT**
- **POSITION**
- **POWER**
- **INSTRUMENTS**
- **COMMUNICATION**
- **EXECUTION**
- **PROCEDURES**
- **MOVEMENT**
- **STABILITY**
- **RUPTURE**
- **ACCESS**
- **OVERLOADING**
- **IMPACT**
- **DROP**
- **FALL**
- **ENERGY RELEASE**
- **TOXIC RELEASE**

Hazard Identification Worksheet

SAFOP SHEET: 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								
Drop								
Fall								
Energy release								
Toxic release								

1. Leave in Place

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

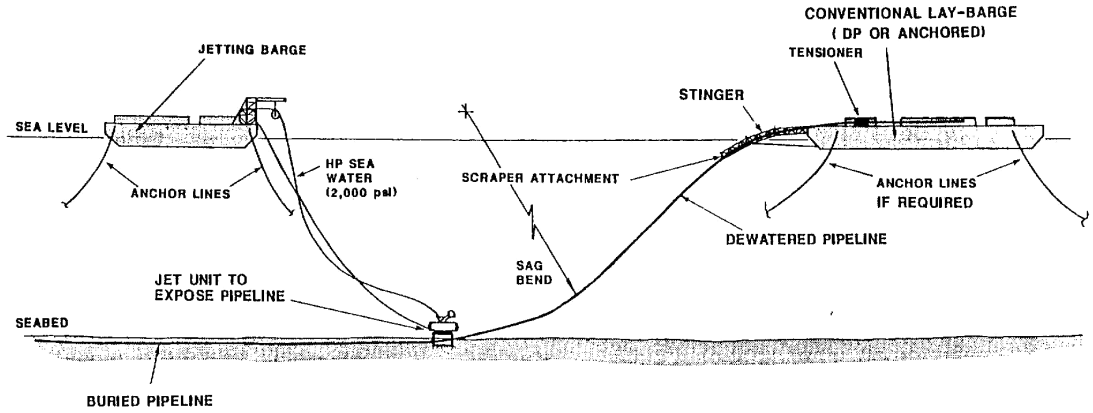
2. Burying or Trenching

Main step in removal procedure	No. of vessels in operation	No. of divers involved/ share of time
Cut tube turn	1 (Tug)	Min. 5 (1 in water at anytime)
Bury pipeline	2 (Tug + Rock dumping vessel)	0

3. Reverse Lay Recovery

Main step in removal procedure	No. of vessels in operation	No. of divers involved/ share of time
Set up of barge	2 (Tug + Barge)	0
Cut and remove tube turn(s)	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Recover pipeline with A&R winch	2 (Tug + Barge)	1 (attaching A&R cable only)
Retrieval of pipe	3 (Tug + Barge + Material Barge)	0
Cutting and transport of pipeline onshore	3 (Tug + Barge + Material Barge)	0

Figure 4.11

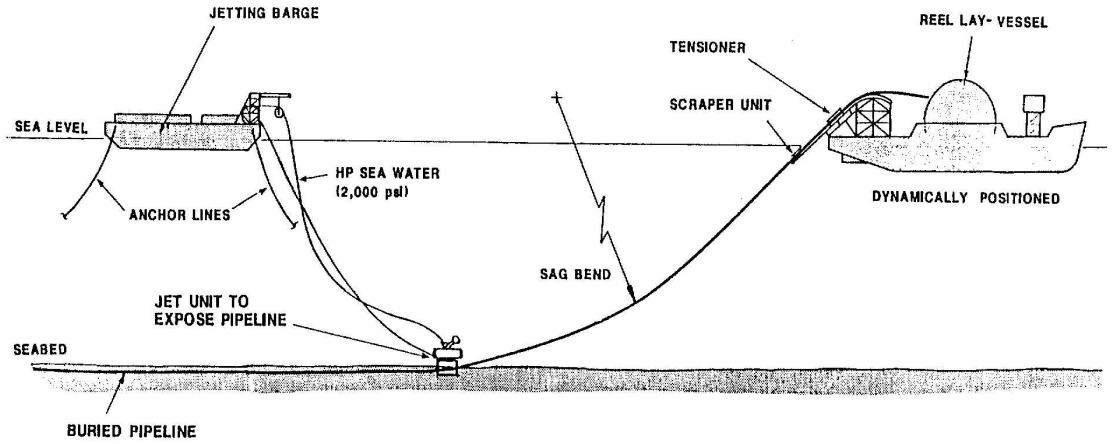


RECOVERY OF ABANDONED PIPELINE BY REVERSE LAY PROCESS

4. Reverse Reel Barge Recovery

Main step in removal procedure	No. of vessels in operation	No. of divers involved/ share of time
Set up of barge	2 (Tug + Barge)	0
Cut and remove tube turn(s)	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Recover pipeline with A&R winch	2 (Tug + Barge)	1 (attaching A&R cable only)
Wound pipe onto reel and transport reel to shore	3 (Tug + Barge + Material Barge)	0

Figure 4.12

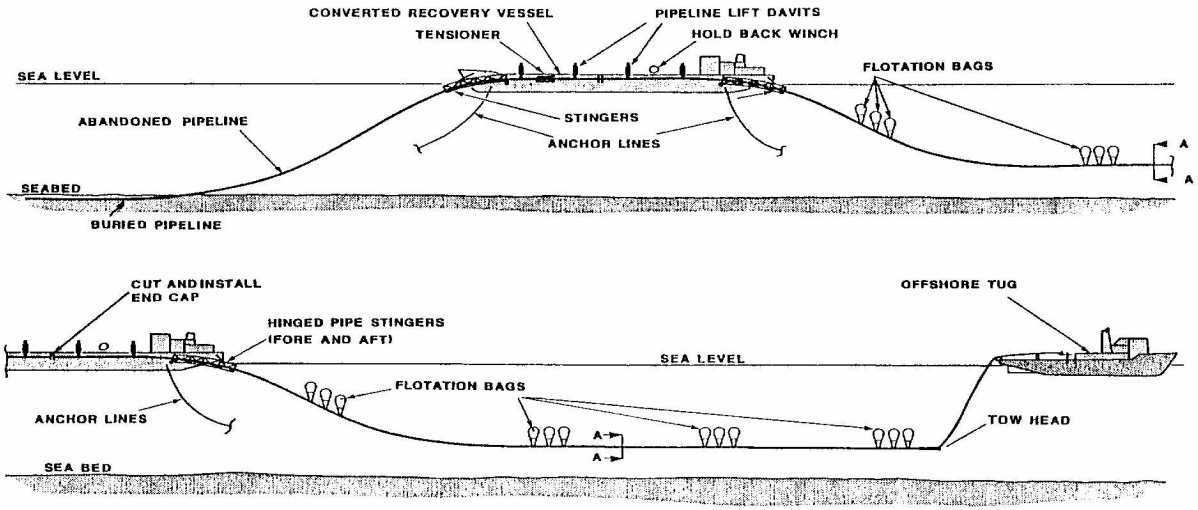


RECOVERY OF ABANDONED PIPELINE BY
REVERSE REEL BARGE LAY PROCESS

5. Long Section Barge Recovery

Main step in removal procedure	No. of vessels in operation	No. of divers involved/ share of time
Set up of barge	2 (Tug + Barge)	0
Cut and remove tube turn(s)	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Cut pipe subsea	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Lift pipeline with crane, transport onshore	2 (Tug + Barge)	0

Figure 4.13



LONG SECTION PIPELINE RECOVERY

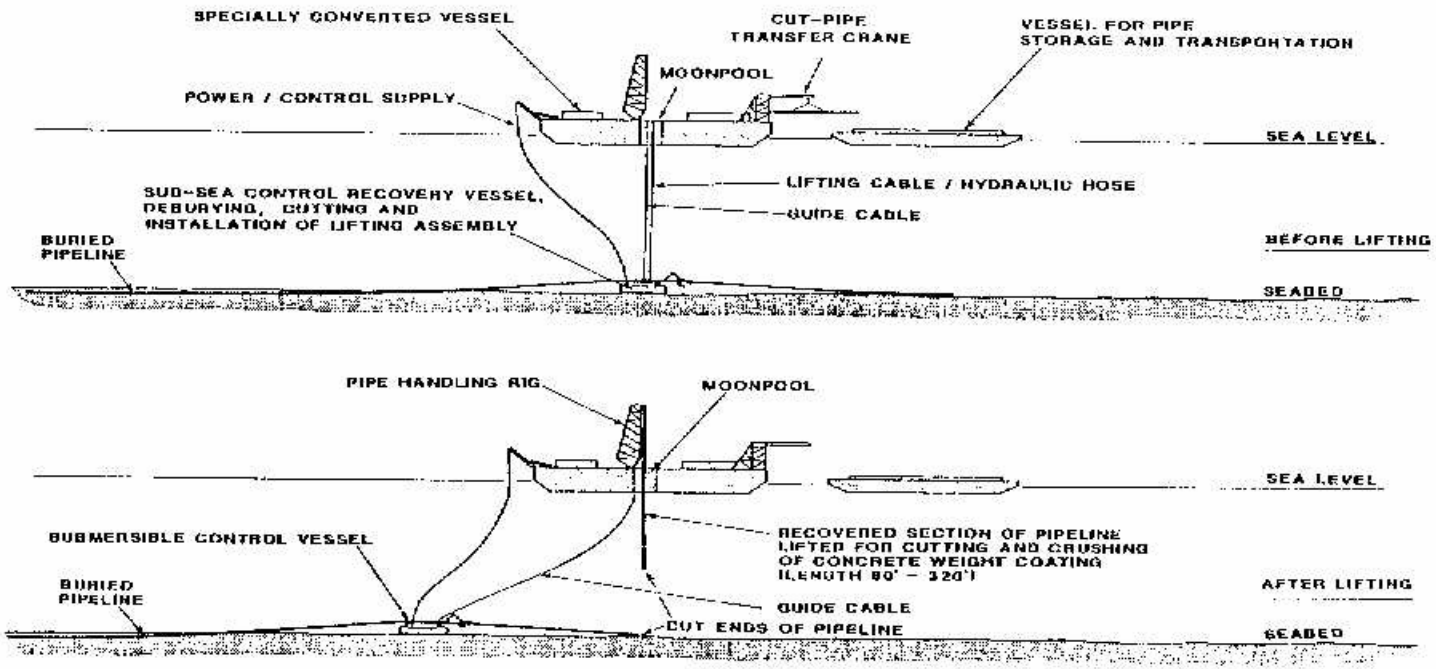
6. Tow Recovery

Main step in removal procedure	No. of vessels in operation	No. of divers involved/ share of time
Set up of barge	2 (Tug + Barge)	0
Cut and remove tube turn(s)	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Cut pipe sections subsea	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Attach flotation buoyancy to the pipe	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Tow of pipe to shore	Multiple (Tugs)	0

7. Short Section Recovery

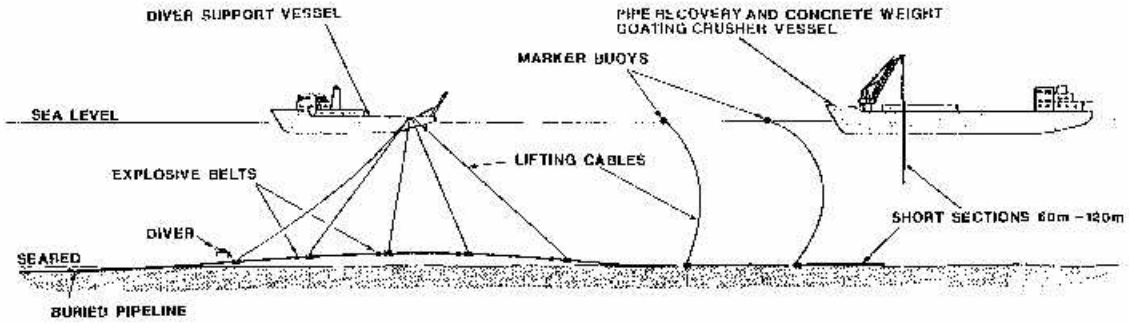
Main step in removal procedure	No. of vessels in operation	No. of divers involved/ share of time
Set up of barge	2 (Tug + Barge)	0
Cut and remove tube turn(s)	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Cut short pipe sections subsea	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Attach lifting slings	2 (Tug + Barge)	1 (attaching lifting sling)
Lift pipe to barge, transport onshore	3 (Tug + Barge + Material Barge)	0

Figure 4.14



SHORT SECTION RECOVERY BY SPECIALLY CONVERTED VESSEL

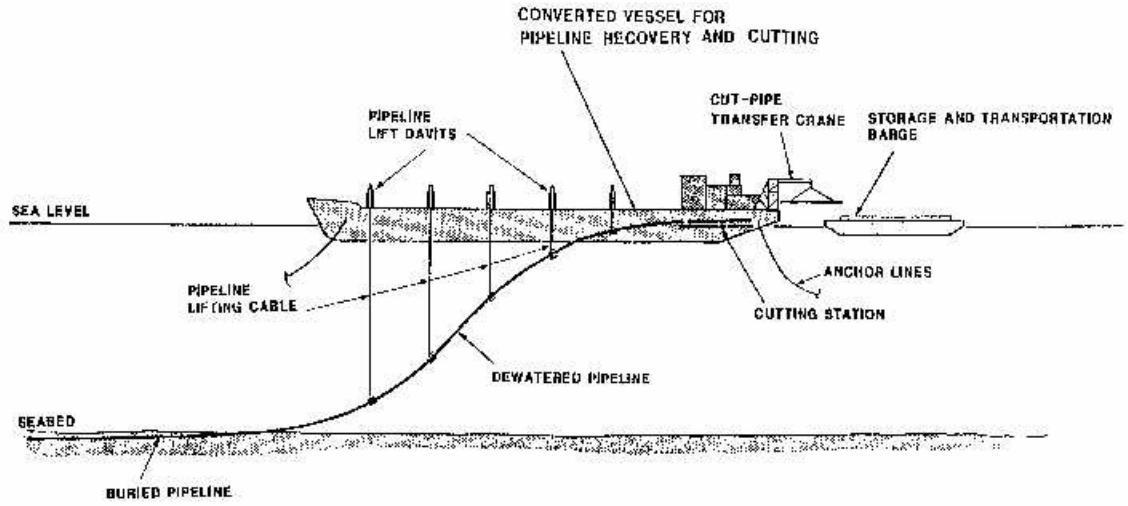
Figure 4.15



- DEBURIAL BY LIFTING AND JETTING.
- DIVER ATTACHES LIFTING CABLES ,INSTALLS CUTTING EXPLOSIVE BELTS AND RETURNS TO D.S.V.
- ALL LIFTING CABLES AND CONTROL WIRES ARE ATTACHED TO MARKER BUOYS AND RELEASED FROM D.S.V. CUTTING DEVICES ARE ACTIVATED.
- RECOVERY AND CRUSHING VESSEL READY FOR RETRIEVAL.
- PIPE SECTIONS RECOVERED, WEIGHT COATING REMOVED, PIPE MADE READY FOR TRANSPORTATION.
- CONCRETE WEIGHT COATING RECOVERED FOR STORAGE AND SUBSEQUENT DUMPING.

SHORT SECTION RECOVERY WITH DIVERS AND WORK / CRANE BARGE

Figure 4.16

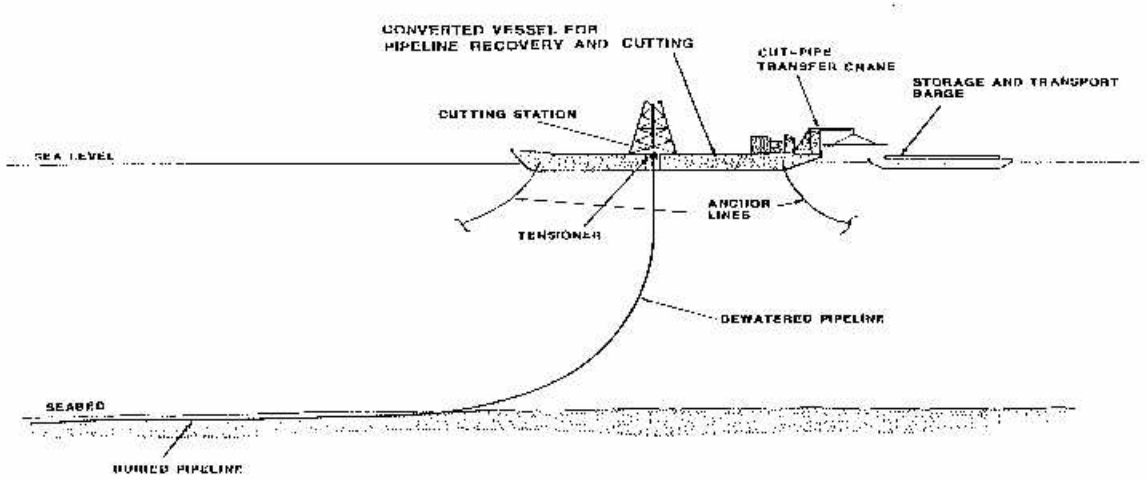


SHORT SECTION (SINGLE/DOUBLE JOINT) PIPELINE RECOVERY

8. J-Lift Recovery

Main step in removal procedure	No. of vessels in operation	No. of divers involved/ share of time
Set up of barge	2 (Tug + Barge)	0
Cut and remove tube turn(s)	2 (Tug + Barge)	Min. 5 (1 in water at anytime)
Recover pipeline with A&R winch	2 (Tug + Barge)	1 (attaching A&R cable only)
Retrieval of pipe	3 (Tug + Barge + Material Barge)	0
Cutting and transport of pipeline onshore	3 (Tug + Barge + Material Barge)	0

Figure 4.17



REVERSE J-LAY PIPELINE RECOVERY

Handling and transport onshore

- Unloading pipe
- Purging the pipe
- Removing anodes
- Removing concrete
- Removing the protective coating
- Cutting pipe
- Cutting concrete
- Recycling/reuse or landfill

Removal Cost Factors

- Location of the pipeline
- Diameter of the pipeline
- Depth of the pipeline
- Length of the pipeline
- Coatings on the pipeline
- Number of crossings the pipeline has with other pipelines
- Availability of barges that can perform the task of pipeline removal.

Cost Estimate Parameters, Offshore

- Costs are based on using existing equipment for the installation of pipelines as removal equipment.
- Reverse Lay is chosen as the removal method because currently this is the most used method for both pipeline lay and removal.
- The average cost per mile is calculated using pipelines of all diameters, at a water depth of 200-500 ft. Most pipelines are in these water depths.
- Pipeline has a length of 20,000 feet.
- Pipelines are flushed clean of contaminants before the operation starts.
- The salvage vessel is within a 2-day mobilization radius.

Definition of disposal cost (Onshore)

- **The disposal cost includes:**
  - Loading off barge/ material barge
  - Cutting of pipeline in 40 feet lengths
  - Loading onto other means of transport (truck, barge, etc.)

- **The disposal cost does not include:**
  - Transport to processing facility
  - Removal of coatings, concrete, anodes, etc.
  - Recycling of materials
  - Cost in connection with landfills

Cost Data for Pipelines in the Gulf of Mexico

Pipe diameter	Pipe length (miles)	Avg. cost ($/mile)	Disposal cost ($/mile)	Sum ($ billion)
< 4"	2,683	294,000	53,000	0.9
4"-12"	20,002	377,000	79,000	9.1
14"-16"	2,874	435,000	84,000	1.5
18"-24"	4,612	461,000	95,000	2.5
26"-30"	1,674	540,000	106,000	1.1
> 30	1,055	636,000	116,000	0.8
Sum				**16.0**

Cost Data for Pipelines in the West Coast Waters (not Including Mobilization)

Pipe diameter	Pipe length (miles)	Avg. cost ($/mile)	Disposal cost ($/mile)	Sum ($ billion)
4"-12"	61	377,000	79,000	0.027
14"-16"	108	435,000	84,000	0.056
18"-24"	52	461,000	95,000	0.029
26"-30"	10	540,000	106,000	0.006
Sum				**0.12**

Cost Data for Pipelines in the Alaskan Waters (not Including Mobilization)

Pipe diameter	Pipe length (miles)	Avg. cost ($/mile)	Disposal cost ($/mile)	Sum ($ billion)
4"-12"	150	377,000	79,000	0.07
16"-24"	10	461,000	95,000	0.006
Sum				**0.076**

Cost Estimates for Various Options

- The cost estimate for the removal of all pipelines is $16.2 billion including handling and deposited to land ready for further transport. The estimate does not include transport onshore and any processing of the pipeline sections.
- Burial/ trenching of all pipelines after flushing is estimated at $1.6 billion.
- Leaving pipelines in place after flushing has virtually no cost.

Cost Estimate Considerations

- If pipeline removal becomes common place better methods and technology should evolve, resulting in for quicker removal and reduced costs.

- A more thorough economic evaluation with NPVs of the established scenarios, both from a private company point of view and from a society point of view, should be considered.

Environmental Assessment

- Pipeline disposition considerations
- Pipeline disposition options
- Pipeline disposition metrics

Pipeline Disposition Considerations

1. Consider both the short and the long-term impact on environment

2. Evaluate mitigating actions that could avert negative effects and promote positive benefits

3. Evaluate impacts upon other potentially sites, such as; scrap yards, waste disposal sites, rail systems, etc.

4. Considered both beneficial and detrimental effects on marine life and habitat

5. The area of impact is no more than 300 ft wide on either side of a pipeline, regardless of the disposal option

Pipeline Disposition Options

A. Remove the pipeline and recycle the materials

B. Remove the pipeline and landfill the materials

C. Reuse the pipeline or preserve it for future use

D. Bury the pipeline

E. Abandon the pipeline in place

Pipeline Disposition Metrics

1. Energy (consumptions and total energy impact)
2. Emissions to atmosphere
3. Discharges to sea or ground
4. Physical impacts/effects on habitat
5. Aesthetic impacts
6. Waste/resource utilization
7. Littering

Environmental Impact Metrics

	A. Remove pipeline, recycle materials	B. Remove pipeline, landfill materials	C. Reuse or preserve pipeline	D. Bury pipeline	E. Abandon pipeline in place
1. Energy	High	High	Low	Moderate	None
2. Emissions	High	High	Low	Low	Low
3. Discharges	Low	Low	Moderate	Low	Low
4. Impacts on habitat	Low	Low	Moderate	Low	Low
5. Aesthetics	Low	Moderate	None	None	None
6. Resource utilization	High	None	High	None	None
7. Littering	Low	Low	Low	Low	Moderate

Conclusion

Regulations

Currently, pipelines in U.S. waters fall under the regulation of the Department of Transportation (DOT) Research & Special Programs Administration Office of Pipeline Safety (RSPA/OPS) and the Minerals Management Service (MMS) of the Department of the Interior (DOI). Currently there are no international rules/laws for the removal and disposal of offshore oil and gas pipelines.

Safety and Risk

The risk assessments demonstrate that pipeline removal options, as compared to in-situ (leave in place) and bury/trenching disposal options, carry a greater risk to personnel due to removal options having increased hands on involvement. As a result of these findings, in the event that pipeline removal is necessary, the extent of the work (hands on involvement of personnel) performed offshore either on a barge or during diving operations should be minimized. The increased use of ROVs and other remotely operated equipment can help to obtain this effect.

Even though there remain risks involved with the handling of equipment and pipeline sections, the overall risk to personnel due to pipeline removal operations is relatively small in instances where the use of remotely operated equipment is taken full advantage of and is suitable for the operation. Of the removal techniques studied, those involving reverse lay methods were found to be safer than those involving tow and sectioning methods due to the reduced number of subsea activities involved. The correct handling of pipe with corrosion resistant coatings and having a proper industrial process for materials separation will be essential to minimize the personnel risk during the final disposal phase, which is conducted onshore.

Cost

If all of the pipelines currently in service were to be removed after abandonment, the cost associated with this removal would be many times that of leaving in place. The cost of removing and disposing all pipelines is estimated at 16.2 billion dollars. The cost does not include transport onshore and any further processing or landfill cost. The cost for burial/trenching is estimated at 1.6 billion dollars.

Environmental Impacts

The impacts on the environment and the marine environment from pipelines and cables left in place were found to be very minor. Conversely recovery operations will have a negative impact on the environment. The number of vessels required for removal operations and long operating hours will result in considerably more releases and emissions than leaving the pipelines in place. In addition the energy savings benefit from recycling the pipeline materials will be exceeded by the energy required to remove the pipelines and separate the materials.

Overall Conclusion

Currently, there are no regulations that require removal of subsea pipelines if they are not an obstruction to navigation. Based on the high costs for removing the pipelines, the personnel risk involved in the removal operations, the negative effect on overall emissions to air and the very limited reduction in discharges to sea, the overall conclusion is that it is better to leave the pipelines in place. If possible, re-use of the pipelines is the optimal solution.