

Rehabilitation to Reduce Leakage Levels and Extend Pipeline Life

Andrew Wedgner
Borouge Pte.



SHAPING the FUTURE with PLASTICS

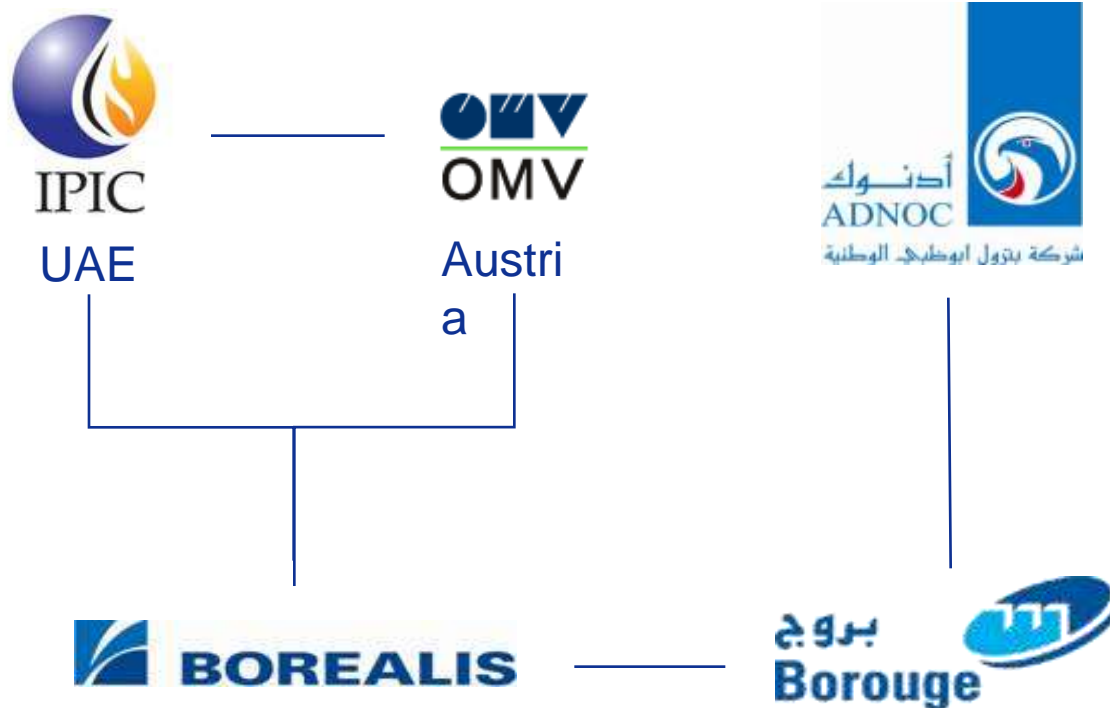
Contents

- A brief Introduction to Borouge
- Why renovate pipelines and how to compare the different systems
- The renovation of pipelines using polyethylene pipes and liners
- Use of a High Stress Crack Resistant PE100 grade for pipes and liners
- Conclusion

A brief Introduction to Borouge

A successful joint venture combining resources, feedstock and technology

- Borouge – A JV between ADNOC and Borealis, combining the best of Europe and the Middle East
- JV formed in 1998, production start up in 2001 in Ruwais, Abu Dhabi. Current capacity of over 2,000 kT/year of Polyethylene and Polypropylene
- Will increase to over 4,000 kT/year in 2014 once Borouge 3 commissioned



Borouge – a leading force in the international plastics market



Providing Solutions in Polyolefins



Infrastructure



Automotive



Advanced Packaging

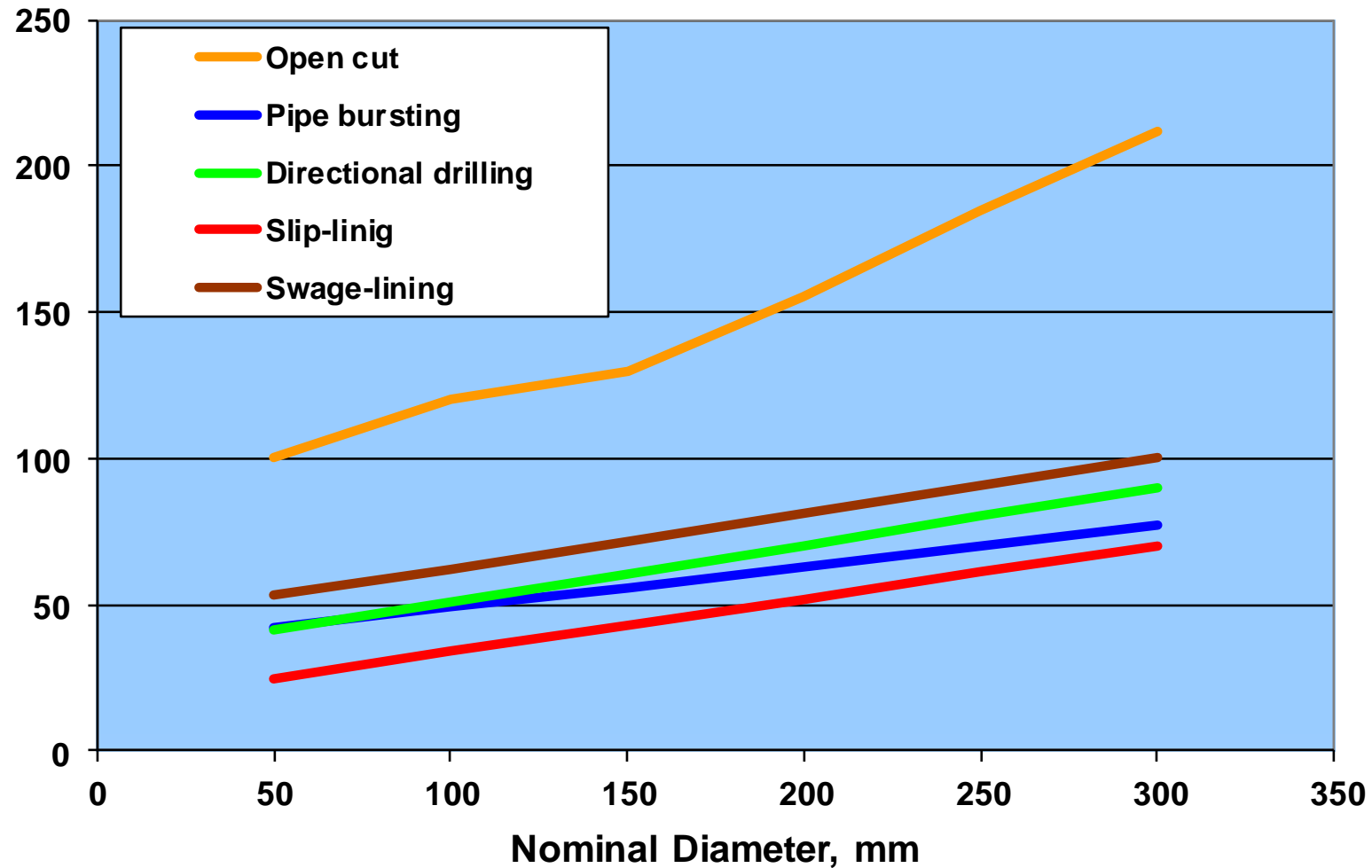
Why renovate pipelines and how to compare the different systems

Pipeline renovation rather than 'open cut' replacement

- Renovation can be thought of as another form of leakage management.
- Eventually the system operator gets to a point where the cost of water loss, frequent leakage detection and repair works justifies the replacement or renovation of a pipeline.
- Several techniques have been developed to match different needs and the insertion of PE pipes has been used in pipelines of up to 1400mm dia.
- The cost savings compared to replacement can be considerable when the cost of disruption is included.



Typical relative pipes installation costs – based on a European urban environment



ISO 11295 provides a guide to the different lining techniques and some standardisation

- Many of the different systems use patented methods that were independently developed by specialist companies in different countries
- Historically these different companies frequently used different descriptions and buzz words to describe their systems and differentiate themselves from competitors
- Using the classifications given in ISO11295 helps End Users to clearly specify systems

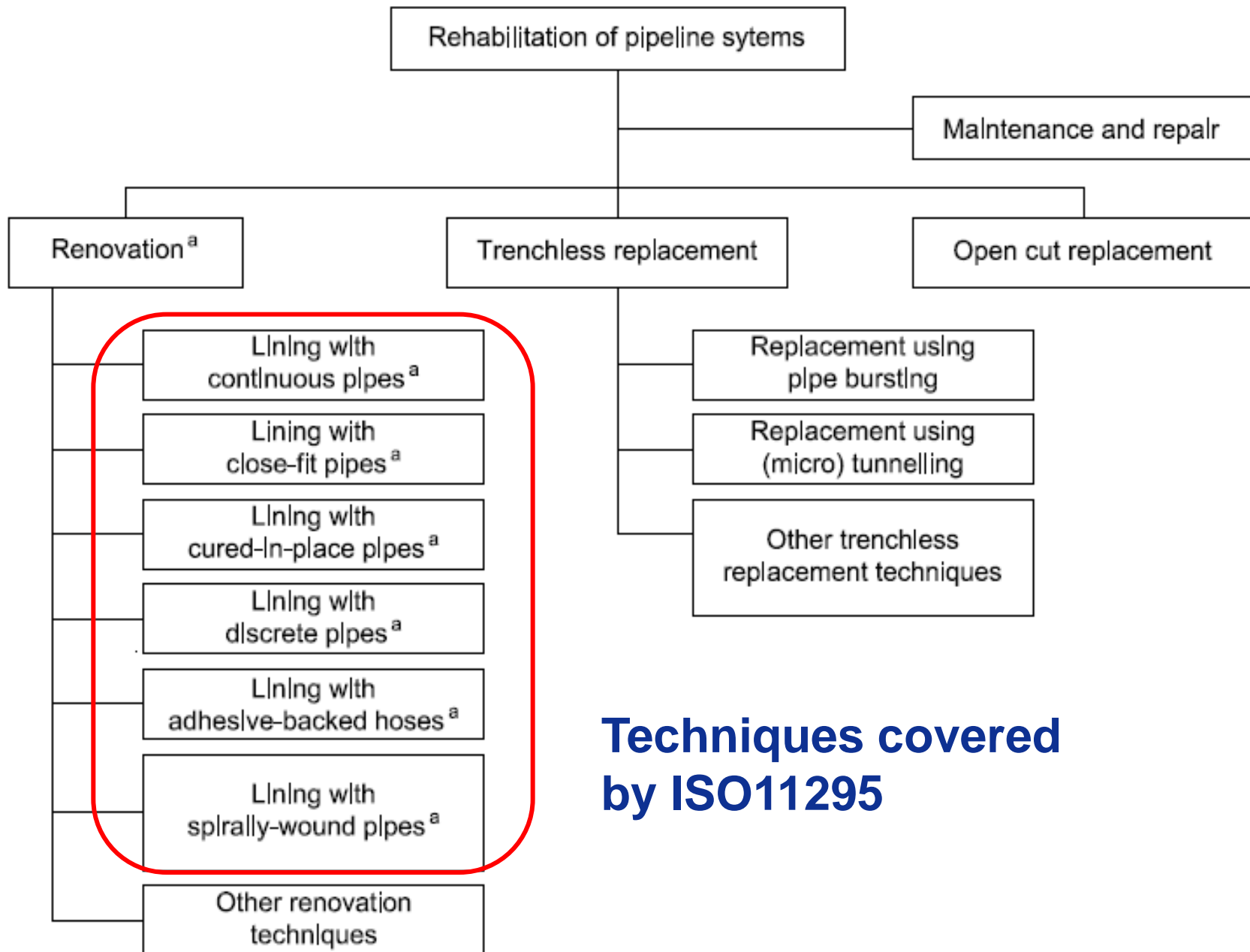
INTERNATIONAL
STANDARD

ISO
11295

First edition
2010-03-01

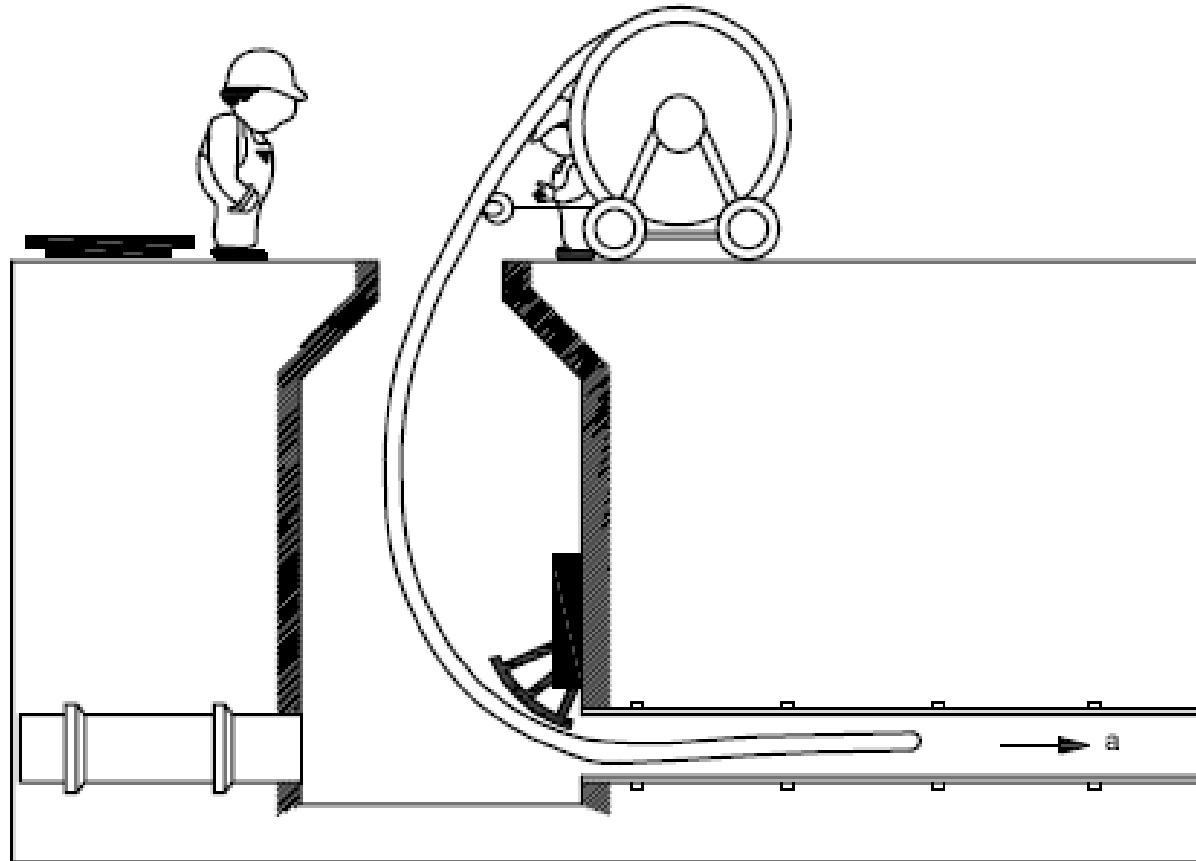
**Classification and information on design
of plastics piping systems used for
renovation**

- **It doesn't cover pipe bursting**



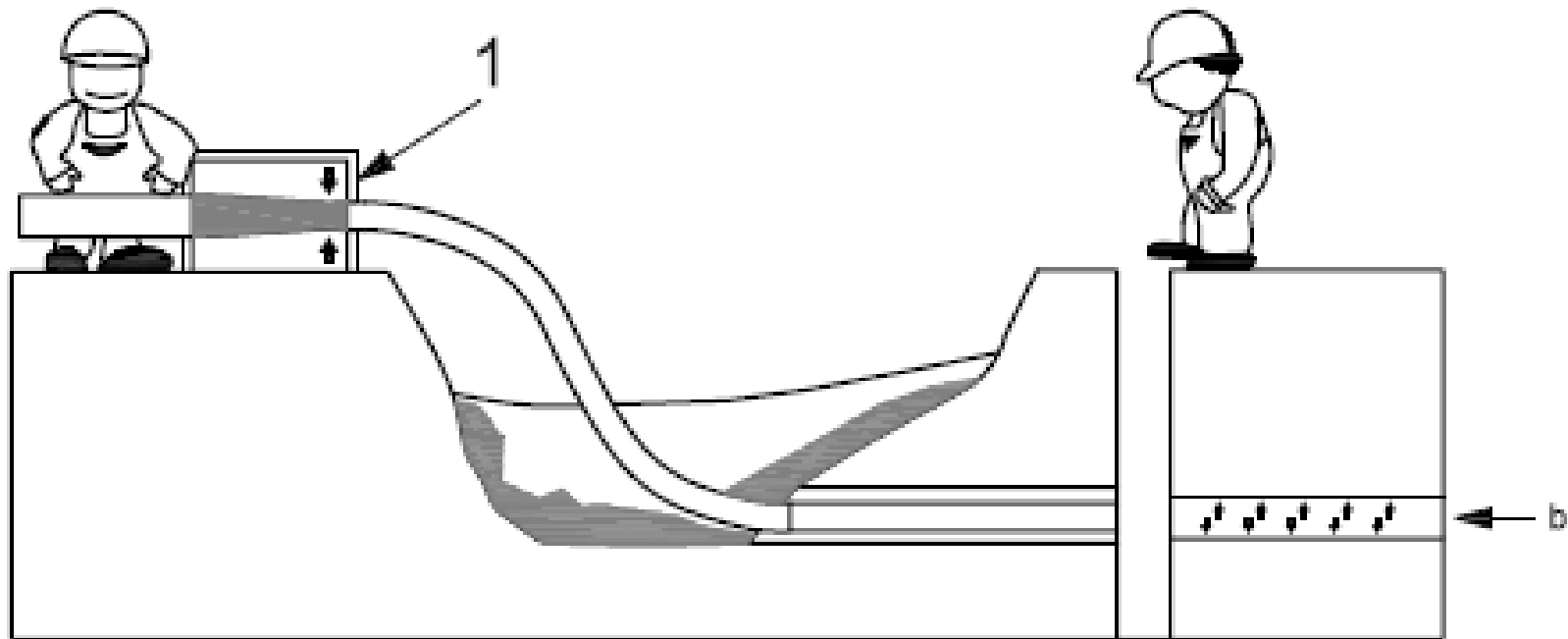
**Techniques covered
by ISO11295**

The standard gives descriptions on the different systems



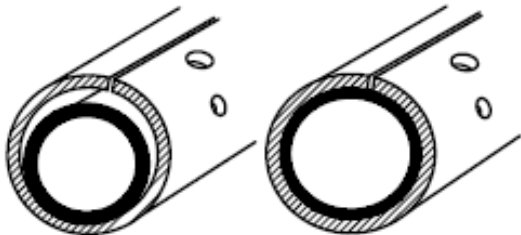
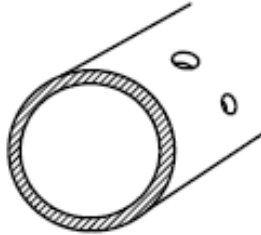
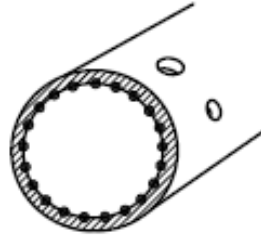
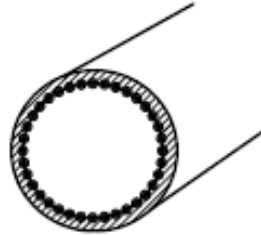
a) Installation of a pipe reduced in cross-section in the pipe manufacturing plant

and gives guidance on their materials, applications, performance and installation



b) Installation of a pipe reduced in cross-section on site

It also provides a system for classifying the pipe or liner structural performance

Class A		Class B	Class C	Class D
				
loose-fit close-fit		inherent ring stiffness	relies on adhesion	relies on adhesion
Independent		Interactive		
Fully structural		Semi-structural		Non-structural
Lining with continuous pipes				This International Standard is not applicable
	Lining with close-fit pipes			
	Lining with cured-in-place pipes			
		Lining with adhesive-backed hoses		

Renovation of pipelines using polyethylene pipes and liners

Several renovation techniques make use of polyethylene pipes and liners



1. Loose (slip) lining

2. Close fit – reduced dia.



4. Pipe bursting

3. Close fit - folded liner



Slip lining using PE80 and PE100 pipes

- Slip lining, also known as loose lining involves pulling a smaller PE pipe through an old pipeline with a winch after the old pipe has been cleaned..
- The pictures show the insertion of a PE80 pipe into a leaking medium pressure steel gas main in Milan.
- Has also been used in water and sewage applications – very little special equipment is needed
- For water mains the loss in flow area is often more than compensated by the reduced friction of PE100 pipe.



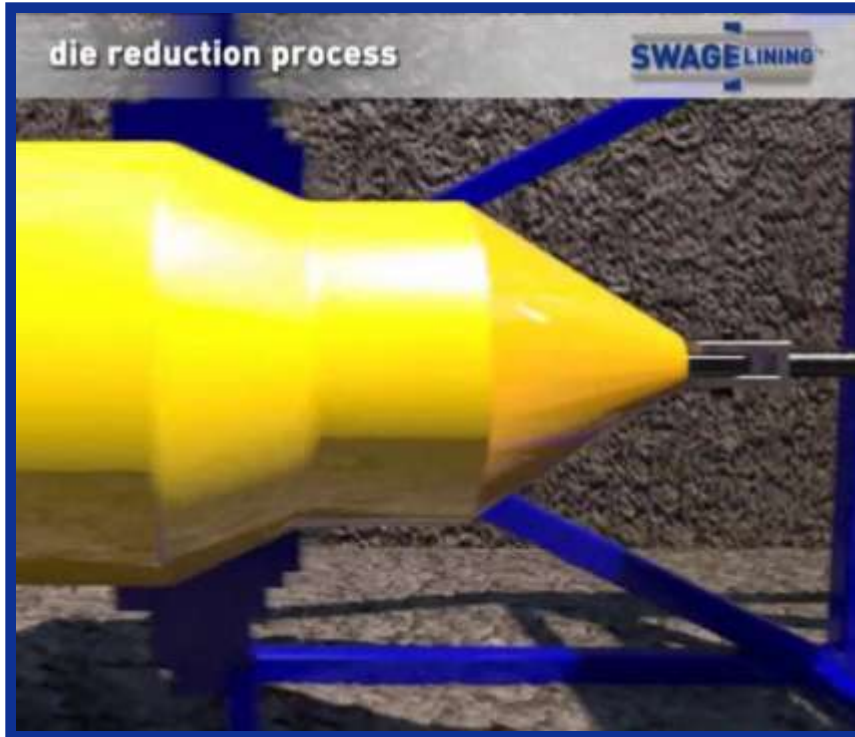
'Close fit' relining using concentric pipe diameter reduction

- A liner is drawn thorough a die or hydraulic rollers to reduce the outside dia. by up to 10%.
- The liner is drawn though the old pipeline by a winch.
- Once the winch is uncoupled and tension released the pipe shortens and expands to form a close fit liner.
- Liner OD should be slightly larger than the host pipe ID
- Best suited to pipelines with only very shallow bends



A 32" steel pipeline to carry iron ore slurry being lined in Australia with HE3490-LS-H

There are two principal methods of achieving the concentric diameter reduction



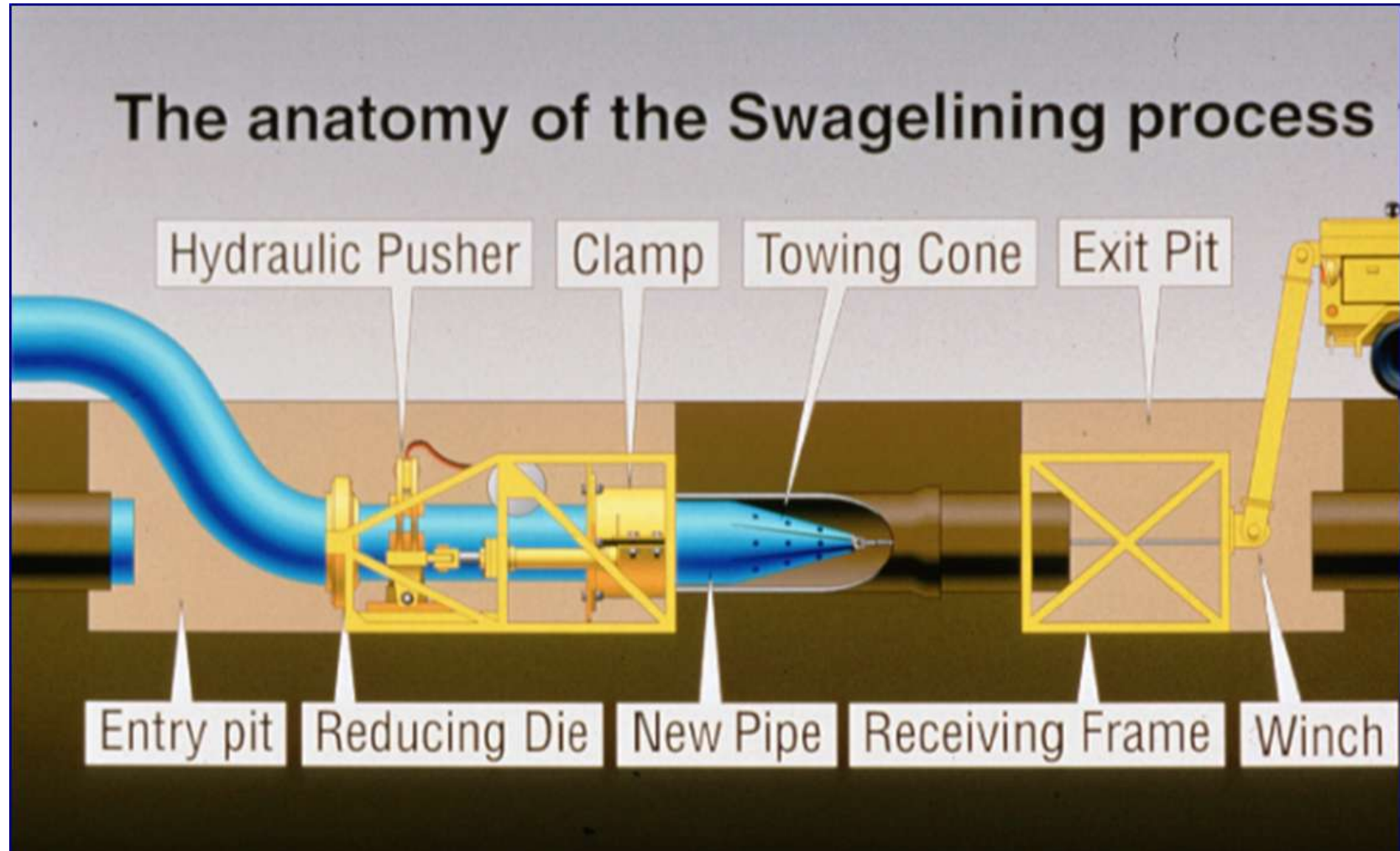
Drawing the lining pipe through a diameter reduction die

In both cases the pipe wall thickness is unchanged, whilst the diameter reduces and length increases

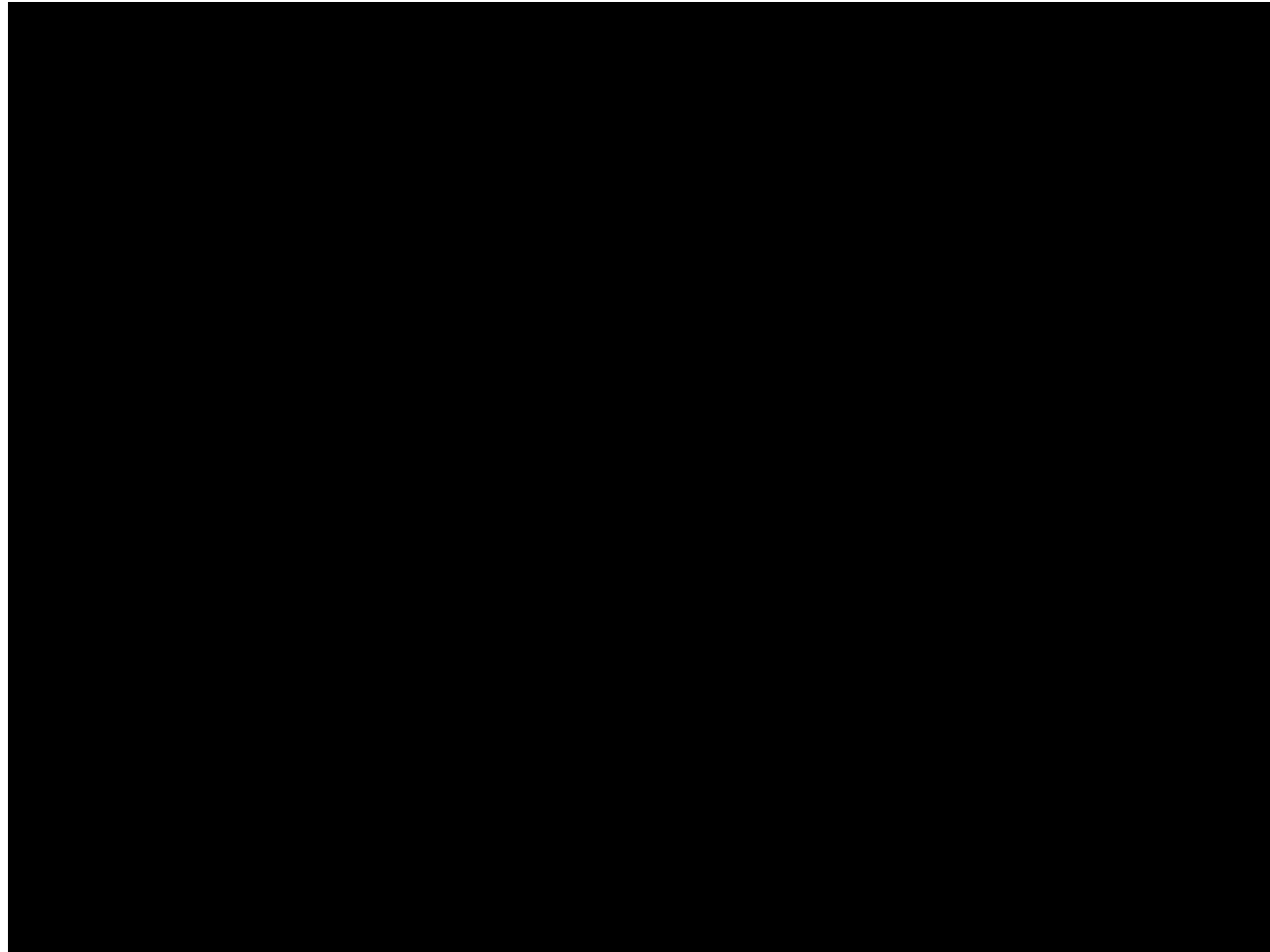


Drawing the pipe through a set of hydraulically powered reduction rollers

The swagelining process and key components

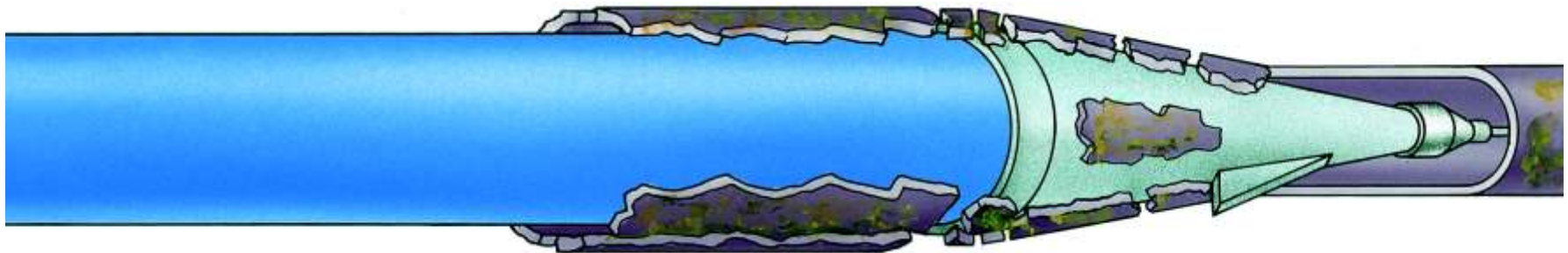


UPS TiteLiner Animation



Renovation by pipe bursting – key points

- Pipe bursting can be used on a wide variety of both pressure and gravity pipelines and drains by using different breaking heads.
- Intro. - International Pipe Bursting Association “Guideline for Pipe Bursting”
- Depending on the host pipe material some systems employ pneumatic or hydraulic breakers whilst others rely on cutting heads, as shown below
- Same sized or larger PE pipe drawn through behind the breaker
- Important to use a PE material with a high resistance to slow crack growth as many sharp shards and fragments remain close to the pipe



Renovation by pipe bursting allows the installation of the same size or larger pipeline

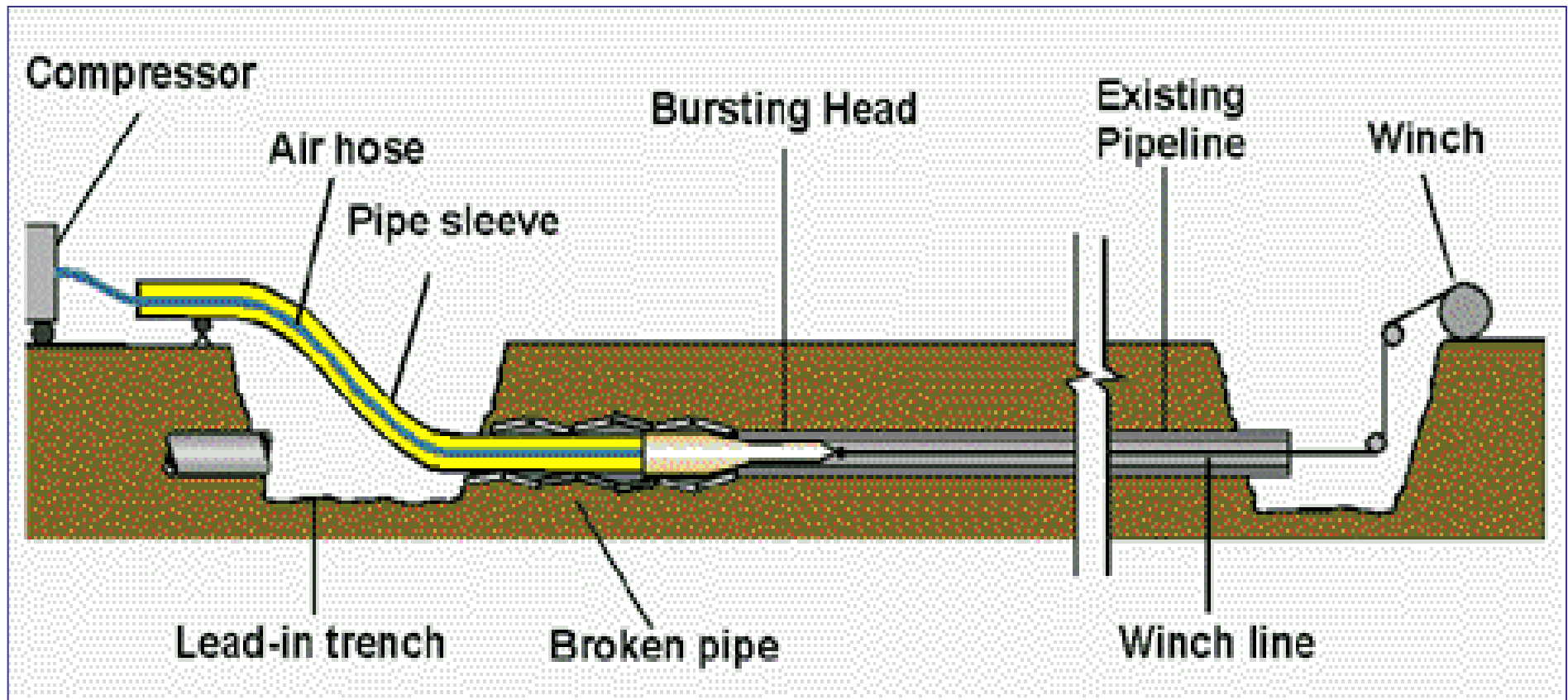
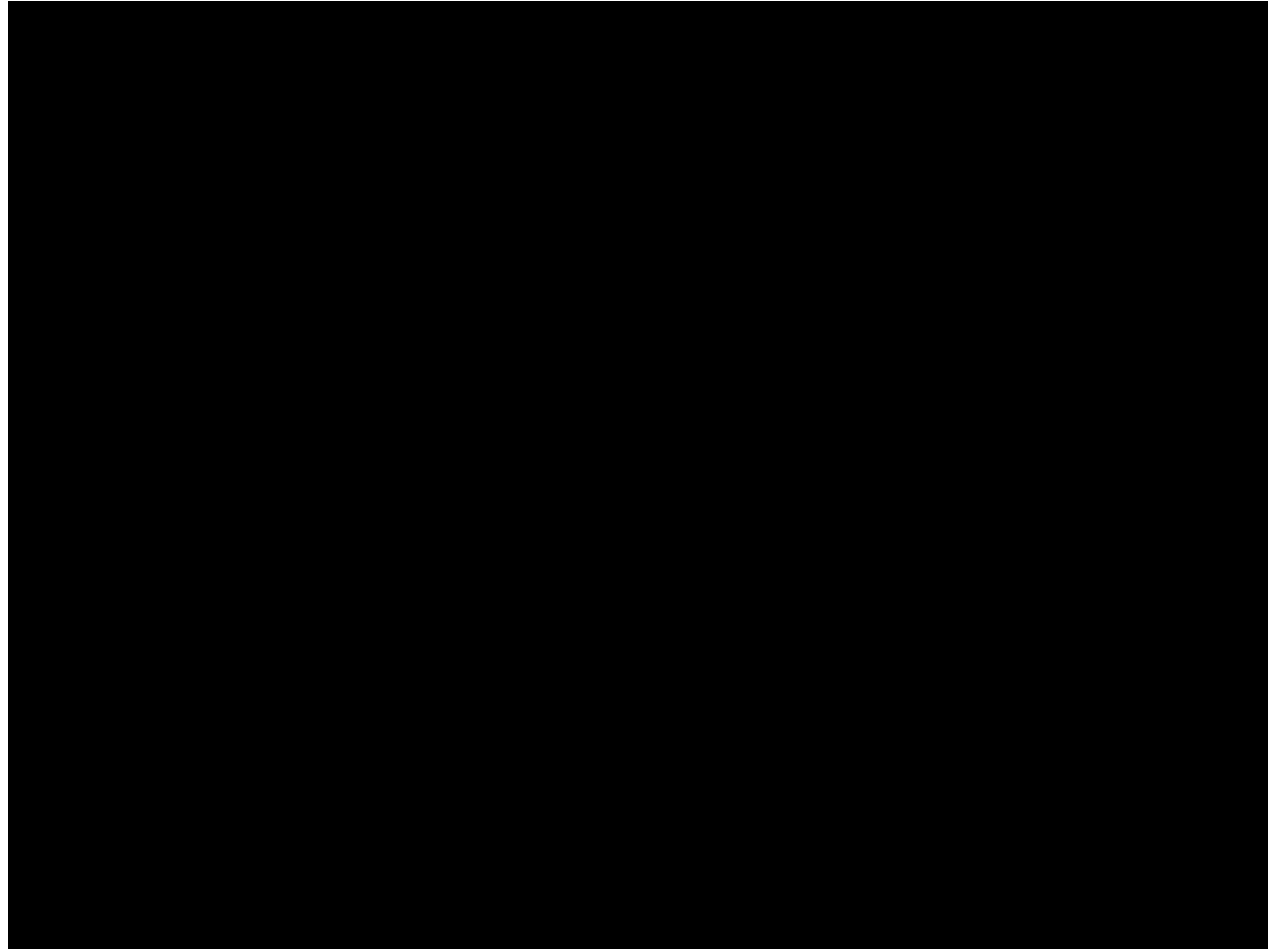


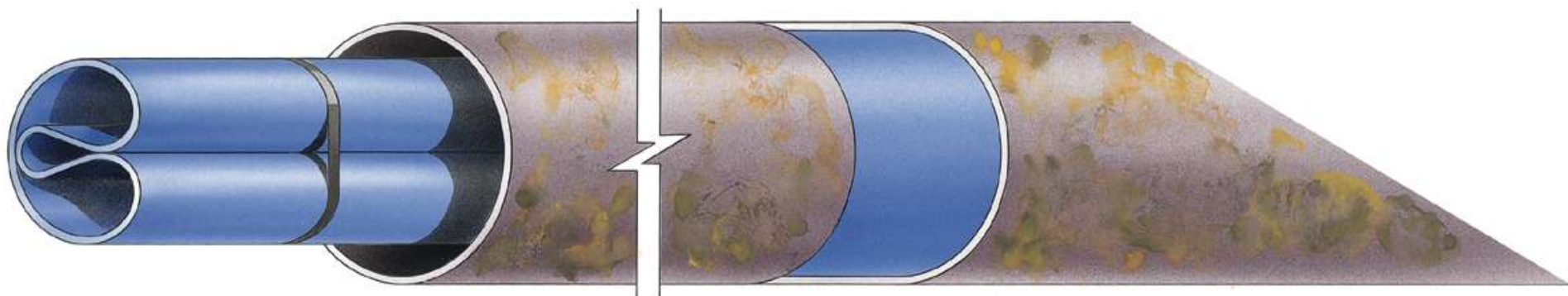
Diagram showing a typical installation using a pneumatic breaker

Animation of a small diameter pipe bursting system using a static bursting head



Close fit relining using folded PE100 liners

- To reduce the overall dimensions of the pipe it is folded into a U or C shape.
- The pipe liner can be easily threaded through the old main as there is more clearance between the liner and pipe and minimal tension on the winch
- Once in place the pipe can be expanded using water or air pressure, some systems first use steam to heat up the pipe and 'assist' the memory effect..
- This technique is particularly suited to deep mains and mains with minor bends and obstructions as the liner is still flexible.

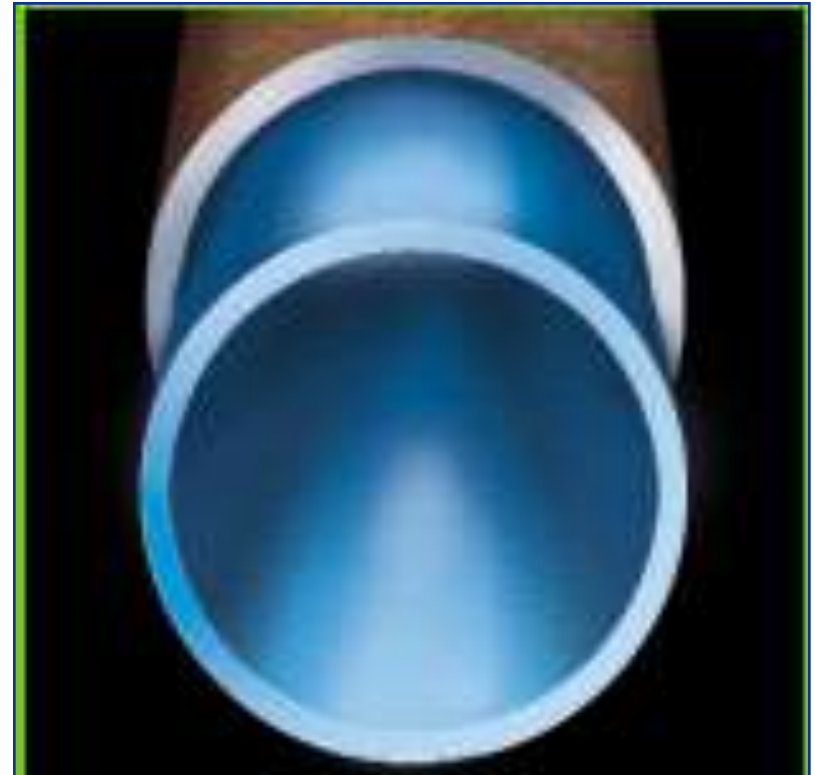


Changes in pipe shape during and after installation

Shape of folded pipe during installation



Shape of expanded pipe after being pressurized



Close fit folded PE pipe liner being formed from a debeaded PE100 pipe

- Different patented systems such as “Subline” and “Subcoil” by Subterra “Insituform” by Insiuform and “Compact Pipe” by Wavin
- All are patented methods
- Independent’ liners are fully structural
- Interactive liners need the strength of a host pipe
- Liners can be site or factory folded and have an OD identical to the host pipe ID
- The folding process exerts major stresses on the pipes. Use of high quality material is essential



Use of a High Stress Crack Resistant PE100 grade for pipes and liners

Why were HSCR PE100 materials developed?

The Problem

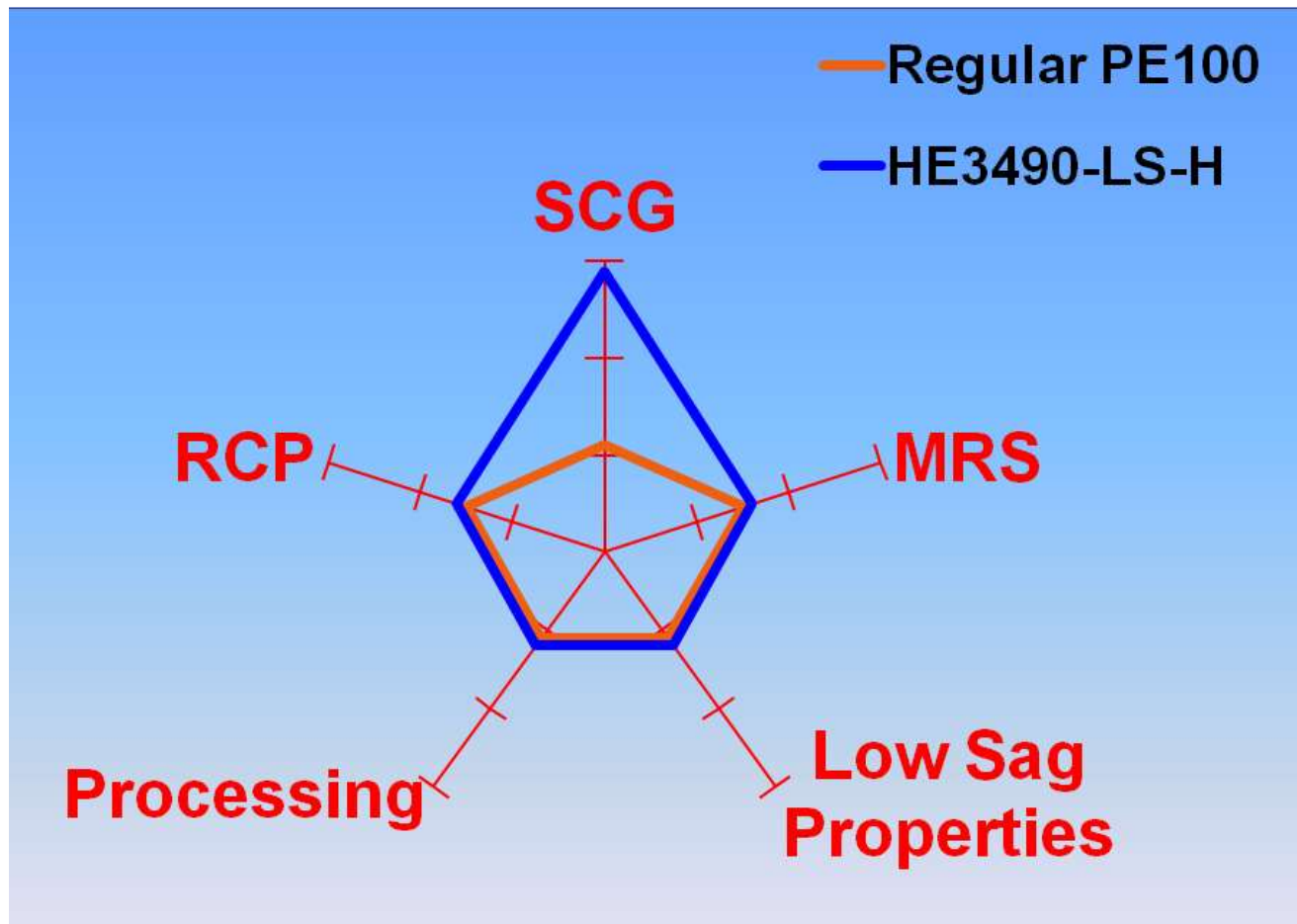
Demanding installation techniques such as pipe bursting and the different types of lining application create challenging conditions which lead to an increased risk of pipe failure from slow crack growth (SCG). This can be initiated by external scratching and scoring during installation and / or point loads from pipe fragments after installation

The Solution

The PE industry has developed new high stress crack resistant HSCR PE100 (PE100RC) materials in which the molecular structure of the PE dramatically slow down crack propagation



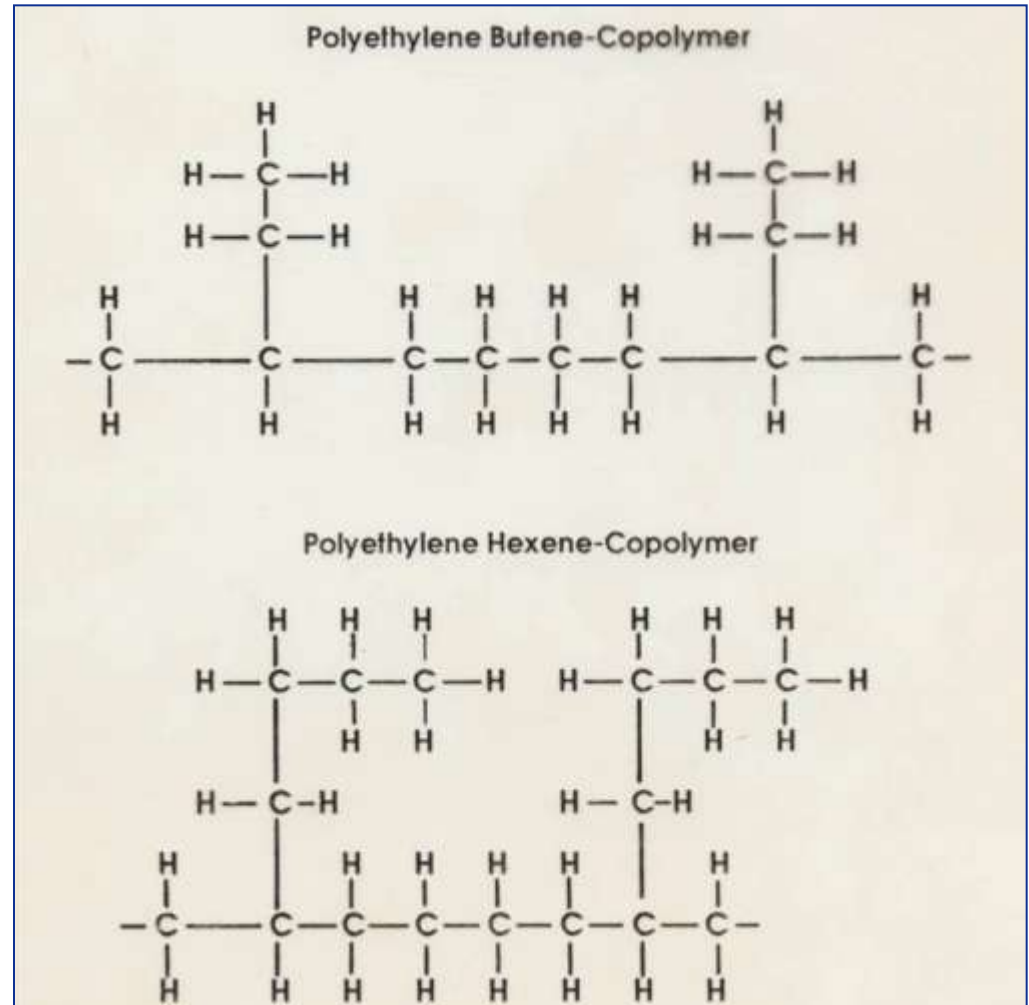
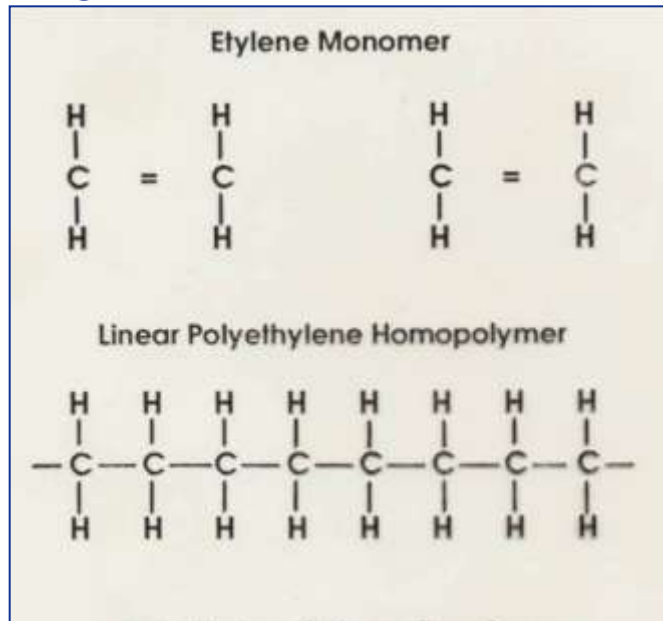
Properties of Borsafe HE3490-LS-H, a HSCR grade, as compared to a 'regular' PE100



- **SCG**
Slow Crack Growth Resistance
- **RCP**
Rapid Crack Propagation Resistance
- **MRS**
Minimum Required Strength - 50 Years
- **Low Sag Properties**
Important for producing larger diameter and high wall thickness pipes

Polyethylene molecular diagrams - effects of different comonomers

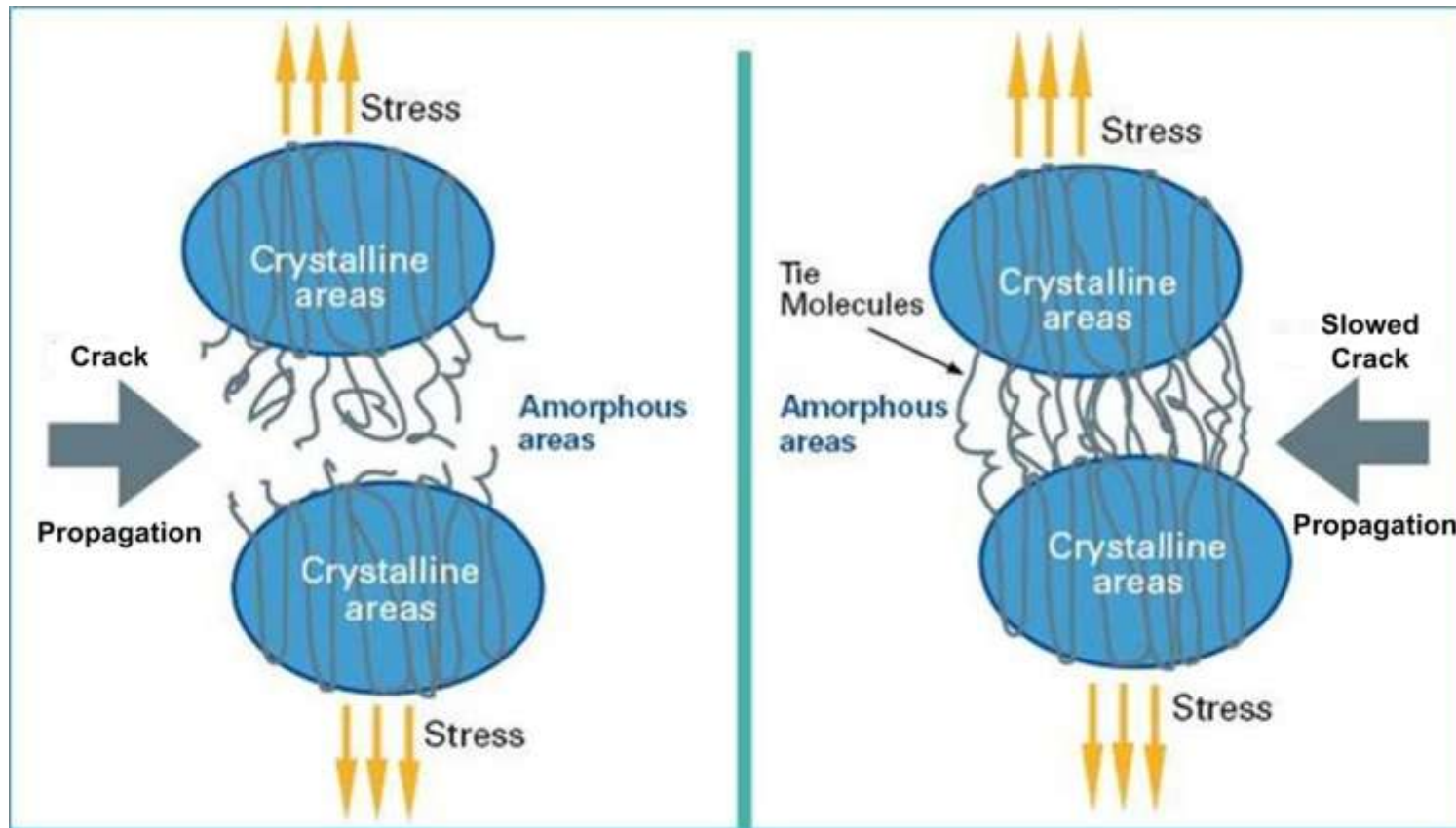
Ethylene is the raw material from which PE and PP are produced. Using hexene rather than butene as the comonomer gives a PE with longer side branches.



How does HE3490-LS-H resist slow crack growth?

Tie molecules with large side branches is the key, having crack propagation rates of less than 10% that of regular PE100

Regular
PE100



HSCR
PE100

Conclusion

- When water loss, leakage management and repair costs become too high, its time 'to replace or renovate a leaking water pipeline
- Make use of ISO 11295 – it's there to help End Users understand the different techniques, select the most appropriate and correctly specify it
- In the case of pipe bursting refer to publication such as the International Pipe Bursting Association Guidelines
- Several effective techniques that employ PE pipes and liners are available
- During installation pipes and liners can be scratched or scored during the installation process, damage that will probably go unseen and can lead to Slow Crack Growth (SCG) failure.
- Borouge recommend that a High Stress Crack Resistant PE100 material (PE100RC) is used to minimise the risk of pipe or liner failure due to SCG



Thank you for your attention