Above Ground Storage Tanks

Day 1: Tank Design Fundamentals (API 650)

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1. Classification of Tanks

- Atmospheric Tanks (API 650)
- Low Pressure Tanks (API 620)

2. Scope of API 650

- Minimum requirements for material, design, fabrication, erection, and testing
- Applicability limits (bottom support, temperature ≤ 93°C)

3. Tank Design Parameters

- Tank Capacity
- Foundation responsibility
- Corrosion Allowance (CA)
- Service Conditions

4. Tank Bottom Design

- Design objectives (draw-off, corrosion prevention, capacity utilization)
- Cone Down Bottom
- Cone Up Bottom

5. Annular Plate Requirements

- Radial width requirements
- Projection beyond shell
- Calculation for increased width

6. Materials & Material Group Selection

- Permissible design metal temperature
- ASTM material grades
- Thickness limitations

7. Shell Design

- Design basis (H, G)
- Required drawings
- Design thickness (td)
- Hydrotest thickness (tt)
- Allowable stresses (Sd, St)
- Shells > 60 m diameter
- Elastic analysis (Appendix K)

8. Thermal Stress Relief

- Requirements for material groups
- Temperature range & duration

Day 2: Roof Systems, Structural Design & Testing

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1. Wind Girders

- Wind girder formula
- Intermediate wind girders

2. Shell Openings

3. Roof Design

- Fixed Roof
- Cone Roof (Truss Supported)
- Dome Roof
- Umbrella Roof

4. Appendix R – Load Combinations

- Fluid & Internal Pressure
- Hydrostatic Test
- Wind (Internal & External Pressure)
- Gravity Loads
- Seismic Loads

5. Top Angle Design

- Participating area calculation
- Load combination requirements

6. Frangible Roof Design

- Tanks ≥ 15 m diameter
- Tanks 9–15 m diameter
- Roof slope, weld restrictions
- Area limitation formula

7. Hydrostatic Testing

- Filling requirements
- Air pressure requirements
- Visual inspection requirements

8. Appendices Overview

- Appendix A – Small Tanks
- Appendix J – Shop Assembled Tanks
- Appendix S – Stainless Steel Tanks
- Appendix AL – Aluminum Tanks
- Appendix C – External Floating Roof
- Appendix H – Internal Floating Roof
- Appendix G – Aluminum Domes

9. Seismic Design & Sloshing

- Definition of sloshing
- Tank damage due to earthquakes

Day 3: Inspection of Storage Tanks (API 653)

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1. Introduction to Tank Inspection

- In-service and out-of-service inspection
- Reporting requirements

2. Materials Selection & Corrosion Allowance

- Material strength requirements
- Common materials
- Corrosion allowance range

3. Types of Inspection

- Routine In-Service Inspection
- External Inspection
- Internal Inspection

4. External Inspection Scope

- Thickness measurement
- Shell & roof inspection
- Weld joints
- Nozzles, manways
- Foundation
- Anchor bolts
- Grounding system
- Wind girder
- Floating roof components
- Cathodic protection

5. Internal Inspection

Pre-Inspection

- Manway condition
- Deposit condition
- Internal abnormalities

Post Inspection

- Shell plate inspection
- Fixed roof inspection
- Floating roof inspection
- Bottom plate inspection
- NDT methods (PT, MT, Vacuum Box, MFL, LFET, UT)

6. Heating Coil Inspection

- Hammer test
- UT measurement
- Radiography
- Hydraulic testing

7. NDT Acceptance Criteria

- Linear indications
- Rounded indications
- Crack-like indications

8. Inspection Frequency (API 653)

- External inspection intervals
- Internal inspection intervals
- RBI extension

9. Thickness & Remaining Life Calculations

- Minimum thickness (tmin)
- Corrosion rate (Cr)
- Remaining life (RL)
- Fill height calculations

10. Causes of Tank Failures

- Weld defects
- Improper weld spacing
- Overfilling
- Brittle fracture
- Lack of inspection

11. Maintenance & SOP

- Walk-around inspection
- Monthly & annual AST inspections
- Record retention

Day 4: On-Stream Robotic Inspection & Life Prediction

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1. Introduction to Robotic Inspection

- Storage tank types
- Roof types
- Conventional inspection limitations

2. Alternative to Internal Inspection (API 575)

3. Robotic Tank Bottom Inspection Technique

- Objective
- System components
- UT probe configuration
- Deployment method

4. Bottlenecks in Bigger Tanks

- Entry port
- Sediment
- Damage types
- Coverage limitations
- Annular plate zone
- Tank sump
- Area under pillars

5. In-Service Robotic Inspection Methodology

- 508 mm manway deployment
- In-service inspection conditions
- Floor coverage
- A-scan & B-scan data

6. Short Range Guided Wave UT (SRUT)

- Annular plate coverage
- % wall loss detection
- Critical zone monitoring

7. UT Data Collection

- 700 UT runs
- 1,350,000 data points
- Maximum, minimum, average thickness

8. Inspection Reporting System

- Thickness reporting
- A-scan
- B-scan
- Video images

9. Extreme Value Analysis (EVA)

- Weibull distribution
- Gumbel distribution
- Corrosion rate calculation
- Remaining life estimation

10. Conclusion

- Technique limitations
- Engineering analysis
- Remaining life assessment
- Shutdown avoidance
- Cost savings