Application of Polyethylene Pipes In Singapore

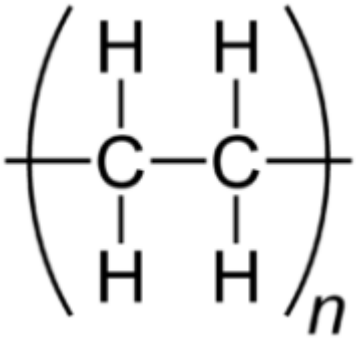
Ken Kong
Head of Section
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2) Products made of Polyethylene
3) Types of Polyethylene Pipes and Fittings
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What Is Polyethylene?

- A form of plastic
- Originated from crude oil with added processes
- Chemical structure, $(C_2H_4)_n$
- Generally in three main groups:
  1. Low density polyethylene (LDPE)
  2. Medium density polyethylene (MDPE)
  3. High density polyethylene (HDPE)



Products made of Polyethylene

- **Low density polyethylene (LDPE)**
  - Low tensile strength & relatively flexible and tough
  - Packaging foam & plastic wraps



- **Medium density polyethylene (MDPE)**
  - Good shock and drop resistance properties
  - Better stress cracking resistance than HDPE
  - Packaging films, carrier bags & bottles



- **High density polyethylene (HDPE)**
  - High strength-to-density ratio and chemical resistant
  - Pipeline systems and storage containers



Types of Polyethylene Pipes and Fittings



PE 80 Yellow Pipe
Low and Medium Pressure network
Pipe Ø: 32mm to 315mm



PE 100 Peelable Pipe
Low and Medium Pressure network
Pipe Ø: 125mm to 500mm



PE 100 Orange Pipe
Medium Pressure network
Pipe Ø: 32mm to 500mm

Types of Polyethylene Pipes and Fittings



PE32 Elbow



PE63X32 Saddle Tee



PE63 End Cap

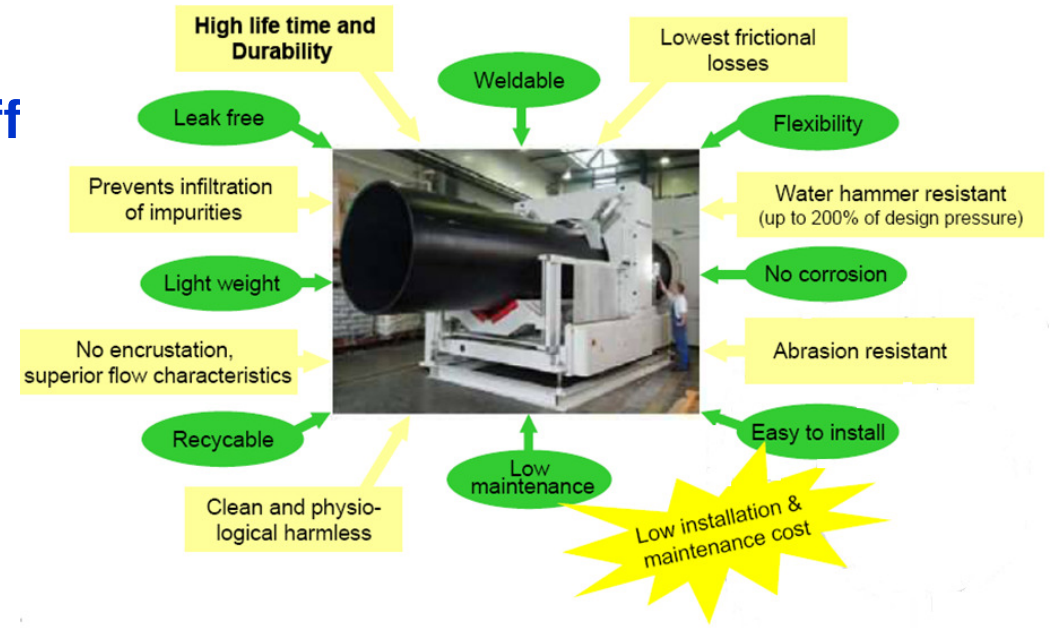


Elbow, T-joint, Coupler & Reducer



Advantages of Using Polyethylene Pipe

- Light weight
- Reliable joints
- Low frictional losses
- Corrosion free
- Flexible to fit into different terrain
- Easy for installation
- Easy to carry out branch off
- Low installation & maintenance cost



Design and Calculation for Maximum Operating Pressure (MOP)

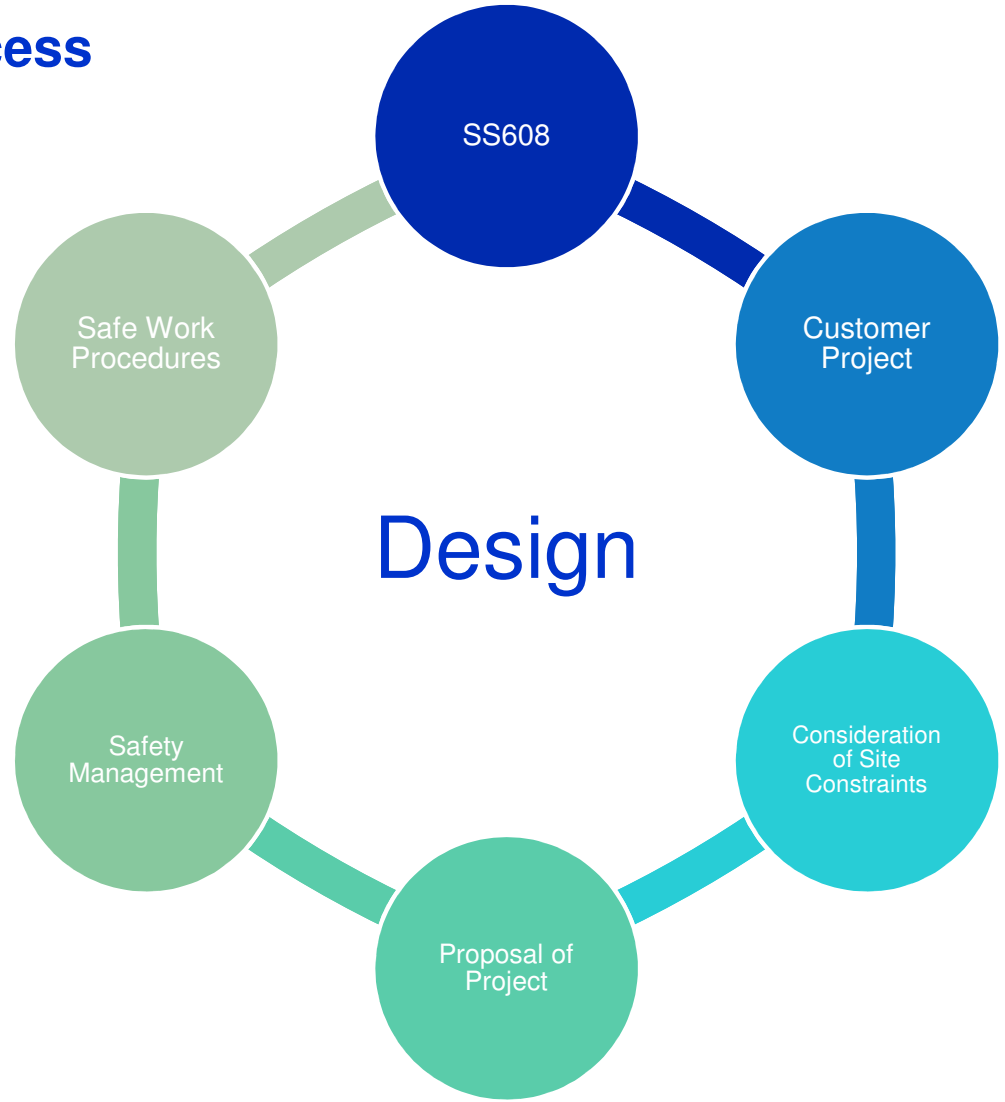
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- **Codes and Standards**
  - SS 608: Code of Practice for gas installation
  - BS EN 1555: Plastics Piping Systems for the supply of gaseous fuels
  - Safety Factor: 2.9 adopted by PowerGas
  - Design Life: Minimum 50 years
  - PE100+ Association: Quality Control for PE Materials

Design and Calculation for Maximum Operating Pressure (MOP)

- **Planning and Design Process**

Proper planning process have to be done first before going into the Designing stage. Following are some of the Planning Process which can be taken into consideration before the designing stage.



Design and Calculation for Maximum Operating Pressure (MOP)

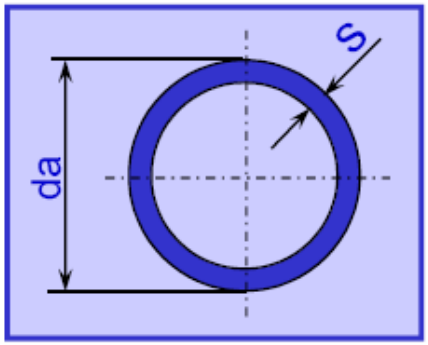
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- Load Required
- Gas Pressure and Quality
- Gas Velocity
- Pipe Route
- Material Type
- Safety Assessment
- Cost of Construction
- Future Maintenance
- Maintenance Techniques
- Gas Network Expansion

Design and Calculation for Maximum Operating Pressure (MOP)

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Standard Dimensional Ratio (SDR)



$$SDR = \frac{da}{s}$$

SDR ... standard dimension ratio
da ... outside diameter [mm]
s ... wall thickness [mm]

Example:

da = 110 mm

s = 10 mm

SDR = ?

$$\mathbf{SDR} = \frac{da}{s} = \frac{110}{10} = \mathbf{11}$$

Design and Calculation for Maximum Operating Pressure (MOP)

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PE Pipe Standard	**BS EN 1555**	
Pressure Rating	**PE80**	**PE100**
MRS (Minimum Required Strength for operating time of 50 years at 20ºC)	8 MPa	10 MPa
PE Gas Pipes	Yellow	Orange
Gas Pipe Fittings	Yellow or Black	Black
Standard Dimension Ratio SDR = Outer Diameter / Thickness	SDR 11, 17.6 & 21	
	Low SDR No.	**High SDR No.**
	Thicker Pipe	Thinner Pipe
	➢ **Example, PE pipe Ø180mm:** ❖ **SDR 11, pipe thickness is 16.4mm** ❖ **SDR 21, pipe thickness is 8.6mm**	

Design and Calculation for Maximum Operating Pressure (MOP)

PE Pipe	Colour	Minimum Required Strength (MRS)	MOP (barg) SDR= 21	MOP (barg) SDR= 17.6	MOP (barg) SDR= 11
PE80	Yellow	8 MPa	2.8	3.3	5.5
PE100	Orange	10 MPa	3.4	4.2	6.9

MOP = (20 x MRS) / (C x {SDR-1})

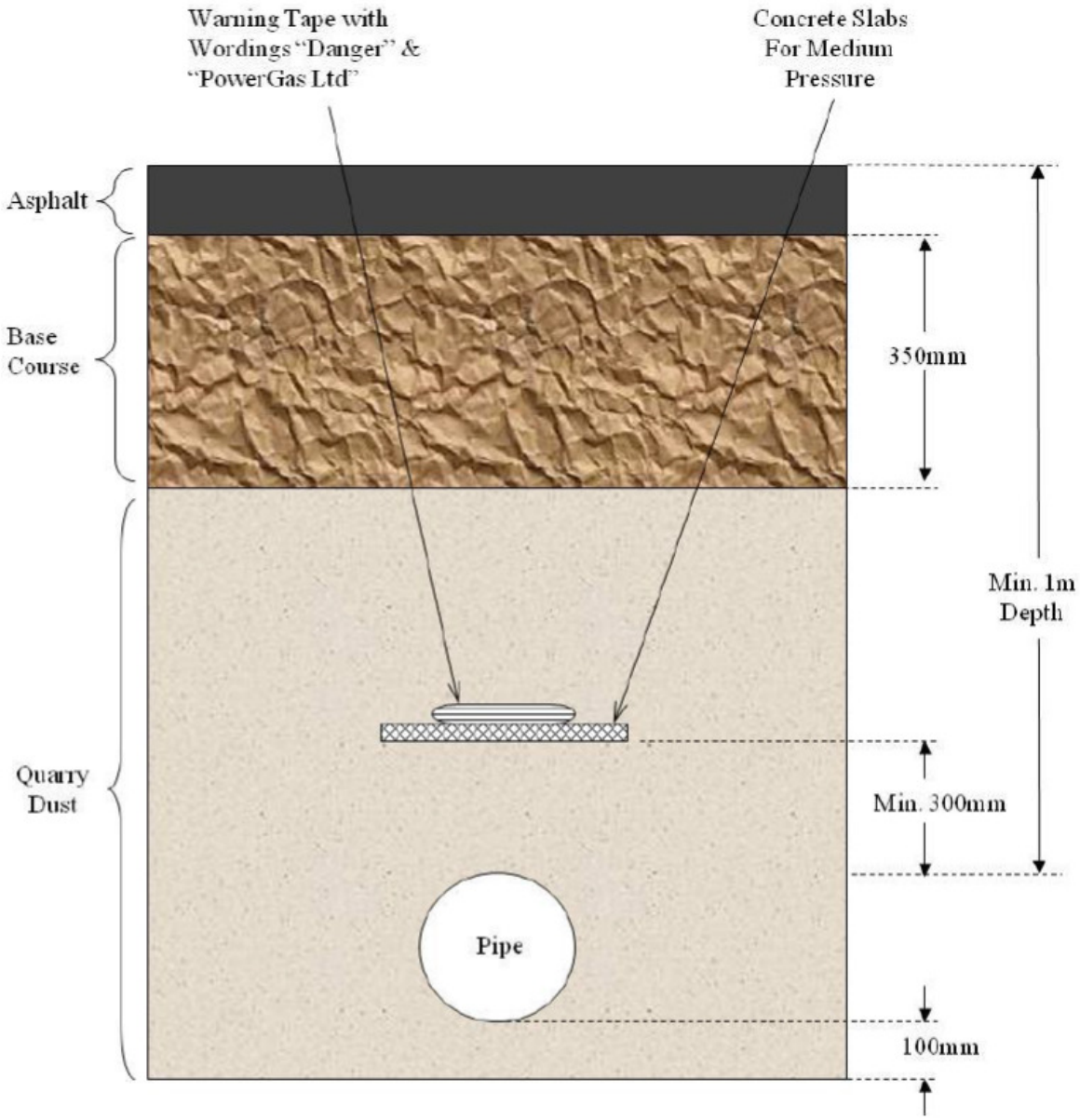
Where,

- ***MOP : Maximum Operating Pressure***
- ***MRS : Minimum Required Strength (MPa)***
- ***C : Safety Factor min 2.0 (Gas) under EN1555***
  2.9 adopted by PowerGas
- ***SDR : Standard Dimension Ratio = D/T***

Design and Calculation for Maximum Operating Pressure (MOP)

Pipe Size For Selection	Requirement
PE80 – For Ø32mm & Ø63mm	Selection with SDR 11 - To maintain min. thickness - Prevent 3rd party damage
PE100 – For Ø125mm & above	Selection with SDR 21 - To maintain min. thickness - Prevent 3rd party damage - With protective outer layer

Laying of Polyethylene Pipes



In accordance to LTA code of practice

Laying Polyethylene Pipes

1. Open-cut Method



Pre-cast Concrete Slabs
(For MP laying)



Warning Tape

Laying Polyethylene Pipes

Points to note:

- Sharp objects such as stones shall be removed away from the pipe
- PE pipe to be surrounded by quarry dust
- Flexibility of PE allow some variations in alignment to suit local terrain
- Minimum advisable bend radius:
  - SDR 11 – DN x 15
  - SDR 17.6 – DN x 25

Laying Polyethylene Pipes

Installation of gate valve





Laying Polyethylene Pipes

2. Trenchless Method

- ❖ **Slip-lining**

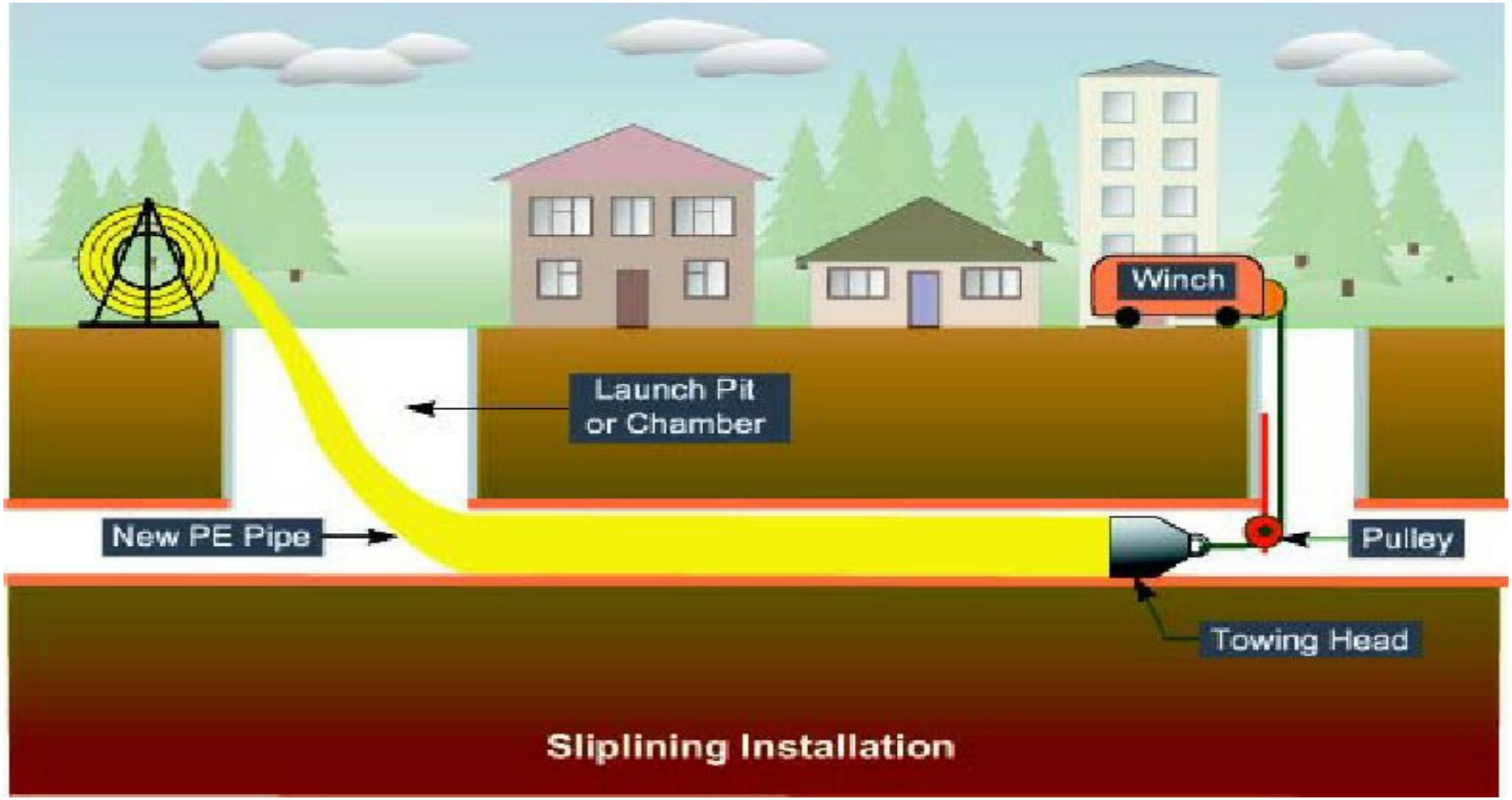




Laying Polyethylene Pipes

2. Trenchless Method

❖ Slip-lining



Jointing of Polyethylene Pipes & Fittings

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Two types of jointing processes

1) **Electrofusion**

2) **Butt Fusion**

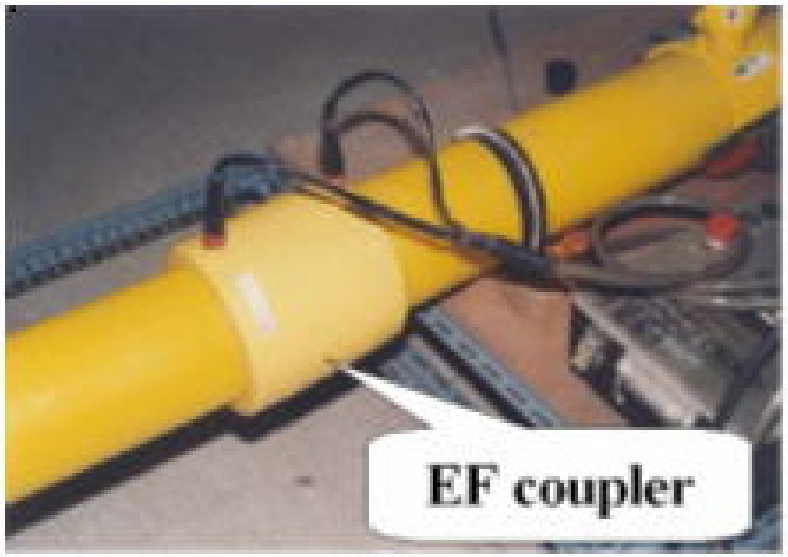
Fusion Jointing

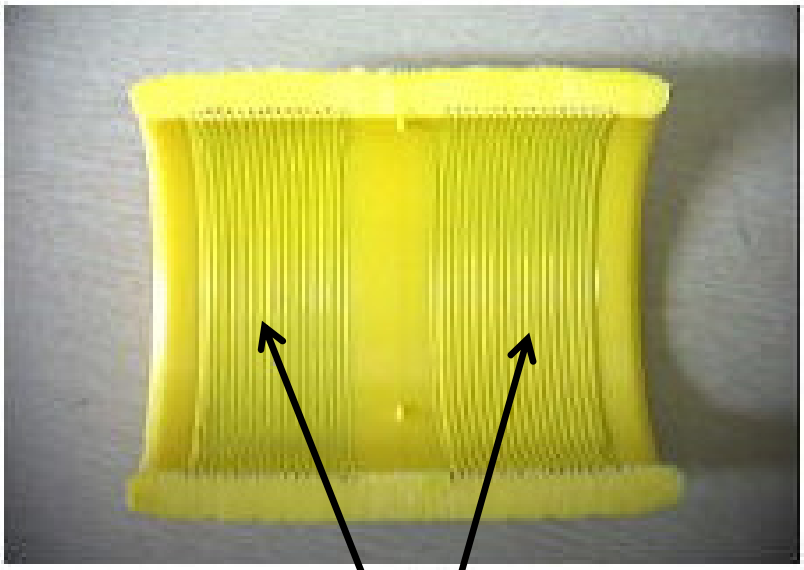
- Comprises applying heat & pressure for a specified time to the mating surfaces to be joined.

- Application of heat & pressure under the correct conditions allows the molecular chains to flow & mix with each other creating a joint as strong as the pipe itself

Jointing of Polyethylene Pipes & Fittings

Electrofusion





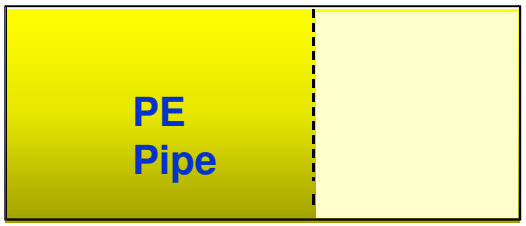
Heating Elements



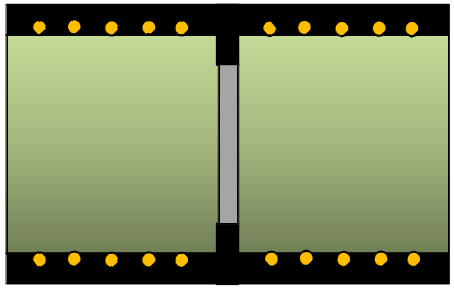
Fusion Equipment

Jointing of Polyethylene Pipes & Fittings

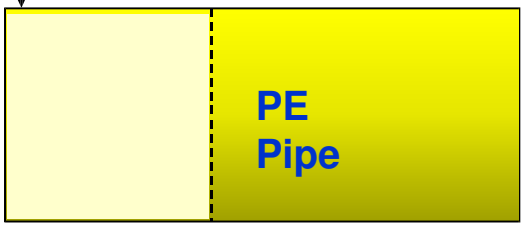
1) PE pipe end surfaces are scrapped clean



Coupler with heating element

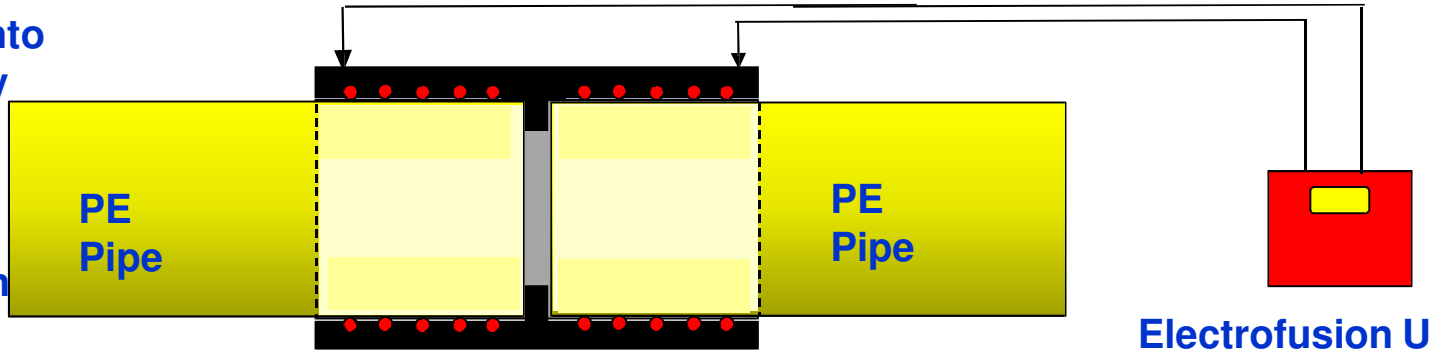


PE pipe end surface scrapped clean and thoroughly



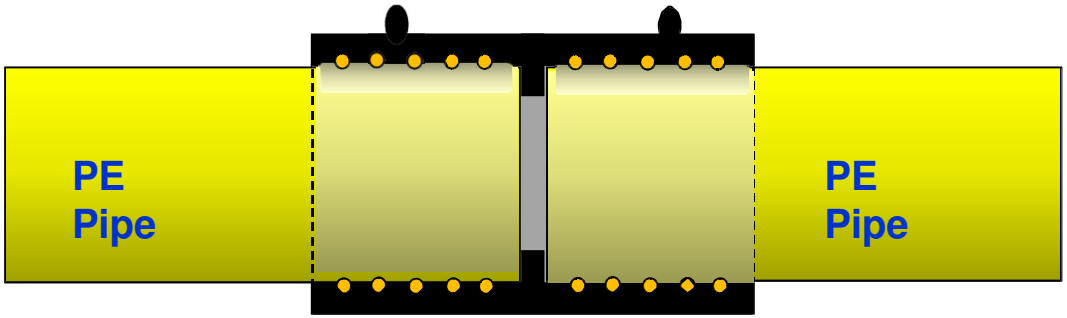
2) Insert pipe ends into coupler completely

3) Coupler heated up by electrofusion unit



Electrofusion Unit

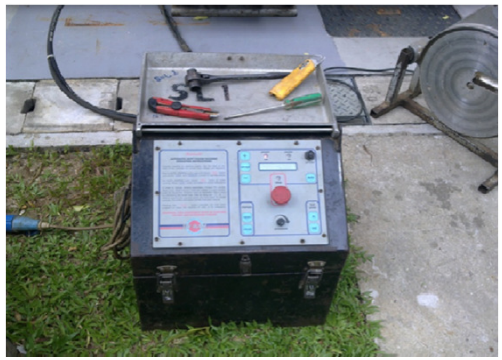
4) On completion and cooled down, PE pipes are fused to coupler



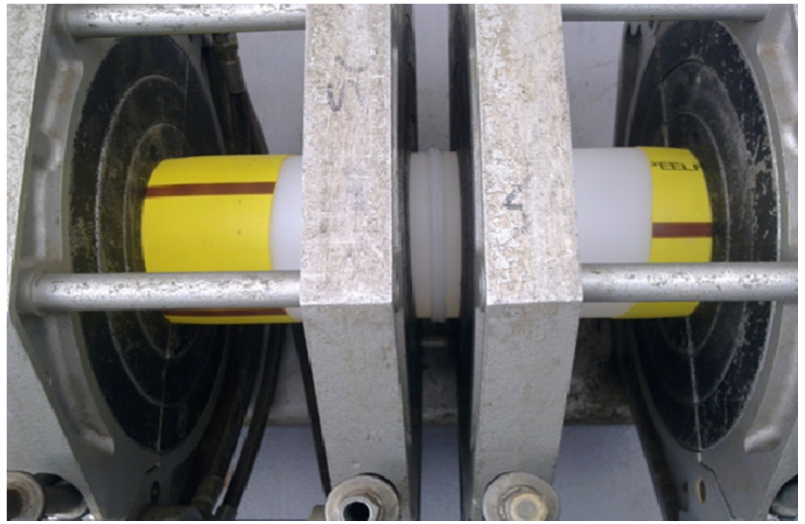
Jointing of Polyethylene Pipes & Fittings

Butt fusion





Butt fusion unit

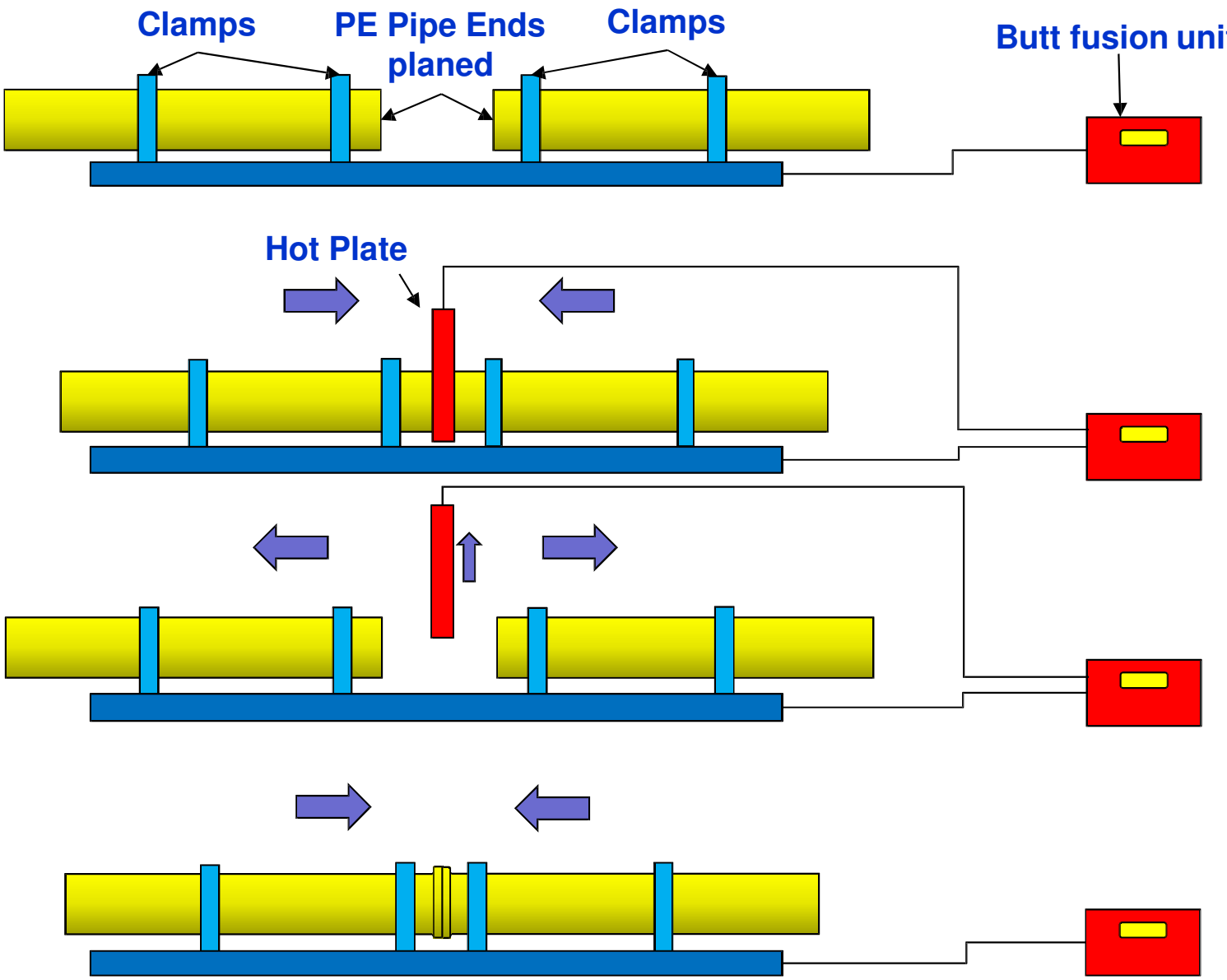


Butt Fusion Process



Butt Joint Completed

Jointing of Polyethylene Pipes & Fittings



1) PE Pipes of same diameter and material held by welding clamp. Two pipe ends are planed to square and good match in alignment.

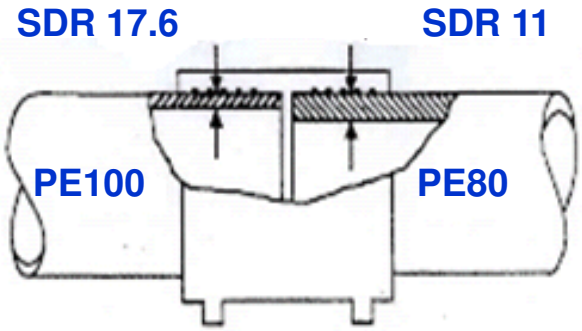
2) PE Pipe jointing ends heated by hot plate for specific duration.

3) Heated PE Pipe ends open apart for the removal of hot plate.

4) Heated PE Pipe ends are forced and fused together by clamps and held for specific duration for cooling

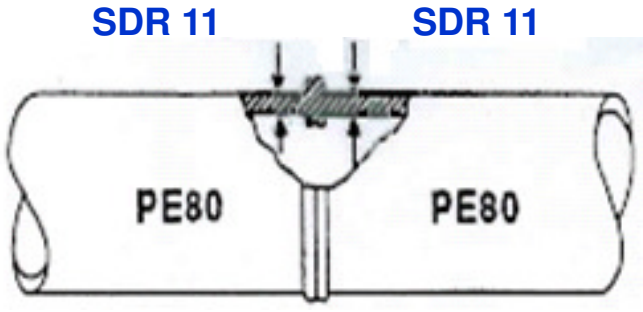
Jointing of Polyethylene Pipes & Fittings

Fusion Jointing



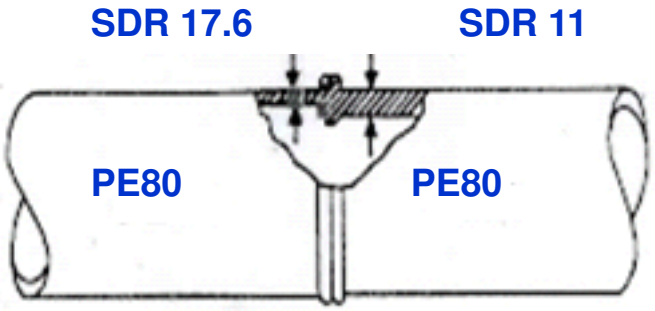
CORRECT

Dissimilar materials & dissimilar wall thickness can be jointed by electro fusion fittings



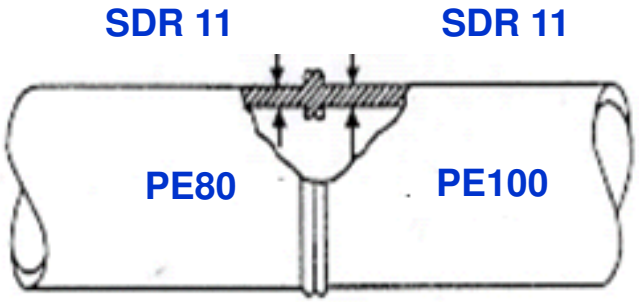
CORRECT

Only similar materials & wall thickness can be jointed by butt fusion



WRONG

Dissimilar wall thickness must not be jointed by butt fusion



WRONG

Dissimilar materials must not be jointed by butt fusion

Jointing of Polyethylene Pipes & Fittings

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Guidelines to produce good quality Joints (Electrofusion Jointing)

Always

- Use approved equipment only
- Scrape pipe surfaces thoroughly and clean with alcohol based swab
- Use alignment clamps or stack loading clamps for tapping tees
- Allow the weld to cool properly

Never

- Touch prepared pipe surfaces, fitting bore & saddle
- Allow assemblies to get damp
- Leave fittings lying around out of their protective packaging
- Leave assemblies for any length of time before welding
- Touch fusion indicators during welding
- Use contaminated fittings

Jointing of Polyethylene Pipes & Fittings

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Guidelines to produce good quality Joints (Butt fusion Jointing)

Always

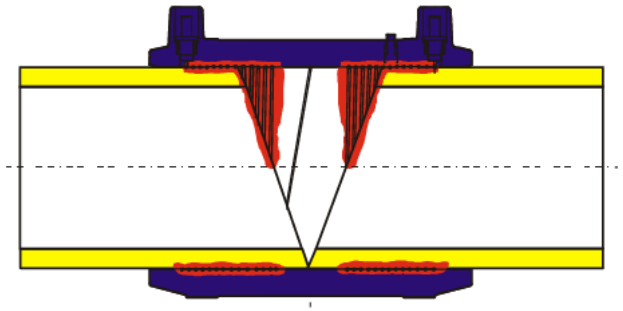
- Check pipe & welding clamps are clean
- Check for thoroughness of pipe trimming
- Check for alignment of pipe ends
- Measure the drag pressure for each weld
- Check that pipe wall thickness match before butt welding
- Stand clear of automatic machines during operation

Never

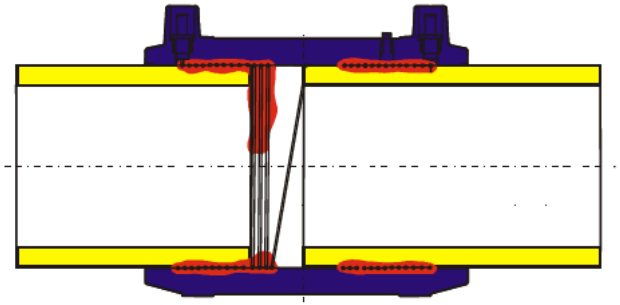
- Attempt to weld together PE pipes of different SDR (wall thickness)
- Allow equipment to get wet or dusty
- Use non-approved machinery
- Remove a weld from the machine before cooling time has elapsed
- Allow untrained personnel to use welding equipment
- Cut corners in any part of the welding procedure
- Weld pipes of different material

Jointing of Polyethylene Pipes & Fittings

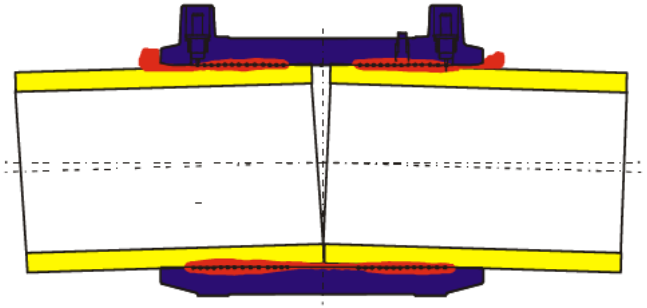
Common Installation faults (Electrofusion Jointing)



1. Diagonal cutting to length



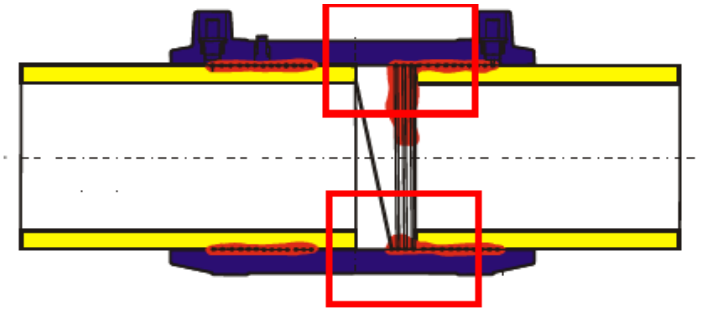
2. Non observance of prescribed insertion depth



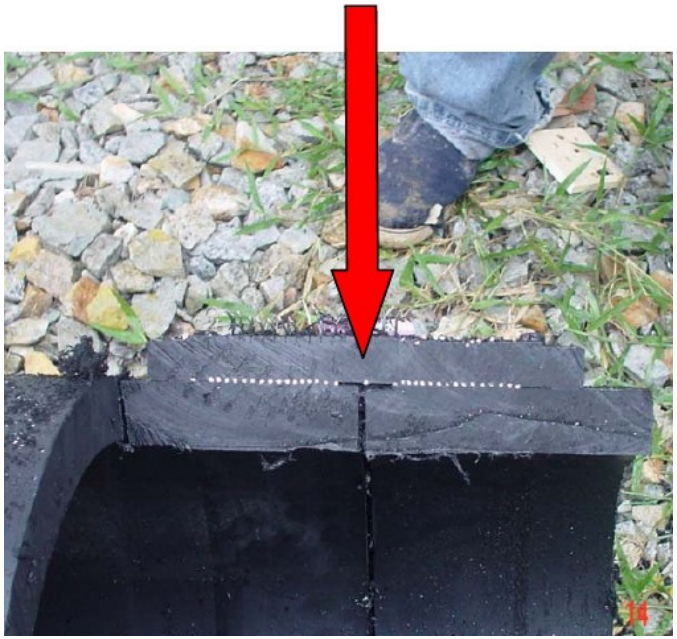
3. Distorted installation

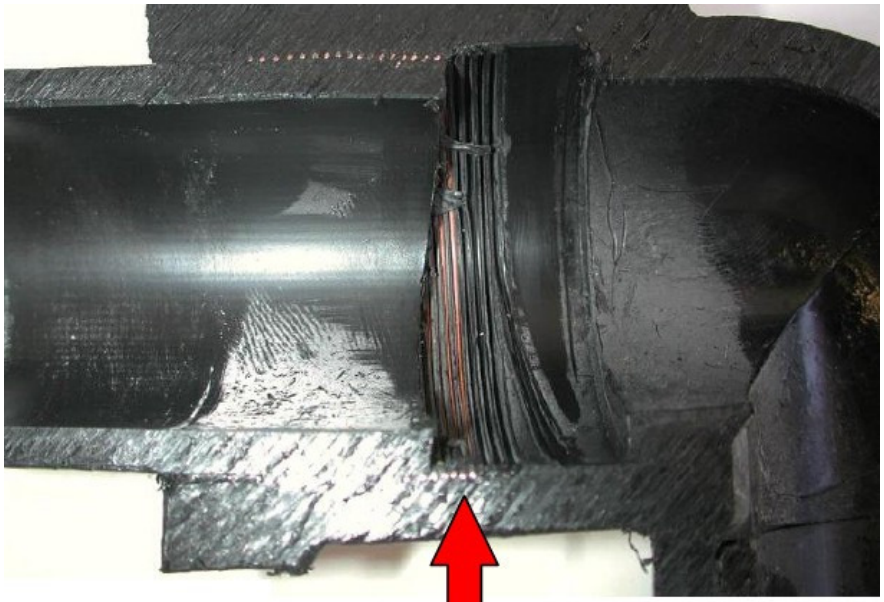
Jointing of Polyethylene Pipes & Fittings

Joint Installation Fault (Electrofusion Jointing)



Correct –
all coils covered by pipe



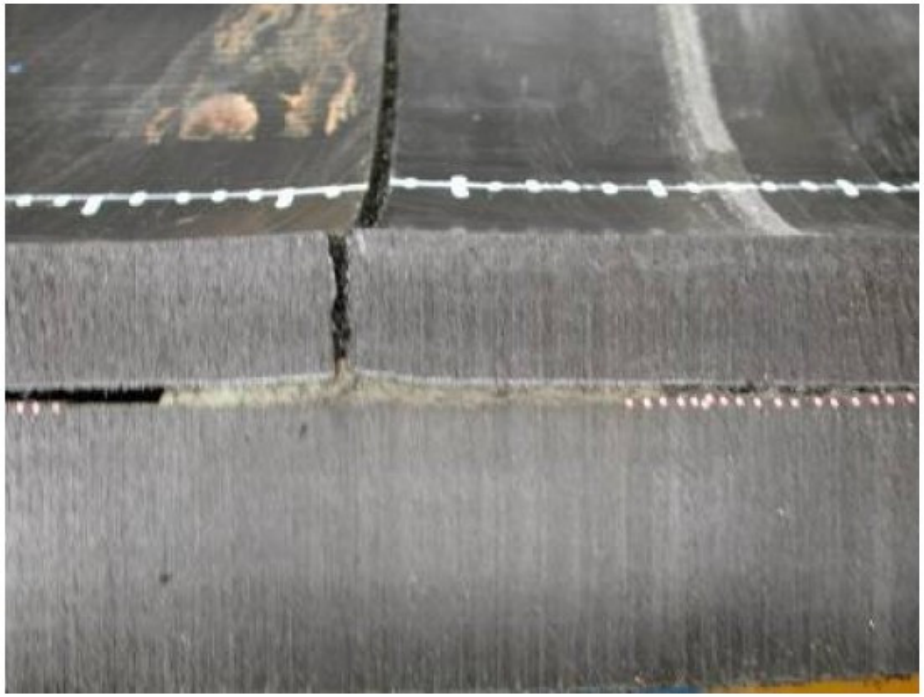


Insufficient insertion of pipe
=> bare coils

Jointing of Polyethylene Pipes & Fittings

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Joint Installation Fault (Electrofusion Jointing)

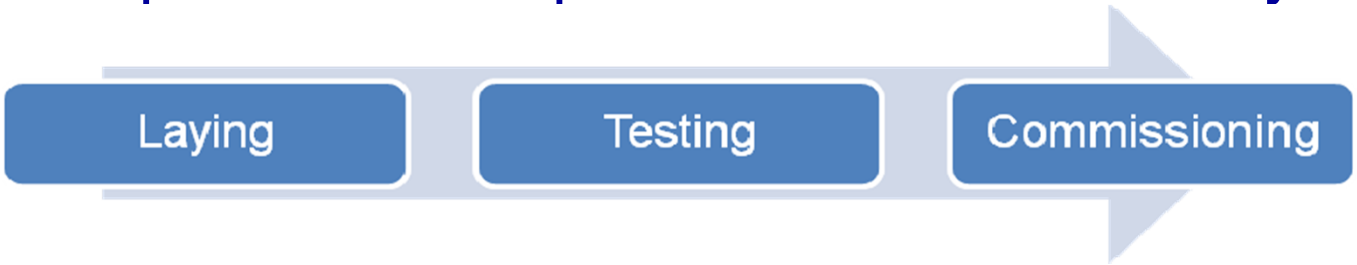




Dirt in fusion zone => non homogeneous connection

Pressure Testing & Commissioning

- All Pipelines to be pressure tested after laying



- Pneumatic Test (Test Pressure up to 1.4 barg)



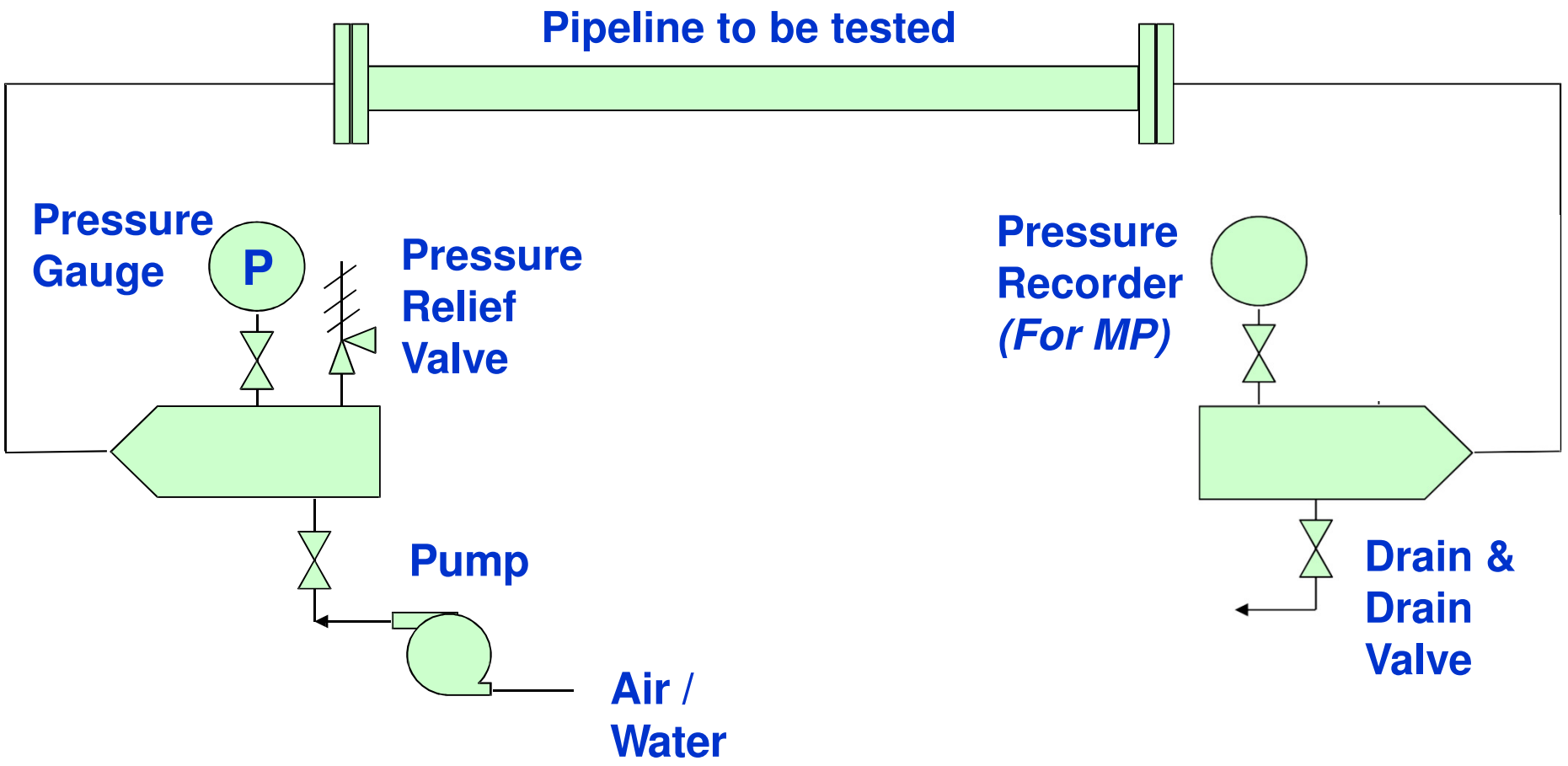
- Hydrostatic Test (Test Pressure greater than 1.4 barg)



Pressure Testing & Commissioning

Gas Distribution Network	Pressure Regime	Pressure	Test Pressure	Test Medium
Town Gas Low Pressure Network	LPB	50 kPa / 0.5 barg	Strength Test 140kPa 2hrs Tightness Test 140kPa 22hrs	Air
	LPA	20 kPa / 0.2 barg		
	LP	4” wg – 8” wg (1 – 2 kPa)		
Natural Gas Medium Pressure Network	MP	3 ~ 7 barg	Strength Test 10.5 barg 2hrs Tightness Test 9.1 barg 24 hrs	Water

Pressure Testing & Commissioning



Note: New pipeline under test shall not exceed 500m in length for easy troubleshooting

Pressure Testing & Commissioning

Pressure Measurement

Purpose

- Pressure monitoring and recording
- Safety indication against over pressure

Equipment

- Bourdon tube pressure gauge
- Digital pressure gauge
- Pressure Chart Recorder

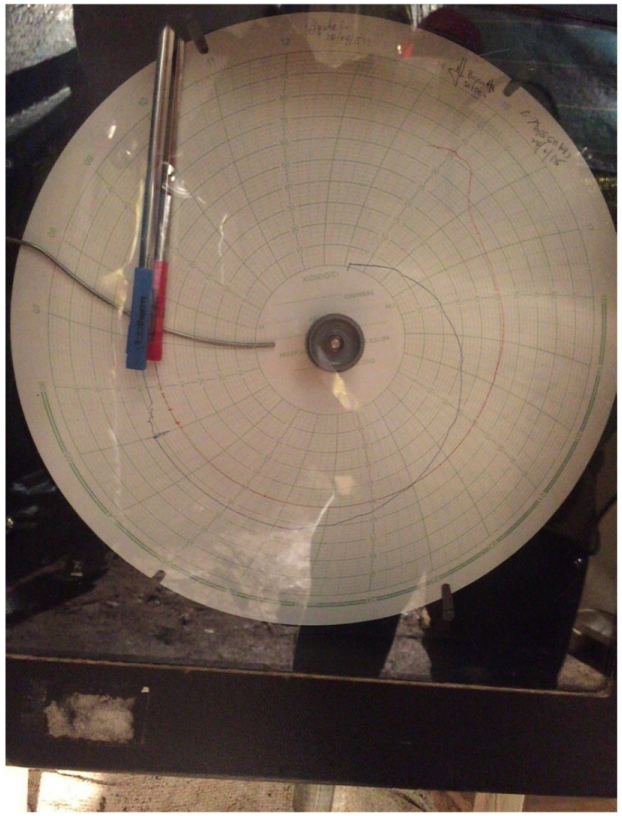
Pressure Testing & Commissioning



Bourdon Tube Pressure gauge



Digital Pressure Gauge

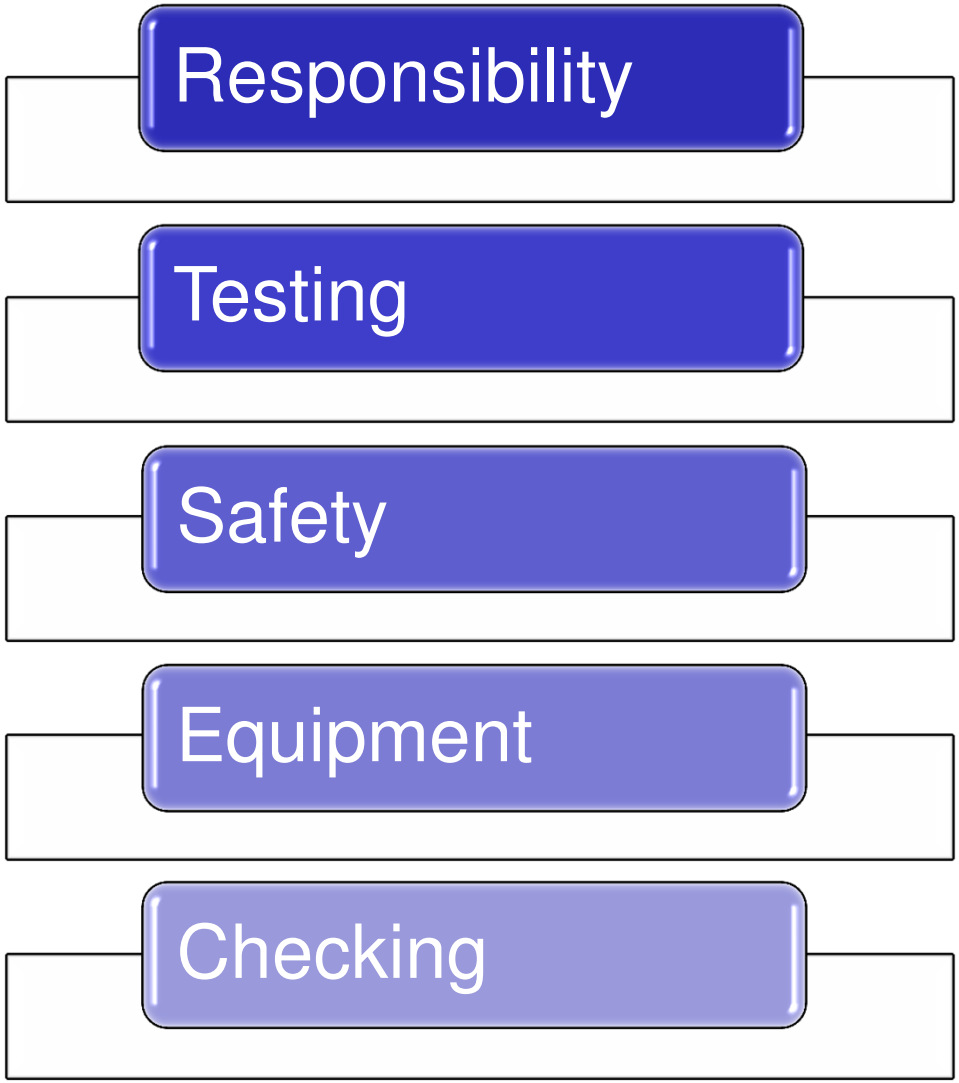


Pressure Chart Recorder

Pressure Testing and Commissioning

Commissioning

During the process of Commissioning, and Charging-in of gas, several pointers must be complied in order to complete the works safely



Pressure Testing and Commissioning

Commissioning

- All new gas pipeline shall be injected with a barrier of N_2 between the gas and air in the pipeline before charging in of live gas
- A "Safe Work Procedure" should be prepared before the commencement of purging operation
- Risk assessment and all relevant permit forms shall be available
- Briefing shall be conducted to all relevant personnel before the operation
- To follow strictly to the "Safe Work Procedures"

Pressure Testing & Commissioning

Purging

- Injection and purging points to be set up at the connection point and end point of newly laid pipeline
- Multiple purging points shall be erected when there are more than one pipeline to be commissioned
- A purging point shall be a vent or portable stand pipe, 3m above ground level with control valve and flame arrestor

Pressure Testing and Commissioning

Commissioning

- A slug of inert gas such as N2 shall be used to separate gas & air if the volume of pipe to be purged exceeds 2.5m^3
- On successful completion of the purging process, the standpipe shall be disconnected from the pipe and the pipe properly plugged off
- The disturbed joints shall be tested for leakage



Flame Arrester



Portable Purging Kit

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