Overview

• Understand the process for evaluating CO2 facility needs
• Overview of FEED study topics
• Discuss facility issues evaluated during FEED study
• Basics of cost estimating for CO2 projects
FEED Study Goals

• Develop conceptual design of facilities
• Evaluate alternatives and options
• Provide cost estimates for analysis of project economics
• Develop schedule for project design, construction, and implementation
• Identify risks which could impact project cost and/or schedule
CO2 Project FEED Study Topics

- CO₂ Supply
- Regulatory
- Facilities
- Water Disposal
- Flood Management
CO2 Supply

- Where are we getting the CO$_2$?
- Purchased vs. Recycle
- CO$_2$ Pipeline Specs
Regulatory

- Regulation for H₂S Operations
- Sour Gas Pipeline Construction
- Injection Well Permitting
- Emissions Limits
Facilities

- Gas Processing / Recycle Facility
- Surface Production Facilities
- Surface Injection Facilities
- Safety Systems

CO₂ Supply
Regulatory
Facilities
Water Disposal
Flood Management
Water Disposal

- Waterflood makeup water
- New or existing water disposal wells
- Commercial water disposal systems
Flood Management

- Injection Well Operation
- Production Well Operation
- Data Collection / Automation
- Staffing Levels

CO₂ Supply
Regulatory
Facilities
Water Disposal
Flood Management
CO$_2$ Supply

• Sources
  – Geologic (Sheep Mountain, Bravo Dome)
  – Anthropogenic (Natural Gas Plants, Ethanol Plants)

• Delivery Method
  – Pipeline
  – Trucking

• Delivery Conditions
  – Pressure
  – Temperature
  – Composition
  – Water Content
Gas Processing

• What to do with the recycle gas stream
  – Hydrocarbon recovery
  – Full-stream reinjection

• Dehydration

• Compression
  – Optimal operating pressures
  – Horsepower requirements
  – Gas engine vs. electric motor drive
  – Efficiency of pumping vs. compression
Typical Recycle Stream

Produced Gas Stream

Inlet Compression

Dehydration (if necessary)

Re-Injection Compression

Field Injection

Emergency Flare
Production Facilities

- Operating pressure
- Flowline sizing and materials
- Separator sizing
- Adequate test facilities?
- Automation requirements
- Vent / relief systems
- Water and oil separation
- Storage capacity – adequate tankage?
- Vapor recovery
Injection System

- Operating pressure
- Water and CO2 distribution system layout
- Injection flowline sizing and materials
- Hydraulic modeling of injection system
- WAG injection skid design / location
Water Handling

- Where to put excess produced water?
  - Utilize in existing waterflood
  - Use for “fill-up” in future CO2 project phases
  - Water disposal wells
  - Surface discharge permits

- Make up water
Auxiliary Systems

- Electric power availability
  - Coordinate with electric power provider
  - Power system analysis
- Fuel gas needs and availability
Cost Estimating

• Utilize conceptual design from FEED study
• Focus on capturing MAJOR costs
• Understand the level of accuracy
• Estimating methods
  – Vendor quotes
  – Historical information
  – Rules of thumb (i.e. $60,000 / inch-mile)
• Acknowledge regional factors
FEED Study Deliverables

• Technical Report
  – Summary of study
  – Design description and justification
  – Comparison of design alternatives
• Capital and Operating Cost Estimates
• Project Schedule
• Risk Analysis
• Process Flow Diagram(s)
• Field Layout / Routing Plans
Needs from Client

• Results of reservoir modeling
  – Forecast production/injection rates and pressures
• Maps
  – Field map with well and facility locations
  – Pipeline maps (CO2 delivery, sales pipelines, etc.)
  – Power distribution system map
• Fluid properties
• Information on existing facilities
  – Equipment lists, drawings, etc.
Questions?