UKOPA

United Kingdom Onshore Pipeline Operators' Association

Update on UKOPA initiative on sleeves

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Background

- 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

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

Example of concrete sleeve

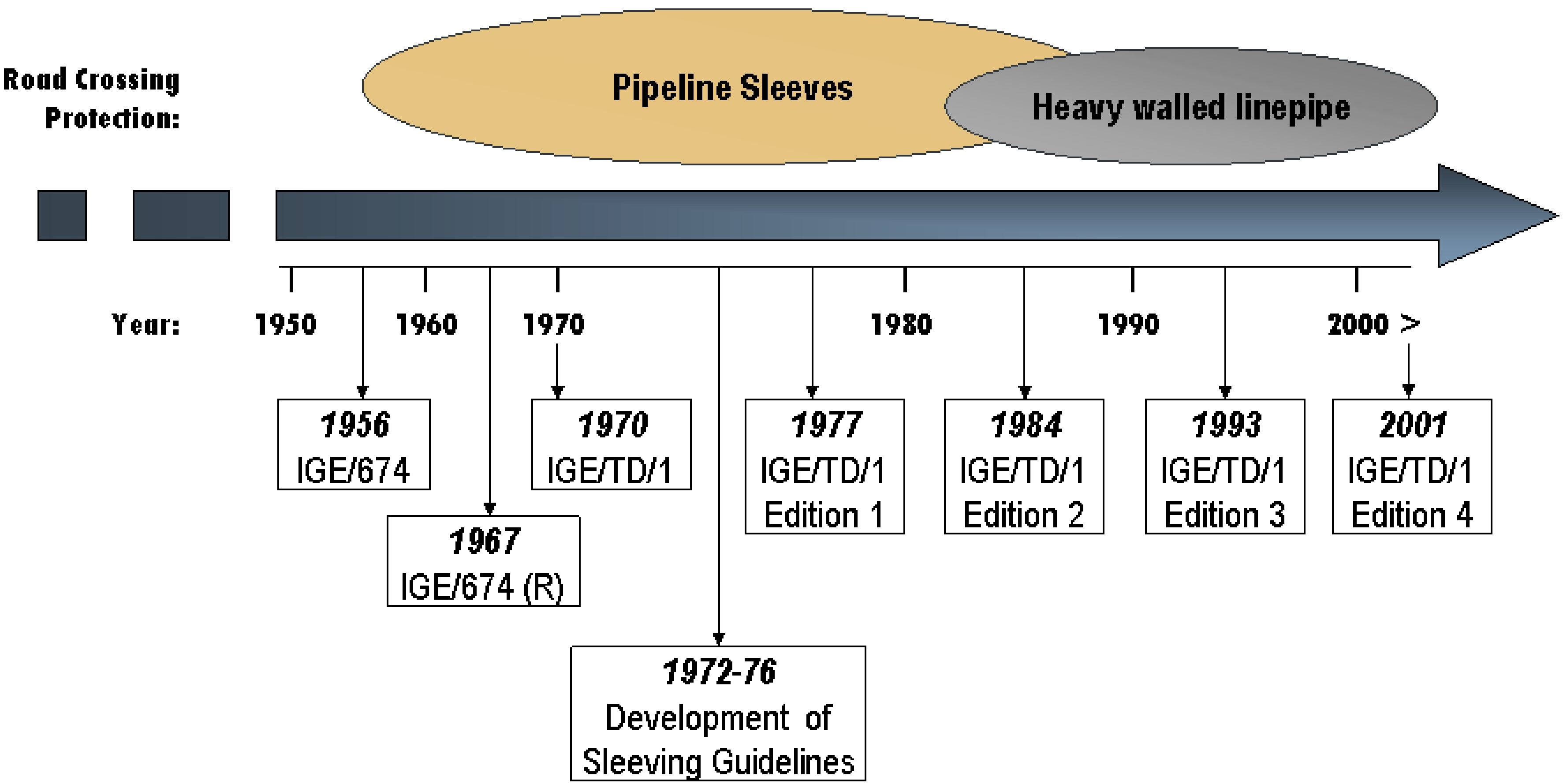
Maintenance of nitrogen filled sleeve

The use of sleeves

- 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

- **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

- **1970 – IGE/TD/1**: Steel Pipelines for High Pressure Gas Transmission
  - *For working pressures above 350 lbf/in2, 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/in2. 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

- 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 – End Seal Type (S.4.7): Rigid	Steel: Flexible	Steel: Shuttering	Concrete: Rigid	Concrete: Flexible	Concrete: 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)	Steel: Rigid	Steel: Flexible	Steel: Shuttering	Concrete: Rigid	Concrete: Flexible	Concrete: Shuttering
Inert Environment Only	Nitrogen (S.3.3.3) (S.7.2)	R	A	X	X	X	X
Combination of: Coating, Environmental control, Cathodic protection	Cementitious (S.3.3.4) (S.7.3)	X	X	A	X	X	R
	Others (S.3.3.5), *eg* Bentonite (S.7.4), grease/oil, foam plastics	A	A	A	X	X	A

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

Section S: Pipeline sleeving

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

1980s

- **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

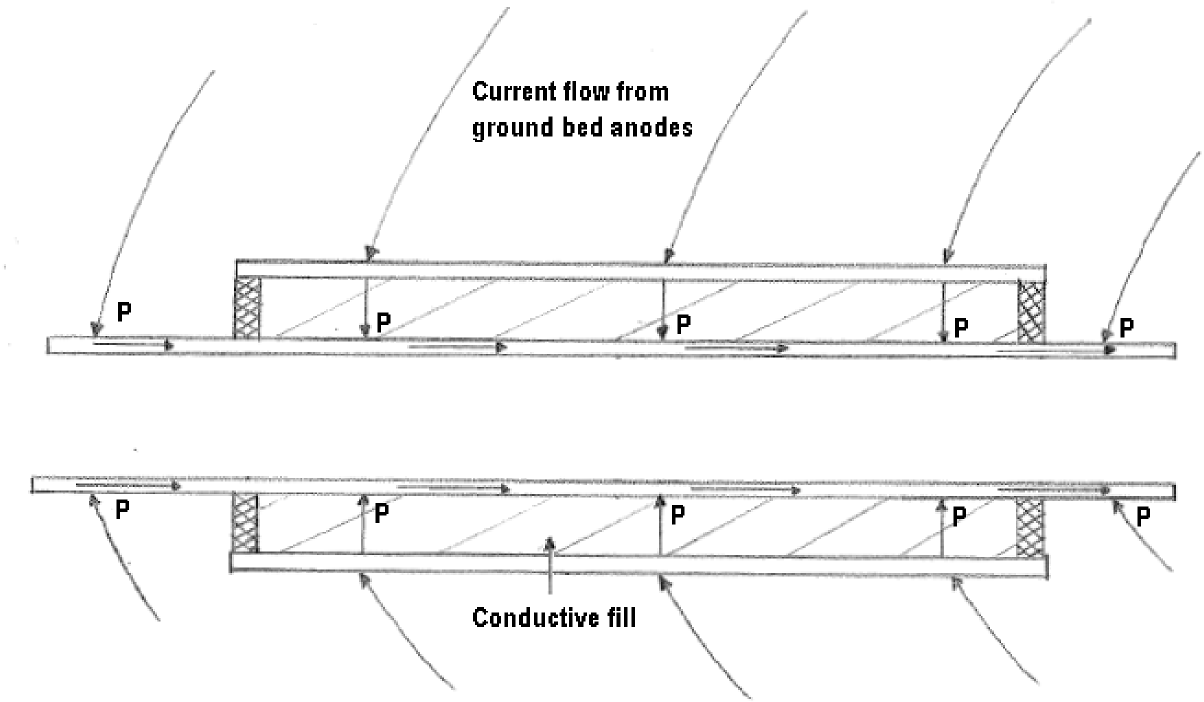
❑ IGE/TD/1 Editions 3 (1993) and 4 (2001)

- ❑ 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

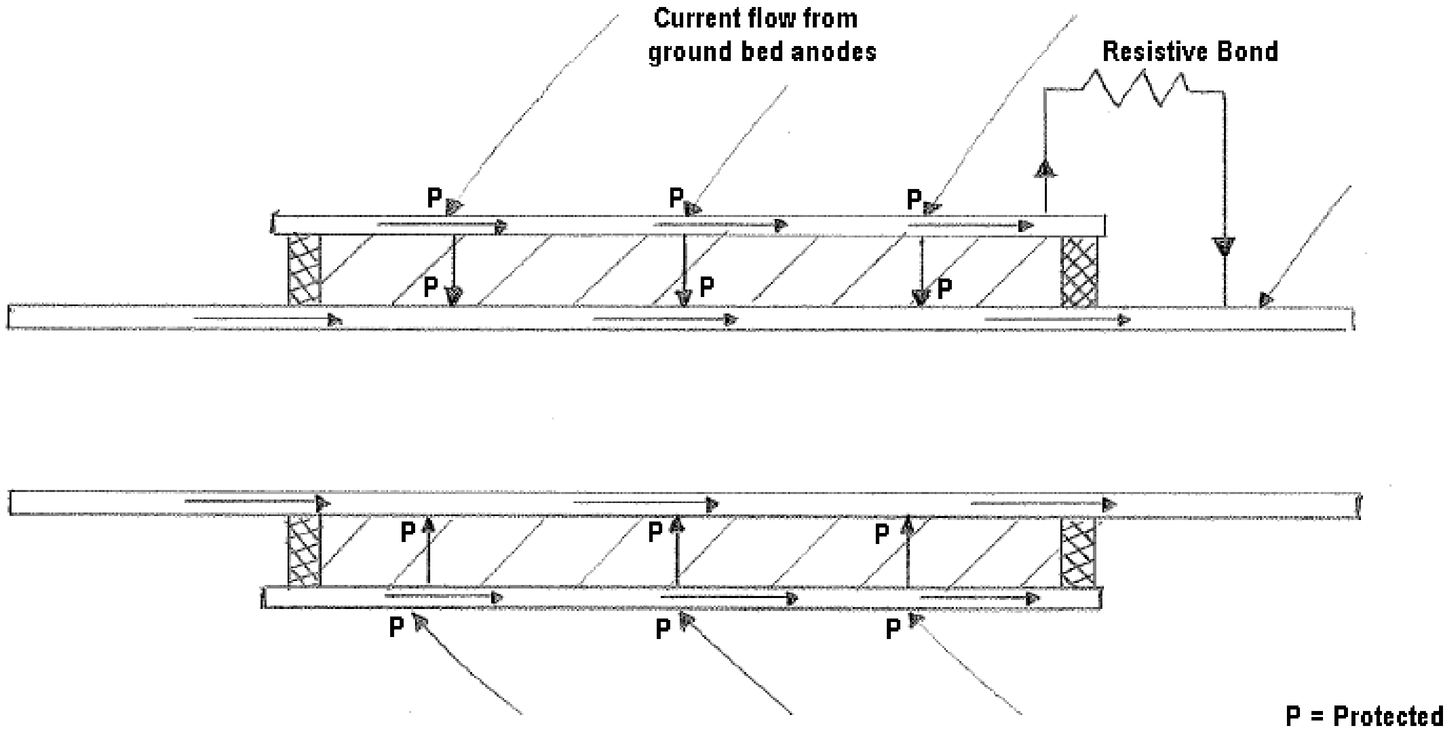
- BSI PD 8010-1 Code of Practice for Pipelines – Part 1: Steel Pipelines on Land
- ASME B31.8 – Gas Transmission and Distribution Piping Systems
- API RP 1102 – Steel Pipelines Crossing Railroads and Highways
- NACE SP0200 – Steel Cased Pipeline Practice

CP of sleeved pipeline

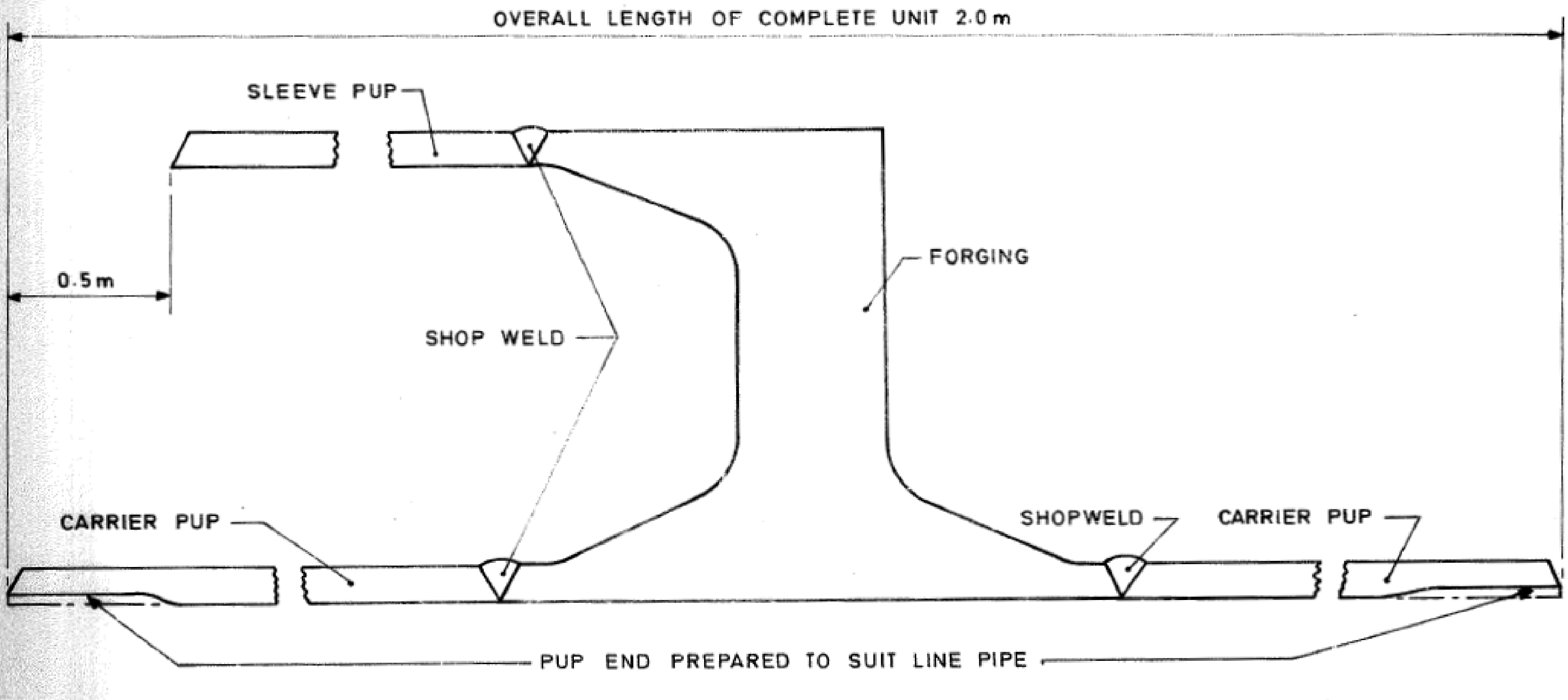


P = Protected

CP of sleeved pipeline



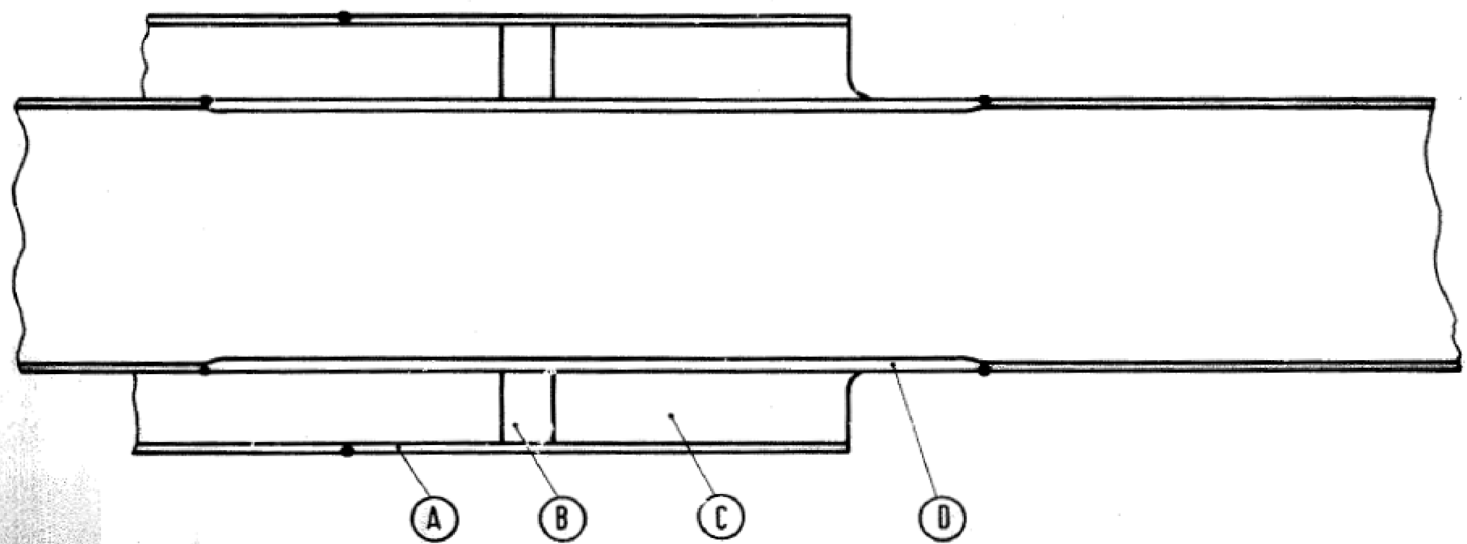
Forged end seal



FORGED END SEAL UNIT (TYPICAL) 24" CARRIER / 36" SLEEVE

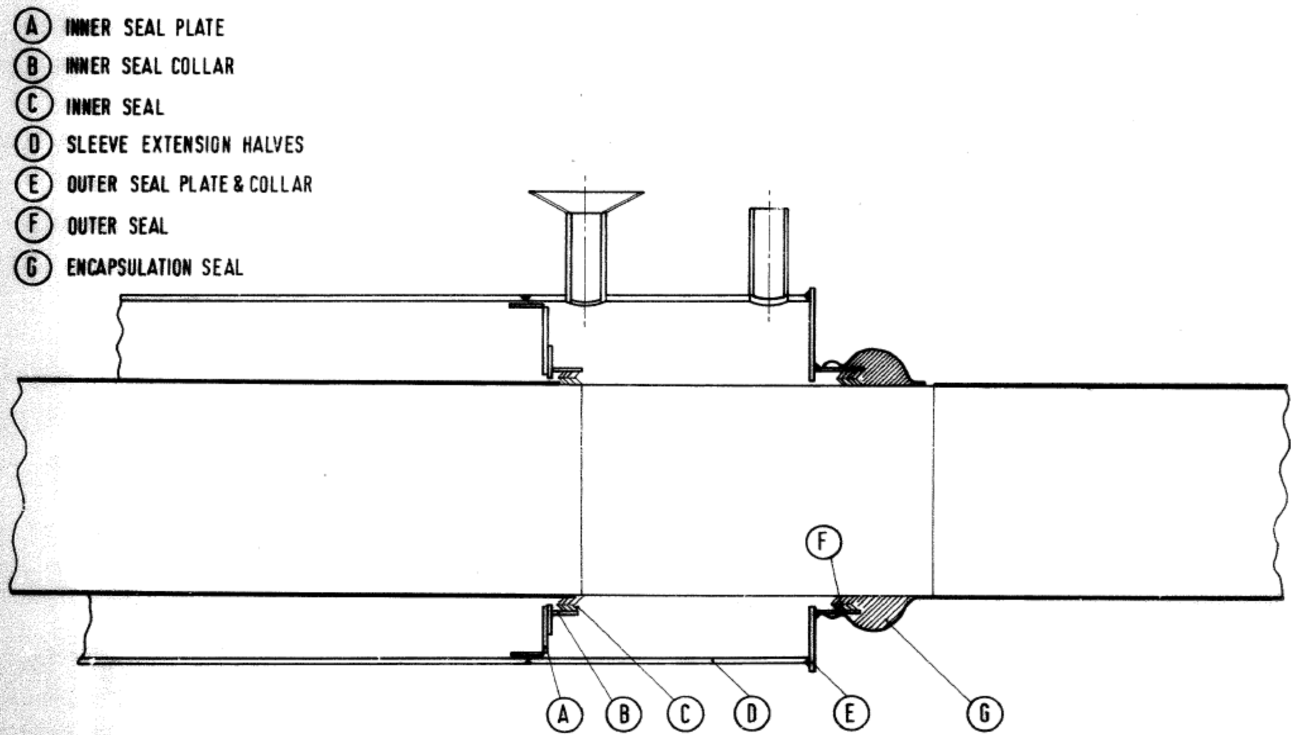
Pre-cast epoxy end seal

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



PRECAST END SEAL (NEW LINE CONSTRUCTION)

Site cast epoxy end seal



SITE CAST END SEAL FOR CONCENTRIC CARRIER AND SLEEVE
(EXISTING LINES)

FIG. 1

New design of epoxy end seal

New design epoxy end seal based on epoxy repair sleeve technology

Incidents on sleeves

- 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

- 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

- 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

Issues for the industry

- 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 initiatives

- Workshops held on 23 November 2010 and 17 March 2011
  - 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

Topics raised at workshops

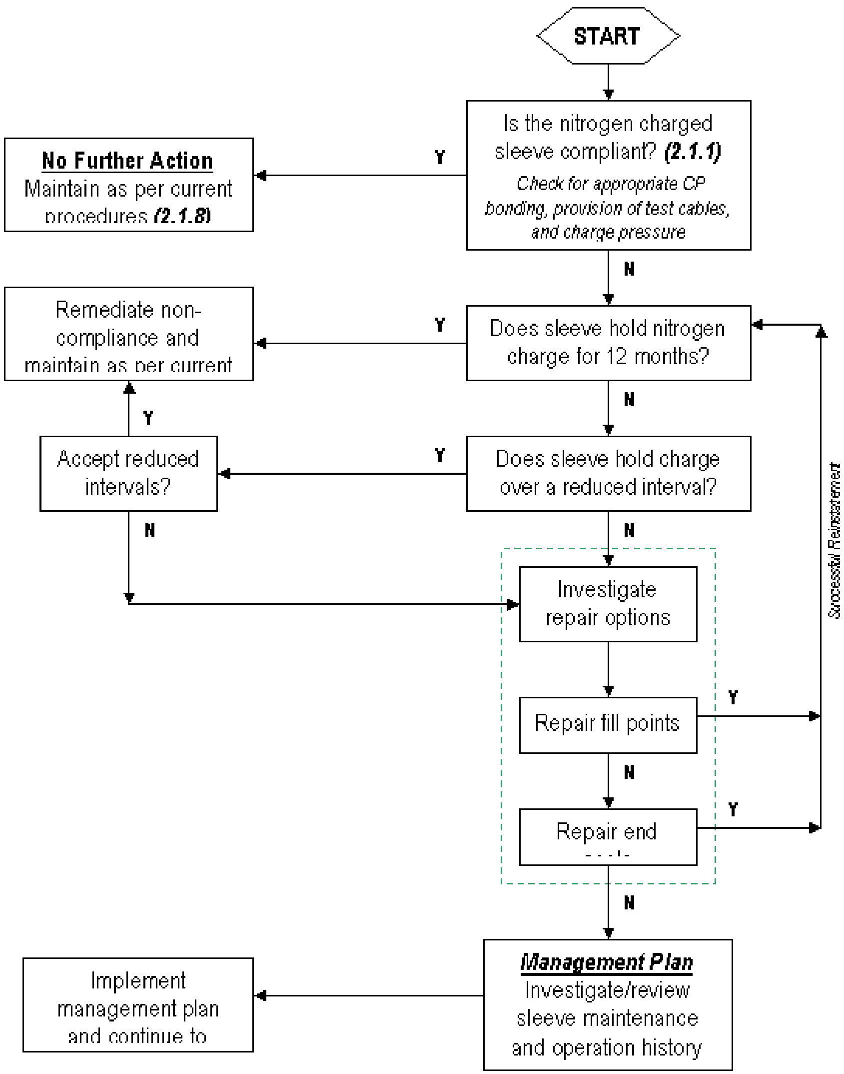
- Establish sleeve populations
- Develop sleeve algorithm to reflect best practice
- Review new and emerging technologies for inspecting sleeves
- Validation of ILI in sleeved sections
- Annular fill for concrete construction sleeves
- Share experience on maintenance and remedial works on sleeves
- Review of findings from ILIs undertaken
- Establish best practice with sleeve crossing designs
- Research using decommissioned sleeves

UKOPA initiatives

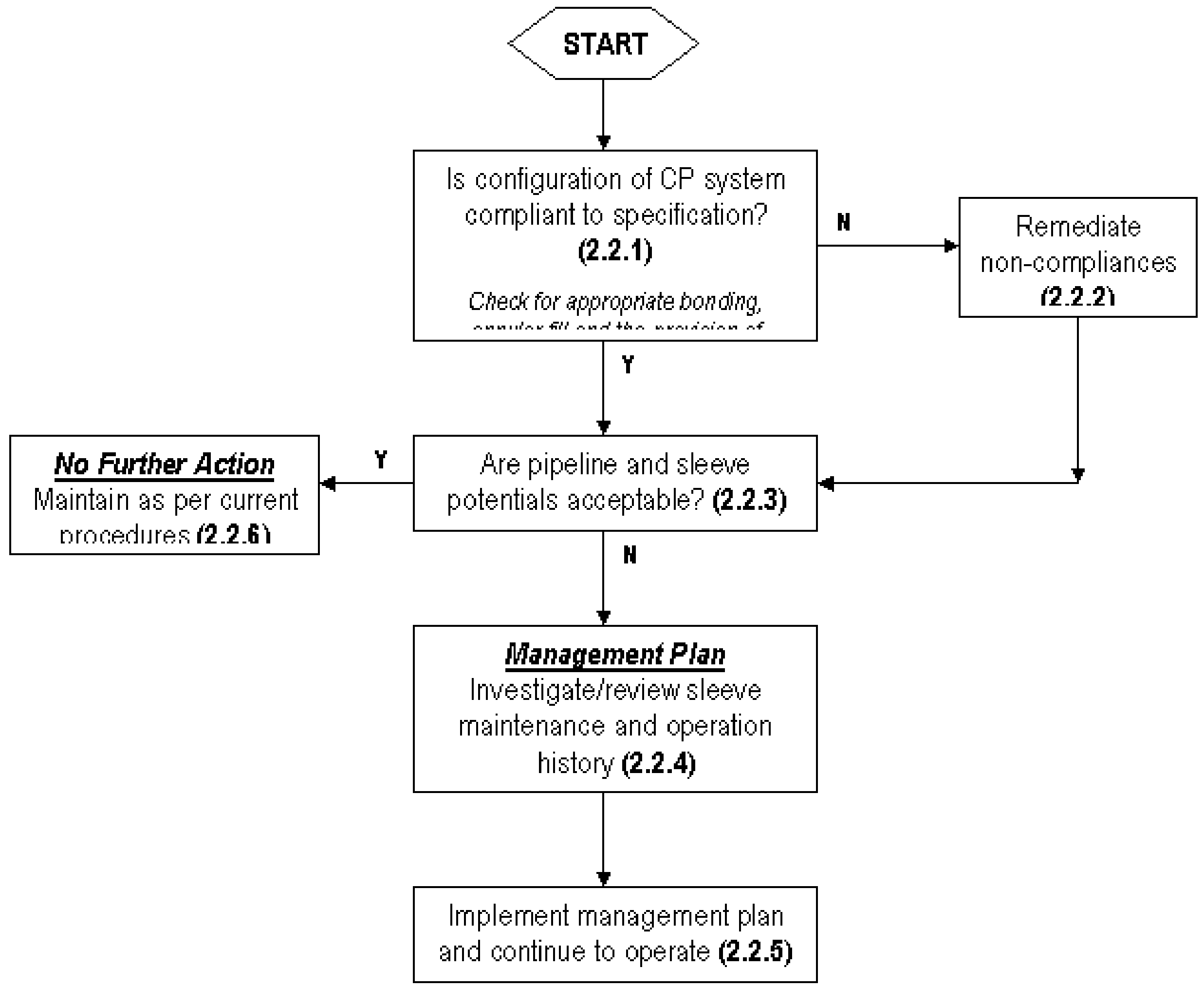
- Development of sleeve maintenance algorithms
  - Nitrogen filled sleeve
  - Sleeve containing annular fill other than nitrogen

- Prioritisation of sleeves for assessment and remediation

Maintenance algorithm for nitrogen charged sleeves



Maintenance algorithm for sleeve containing annular fills other than nitrogen



Prioritisation of sleeves for assessment and remediation – GL Noble Denton approach

- Produce a sleeve inspection scoring scheme that
  - Uses the engineering characteristics to differentiate between the different sleeve configurations in use
  - Indicates those sleeves that have higher likelihoods of failing and thereby resulting in an escape of gas that could lead to multiple fatalities
  - Indicates those sleeves that are a low likelihood of failing in such a way as to produce multiple fatalities

Factors included

Pipeline characteristics

- Pipeline installation date
- Operating pressure
- Pipeline wall thickness
- Pipeline diameter
- Pipe coating
- Piggable (Y/N)

Sleeve characteristics

- Protection reason (i.e. road, rail, or water)
- Sleeve location (R or S or T)
- Sleeve installation date
- Sleeve length
- Sleeve material
- Sleeve end-seal
- Annular fill material
- Inspection and monitoring data

Date of last in-line inspection

- Cathodic protection
- Status of nitrogen fill in annulus

Overall Sleeves Risk Ranking

- The different factors are given scores indicative of how likely that factor is to increase the risk associated with the sleeve

- The scores for the individual factors are then combined together to give an empirical number within a non-linear ranking scheme that has been designed to identify those sleeves most at risk of housing a leaking pipeline within a high consequence area

- Three general zones:
  - High scores for sleeves that are a high priority for inspection
  - Low scores for sleeves that are a low priority for inspection
  - An intermediate region

- N.B. The scoring scheme is an estimate of relative likelihood of a failure - not that the pipe with a higher score will fail before a pipe with a lower score

Concluding remarks

- 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 have been developed
- Risk ranking is being developed