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CO₂ Pipeline Project Manager
Denbury CO₂ Pipeline Network

**Rockies**
- Denbury owned Rocky Mountain Fields With EOR Potential
- Existing Anthropogenic CO₂ Sources
- Proposed Coal to Gas or Liquids
- Existing or Proposed CO₂ Source

**Gulf Coast**
- Existing CO₂ Pipelines (835 mi. in operation)
- CO₂ Pipelines Under Development
- Delta Pipeline
- Jackson Dome
- Sonat MS Pipeline
- NEJD Pipeline
- Green Pipeline

**Existing CO₂ Pipelines (835 mi. in operation)**

**CO₂ Pipelines Under Development**

- Denbury owned Rocky Mountain Fields With EOR Potential
- Existing Anthropogenic CO₂ Sources
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CO₂ Pipeline Right-of-Way

- Approx. 12 mi (19 km) to the SE operations unit in Citronelle Oil Field
- Right-of-Way
  - 1¼ mi (2 km) inside Plant Barry property
  - > 8 mi (13 km) along existing power corridor
  - 2 mi (3 km) undisturbed forested land
  - Permanent cleared width 20 ft (6 m)
  - Temporary construction width 40 ft (12 m)
- Right-of-Way habitat
  - 9 mi (14.5 km) of forested and commercial timber land
  - 3 mi (5 km) of emergent, shrub and forested wetlands
  - Endangered Gopher Tortoise habitat
    - 110 burrows in or adjacent to construction area
**CO₂ Pipeline and Measurement Design**

- Welding - API 1104 & B31.3 (plant section)
- 4-inch (10 cm) pipe diameter
- X42/52 carbon steel pipe
- MOP – 2,220 psig (flange limitation)
- Normal operating pressure: 1,500 psig (10.3 MPa) maximum
- Buried average of 5 ft (1.5 m) with surface re-vegetation and erosion control

*Handling pipe for horizontal directional drill*
• Directional drilled 18 sections of the pipeline under roads, utilities, railroad tracks, tortoise colonies, and wetlands.
• Trenched remaining sections
• Corrosion protection
  • Fusion Bond Epoxy coated pipe
  • “Jeep” pipe for coating damage; manually coat joint welds and scratches
  • Impressed current cathodic protection
  • AC mitigation for overhead powerlines using copper wire
  • ACVG survey after construction to check again for coating damage
  • Caliper tool run to check for dents caused by rock or equipment
Denbury pipeline purity requirement is:

- > 97% dry CO₂ at 115°F (46°C)
- < 0.5% inerts (incl. N₂ & argon)
- < 30 lb water per 1MMSCF
- < 20 ppm H₂S

Impurities affect and sometimes amplify pipe fracture toughness requirements

- Hydrogen & N₂ problematic

Toughness requirements for this project met by standard X42 pipe. Other projects require added wall thickness, modified pipe chemistry and/or crack arrestor installation.
CO₂ Pipeline and Measurement Design

- CO₂ measured with senior orifice meter and gas chromatograph
- Custody measurement meets AGA Report #3, Parts 1 & 2
- Accuracy and mechanical issues with turbine, Coriolis, & ultrasonic meters
  - Turbine – CO₂ is dry – damages moving parts. CO₂ viscosity range can be problematic
  - Coriolis – Accuracy not as good as orifice
  - Ultrasonic – CO₂ absorbs and distorts signal
- Communication using SCADA and satellite.
- Check meter installed for pipeline leak detection and verification of injected volumes

Check meter station and building at Denbury Citronelle Field
CO₂ Pipeline and Measurement Design

- CO₂ Specific Design Requirements
  - Valve seals – Accepted: Nylon, peroxide cured Buna N (HBNR-90/95), ethylene propylene rubber (EPDM)
  - Valve packing – Teflon
  - Low temperature materials for valves used for blowdown service only.
  - Mainline valve station similar to natural gas with blowdowns for maintenance.

Mainline valve station & CP test station
CO₂ Pipeline and Measurement Commissioning

- Pipeline and meter stations left with 50 psig of nitrogen to inhibit moisture and corrosion until commissioning.
- Low pressure CO₂ used to sweep and vent nitrogen.
- Pressure increased to full operating pressure.
- Samples obtained for CO₂ stream analysis.
- System will be blocked in awaiting notice to begin injection activities.
- Analyzers at custody and check meter stations take ~ 1 day to stabilize.
- Samples will be taken periodically for permits and GHG reporting.
Questions??

Thank you!