



Update on sleeves

B Mackay

# Background

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- ❑ The integrity management of pipeline sleeves is an issue for all pipeline operators and the HSE have suggested this could be a topic for an industry initiative.
- ❑ Main threat is integrity of the carrier pipe in the sleeve
- ❑ Pipeline sleeves, of different types and annular fills, have historically been used;
  - to provide pressure containment in the event of a failure
  - to provide additional protection at crossings
  - to assist in the construction process.
- ❑ **Aim is to develop and agree a UKOPA strategy for managing pipeline sleeves.**

# The use of sleeves

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- ❑ Sleeves (or casings) have been installed to protect pipelines which cross traffic routes – roads, railways, watercourses



Example of concrete sleeve



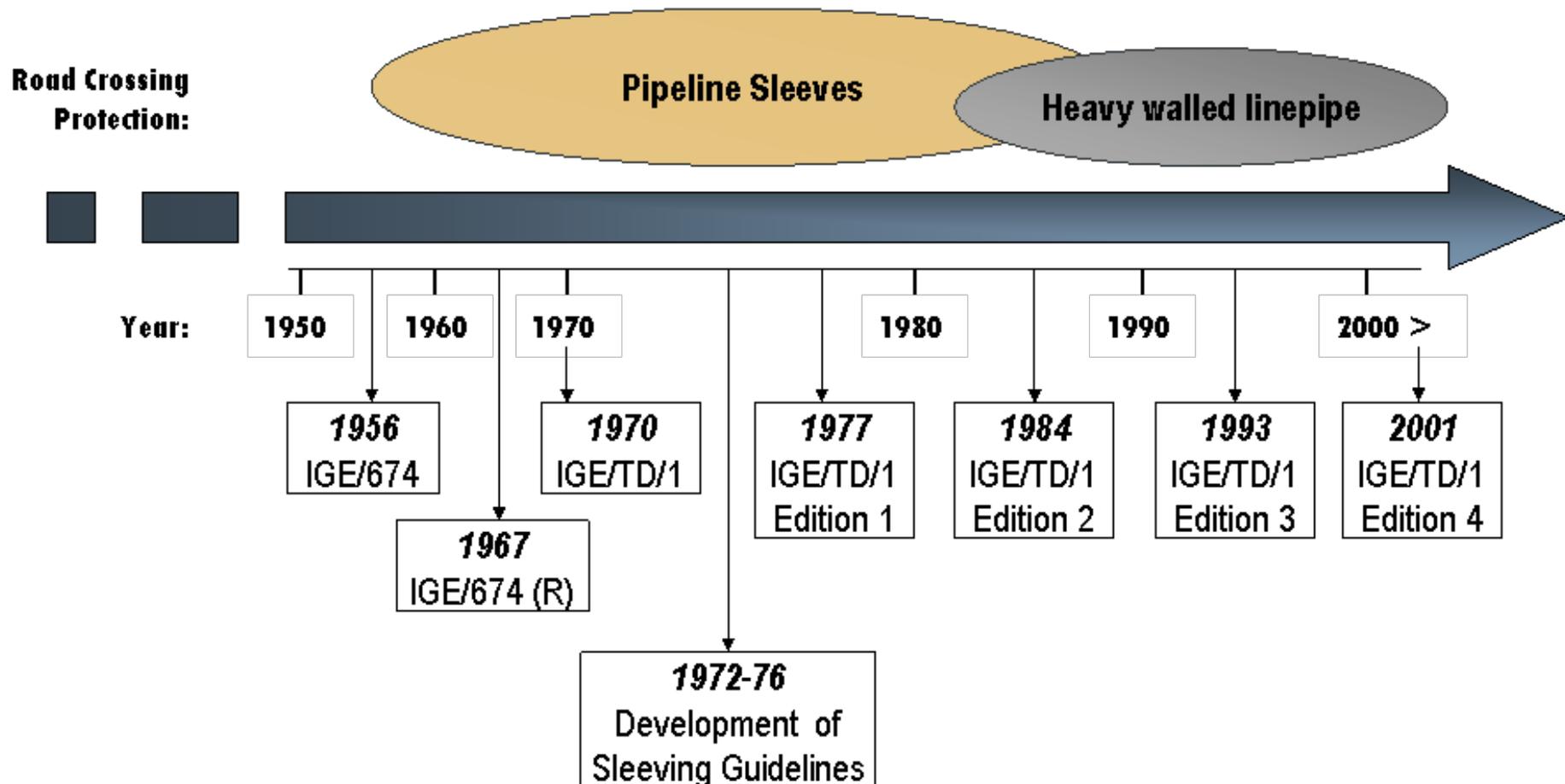
Maintenance of nitrogen filled sleeve

# The use of sleeves

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- ❑ Sleeves were installed to:
  - ❑ Protect the public or nearby installations from the consequences of pipeline failure
  - ❑ Protect the pipeline from outside interference
  - ❑ Facilitate construction processes
  
- ❑ Sleeve technology developed along with the development and construction of the pipeline network – many designs/types in service

# IGE/TD/1 historical sleeving practices



## 1950s – 1960s

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- ❑ **1956 - IGE/674:** Recommendations Concerning the Installation of High Pressure Pipelines
  - ❑ *When the pipeline has to cross a carriageway, railway, or watercourse the method adopted is a matter for individual design, after consultation with all the authorities concerned. When a pipe is protected by sleeving it with a large size tube, the annular space should be vented and fitted with a flame arrestor.*
  
- ❑ **1967 - IGE/674 Re-Print:** Recommendations Concerning the Installation of High Pressure Pipelines
  - ❑ *Crossings of railways, roads, rivers, streams, can be sleeved in pre-cast concrete or steel pipe or other materials. The annular space should be filled with a suitable material or sealed and vented to atmosphere*

## 1970s

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- ❑ **1970 – IGE/TD/1: Steel Pipelines for High Pressure Gas Transmission**
  - ❑ *For working pressures above 350 lbf/in<sup>2</sup>, pipelines laid in roads should be sleeved; where such pipelines are laid in close proximity to roads or railways, consideration should be given to sleeving, having regard to the density of traffic. All crossings of roads and railways should be steel sleeved for working pressures exceeding 350 lbf/in<sup>2</sup>. The sleeve should extend for a suitable distance either side.*
  
- ❑ 1972 – Provisional Section on Pipeline Sleeving (Addition to TD/1)
  
- ❑ 1976 – Section S: Pipeline Sleeving

## Section S: Pipeline sleeving

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- ❑ Introduced sleeve design classes:
  - ❑ **Class 1** - Sleeves required to protect the public, or judged desirable to protect some other installation, from the consequences of failure of the carrier pipe. Also serve to protect the carrier pipe from outside interference.
  - ❑ **Class 2** - Sleeves provided in order to protect the carrier pipe from outside interference
  - ❑ **Class 3** - Sleeves installed only to facilitate the construction of the carrier pipe

# Historical sleeving practices adopted in the UK

R = Recommended System (*NB* The table should be read from left to right to find the recommended system in each set of circumstances.)  
 A = Alternative System only to be used if recommended system cannot reasonably be applied.  
 X = Unacceptable System.

Sleeve Class	Application (S.2.2)	Sleeve Material (S.4.1)					
		Steel			Concrete		
		End Seal Type (S.4.7)					
		Rigid	Flexible	Shuttering	Rigid	Flexible	Shuttering
1	To meet the requirements of 5.5.1, 5.5.2.1 or 5.7 to give protection against consequences of carrier pipe failure. Also to protect carrier pipe against outside interference.	R	A	A	X	X	X
2	To meet the requirements of 5.5.2.2 to protect the carrier pipe against outside interference.	R	A	A	X	X	A
3	Required only to facilitate construction of the carrier pipe.	A*	A	A	X	X	R
Method of Corrosion Control (S.7)		Annular Fill (S.3.3)					
Inert Environment Only		Nitrogen (S.3.3.3) (S.7.2)					
Combination of: Coating Environmental control Cathodic protection		Cementitious (S.3.3.4) (S.7.3)					
		Others (S.3.3.5), <i>eg</i> Bentonite (S.7.4), grease/oil, foam plastics					

\* Where a steel sleeve is used it should preferably have rigid end seals and nitrogen fill.

## Section S: Pipeline sleeving

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- Sleeving of existing pipelines
- Sleeve construction
- Pipe spacers
- Annular fill and corrosion control
- Maintenance of sleeved lengths

# 1980s

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## ❑ 1984 – IGE/TD/1 Edition 2

### ❑ High Density Traffic Routes

- a. Utilise pipe with a nominal wall thickness of not less than 11.91 mm, OR
- b. Be steel sleeved in accordance with Class 1

### ❑ Other Traffic Routes

- a. Utilise pipe with a nominal wall thickness not less than 9.52 mm, or be provided with impact protection, OR
- b. Be steel sleeved in accordance with Class 2

# 1990s

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## IGE/TD/1 Editions 3 (1993) and 4 (2001)

- Heavy walled pipeline is recommended for crossings, sleeves should only be used to facilitate construction
- Construction sleeves should be concrete, however a steel sleeve may be implemented designed to incorporate a nitrogen fill with the use of forged end seals
- Existing sleeves that meet Class 1 or 2 of Edition 2 may continue to be used to allow the pipeline to operate up to its original design factor

## Alternative design standards

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- ❑ BSI PD 8010-1 Code of Practice for Pipelines – Part 1: Steel Pipelines on Land
  
- ❑ ASME B31.8 – Gas Transmission and Distribution Piping Systems
  
- ❑ API RP 1102 – Steel Pipelines Crossing Railroads and Highways
  
- ❑ NACE SP0200 – Steel Cased Pipeline Practice

# Incidents on sleeves

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- ❑ Colonial Pipeline Company – 1980
  - ❑ 32” diameter liquid (aviation kerosene) pipeline
  - ❑ Failure occurred at an area near the bottom of the pipe thinned by corrosion
  - ❑ Corrosion caused by ground water leaking into the annular space between the carrier pipe and sleeve
  - ❑ Sleeve had been electrically shorted to the carrier pipe for 10-12 years
  - ❑ No fatalities but significant environmental damage

## Incidents on sleeves

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- ❑ Texas Eastern Gas Pipeline Company – 1985
  - ❑ 30” diameter natural gas pipeline
  - ❑ Failure occurred due to thinning of the pipe wall by corrosion
  - ❑ Sleeved crossing located 2 miles downstream of a compressor station
  - ❑ Pipeline temperature 70°C and coating damage was noted
  - ❑ Water condensing on carrier pipe provided an electrolyte for atmospheric corrosion
  - ❑ Escaping gas ignited and burned
  - ❑ Five fatalities and extensive damage to property

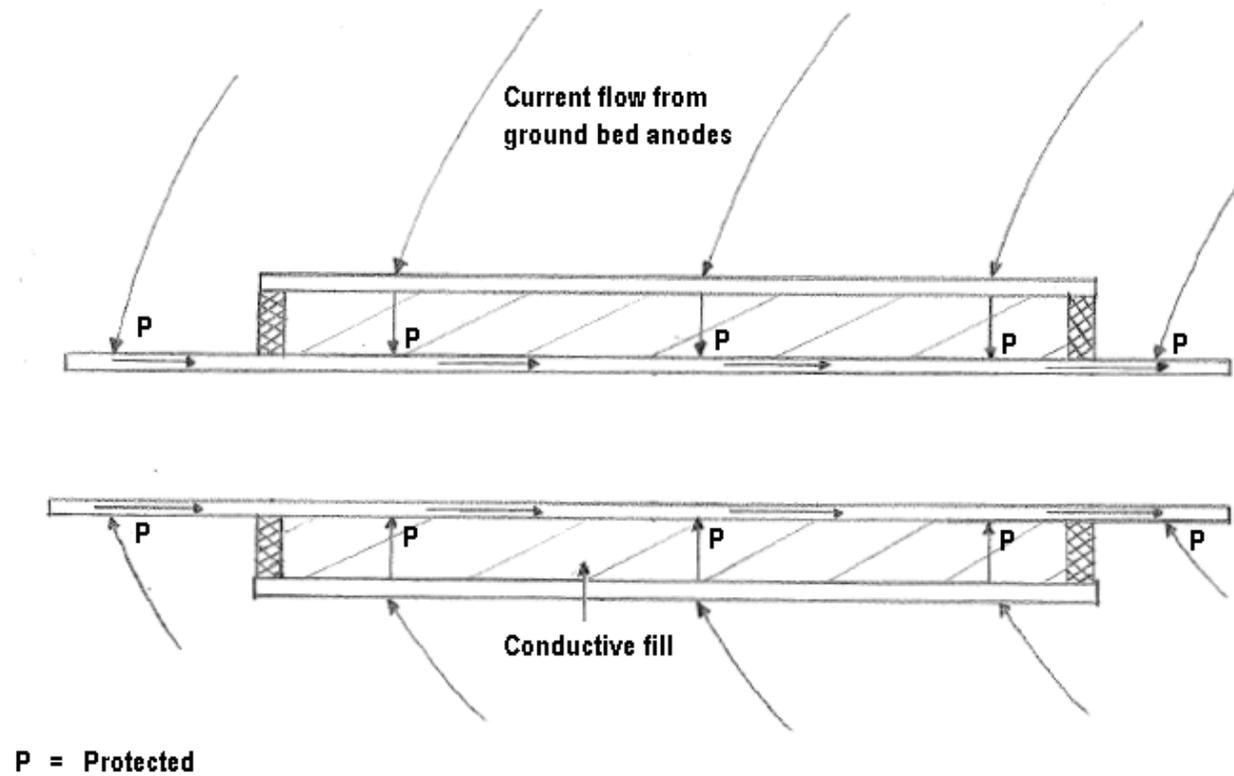
## Incidents on sleeves

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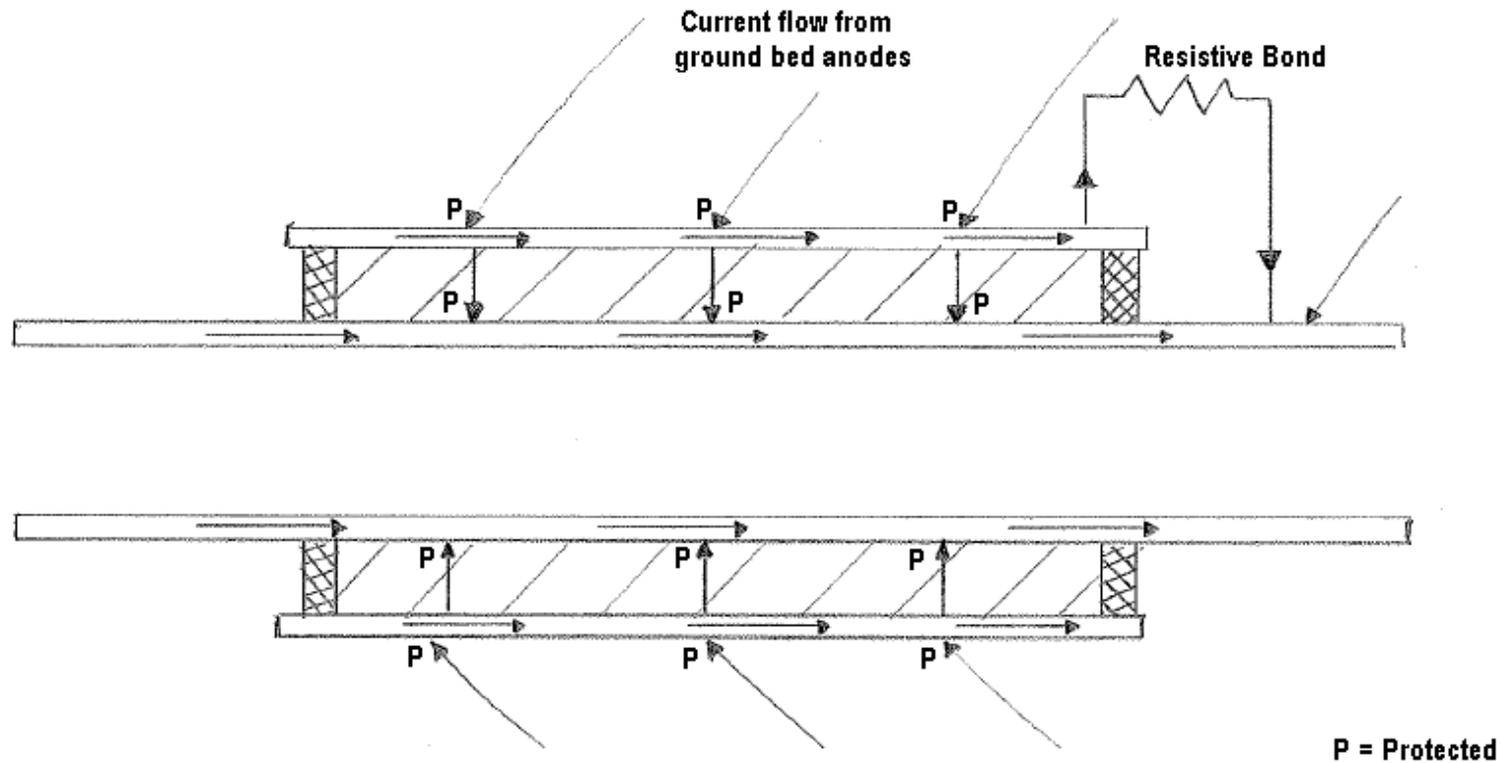
- ❑ Columbia Gulf Transmission Company – 2007
  - ❑ 30" diameter natural gas pipeline
  - ❑ Failure occurred at or near the sleeve crossing under a motorway
  - ❑ Operating pressure at time of failure ~64 barg
  - ❑ Failure due to external corrosion of the carrier pipe
  - ❑ Failure resulted in a undetermined release of natural gas, an explosion and fire
  - ❑ One fatality and one injury
  - ❑ Some damage to property



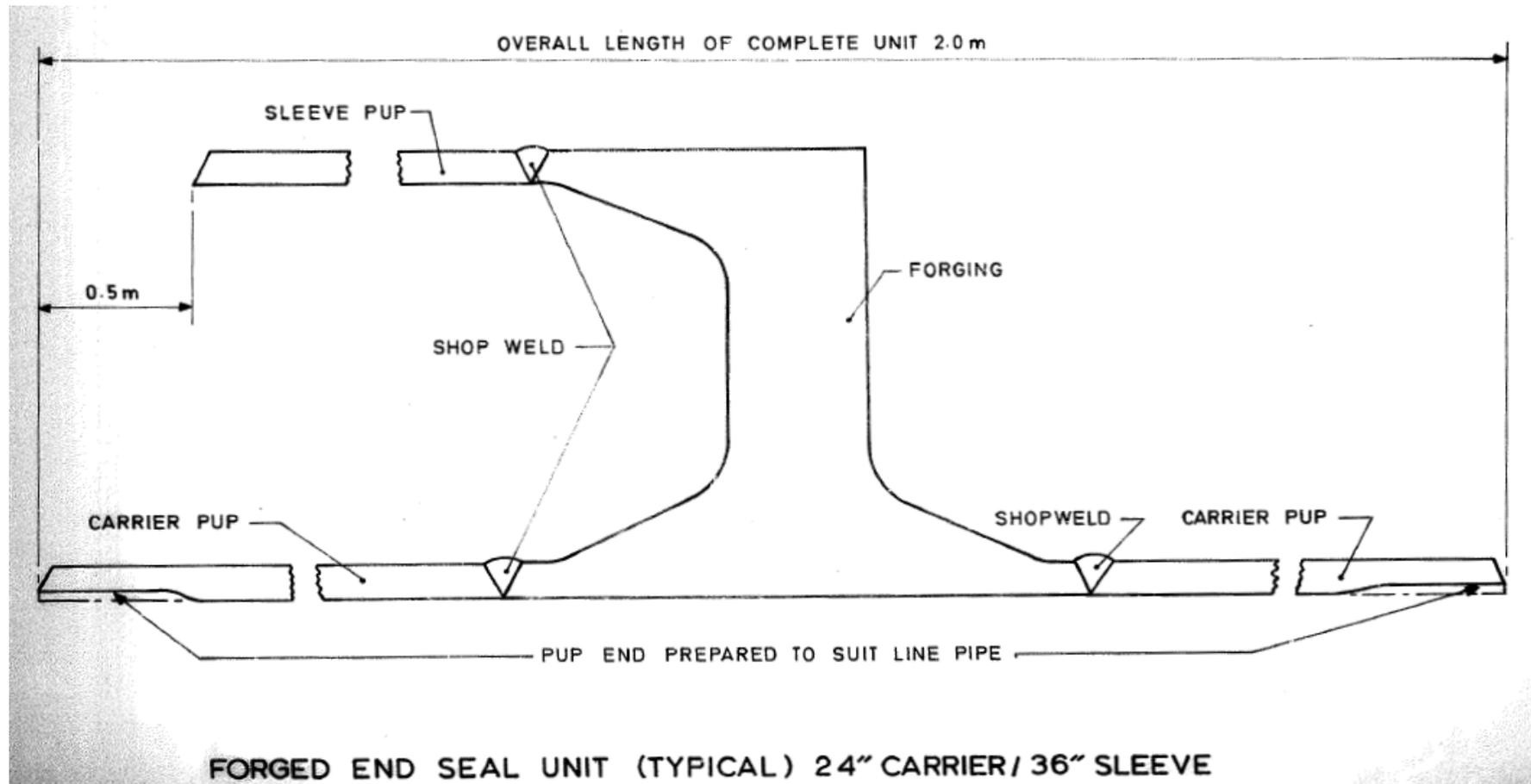
# CP of sleeved pipeline



# CP of sleeved pipeline

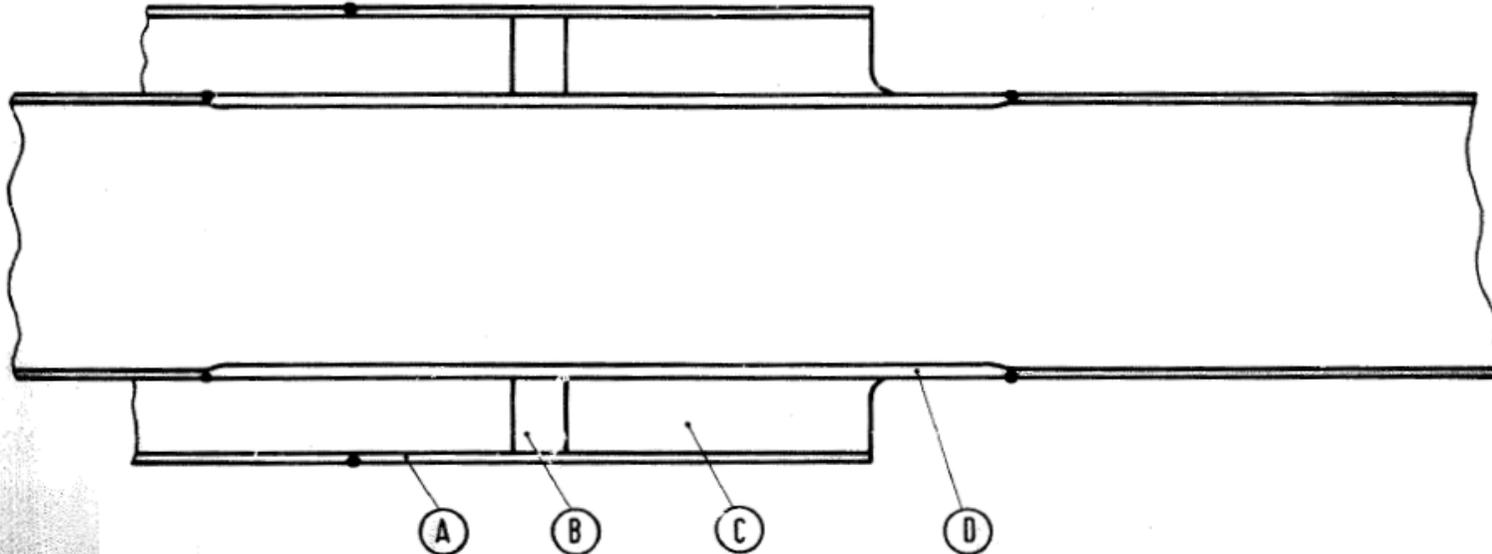


# Forged end seal



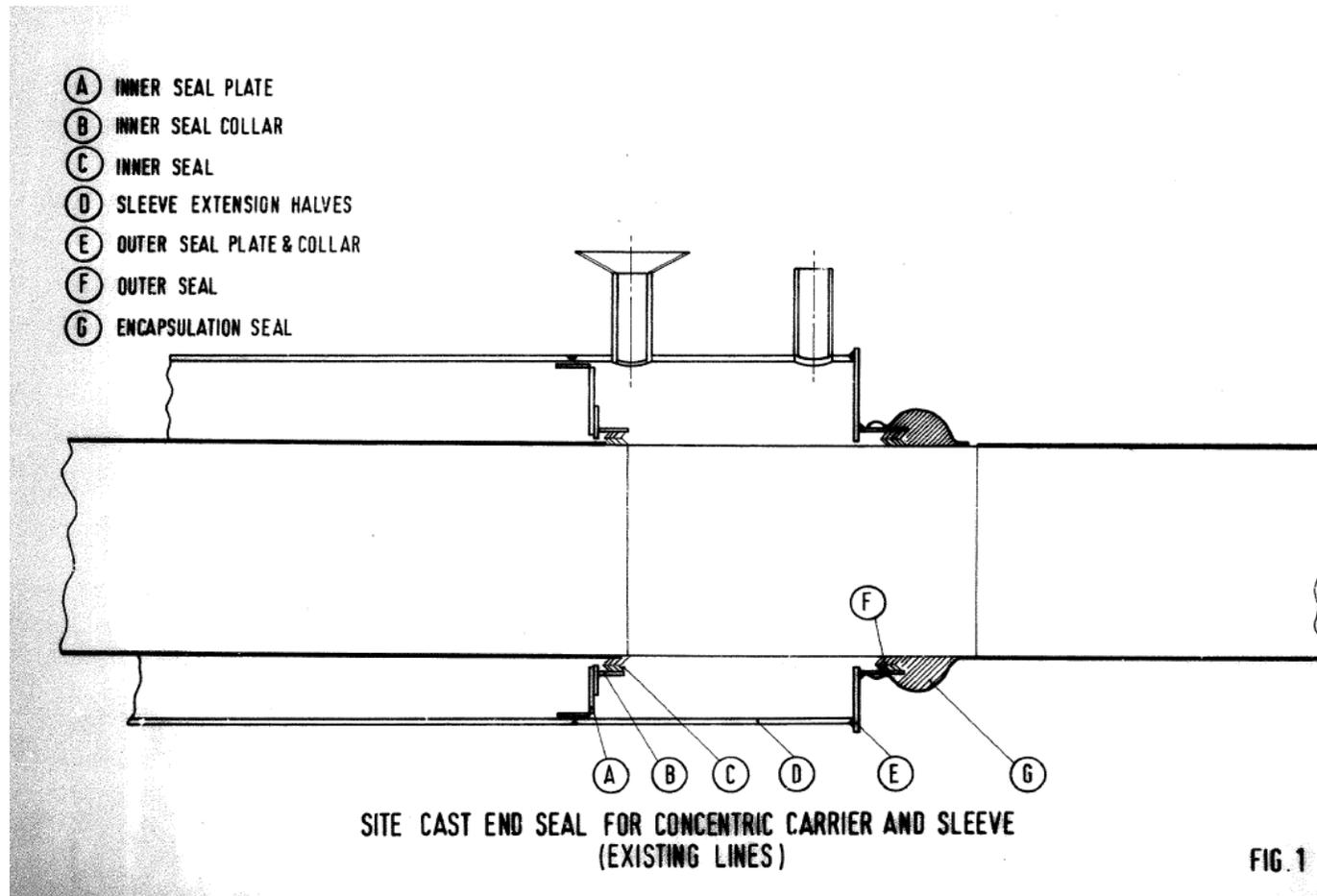
# Pre-cast epoxy end seal

- Ⓐ SLEEVE PUP
- Ⓑ SEALANT GROUTING MATERIAL
- Ⓒ LOAD CARRYING GROUT
- Ⓓ CARRIER PUP



PRECAST END SEAL (NEW LINE CONSTRUCTION)

# Site cast epoxy end seal



# New design of epoxy end seal

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New design epoxy end seal  
based on epoxy repair sleeve  
technology



## Issues for the industry

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- Large number of pipeline sleeves, many on unpiggable pipelines, of different configurations, different fill materials etc
  
- What is the condition of the carrier pipe?
  
- Record to date has been good, but these are aging assets – a few incidents have occurred in the US
  
- What is best practice for maintenance, inspection, remediation?

# UKOPA workshop – Nov 2010

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- ❑ Initial workshop held on 23 November 2010 at IGEM House, Kegworth, which was facilitated by GL Noble Denton.
  
- ❑ Attended by 22 UKOPA representatives, covered:
  - Historical sleeving practices
  - Overview of design standards
  - Incidents
  - What are current issues and challenges
  - How do we develop a common strategy for managing the integrity of sleeve crossings
  - Presentation on nitrogen sleeve remote monitoring

# UKOPA workshop – March 2011

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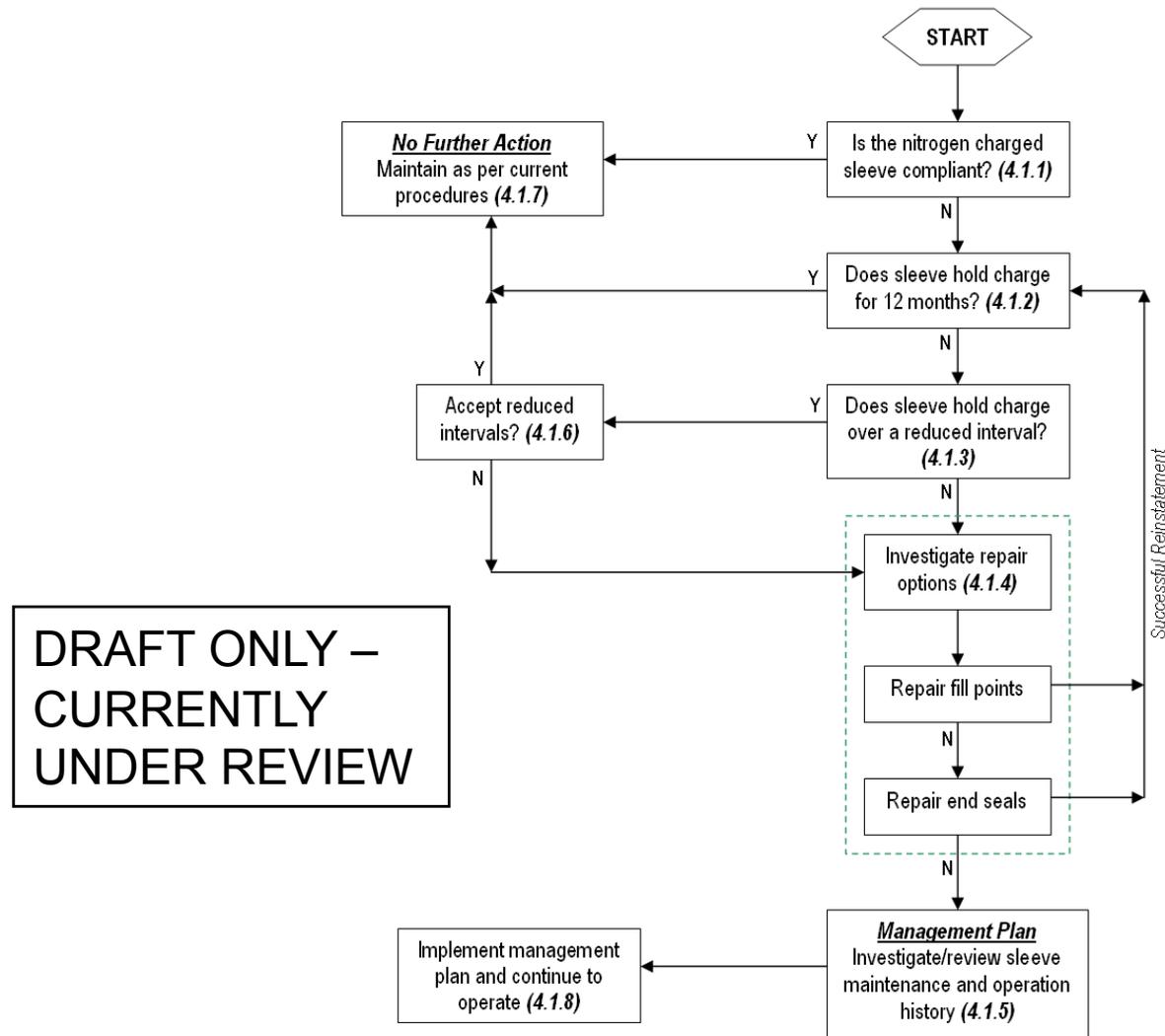
- ❑ Workshop held on 17 March 2011 held at GL Noble Denton, Loughborough, which was facilitated by GL Noble Denton.
  
- ❑ Workshop attended by:
  - Ineos
  - BPA
  - BP
  - Sabic Europe
  - Northern Gas Networks
  - Wales & West Utilities
  - Scotia Gas Networks
  - National Grid Gas Transmission
  - National Grid Gas Distribution
  - Observer from Ark Corrosion

## UKOPA workshop agenda – March 2011

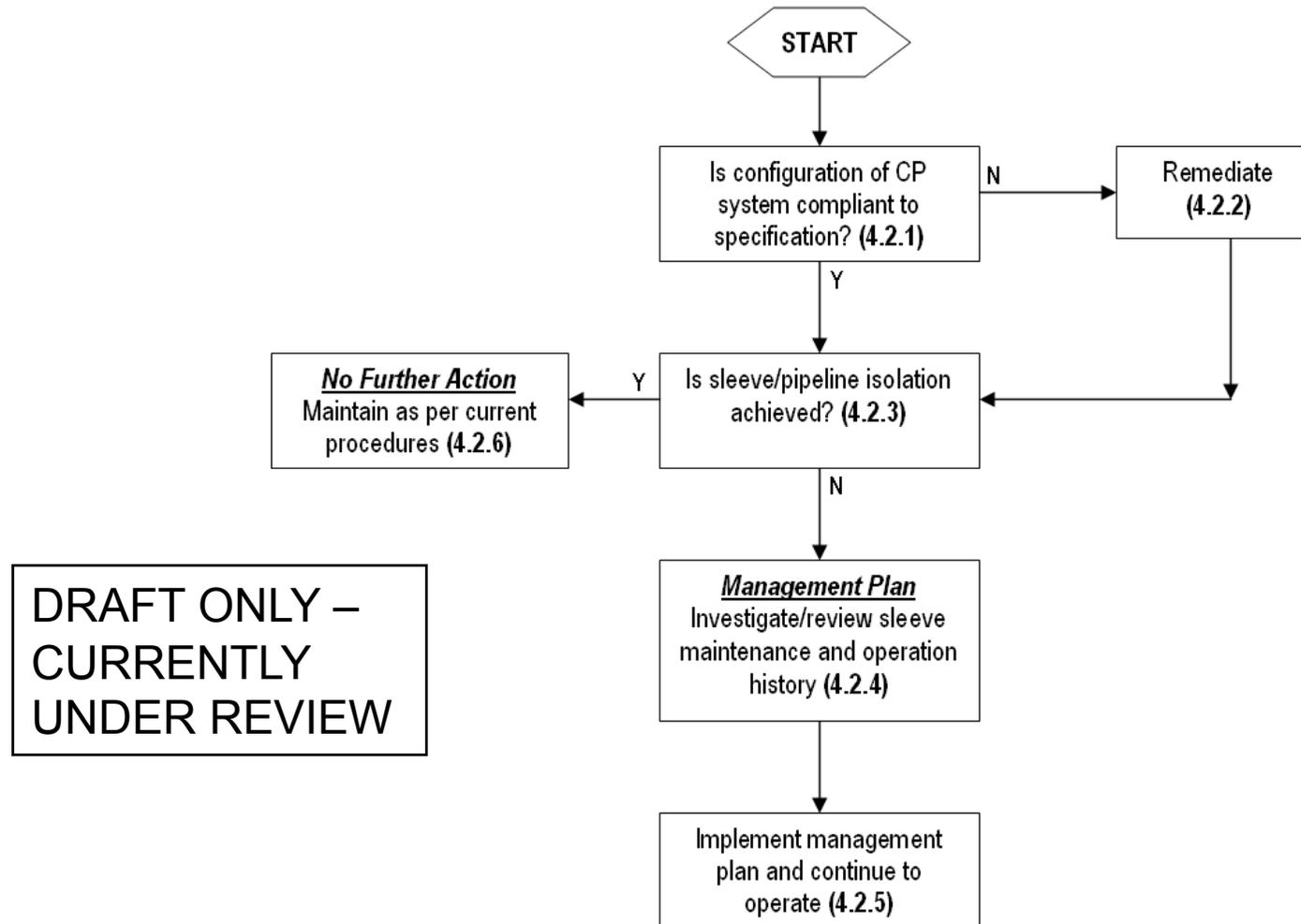
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- ❑ Development of sleeve maintenance algorithm
  - Nitrogen filled sleeve
  - Sleeve containing annular fill other than nitrogen
  
- ❑ Prioritisation of sleeves for assessment and remediation

# Maintenance algorithm for nitrogen charged sleeves – draft



# Maintenance algorithm for sleeve containing annular fills other than nitrogen – draft



**DRAFT ONLY –  
CURRENTLY  
UNDER REVIEW**

## Prioritisation of sleeves for assessment and remediation

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- Risk based scoring system to be developed
  - Piggable, un-piggable
  - Pressure, diameter
  - Annular fill
  - Sleeve location
  - Condition, inspection history, design records
  - CP compliance
  - Depth of cover
  - etc

## Workshop actions - immediate

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- Establish sleeve population
- Develop sleeve algorithm to reflect best practice
- Review new and emerging technologies for inspecting sleeves
- Validation of ILI in sleeved sections
- Annular fill for concrete construction sleeves

## Workshop actions – short/longer term

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- Share experience on maintenance and remedial works on sleeves
  
- Review of findings from ILIs undertaken
  
- Establish best practice with sleeve crossing designs
  
- Research using decommissioned sleeves

## Concluding remarks

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- Pipeline sleeves represent a potential integrity threat, particularly on unpiggable pipelines
- Aim of initiative is to develop best practice for maintenance, inspection, remediation
- Maintenance algorithms are being developed
- Risk ranking is to be developed