Chapter 3
Pipeline Operations
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Chapter 3 - Objectives

1. Identify A Minimum Of Three Different Types Of Pipeline Markers That May Be Found Along A Pipeline Corridor.

2. Identify The Following Information On A Pipeline Marker:
   a. Product
   b. Owner
   c. Emergency Telephone Number


5. Identify And Describe The Basic Design And Construction Features Of A Pipeline System, Including:
   a. Piping
   b. Corrosion Protection
   c. Pumps And Compressors
   d. Meters
   e. Valves – Manual, Automatic And Emergency Shutdown Systems
   f. Pressure Relief Valves
   g. Supervisory Control And Data Acquisition System

Chapter 3 – Instructor Overview

1. Identify a minimum of three different types of pipeline markers that may be found along a pipeline corridor.

   Painted metal or plastic posts – used to indicate the rights-of-way.
Pipeline casing vents are where a pipeline crosses under a road or rail corridor within a pipeline casing.

Aerial markers have a specific number that indicates a specific geographic location along the rights-of-way.

2. Identify the following information on a pipeline marker.

Pipeline markers must provide the pipeline contents, the pipeline operator, and an emergency telephone number. (Note: Review slides and have participants identify)

3. Describe the purpose of a pipeline right-of-way.

The rights-of-way (ROW) facilitates the delivery of products to consumers and end users across the country. ROW is a strip of land usually about 25 to 150 feet wide containing one or more pipelines or other subsurface utilities (e.g., communications, fiber optics cables).

4. List three clues that may indicate the presence of an underground pipeline rights-of-way.

Pipeline markers, rights-of-way and value stations (aboveground).

5. Identify and describe the basic design and construction features of a pipeline system, including:

Piping – pipelines vary from 2 inches to 48 inches in diameter and comes in 40-60 ft sections of seamless steel or steel welded longitudinal seam. These are welded together at the site. Once welded at the site radiographic inspection occurs. Piping is then protected from corrosion by coatings and wrappings, heat shrink sleeves, and
cathodic protection. All piping is placed on protective bedding material.

**Corrosion Protection** – is provided by coatings and wrappings, heat shrink sleeves and cathodic protection.

**Pumps and compressors** – pumps are used to provide the pressure and force to move products in a liquid pipeline. Compressors are placed at intervals in the pipeline to maintain the flow of the product.

**Pressure Relief Values** – provide overpressure protection for pipeline systems and storage tanks. These values are open automatically and relieve pressure when actuated at a pre-set pressure. Natural gas is vented directly into the atmosphere.

**Supervisory Control and Data Acquisition System** – is a computerized system of monitoring the pipeline. This system monitors pressure, temperature, flow, alarms, and other condition throughout the pipeline system.
[2] Objectives

a) Identify A Minimum Of Three Different Types Of Pipeline Markers That May Be Found Along A Pipeline Corridor.

b) Identify The Following Information On A Pipeline Marker:
   i) Product
   ii) Owner
   iii) Emergency Telephone Number

c) Describe The Purpose Of A Pipeline Rights-of-way.


[3] Objectives

a) Identify And Describe The Basic Design And Construction Features Of A Pipeline System, Including:
   i) Piping
   ii) Corrosion Protection
   iii) Pumps And Compressors
   iv) Meters
   v) Valves – Manual, Automatic And Emergency Shutdown Systems
   vi) Pressure Relief Valves
vii) Supervisory Control And Data Acquisition System

[4] Introduction

a) Safe And Effective Response To A Pipeline Emergency Are Based Upon The Basic Principles Of Hazardous Materials Emergency Response.


[5] Introduction

a) The Purpose Of This Chapter Is To Provide A Basic Overview Of Pipeline Design, Construction And Operations.

b) Topics Will Include
   i) Methods Of Identifying Pipelines And Pipeline Right-of-ways
   ii) The Basic Design, Construction And Operation Of Pipelines

[6] Overview Of The Pipeline Transportation Chain

a) Pipelines And Piping Systems Are The Safest And Second Largest Method Of Hazardous Materials Transportation Within The United States

b) All Piping Systems Are Based Upon The Following Principles:
   i) A Material Is Inserted Or Injected Into A Pipe
   ii) The Product Is Moved From This Origination Point To A Pre-specified Destination
   iii) The Product Is Ultimately Removed From The Pipeline At Its Destination Point
Pipeline Transportation Chain

[8] Crude Oil Pipelines

a) Crude Oil Is Petroleum Taken Directly Out Of The Ground From Both On-shore And Off-shore Production Facilities

b) Crude Oil May Also Have A High Concentration Of Hydrogen Sulfide (H2S)

i) Commonly Referred To As A “Sour Crude,” Exposures To Low Concentrations Of This Toxic Gas Can Result In Death.

[9] Crude Oil Pipelines

a) Gathering Lines Are Small Pipelines, Usually 2 To 8-inches Diameter

i) They Move The Crude Oil Mixture From Individual Wellheads And Production Locations To An Oil Processing Facility

b) Depending Upon The Location Of The Production Site And The Type Of Crude Oil Being Produced, The Crude Oil Is Then Shipped Through Larger Trunk Lines Or By Cargo Tank Trucks To A Refinery Or Shipping Terminal.
[10] Liquid Pipelines

a) The Most Common Liquids Transported By Pipelines Are Refined Petroleum Products

b) Gasoline, Aviation Gas, Jet Fuel, Home Heating Fuels, And Diesel Fuels, Carbon Dioxide, Natural Gas Liquids (NGL), Liquefied Petroleum Gas (LPG) And Anhydrous Ammonia

c) Transmission Pipelines Move Refined Products From Refineries To Marketing And Distribution Terminals

d) The Products Are Then Loaded Onto Rail Cars, Cargo Tanks Trucks, And Barges For Delivery To The Consumer

e) Refined Petroleum Product Transmission Pipelines Carry Several Different Liquid Products Simultaneously


a) Natural Gas May Be Produced
   i) As A Separate Material
   ii) During Exploration And Production Operations
   iii) As A By-product As A Result Of Crude Oil Production Operations

b) Transmission Pipelines Ranging Up To 48-inches In Diameter Move The Natural Gas From Production And Processing To The Distribution Network

c) The Natural Gas Distribution Network Ultimately Delivers The Product To Residential And Industrial Consumers
[12] Identification Of Pipelines
a) The Location Of An Underground Pipeline Is Usually Marked By Aboveground Signs And Markers That Indicate The Presence Of A Pipeline.

b) The Primary Function Of These Markers Is To Alert Those Who Might Be Working Along The Pipeline Corridor Or Doing Construction In Close Proximity To The Pipeline, And To Provide Initial Emergency Contact Information

[13] Identification Of Pipelines
a) Although The Color, Format And Design May Vary, All Markers Are Required To Provide The Pipeline Contents The Pipeline Operator, And An Emergency Telephone Number

b) Other markers may also be found along the rights-of-way, including:
   i) Painted metal or plastic posts may be used to indicate the rights-of-way, especially in urban and suburban areas.

[14] Identification Of Pipeline

[15] Identification Of Pipelines
a) Pipeline casing vents are sometimes found where a pipeline crosses under a road or rail corridor within a pipeline casing

b) Aerial markers are larger markers with a specific number that
indicate a specific geographic location along the pipeline rights-of-way.

c) While Pipeline Markers Indicate The Presence Of A Pipeline(s), The Absence Of A Pipeline Marker Is No Assurance That A Pipeline Is Not Present

[16] Identification Of Pipelines

Pipeline is flown every 3 months by air on a transmission pipeline.

[17] Pipeline Rights-of-Way (ROW)

a) The ROW Is A Strip Of Land Usually About 25 To 150 Feet Wide Containing One Or More Pipelines Or Other Subsurface Utilities (E.G., Cables Communications,)

b) The ROW:

i) Enables Pipeline Personnel To Gain Access For Inspection, Maintenance, Testing Or Emergencies Aerial Surveillance Of The Pipeline

[18] Pipeline Rights-of-Way (ROW)

a) Identifies An Area That Restricts Certain Activities To Protect The Landowner and The Community


a) The Primary Method To Identify Pipelines And Their Rights-of-way Is Through The Use Of Pipeline Markers Located At Roads, Railways And Other Intervals Along The ROW

b) Pipeline Markers Only Show The Approximate Location Of The Buried Pipelines, As The Depth And Exact Location Of The Pipelines Can Vary Within The ROW


a) ROWs Are Either Owned By The Pipeline Operator Or Acquired Through An Agreement With The Property Owner.

b) Pipeline Companies Are Responsible For Maintaining Their Rights-of-way To Protect The Public And Environment, The Line Itself, And Other Customers From Loss Of Service.

c) Typically, A Permit Must Be Obtained From The Pipeline Operator For Any Activity Or Encroachment Into The ROW

[21] Pipeline Design And Construction

a) Whether New Construction Or A Pipeline Replacement Project, There Are Numerous Governmental, Regulatory, Engineering, And Community Issues That Must Be Integrated Into Pipeline Design And Construction

b) Pipeline Design And Construction Is Typically A Three-stage Process.

i) Pre-construction Phase

ii) Construction Phase

iii) Post-construction Phase
[22] The Pipeline
   a) Pipelines Can Vary From 2-inch Diameter For Gathering Lines to 48-inches For Transmission Or Trunk Lines.
   b) Most Modern Pipelines Are Constructed Of Either Seamless Steel Or Steel With A Welded Longitudinal Seam In 40 To 60 Ft. Lengths.
   c) The Individual Pipe Joints Are Welded Together Into Strings.
   d) To Inhibit Corrosion, Pipe Coatings And Wrappings Applied At The Steel Mill Or On-site Are Used.

[23] The Pipeline
   a) Once The Pipeline Trench Is Completed, A Layer Of Protective Bedding Material (E.G., Sand Free Of Large Stones That Could Damage The Coating) Is Placed In The Trench And Then Compacted To Provide Adequate Support For The Pipeline

[24] The Pipeline
   a) Minimum Depths Vary
   b) Natural Gas Distribution Mains Have A 24-inch Minimum Depth
   c) Federal Regulations Require That Transmission Pipelines Have A Minimum Depth Of 30 Inches In Rural Areas And Deeper In More Populated Areas
[25] The Pipeline
   a) When Crossing A River, Most Pipelines Are Drilled Under The Riverbed Without Disturbing The Bottom Surface. If Drilling Is Not Possible, The Piping May Be Laid And Weighted With Concrete Or Steel Anchors To Keep It On The Bottom. P-48
   b) Aboveground Pipelines May Be Found At Pump And Compressor Stations, Meter Stations, Some Valve Stations, River Crossings, Bridges, And Plant And Terminal Facilities.

[26] The Pipeline
   a) Aboveground Pipelines Are Also Constructed In A Zigzag Pattern Instead Of A Straight Line To Allow For Pipeline Movement Due To Thermal Expansion Or Ground Movement.
   b) Once In-place, The Pipeline Must Then Be Tested For Leaks Before Being Placed In Service. P-48

[27] Corrosion Control
   a) Corrosion Is A Natural Process That, Under The Proper Conditions, Can Affect Any Metal Or Alloy.
   b) Pipeline Operators Must Also Have Written Guidelines And Procedures For Most Corrosion-related Activities. Like Any Tool, Corrosion Control Systems Must Be Maintained To Be Effective.
   c) Pipeline Corrosion Is Most Prevalent When The Failure Of Coatings, Inhibitors, Or Cathodic Protection Occurs In A Corrosive Environment. P-48
[28] Types and Causes of Corrosion

a) External Corrosion May Be Caused By Damage To Coatings, Manufacturing Defects Within The Metal, Or Through The Loss Of Cathodic Protection.

b) Internal Corrosion Of Pipelines Is A Concern To All Pipeline Operators. Causes Include Chloride, Carbon Dioxide, Hydrogen Sulfide, Oxygen, And Micro-biological Activity.

c) Stress Corrosion Cracking (SCC) Is The Cracking Of A Pipeline From The Combined Influence Of Tensile Stress And A Corrosive Medium.

d) Microbiologically influenced Corrosion (MIC) involves Microbes that Produce Corrosive Conditions

[29] Maintenance, Inspection And Prevention

a) Corrosion Protection Tools
   i) Corrosion Control Injection Systems
   ii) Protective Coatings
   iii) Inhibitors
   iv) Cathodic Protection

b) Corrosion Inspection and Monitoring
   i) Laboratory Samples of Fluids
   ii) Corrosion Coupons
   iii) Electrical Readings at Specific Points Along the Pipeline
   iv) In Line Inspection Tools or Smart Pigs
[30] **Pipeline Pigs**

a) A Pipeline Pig Is A Device That Moves Through The Inside Of A Pipeline For The Purpose Of Cleaning, Dimensioning Or Inspecting The Pipe.  
b) General Categories of Pigs  
   i) Conventional or Utility Pigs  
   ii) Geometry Pigs  
   iii) In-Line Inspection ILI Tools  

[31] **Pig Receiver on a Natural Gas Pipeline**

[32] **Moving And Controlling The Product**

a) Pumps And Compressors Provide The Force And Pressure To Move Liquid And Gas Products Through A Pipeline System.  
i) **Pumps** Are Commonly Used To Provide The Pressure And Force To Move Products In A Liquid Pipeline.  
ii) **Compressors** Are Typically Used On Gas Pipelines To Boost And Maintain The Pipeline Pressure, Thereby Keeping The Gas Flowing.
[33] Moving And Controlling The Product
   a) The Size Of The Pumps And Compressors Used In A Pipeline System Will Be Dependent Upon The Type Of Pipeline, And The Product And Volumes Being Transported.
   b) Valves Are A Critical And Essential Element Of A Pipeline System In Controlling The Movement And Flow Of Product.

[34] Moving And Controlling The Product
   a) Valves Can Be Identified By Type Or By Function, And Can Be Equipped With Locking Devices To Prevent The Accidental Or Malicious Operation Of The Valve.
   b) Types Of Valves Commonly Found On Pipeline Systems Include Gate Valves, Plug Valves, Ball Valves, Butterfly Valves, And Check Valves.

[35] Moving And Controlling The Product
   a) Pipeline Flow Rates And Pressures On Transmission Lines And Large Distribution Lines Are Controlled Through The Use Of Large Control Valves.
   b) Safety Note
Problems That Are Worse Than The Original Event.

[36] Moving And Controlling The Product
   a) Pressure Relief Valves (PRV) Provide Over-pressure Protection For Pipeline Systems And Storage Tanks.
      i) Spring-actuated Valves That Automatically Open And Relieve Pressure When Actuated At A Pre-set Pressure.
   b) When Actuated, PRVs Can Generate A Tremendous Amount Of Noise, As Well As Strong Odors If The Natural Gas Is Odorized.

[37] Moving And Controlling The Product
   a) Remember - A PRV Venting To The Atmosphere Is Performing Properly, And Its Discharge Should Never Be Isolated Or Restricted By Emergency Response Personnel.
   b) Both Liquid And Gas Pipelines Use Valve Manifolds To Control The Flow Path Of Products. Manifolds, With Numerous Valves And Meters, Are Used To Divide The Pipeline Flow Into Parts, To Combine Several Flows Into One Larger Pipeline Flow, Or To Reroute Product Flow To Several Possible Locations.

[38] Manifolds
   a) Manifolds May Perform A Number Of Operations, Including:
      i) Pumping Product Through The Main Pipeline At A Pumping Station.
ii) Receiving Product From The Field Into Any Tank.

iii) Delivering Product From The Main Pipeline Into Any Storage Tank.

iv) Transferring Product From One Tank To Another.

[39] Manifolds

v) Pumping Product From A Storage Tank Into The Main Pipeline.

vi) Pumping Product From A Storage Tank To A Loading Rack.

vii) Isolating Tanks From The Main-line Flow

viii) Injecting Product From Any Storage Tank Or Additive Tank Into The Main Pipeline

b) Meters Are Used To Measure And Record The Quantity Or Volume Of Product Passing Through A Specific Location

39) Pipeline Control Centers

a) The Pipeline Control Center Is The Heart Of Pipeline Operations. Information About The Pipeline’s Operating Equipment And Parameters Is Communicated Into The Control Center, Where Operators Use Computers To Monitor The Pipeline Operation.

b) Pipeline Monitoring Is Accomplished Through A Computerized System Known As A Supervisory Control And Data Acquisition (SCADA) System.
40) Pipeline Control Centers
   a) Computer Screens And Analog Readings Provide The Control Center With An Ongoing Display Of Pipeline Pressure, Temperature, Flow, Alarms And Other Conditions In The Pipeline From All Of The Stations Along The Pipeline.

   b) Major Transmission And Distribution Pipelines Have An Automated Leak Detection System That Constantly Checks The “Line Balance” And System Pressures.

41) Pipeline Control Centers
   a) Many Pipeline Operators Have Their 24-hour Emergency Phone Number Connected Directly To The Pipeline Control Center.

   b) The SCADA System Continuously Monitors The Volume In The Pipeline And Provides Line Balance Reports. Most SCADA Systems Offer Multiple Computer Screens So That An Operator Can Instantly Check Operations And Facts At Any Location.

42) Pipeline Control Centers
   a) The SCADA System Can Display Information Graphically So That It Can Be More Easily Understood. If A Change Occurs, Such As The Opening Or Closing Of A Valve, The Shape Representing That Specific Valve On-screen Changes As Well.
43) Summary
   b) Pipelines Can Vary From 2-inch Diameter For Gathering Lines Or Small Distribution Lines, To 48-inches For Transmission Or Trunk Lines.
   c) Pumps And Compressors Provide The Force And Pressure To Move Liquid And Gas Products Through A Pipeline System.

44) Summary
   a) Emergency Response Personnel Should Never Attempt To Isolate Any Pipeline Valves On Large-diameter Transmission Or Distribution Lines Unless Under The Direction Of Pipeline Operations Personnel
   b) Failure To Do So May Actually Create Additional Problems That Are Worse Than The Original Event.