

Good Practice Guide

Pipeline Decommissioning and Abandonment

UKOPA/GP/038 1.0

July 2023

GUIDANCE ISSUED BY UKOPA:

The guidance in this document identifies what is considered by UKOPA to represent current UK pipeline industry good practice within the defined scope of the document. All requirements should be considered guidance and should not be considered obligatory against the judgement of the Pipeline Owner/Operator. Where new and better techniques are developed and proved, they should be adopted without waiting for modifications to the guidance in this document.

Comments, questions, and enquiries about this publication should be directed to:

UK Onshore Pipeline Operators' Association

Pipeline Maintenance Centre
Ripley Road
Ambergate
Derbyshire
DE56 2FZ

E-mail: enquiries@ukopa.co.uk

Website: www.UKOPA.co.uk

Disclaimer

This document is protected by copyright and may not be reproduced in whole or in part, by any means without the prior approval in writing of UKOPA. The information contained in this document is provided as guidance only and while every reasonable care has been taken to ensure the accuracy of its contents, UKOPA cannot accept any responsibility for any action taken, or not taken, on the basis of this information. UKOPA shall not be liable to any person for any loss or damage which may arise from the use of any of the information contained in any of its publications. The document must be read in its entirety and is subject to any assumptions and qualifications expressed therein. UKOPA documents may contain detailed technical data which is intended for analysis only by persons possessing requisite expertise in its subject matter.

Copyright ©2023, UKOPA. All rights reserved

Revision and change control history

Planned revision: 2028

Edition	Date	No. of pages	Summary of changes
A	11.05.22	17	First draft incorporating comments
B	04.09.22	19	Second draft incorporating additional comments, cost estimates and risk assessment template
C	13.06.23	22	Third draft incorporating external review
1	11/07/2023	20	Issued for use

CONTENTS

Executive Summary	1
1. Objectives/Scope of Work	2
2. Introduction	3
2.1 Background	3
2.2 Scope	3
2.3 Application	3
2.4 Definitions	4
3. Requirements of Legislation	5
3.1 Pipelines Safety Regulations 1996	5
3.2 Pipe-Lines Act 1962	5
3.3 Gas Acts 1986 and 1995	6
3.4 The Construction (Design and Management) Regulations 2015	6
3.5 The Management of Health and Safety at Work Regulations 1999	6
4. Requirements of UK Standards	7
4.1 IGEM/TD/1	7
4.2 PD 8010-1:2015+A1:2016	8
5. Technical and Environmental Issues	9
6. Rights in Land	10
7. Recommendations for Decommissioning, Mothballing and Abandonment	11
7.1 Decommissioning	11
7.2 Mothballing	11
7.3 Abandonment	11
7.4 Risk Assessment	15
7.5 Costs	15
8. Summary and Conclusion	16
9. References	17
Appendix 1 - Pipeline Decommissioning and Abandonment Risk Assessment Template	18
Appendix 2 - Pipeline Abandonment Cost Estimates	19
A2.2 Costs for Lift and Remove	19

EXECUTIVE SUMMARY

This UKOPA good practice guide has been developed by the UKOPA Pipeline Integrity Working Group to provide guidance on the decommissioning and abandonment of pipelines and associated installations. The guidance within the document is applicable to onshore pipelines operated by the UKOPA member companies, as defined in IGEM/TD/1 and PD 8010-1.

This document presents the requirements of legislation, regulations, and standards, with a brief interpretation of these requirements and discussion of cost and safety implications for pipeline decommissioning and abandonment.

The options and the requirements for pipeline decommissioning and abandonment can be complex and project and location specific. When a pipeline is no longer required for operational use, it should be decommissioned, followed by either mothballing, which involves ongoing maintenance and integrity management, or abandonment, involving permanent surrender of legal rights, and some combination of sectioning, grout filling, and uplift and removal.

The requirements for the options for decommissioning and abandonment which are considered to be good practice based on current knowledge and experience are presented. An overview of a risk assessment which may be applied to all options is given, and the costs are considered. It is noted that in many cases, specific pipeline abandonment projects will comprise a mix of the various options, which will significantly affect the risk assessment required and the costs.

1. OBJECTIVES/SCOPE OF WORK

The objectives of this good practice guide (GPG) are to provide guidance to pipeline operators on the temporary and permanent decommissioning and abandonment of onshore, rigid steel pipelines and associated installations in accordance with requirements of legislation and standards, and the associated costs which should be considered.

2. INTRODUCTION

2.1 Background

The UKOPA Pipeline Integrity Working Group has developed this good practice guide for carrying out pipeline decommissioning and abandonment activities which are required by legislation and standards. The experience and input of UKOPA member pipeline operators has been sought and is included.

The guide takes into consideration reviews of the subject which have been carried out in other countries [1] [2], and applies this learning within the UK context. A key consideration is the management of ongoing risks and liabilities, which may persist long after decommissioning works are complete. The appropriate management options are affected by the legal status of the pipeline – mothballed or abandoned – and by the engineering choices made by the operator as part of the decommissioning and abandonment process.

2.2 Scope

Work has included reviews of:

- Legislation applicable in the United Kingdom.
 - The Pipelines Safety Regulations 1996 [3] [4]
 - Pipe-Lines Act 1962 [5]
 - Gas Act 1986 [6]
 - Gas Act 1995 [7]
 - The Construction (Design and Management) Regulations 2015 [8]
 - The Management of Health and Safety at Work Regulations 1999 [9]
- Relevant standards
 - IGEN/TD/1 [10]
 - PD 8010-1 [11]
- Technical and environmental considerations.
- Rights in Land for pipelines.
- Pipeline abandonment costs.

2.3 Application

The guidance in this document is applicable to all buried, rigid steel onshore pipelines operated by the UKOPA member companies in the UK. These pipelines can be categorised as:

- Natural gas transmission and distribution pipelines.
- Petrochemical liquids and gas pipelines.
- Oil and refined liquid pipelines.

The guidance is generally applicable to the above pipelines, however, where appropriate, the principles of the document can be equally applied to other pipelines with consideration of differing legislative requirements.

For gas pipelines the guidance is generally applicable to pipelines with operating pressures above 7 bar, however the principles of the document can be equally applied to gas pipelines operating at lower pressures.

Within this document:

Shall: indicates a mandatory requirement.

Should: indicates good practice and is the preferred option.

2.4 Definitions

Decommissioning and abandonment are addressed in several standards, Acts of Parliament, regulations, and company documents, often using differing terminology. For the purposes of this document, the following terminology is defined and utilised:

Abandoned / Abandonment	<p>Assets in the abandoned state cannot be put back into service under any circumstances. The pipeline operator has no ongoing legal rights or interests in any off-site assets in this category, other than statutory obligations under the “polluter pays” principle. Decommissioning is a necessary precursor to abandonment.</p> <p>Abandonment is synonymous with “permanent decommissioning” (as used in IGM standards).</p>
Decommissioned / Decommissioning	<p>Decommissioning refers to the act of removing a pipeline from service. It would typically involve de-pressurising and emptying the contents from the pipeline, isolating the pipeline from process fluids, and de-energising some (but not necessarily all) of the associated equipment.</p> <p>Following decommissioning, a pipeline may be moved to either “mothballed” or “abandoned” status.</p>
In Service	<p>Assets in service are those that are operational, maintained and inspected in compliance with the applicable standards and current regulations.</p>
Mothballed	<p>Mothballed assets are assets which have been removed from active service (i.e. have undergone decommissioning), but which could be brought back into service if required.</p> <p>The term may be used synonymously with “decommissioned”, or “in reserve”.</p>

3. REQUIREMENTS OF LEGISLATION

3.1 Pipelines Safety Regulations 1996

The PSR [3] are enacted under the Health and Safety at Work etc. Act 1974 [12], and cover the safe design, construction, and operation of pipelines. The PSR are risk based and replace some sections of the Pipe-Lines Act 1962 [5].

Regulation 14 of the PSR covers the decommissioning of pipelines and requires that the operator shall ensure that a pipeline which is not being used is left in a safe condition, and that any work undertaken in decommissioning the pipeline is performed safely.

The guidance to this regulation includes:

- **Paragraph 64** states that decommissioned pipelines must not become a source of danger, and at the end of its useful life a pipeline should be either dismantled and removed or left in a safe condition. Consideration should be given to the physical separation and isolation of the pipeline. It may be necessary to purge or clean the pipeline; due consideration should be given to the hazardous properties of any fluid conveyed in the pipeline or introduced during the decommissioning.
- **Paragraph 65** states that depending on the physical dimensions of an onshore pipeline and its location, under the general provisions of the Health and Safety at Work Act, it may be necessary to consider the risk of the pipeline corroding and causing subsidence or acting as a channel for water or gases.
- **Paragraph 67** states that work done in carrying out the final decommissioning of a pipeline should be done in a safe and controlled manner.

Regulation 22 covers Notification in other cases, and includes:

- Change of operator.
- Schedule 5 item 5 - Notification to the HSE is required of the plan to decommission a major accident hazard pipeline, whether on a long term (mothball) or permanent basis.
- Where an event under schedule 5 takes place in an emergency, the operator shall notify HSE as soon as reasonably practicable.

The guidance to this regulation confirms that this regulation concerns any significant changes to the pipeline which affect the level of risk. Notification to HSE is required of certain changes such as changes in the operating regime, major modifications to the pipeline, changes in fluid and cessation of use of the pipeline.

3.2 Pipe-Lines Act 1962

The Pipe-Lines Act 1962 [5] covers the construction and safe operation of pipelines from planning through to abandonment. The Pipe-Lines Act 1962 does not exclude pipelines constructed under the Gas Acts. Sections 12, 38 and 44 may apply as follows.

- **Section 12** relates to access to the land using a compulsory rights order. When the pipeline is abandoned, the rights order may be revoked by the responsible Secretary of State. The Minister referenced in the Pipe-Lines Act 1962 is the Minister for Power. The current (2023) responsible minister is Secretary of State for Energy Security and Net Zero.

- **Section 38** requires the pipeline owner to inform the Minister (Secretary of State for Energy Security and Net Zero) of a change of ownership of the pipeline.
- **Section 44** requires the protection of water sources against pollution, which must be considered if there are any changes to the pipeline right of way or the pipeline is to be abandoned.

3.3 Gas Acts 1986 and 1995

The Gas Acts 1986 [6] and 1995 [7] cover the supply of gas, and do not address decommissioning or abandonment of pipelines. If access to the land was obtained using compulsory purchase or compulsory rights orders and if the land on which the pipeline and associated block valves are constructed is to be sold to a third party, the Gas Act 1986 Schedule 3 Part 1 paragraph 3 may be applicable. This states that: "Where a gas transporter has acquired any land by virtue of paragraph 1 above [compulsory purchase], he shall not dispose of that land or of any interest in or right over it except with the consent of the Director [General of Gas Supply]."

3.4 The Construction (Design and Management) Regulations 2015

These regulations are applicable to the abandoning of a pipeline and if any deconstruction works on the pipeline (including cutting, welding, and fill of the pipeline) are planned to take longer than 30 days or 500 person days then the project becomes 'notifiable' under these regulations and completion of the Health and Safety Executive's Form F10 is required. Some of the permanent abandonment options proposed in this good practice guide will be notifiable.

3.5 The Management of Health and Safety at Work Regulations 1999

Consultation with the local planning authorities will not be required for the decommissioning of the pipeline, but any change of use, particularly to the above ground facilities would require planning consultation and/or planning permission. Any construction works will require consultation with the relevant Environment Agency.

4. REQUIREMENTS OF UK STANDARDS

4.1 IGEM/TD/1

Decommissioning of natural gas pipelines is addressed in IGEM/TD/1 Edition 6 [10] Clause 12.10.2 which requires:

- The pipeline is cleared and purged to remove flammable gases, vapours, and residues.
- Pipeline surveillance is continued.
- The CP system is maintained.

Permanent decommissioning (abandonment) is addressed in IGEM/TD/1 Edition 6 Clause 12.10.6 which requires:

- The following options are considered:
 - Removal of the pipeline.
 - Leaving the pipeline in-situ but rendered permanently safe. This may involve removing components (e.g. valves) and capping open ends so as to leave all sections gas tight.
- The most appropriate option is selected taking into account:
 - Public safety.
 - Environmental protection.
 - Future land use.
 - Legal duties and residual liabilities.
 - Practical difficulties and financial considerations.
 - Maintenance requirements.

If the pipeline is left in-situ, IGEM/TD/1 requires:

- The residual responsibilities of the operator to monitor asset condition and carry out remedial work are considered.
- The pipeline is cleared and purged of any flammable gases, vapours, or residues.
- The pipeline is physically separated and isolated from other parts of the system.
- Remaining pipeline sections are filled with non-hazardous material (e.g. grout), especially for large diameter pipelines at crossings and other locations sensitive to subsidence.
- If grout filling is impractical:
 - The pipeline is charged with inert gas.
 - Vent and fill points are sealed.
 - Leakage tests and pressure checks are carried out and inert gas recharged as necessary.
 - The pipeline is identified with suitable markers.
 - Records are maintained.

4.2 PD 8010-1:2015+A1:2016

Decommissioning is addressed in PD 8010-1 [11] Clause 13.2.5 which recommends:

- Pipelines are decommissioned if planned to be out of service for an extended period.
- Decommissioned pipelines are maintained in a safe condition.
- The CP system is maintained where necessary.
- Pipelines are abandoned where no further use is planned.

Abandonment is addressed in PD 8010-1 Clause 14 which recommends:

- Abandoned pipelines are disconnected from other parts of the pipeline system remaining in service.
- The pipeline is divided into sections, if necessary, with all open ends capped and sealed.
- Precautions are taken to prevent the pipeline from becoming a source of danger or nuisance or having an undesirable effect on any watercourses.
- All conveyed fluids are removed, and the pipeline cleaned to ensure no toxic materials remain.
- In certain areas, e.g. those subject to subsidence or where heavy external loads can occur, the abandoned line is filled with a suitable filler.
- If the above steps cannot make the abandoned pipeline safe, the pipeline is removed.
- All above-ground sections of the pipeline system are removed to not less than 900 mm below ground level.
- Land is backfilled and reinstated in accordance with normal pipeline construction practices.
- Records of abandonment actions are kept.
- A plan showing the size, depth and location of the abandoned pipeline is prepared and is shared with landowners and occupiers.

5. TECHNICAL AND ENVIRONMENTAL ISSUES

The Canadian energy regulator (CER, formerly known as NEB) published a discussion paper on Pipeline Abandonment [1] which describes carrying out an initial scoping exercise to identify the technical and environmental issues associated with pipeline abandonment, followed by verification through field studies. The primary issues identified in this study were:

- Land use management, including environmentally sensitive locations.
- Ground subsidence, including that which may be caused by structural deterioration of large diameter pipelines and subsidence due to soil settlement following removal of the pipeline.
- Soil and groundwater contamination due to release or spillage of pipeline contents or deposits.
- Pipe cleanliness taking account of remaining residues and testing for these and considering the requirements for pigging before abandonment.
- Water crossings taking account of potential for contamination and therefore pipe cleanliness, and potential for pipe exposure (floatation).
- Erosion, slope stability, including during removal, taking account of any erosion control activities undertaken during operation.
- Utility and pipeline crossings, taking account of agreements in place with utility / crossing operators.
- Creation of water conduits which may lead to unnatural drainage and material transport, and the environmental impact of this.
- Associated apparatus including disconnection and removal of above ground facilities, and items such as culverts, CP test posts and ground beds, anchor blocks etc; and
- Cost of abandonment, including required resources, salvaged materials, regulatory and legal costs.

In addition to the above, any associated post abandonment responsibilities such as post abandonment surveys, ensuring right of way access and monitoring of environmentally sensitive areas for residual contamination must be identified and considered.

A follow-on study [2] identified gaps in knowledge related to pipeline abandonment and made recommendations for further research to close these gaps, including:

- Detection of residual contamination.
- Risk assessment.
- Decomposition of pipe materials.
- Cleaning methods and disposal of cleaning fluids.
- Abandonment under water bodies.
- Pipeline exposure including the influence of buoyancy and frost heave.
- Evaluation of historical pipeline abandonment programs.
- Collapse of soil.
- Validation of culvert failure model.

6. RIGHTS IN LAND

Different pipelines (and different sections of a single pipeline) can have a wide range of legal mechanisms and instruments to confer the Rights in Land which allow the pipeline to be constructed, operated, and maintained. These Rights may be individually negotiated with affected landowners/occupiers, and specific to the pipeline and land parcel, or they may be more generally applicable to the pipeline route, through legislation or regulation.

Terminology relating to the Rights in Land associated with a pipeline route (e.g. Wayleave, Easement, Right-of-Way; Easement Agreement, Lease, Deed-of-Grant, Compulsory Purchase; etc) can have specific legal meanings, which may be different in different jurisdictions. For the purposes of this document, the generic term “Rights in Land” is used, unless otherwise noted.

Pipeline Rights in Land largely follow the standards suggestions/points. However, a percentage of the pipeline population do not have formal agreements at present, and these are negotiated into formal agreements when alterations etc. are made to any of the pipelines in concern.

Agreements can vary drastically depending on proposed land use, the current and future ownership of the pipeline, or owners whose land the pipe goes through.

If the pipeline is mothballed, the original Rights in Land would typically stay in place, and should be protected by the pipeline owner, for example through route surveillance, marker post maintenance, and protection against encroachment and third-party damage.

If the pipeline is abandoned, the Rights in Land can be surrendered, or transferred to the landowner/buyer's possession. This would allow the new owner to remove the pipe as part of their development/works.

When abandoned pipelines remain in-situ, pipeline companies may remain responsible for the pipeline and any disruption it may cause, i.e.

- Ground movement due to collapse.
- Fluid flowing if not capped correctly, remnants of gas / oil or field water flowing through pipe, which may cause issues for landowners at the end of the pipe's open sections.
- The abandoned pipe may form an obstruction to future land use.

The pipeline abandonment process needs to carefully consider and address these potential long-term issues and liabilities. Under the “polluter pays” principle it may not be legally possible to fully mitigate or transfer these risks.

Requirements for decommissioning and abandonment may be pre-agreed terms of the Right in Land agreement. For instance, pipelines going under Network Rail land are normally agreed to be grouted if the pipeline is abandoned.

7. RECOMMENDATIONS FOR DECOMMISSIONING, MOTHBALLING AND ABANDONMENT

7.1 Decommissioning

Pipelines should be decommissioned prior to mothballing or abandonment. The pipeline should be isolated and depressurised, and the fluid should be removed by purging or pigging.

Hydraulic analysis of the decommissioning operation should be performed to confirm that the pipeline pressures and temperatures will remain within safe operating limits.

Fluid removal should consider the following factors:

- Handling of hazardous substances (mercury, NORM).
- Fluid removal from dead legs, and cavities including valve bodies and sleeve annuli.
- Cleanliness requirements (particularly for liquid lines).

7.2 Mothballing

Mothballing enables the pipeline to be re-commissioned in future for the same, or another purpose. Other purposes may involve a change of transported fluid, or selling the pipeline to a third party, for example utility service providers for routing of telecommunication cables.

The pipeline should be filled with an inert gas, typically nitrogen, after decommissioning until the pipeline is required for re-use, or is to be abandoned. The nitrogen pressure should be charged to and maintained at a pressure of 1-2 barg. For liquid pipelines, inhibited water may be used as an alternative to nitrogen.

A mothballed pipeline should be subject to ongoing maintenance similar to that for an operational pipeline. Maintenance should be carried out in accordance with the operator's normal procedures and should include regular checks on the cathodic protection system, regular valve movement and greasing where required, and pipeline route maintenance and surveillance. Parts of the cathodic protection, control and instrumentation, and electrical systems may need to be maintained to ensure the safety of the pipeline route and vicinity, and modifications to the cathodic protection system may be required to maintain electrical continuity if sections of pipeline are physically isolated.

Maintenance should also address the integrity and safety of any structures associated with the pipeline, including valve chambers and compounds, bridge structures, tunnels, pipe supports, etc.

Any damage to the pipeline which affects the safety of the pipeline or pipeline route should be repaired.

If the owner/operator is no longer willing or able to carry out the minimum maintenance necessary to ensure the safety and structural integrity of a mothballed pipeline, the pipeline should be abandoned.

Mothballed pipelines may still be subject to business rates and taxes, and any ongoing requirements should be checked with the Valuation Office.

7.3 Abandonment

Pipelines should be abandoned when the existing operator requires no further use of the pipeline, and no alternative use has been identified.

Above-ground sections of pipeline, and above-ground equipment such as marker posts and test posts, should be removed.

Buried sections of pipeline should be abandoned in-situ or removed. The selection of the preferred option for abandonment will depend on the pipeline- and location-specific practical issues to be addressed, risk assessment and the costs. Project specific considerations include:

- Abandonment requirements linked to the location-specific Rights in Land.
- Where a number of pipelines in a common right-of-way are to be decommissioned, mothballing until a later date allows minimum maintenance to be carried out until all pipelines in the area are decommissioned, allowing permanent abandonment for multiple pipelines in one phase.
- Specific requirements related to pipeline properties should be considered:
 - Diameter.
 - Length.
 - Elevation profile.
 - Location (IGEM/TD/1 area type or PD 8010 location class).
 - Product.
 - Crossings.
 - Likelihood that the pipeline will act as a conduit for water or other contamination.
 - Likelihood that the pipeline will form an obstruction to future land use.

Consideration should be given to the ownership and long-term safety and integrity of any structures associated with the pipeline, including valve chambers and compounds, bridge structures, tunnels, pipe supports, fences and barriers, etc, particularly where failure or collapse of abandoned structures could lead to a risk to the public.

If the pipeline to be abandoned was initially constructed under compulsory purchase or compulsory rights orders to gain access to the land then the Gas Act 1986 Schedule 3 and the Pipe-Lines Act, 1962 section 12 may also be applicable.

7.3.1 Abandonment in-situ

If the pipeline is left in-situ, the operator should ensure that:

- The pipeline route remains safe.
- Subsidence is prevented.
- The pipeline has no adverse effect on other buried structures e.g. electrical interference.
- The pipeline does not become a conduit for water or other contaminants.

The pipeline should be divided into sections and capped to prevent migration of water over long distances. This is particularly important in hilly terrain where the pipe could act as a collector and conduit for water and create a spring or boggy area at the low point.

Where subsidence is considered an issue, or where risk assessment indicates it is necessary, a solid grout material should be used to fill:

- Pipeline sections at major road, rail, and water crossings.
- Other locations where future collapse of the pipeline (e.g. through corrosion) could lead to subsidence.
- Voids such as below-ground valve chambers.

Small diameter pipelines are unlikely to have a significant effect on inducing surface settlement if they corrode/collapse, so grouting may not be necessary for lines up to approximately 300 mm. It is recommended that operators conduct a thorough risk assessment, including review of likely soil types when evaluating whether or not grouting is necessary.

Grout is a low-cost fill material made from cement and pulverised fuel ash, has little inherent strength, but is sufficient to fill a void. Filling the pipeline with grout prevents water transport, prevents future collapse, and ensures retention of structural strength.

The required number and spacing of grout fill points will depend upon the pipeline diameter, the pipeline gradient, and the flow of material in the pipe. Grout filling of smaller diameter pipelines (e.g. up to 324 mm diameter) is problematic, due to resistance to flow and difficulties in pumping. This results in higher costs due to the increased number of access points needed. For larger diameter pipelines, grouting difficulties include the limited length that can be grouted due to flow restrictions, and the increased cost and logistics issues associated with the volume of grout material needed.

An alternative to grout fill is foamed concrete. This is a higher cost material made from cement mortar mixed with a pre-formed foam. It is a type of porous concrete which is light weight and low density, as it comprises approximately 50% air. It is fluid and so is workable and can be applied through small openings. This material may provide advantages in certain situations, despite the increased cost. Polymeric solutions and foams are also available as an alternative to grouting but may require specialist approval as they have a lower compressive strength.

Pipeline sections abandoned in-situ should be marked and records maintained for the entire length of the pipeline route.

The legal responsibility for the abandoned pipe should be clarified. This may be different for different operators, and for different pipelines or sections of pipelines, depending on the requirements of the relevant Rights in Land and the legislation the pipeline was constructed under. Once the pipeline is abandoned, it typically becomes the property of the landowner. However the legal liability for any contamination arising from the pipeline may stay with the pipeline's final owner/operator in perpetuity. Hydrocarbon residue remaining in an abandoned pipeline section may become a liability sometime after abandonment, at which time it may be difficult to identify the responsible party. An advantage of grouting is that it will displace or isolate this contamination and minimise the operator's long-term post-abandonment risk.

7.3.2 Lift and Removal

The issues which should be addressed in considering lift and removal as a method of permanent abandonment include:

- Environmental impact (including a complete Environmental Impact Assessment).

- Safety issues.
- Landowner consents.
- Access to the right of way and if necessary, agreement of a working width.
- Local disruption.
- Trench backfill, drainage and land reinstatement, including the sourcing of additional backfill material to maintain original grade.
- Cleaning of the pipeline to remove hazardous deposits and contaminants.

Specific consideration of lift and removal of pipe sections to be abandoned may be required in cases where:

1. The depth of cover is low, and the abandoned section may obstruct land use and pose a hazard to agricultural machinery.
2. An abandoned pipeline section left in-situ may hamper future land developments and reduce the value of the land.

A full construction working width would be required as well as all the equipment and facilities usually required for the construction of a pipeline including land for pipe dumps etc.

If the majority of the pipeline is dismantled, the sections of pipeline which have been installed with an auger bore or horizontal directional drill as well as special crossings may remain in place to avoid disruption and may require grouting for stabilisation and load bearing.

Removed sections of pipeline should be scrapped or considered for storage and reuse, depending upon the condition. Possible uses include:

- Construction of new pipelines.
- Fabrication of repair sleeves.
- Destructive testing.
- Research & development projects.

Consideration should be given to the potential for contamination hazards associated with the uplifted pipe, for example if the pipeline has historically transported leaded fuels or other products which can leave hazardous residues.

There are major environmental costs for the lift and removal option. However, this option removes the risk of damaging agricultural machinery involved in deep works and will not influence any future change in land use and land value.

7.3.3 Installations

Above-ground installations associated with the abandoned pipeline should be removed. This will typically involve removal of all above ground pipe and equipment, to a depth of at least 900mm, reinstating the land (including any decontamination required) and removing the fence.

7.4 Risk Assessment

All hazards affecting the integrity of the pipeline which may need to be managed during decommissioning and mothballing and /or abandonment should be identified, and a risk assessment carried out to demonstrate compliance with PSR 96 Regulations 14 and 22.

The risk assessment should consider the risks associated with execution of each stage of the decommissioning and abandonment activities and the hazards posed by assets to be left in-situ or to be removed and should identify requirements for ongoing maintenance.

The risk assessment should take account of all details of and attributes of the pipeline and associated block valves, structures, and operational equipment. The hazards to adjacent population and infrastructure along the route of the pipeline should be identified and the risks evaluated. This should include consideration of:

- Road, rail, and water crossings.
- Environmental sites, nature reserves, areas of special conservation.
- Sites of special scientific interest.

The risk assessment should be fully documented, including the process applied, assumptions and actions to be completed, the responsible parties and the dates for completion.

An example template for the risk assessment is given in Appendix 1.

7.5 Costs

Cost estimates for the two main options for pipeline abandonment, grout filling or lifting and removal, are presented in Appendix 2.

These cost estimates demonstrate that the lift and removal options is at least an order of magnitude higher than grout filling, and therefore it is likely that engineering, environmental and legal factors will dictate the choice of abandonment approach rather than cost.

8. SUMMARY AND CONCLUSION

The requirements for the options for pipeline decommissioning, mothballing and abandonment which are considered to be good practice based on current knowledge and experience have been presented.

An overview of a risk assessment which may be applied to all options is given, and the costs are considered.

It is noted that in many cases, specific pipeline abandonment projects will comprise a mix of the various options, which will significantly affect the risk assessment required and the costs.

9. REFERENCES

- [1] Government of Canada, National Energy Board, "Pipeline Abandonment – A Discussion Paper of Technical and Environmental Issues,," National Energy Board, January 1996.
- [2] Det Norske Veritas, "Pipeline Abandonment Scoping Study, Report No. EP028844," National Energy Board (NEB), November 2010.
- [3] HMGov, "Pipelines Safety Regulations 1996, Statutory Instrument 1996. No. 825," HMGov, 1996.
- [4] HSE, L82 A guide to the Pipelines Safety Regulations 1996, Guidance on Regulations, 5, Ed., HSE Books, 1996.
- [5] HMGov, *Pipe-Lines Act 1962, c. 58 (Regnal. 10_and_11_Eliz_2)*, HMGov, 1962.
- [6] HMGov, *Gas Act 1986, c. 44*, HMGov, 1986.
- [7] HMGov, *Gas Act 1995, c. 45*, HMGov, 1995.
- [8] HMGov, *The Construction (Design and Management) Regulations 2015, No. 51*, HMGov, 2015.
- [9] HMGov, "The Management of Health and Safety at Work Regulations 1999. Statutory Implement 1999/3242," HMGov, 1999.
- [10] IGEM, "IGEM/TD/1 Edition 6, Communication 1848, Steel Pipelines for High-Pressure Gas Transmission," Institution of Gas Engineers and Managers, Kegworth, 2021.
- [11] "PD 8010-1:2015+A1:2016 Pipeline systems – Part 1: Steel pipelines on land – Code of practice," BSI Standards Publication, 2016.
- [12] "Health and Safety at Work etc. Act (HSWA) 1974," HM Gov., 1974.

APPENDIX 1 - PIPELINE DECOMMISSIONING AND ABANDONMENT RISK ASSESSMENT TEMPLATE



APPENDIX 2 - PIPELINE ABANDONMENT COST ESTIMATES

A2.1 Abandon in-situ

Estimated costs for grout filling of abandoned pipelines are presented in Table 1.

Costs £k/km	Nominal Pipeline Diameter (mm)						
	200	300	400	600	750	900	1200
Estimated costs	18.75	28.12	37.5	56.24	70.3	84.36	112.48

Table 1 Cost Estimates for Pipeline Grout Filling

Notes:

- Indicative costs are based on 2020 per km estimate for 300 mm diameter pipeline.
- Project costs will depend upon the length of pipeline and the complexity of the project specific set up, engineering works (lengths to be grouted, modifications) and access.

A2.2 Costs for Lift and Remove

The activities for lift and remove of a pipeline involve:

- Mobilisation of heavy construction machinery to site.
- Excavation of the pipeline trench.
- Cutting the pipeline into sections.
- Lifting the pipeline sections from the trench.
- Transporting and storing pipeline sections.
- Reinstatement of land.

The above activities are related to those for pipeline construction, so guide costs for lift and remove have been estimated from pipeline construction costs. Pipeline cost data was taken from the pipeline construction cost data compiled by UKOPA for the pipeline rating revaluation study carried out in 2005. This data provides the cost of construction per km, and the breakdown of contractors' costs, material costs and resource costs for a range of gas industry pipeline projects.

The data was analysed to obtain average costs by pipeline diameter. The 2005 costs are significantly lower than current costs, and have been uplifted through consultation with construction experts to give the costs given in Table 2:

Costs £k/km	Nominal Pipeline Diameter (mm)						
	200	300	400	600	750	900	1200
2005	161	363	426	726	910	1090	1457
Current	403	908	1065	1815	2270	2750	3643

Table 2 Cost Estimates for Pipeline Construction

The original cost data indicated that the contractor costs were on average 65% of the project cost per km. For this study, the contractor costs are assumed to provide an estimate of the potential cost of abandoning existing pipelines, based on removing the pipelines and reinstating the land. Applying this assumption, the estimated costs for abandonment through lift and remove given in Table 3 were derived.

Costs £k/km	Nominal Pipeline Diameter (mm)						
	200	300	400	600	750	900	1200
Estimated costs	262	590	692	1180	1476	1788	2368

Table 3 Cost Estimates for Lift and Remove

Notes:

- Construction costs based on UKOPA pipeline rerating study (2005) uplifted to 2021.
- Lift & remove costs for pipeline abandonment assumed equal to the main contractor costs for pipeline construction.