



## SECARB – Plant Barry to Citronelle 4" CO<sub>2</sub> Pipeline

Thursday, March 8, 2012



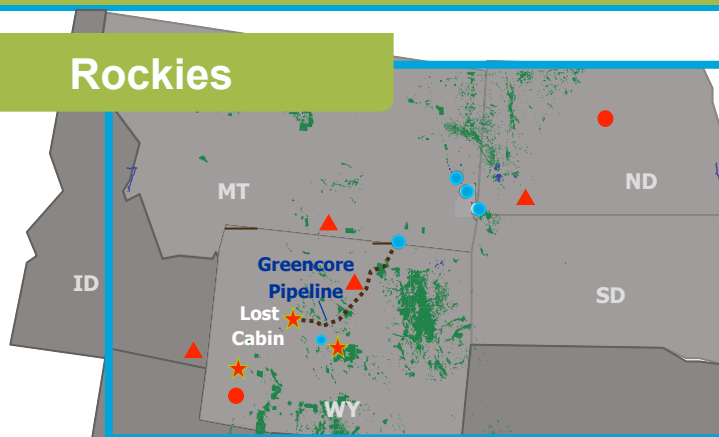


**Speaker: Christina Harvick**  
**CO<sub>2</sub> Pipeline Project Manager**

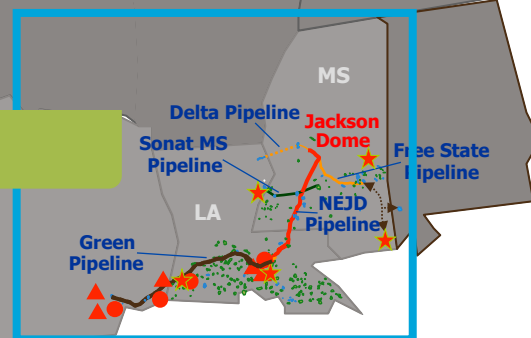
# Denbury CO<sub>2</sub> Pipeline Network



## Rockies



## Gulf Coast



- Existing CO<sub>2</sub> Pipelines (835 mi. in operation)
- ..... CO<sub>2</sub> Pipelines Under Development
- Denbury owned Rocky Mountain Fields With EOR Potential
- Existing Anthropogenic CO<sub>2</sub> Sources
- ▲ Proposed Coal to Gas or Liquids
- ★ Existing or Proposed CO<sub>2</sub> Source

# CO<sub>2</sub> 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



# CO<sub>2</sub> Pipeline and Measurement Design



- Applicable regulatory standard: US Dept of Transportation, 49 CFR Part 195 —Transportation of Hazardous Liquids by Pipeline
- 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**

# CO<sub>2</sub> Pipeline Design and Construction



- 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



# CO<sub>2</sub> Pipeline and Measurement Design



- Denbury pipeline purity requirement is:
  - > 97% dry CO<sub>2</sub> at 115°F (46°C)
  - < 0.5% inerts (incl. N<sub>2</sub> & argon)
  - < 30 lb water per 1MMSCF
  - < 20 ppm H<sub>2</sub>S
- Impurities affect and sometimes amplify pipe fracture toughness requirements
  - Hydrogen & N<sub>2</sub> 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.



**Custody meter station and building**

# CO<sub>2</sub> Pipeline and Measurement Design



- CO<sub>2</sub> 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 – CO<sub>2</sub> is dry – damages moving parts. CO<sub>2</sub> viscosity range can be problematic
  - Coriolis – Accuracy not as good as orifice
  - Ultrasonic – CO<sub>2</sub> 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**

# CO<sub>2</sub> Pipeline and Measurement Design



- CO<sub>2</sub> 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.

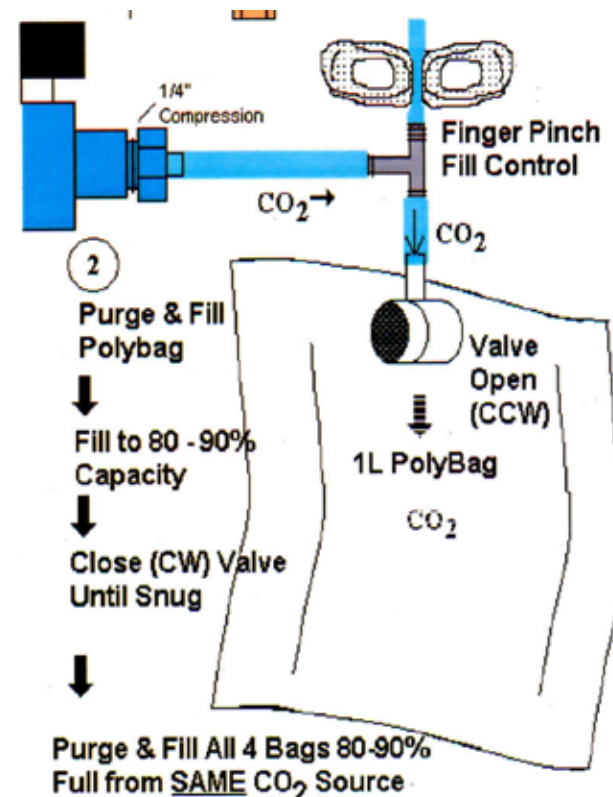


**Mainline valve station & CP test station**

# CO<sub>2</sub> Pipeline and Measurement Commissioning



- Pipeline and meter stations left with 50 psig of nitrogen to inhibit moisture and corrosion until commissioning.
- Low pressure CO<sub>2</sub> used to sweep and vent nitrogen.
- Pressure increased to full operating pressure.
- Samples obtained for CO<sub>2</sub> 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!***