# Buried and Underground Pipelines: Design, Construction, Testing and Maintenance

Materials, Corrosion, Failure Investigation, Rehabilitation and Asset Management

| FORMAT | DATES | CPD POINTS | |
|---|---|---|---|
| Online | 10 – 11 November 2026 | 2 CPD Points | R 8 999 per delegate |

## Overview

Buried and underground pipelines are among the most critical and least visible components of modern infrastructure. Water transmission mains, distribution pipelines, wastewater networks, rising mains, industrial pipelines and other underground services are expected to operate reliably for decades while exposed to soil loading, groundwater, traffic loading, changing operating conditions, corrosion, material deterioration, construction defects and environmental influences.

The performance of a buried pipeline cannot be considered separately from its surrounding soil and installation conditions. Pipe behaviour, bedding, embedment, backfill, compaction and external loading all influence long-term performance. Understanding the relationship between the pipe and the surrounding ground is therefore fundamental to the design, construction and maintenance of buried pipeline systems.

This theory-based course follows the complete lifecycle of a buried pipeline through three central questions:

**How Do We Design the Pipeline? → How Do We Build, Test and Understand Failure? → How Do We Keep the Pipeline Working?**

The programme has particular relevance to South African water and wastewater infrastructure, while also considering applications in mining, municipal, civil infrastructure and industrial pipeline systems. It takes a lifecycle approach, linking initial planning and material selection with construction quality, hydraulic performance, corrosion, failure investigation, condition assessment, rehabilitation and long-term asset management.

The programme is deliberately theory-based. It does not require delegates to undertake physical pipe installation, excavation, welding, field testing or other practical site activities. Instead, learning is supported through technical explanations, engineering principles, diagrams, worked examples, failure case studies, material comparisons, rehabilitation scenarios and discussion of relevant standards and good practice.

## Who Should Attend

**ENGINEERS**

- Civil Engineers
- Water Engineers
- Municipal Engineers
- Infrastructure Engineers
- Pipeline Engineers
- Mechanical Engineers involved in pipeline systems
- Mining Engineers involved in water and slurry infrastructure
- Environmental Engineers
- Asset Management Professionals

**TECHNICAL AND INFRASTRUCTURE PROFESSIONALS**

Engineering Technologists and Technicians | Pipeline and Infrastructure Managers | Maintenance Managers | Project Managers | Construction Managers | Technical Officers | Municipal Infrastructure Officials | Water-Services Professionals | Asset Managers | Consultants | Contractors | Technical Representatives

## Why This Course Matters

A pipeline can be correctly specified and still experience premature deterioration or failure if the relationship between the pipe, soil, installation conditions, operating environment and long-term maintenance requirements is not properly understood.

**Common pipeline problems include:**

- ✓ Leakage and bursts
- ✓ Joint failures and separation
- ✓ Excessive pipe deflection
- ✓ Structural deterioration
- ✓ Internal and external corrosion
- ✓ Coating and lining deterioration
- ✓ Poor bedding or backfill
- ✓ Differential settlement and ground movement
- ✓ Pressure transients and water hammer
- ✓ Construction and installation defects
- ✓ Material incompatibility
- ✓ Excessive external loading
- ✓ Age-related deterioration
- ✓ Inadequate inspection and maintenance
- ✓ Poorly prioritised rehabilitation and replacement decisions

Corrosion is particularly important in ageing metallic pipeline infrastructure. South African water-sector research has identified internal and external corrosion mechanisms as contributors to leakage and failure in metallic potable-water pipelines, including microbiologically influenced corrosion, coating deterioration, stray currents and inadequate cathodic protection.

The course therefore moves beyond the question of:

**"How do we install a pipeline?"**

and examines the broader lifecycle question:

**"How do we select, design, construct, test, maintain, assess, protect, repair and rehabilitate buried pipelines so that they can deliver reliable service throughout their intended life?"**

## Course Objectives

By the end of the course, delegates should be able to:

- ✓ Explain the fundamental principles governing buried and underground pipeline systems.
- ✓ Distinguish between principal buried-pipeline applications, including water, wastewater, rising mains, bulk transfer and selected industrial systems.
- ✓ Understand the factors influencing pipeline route selection and underground installation.
- ✓ Compare major pipeline materials and their advantages, limitations and typical applications.
- ✓ Explain the relationship between pipe behaviour, soil conditions, bedding, embedment and backfill.
- ✓ Understand flexible and rigid buried-pipe behaviour.
- ✓ Explain the hydraulic principles governing buried pressure and gravity pipelines.
- ✓ Understand pressure transients, surge and water hammer and their implications for pipeline integrity.
- ✓ Explain trench design, bedding, embedment, backfilling and compaction principles.
- ✓ Understand pipeline jointing, connections, fittings, valves and associated infrastructure.

- ✓ Explain the purpose and principles of pipeline inspection, testing, commissioning and acceptance.
- ✓ Identify construction and installation defects that may contribute to premature pipeline failure.
- ✓ Explain the mechanisms and causes of internal and external corrosion.
- ✓ Understand the principles of corrosion protection, coatings, linings and cathodic protection.
- ✓ Apply a structured approach to pipeline failure investigation and root-cause analysis.
- ✓ Understand pipeline condition assessment and deterioration mechanisms.
- ✓ Compare repair, rehabilitation and replacement strategies.
- ✓ Understand the principles and applications of major trenchless pipeline technologies.
- ✓ Explain risk-based maintenance and lifecycle asset-management principles.
- ✓ Understand how condition, criticality, consequence of failure and service requirements influence maintenance and rehabilitation decisions.

## Part 1: How Do We Design the Pipeline? — Modules 1 to 5

### 1 Understanding Buried and Underground Pipeline Systems

#### 1.1 INTRODUCTION TO BURIED PIPELINES

- What constitutes a buried pipeline system
- Buried versus above-ground pipelines
- Pressure and non-pressure pipelines
- Water pipelines
- Wastewater pipelines
- Rising mains
- Bulk-transfer pipelines
- Industrial and mining pipeline applications
- Pipeline corridors and servitudes
- Components beyond the pipe barrel

#### 1.2 THE BURIED PIPELINE LIFECYCLE

- Planning
- Route selection
- Site investigation
- Design
- Material selection
- Procurement
- Construction
- Installation
- Testing
- Commissioning
- Operation
- Inspection
- Maintenance
- Condition assessment
- Rehabilitation
- Replacement

#### 1.3 PIPELINE FAILURE AS A LIFECYCLE PROBLEM

- Design-related failure
- Material-related failure
- Manufacturing defects
- Construction and installation defects
- Operational failure
- Environmental influences
- Maintenance-related deterioration
- Interaction between multiple failure mechanisms

### 2 Pipeline Route Selection and Site Conditions

#### 2.1 ROUTE SELECTION CONSIDERATIONS

- Topography
- Existing infrastructure
- Roads and railways
- River and watercourse crossings
- Servitudes
- Environmental constraints
- Access requirements
- Future maintenance access
- Existing utility corridors

#### 2.2 GROUND AND SITE CONDITIONS

- Soil types
- Groundwater
- Rock
- Expansive soils
- Collapsible soils
- Aggressive soils
- Contaminated ground
- Settlement
- Slope instability
- Ground movement

#### 2.3 GEOTECHNICAL INFORMATION REQUIRED

- Site investigation
- Soil classification
- Groundwater conditions
- Excavation conditions
- Backfill suitability
- Embedment requirements
- Ground conditions affecting pipeline performance

### 3 Pipe Materials and Material Selection

There is no universally "best" pipeline material. Material selection depends on pressure, diameter, fluid characteristics, soil environment, installation method, structural requirements, expected service life and lifecycle cost.

#### 3.1 METALLIC PIPES

- Steel
- Ductile iron
- Cast iron in existing and historical systems
- Metallic pipe failure mechanisms
- Corrosion susceptibility
- Protective systems

#### 3.2 PLASTIC PIPES

- PE/HDPE
- PVC-U
- PVC-M
- PVC-O
- Flexible-pipe behaviour
- Jointing considerations
- Chemical resistance
- Long-term performance considerations

#### 3.3 GRP AND COMPOSITE SYSTEMS

- Construction and composition
- Structural characteristics
- Corrosion resistance
- Jointing systems
- Application considerations

## 3 Pipe Materials and Material Selection (continued)

### 3.4 CONCRETE AND REINFORCED CONCRETE PIPELINES

- Rigid-pipe behaviour
- Structural characteristics
- Chemical attack
- Wastewater environments
- Durability considerations

### 3.5 MATERIAL-SELECTION FRAMEWORK

- Pressure requirements
- Diameter
- Fluid characteristics
- Soil conditions
- Groundwater
- External loading
- Installation method
- Expected service life
- Maintenance requirements
- Lifecycle cost

## 4 Hydraulic Principles and Pipeline Performance

This module focuses on how buried pipelines behave hydraulically rather than presenting a software-based hydraulic-design course.

### 4.1 FLOW AND VELOCITY

- Flow regimes
- Pressure pipelines
- Gravity pipelines
- Hydraulic gradient
- Head loss
- Pipeline capacity
- Velocity considerations

### 4.2 PIPELINE PERFORMANCE UNDER DEMAND

- Design flow
- Peak flow
- Minimum flow
- Future demand
- Velocity requirements
- Hydraulic Grade Line
- Energy Grade Line
- System performance considerations

### 4.3 PRESSURE AND PUMPING SYSTEMS

- Working pressure
- Pressure class
- Operating pressure
- Surge pressure
- Vacuum conditions
- Pumping-system interactions

### 4.4 PRESSURE TRANSIENTS, WATER HAMMER AND SURGE PROTECTION

- Causes of pressure transients
- Valve closure
- Pump start-up and shutdown
- Pump trip
- Rapid flow changes
- Pressure-wave propagation
- Consequences for pipeline integrity
- Surge-control principles

## 5 Pipe-Soil Interaction and Structural Behaviour

Buried-pipeline performance depends on both the pipe and the surrounding soil and installation conditions.

### 5.1 PIPE-SOIL INTERACTION

- External loading
- Soil support
- Bedding
- Embedment
- Backfill
- Compaction
- Soil stiffness
- Load transfer

### 5.2 FLEXIBLE PIPE BEHAVIOUR

- Pipe deflection
- Ring stiffness
- Long-term deformation
- Soil support
- Backfill quality
- Installation effects

### 5.3 RIGID PIPE BEHAVIOUR

- Load transfer
- Structural capacity
- Bedding support
- Crack development
- External loading

### 5.4 EXTERNAL LOADING

- Traffic loading
- Construction loading
- Cover depth
- Surface loading
- Ground movement
- Settlement
- Differential settlement

# Part 2: How Do We Build, Test and Understand Failure? Modules 6 to 10

## 6 Trench Design, Bedding and Backfill

### 6.1 TRENCH CONFIGURATION

- Trench width
- Trench depth
- Working space
- Excavation stability
- Groundwater management
- Construction constraints

### 6.2 BEDDING

- Purpose of bedding
- Bedding materials
- Bedding classes
- Pipe support
- Consequences of inadequate bedding

## 6 Trench Design, Bedding and Backfill (continued)

### 6.3 EMBEDMENT AND BACKFILL

- Haunching
- Side support
- Initial backfill
- Backfill layering
- Compaction
- Backfill quality

### 6.4 INSTALLATION-RELATED RISKS

- Point loading
- Poor alignment
- Inadequate compaction
- Unsuitable backfill
- Differential settlement
- Inadequate pipe support

South African buried-pipeline construction practice recognises the importance of correctly specified earthworks, trenching, bedding and backfill. Relevant SANS 1200 specifications include **SANS 1200 D — Earthworks**, **SANS 1200 DB — Earthworks (Pipe Trenches)** and **SANS 1200 LB — Bedding (Pipes)**, used together with the applicable pipeline and project specifications.

## 7 Pipe Installation, Jointing and Components

### 7.1 INSTALLATION PRINCIPLES

- Alignment
- Levels
- Gradients
- Pipe handling
- Pipe placement
- Joint preparation
- Installation tolerances

### 7.2 JOINTING SYSTEMS

- Mechanical joints
- Push-fit joints
- Flanged joints
- Welded joints
- Butt fusion
- Electrofusion
- Restrained joints
- Flexible joints

### 7.3 SPECIAL COMPONENTS

- Valves
- Air valves
- Scour valves
- Hydrants
- Manholes
- Chambers
- Thrust blocks
- Anchor blocks

### 7.4 CONSTRUCTION INTERFACES

- Connections to existing infrastructure
- Road crossings
- Railway crossings
- Watercourse crossings
- Tie-ins
- Isolation requirements

## 8 Pipeline Quality Control, Testing and Commissioning

### 8.1 CONSTRUCTION QUALITY CONTROL

- Material verification
- Dimensional checks
- Joint inspection
- Installation records
- Construction records
- Quality documentation

### 8.2 PRESSURE TESTING

- Test sections
- Test pressures
- Test duration
- Leakage assessment
- Pressure behaviour
- Common causes of pressure-test failure

### 8.3 GRAVITY PIPELINE TESTING

- Infiltration
- Exfiltration
- Joint integrity
- Deflection assessment
- Pipeline acceptance

### 8.4 CLEANING, FLUSHING AND DISINFECTION

- Pipeline cleaning
- Flushing
- Disinfection principles
- Water-quality considerations
- Return-to-service requirements

### 8.5 COMMISSIONING AND HANDOVER

- As-built information
- Test documentation
- Certificates
- Asset-register information
- Handover records
- Operation and maintenance information

## 9 Corrosion and Pipeline Deterioration

### 9.1 UNDERSTANDING CORROSION

- Electrochemical principles
- Internal corrosion
- External corrosion
- Pitting corrosion
- Microbiologically influenced corrosion
- Galvanic effects
- Stray-current effects
- Corrosion-related leakage and failure

### 9.2 ENVIRONMENTAL INFLUENCES

- Soil resistivity
- Moisture
- Groundwater
- pH
- Chlorides
- Sulphates
- Dissolved oxygen
- Temperature
- Soil chemistry

### 9.3 CORROSION PROTECTION

- Protective coatings
- Linings
- Wrapping systems
- Electrical isolation
- Cathodic protection principles
- Monitoring and inspection

## 9 Corrosion and Pipeline Deterioration (continued)

### 9.4 COATINGS AND LININGS

- External coatings
- Internal linings
- Surface preparation
- Coating defects
- Field joints
- Coating inspection
- Lining deterioration

South African water-sector research has identified internal and external corrosion mechanisms as contributors to leakage and failure in metallic potable-water pipelines, including microbiologically influenced corrosion, coating deterioration, stray currents and inadequate cathodic protection.

**ISO 15589-1:2026** addresses cathodic protection of on-land pipeline transportation systems. Although developed within the petroleum, petrochemical and natural gas sector, its scope also permits application to on-land pipeline and piping systems in other industries and media, including water and slurries.

## 10 Pipeline Failures, Forensics and Root-Cause Investigation

### 10.1 WHY PIPELINES FAIL

- Design deficiencies
- Material-selection errors
- Manufacturing defects
- Installation defects
- Poor bedding and backfill
- Excessive external loading
- Pressure transients
- Corrosion
- Joint failure
- Ground movement
- Ageing
- Third-party damage
- Operational conditions

### 10.2 PIPELINE FAILURE MODES

- Burst
- Leakage
- Cracking
- Buckling
- Collapse
- Excessive deflection
- Joint separation
- Corrosion perforation
- Hydraulic failure

### 10.3 FAILURE INVESTIGATION FRAMEWORK

- What failed?
- Where did it fail?
- When did it fail?
- What changed before the failure?
- What evidence is available?
- What failure mechanisms are possible?
- Which mechanism best explains the evidence?
- What is the root cause?
- What corrective action is required?
- How can recurrence be prevented?

### 10.4 FAILURE CASE STUDIES

- Burst pipelines
- Corroded steel pipelines
- Failed joints
- Poorly compacted trenches
- Excessive pipe deflection
- Pressure-transient damage
- Ground-movement failures
- Premature deterioration

# Part 3: How Do We Keep the Pipeline Working? Modules 11 to 15

## 11 Pipeline Inspection and Condition Assessment

### 11.1 WHY CONDITION ASSESSMENT MATTERS

- Understanding current condition
- Predicting future performance
- Reducing unexpected failures
- Identifying deterioration
- Prioritising interventions
- Supporting rehabilitation decisions

### 11.2 INSPECTION APPROACHES

- Visual inspection
- CCTV inspection
- Acoustic inspection
- Leak detection
- Pressure monitoring
- Flow monitoring
- Internal inspection
- External inspection
- Corrosion assessment

### 11.3 CONDITION ASSESSMENT

- Structural condition
- Hydraulic condition
- Operational condition
- Environmental condition
- Material condition
- Failure history
- Maintenance history

### 11.4 RISK-BASED ASSESSMENT

- Probability of failure
- Consequence of failure
- Pipeline criticality
- Service disruption
- Environmental consequences
- Public-health considerations
- Financial exposure

**ISO 24516-3** provides guidance for the technical management of wastewater collection-network assets, including investigation, condition assessment, performance information, maintenance and rehabilitation decision-making.

## 12 Repair, Rehabilitation and Replacement

### 12.1 THE INTERVENTION HIERARCHY

- Routine maintenance
- Preventive maintenance
- Corrective maintenance
- Repair
- Renovation
- Rehabilitation
- Replacement

### 12.2 WHEN SHOULD A PIPELINE BE REHABILITATED?

- Structural deterioration
- Leakage
- Corrosion
- Hydraulic deterioration
- Capacity limitations
- Repeated failures
- Critical-service risks
- Reduced remaining service life

### 12.3 REHABILITATION DECISION-MAKING

- Pipeline condition
- Remaining useful life
- Criticality
- Failure risk
- Service requirements
- Construction constraints
- Cost
- Lifecycle implications

### 12.4 REHABILITATION TECHNIQUES

- Internal lining
- Spray-applied lining
- Sliplining
- Close-fit lining
- Cured-in-place pipe
- Pipe bursting
- Replacement

> **ISO 11295:2026** provides an international framework for plastics piping systems used for pipeline rehabilitation, covering activities such as investigation and condition assessment, rehabilitation planning, project specification, application of rehabilitation techniques and documentation. Its scope is specifically focused on plastics-based renovation and trenchless replacement rather than rehabilitation techniques generally across all pipe materials.

## 13 Trenchless Pipeline Technology

Trenchless technology is presented as a group of intervention options within the broader rehabilitation and replacement decision-making process.

### 13.1 WHY TRENCHLESS METHODS ARE USED

- Reduced surface disruption
- Road crossings
- Railway crossings
- River crossings
- Urban areas
- Congested underground corridors
- Reduced excavation requirements

### 13.2 MAJOR TRENCHLESS TECHNIQUES

- Horizontal Directional Drilling
- Pipe Jacking
- Microtunnelling
- Pipe Bursting
- Sliplining
- Cured-in-Place Pipe
- Close-Fit Lining

### 13.3 TECHNOLOGY SELECTION

- Existing pipeline condition
- Diameter
- Pipeline length
- Ground conditions
- Access requirements
- Hydraulic requirements
- Structural requirements
- Cost
- Construction risk
- Environmental constraints

### 13.4 REHABILITATION VERSUS REPLACEMENT

- Structural rehabilitation
- Non-structural rehabilitation
- Full replacement
- Hydraulic implications
- Design life
- Construction risk
- Lifecycle considerations

> The 2026 revision of **ISO 11295** provides a current classification of plastics-based renovation and trenchless replacement technique families and links investigation, planning, specification, application and documentation.

## 14 Pipeline Maintenance and Asset Management

### 14.1 FROM MAINTENANCE TO ASSET MANAGEMENT

- Why maintenance alone is insufficient
- Asset registers
- Asset inventory
- Condition information
- Criticality
- Failure history
- Maintenance history
- Remaining useful life

### 14.2 MAINTENANCE STRATEGIES

- Reactive maintenance
- Preventive maintenance
- Condition-based maintenance
- Risk-based maintenance
- Planned rehabilitation
- Renewal programmes

### 14.3 LIFECYCLE MANAGEMENT

- Planning
- Capital expenditure
- Operation
- Maintenance
- Rehabilitation
- Replacement
- Whole-life cost
- Lifecycle performance

## 14 Pipeline Maintenance and Asset Management (continued)

### 14.4 RISK-BASED PRIORITISATION

- Likelihood of failure
- Consequence of failure
- Critical pipelines
- Service interruption
- Environmental risk
- Public-health risk
- Financial exposure

### 14.5 ASSET-MANAGEMENT INFORMATION

- Asset registers
- GIS information
- Inspection data
- Failure records
- Condition data
- Maintenance records
- Work orders
- Rehabilitation history
- Replacement history

The **ISO 24516 series** provides guidance for the management of water and wastewater assets. **ISO/TR 24589-1:2024** provides supporting good-practice information for water-supply systems, while **ISO/TR 24589-2:2025** addresses wastewater systems.

## 15 South African Standards, Specifications and Regulatory Framework

The course introduces the role and application of relevant standards rather than attempting to reproduce the standards themselves.

### KEY REFERENCES

- SANS 1200 D — Earthworks
- SANS 1200 DB — Earthworks (Pipe Trenches)
- SANS 1200 L — Medium Pressure Pipelines
- SANS 1200 LB — Bedding (Pipes)
- SANS 1200 LD — Sewers
- SANS 1200 LE — Stormwater Drainage
- Relevant SANS standards covering pipe materials, valves, fittings and associated components
- SANS 10252 — Water supply and drainage installations for buildings, where applicable to interfaces with building systems
- Applicable water-services legislation
- Applicable occupational health and safety requirements
- Municipal and project-specific specifications

The SANS 1200 series should be understood as a collection of specifications addressing different aspects of civil and pipeline construction rather than as one universal buried-pipeline standard. The course focuses on understanding the role, scope and application of the relevant specifications within a pipeline project.

# Learning Methodology

The course uses a structured theory-based learning approach incorporating:

- ✓ Technical presentations
- ✓ Engineering principles
- ✓ Diagrams and technical illustrations
- ✓ Worked examples
- ✓ Pipeline material comparisons
- ✓ Failure case studies
- ✓ Corrosion scenarios
- ✓ Rehabilitation decision scenarios
- ✓ Asset-management scenarios
- ✓ Standards and specification discussions
- ✓ Facilitated technical discussions
- ✓ Question-and-answer sessions

# Registration Form

Buried and Underground Pipelines | 10 – 11 November 2026 | Online

**R 8 999**
per delegate

## BOOKING CONTACT (APPROVING OFFICIAL)

FULL NAME (MR / MRS / MS)

POSITION

COMPANY NAME

VAT NUMBER

TELEPHONE

EMAIL

ADDRESS

SIGNATURE

DATE

## FINANCE AND PAYMENT

PERSON RESPONSIBLE FOR FINANCE

DIRECT TEL NO.

DATE OF PAYMENT

PURCHASE ORDER / REFERENCE NO.

| ACCOUNT HOLDER | BANK | BRANCH | ACCOUNT NO. |
|---|---|---|---|
| Independent Training Management (Pty) Ltd | FNB South Africa | Randburg (251650) | 62685879276 |

## DELEGATES ATTENDING THIS WORKSHOP

| # | FULL NAME | POSITION | EMAIL |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |

### Course Deliverables

- 2 CPD Points
- Comprehensive delegate course manual and presentation material
- Failure case studies, worked examples and rehabilitation decision scenarios
- Certificate of attendance or completion, subject to applicable course and CPD requirements

## TERMS AND CONDITIONS

1. **Fees** are current at time of print; Independent Training reserves the right to change them.
2. **Additional delegate rates** apply for bookings made at the same time, on the same course.
3. **Confirmation**: on receipt of this form and payment/PO, you will receive email confirmation with venue details, map and start times.
4. **Attendance**: no learner may attend without proof of payment or an order number.
5. **Substitution**: delegate substitutes may be made at any time at no penalty, provided we are notified in writing.
6. **Payment** is due 5 working days before the course by cheque or EFT, quoting the invoice reference and organisation name. Cancellations must be emailed to Independent Training; please notify us immediately of any reschedule or cancellation.

### CANCELLATION CHARGES

| | |
|---|---|
| 11 to 30 days before course | 10% |
| 6 to 10 days before course | 20% |
| 4 to 6 days before course | 30% |
| 1 to 3 days before course | 50% |