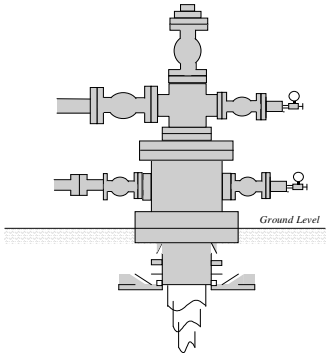
Class V Experimental Well Permit Process Items & Potential Issues for Western Kentucky CO_2 Storage Project

Presentation
to
Kentucky Consortium for Carbon Storage (KYCCS)

July 23, 2008

Presented by:



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Agenda – the 3 P's

- Project Goals and Approaches (Project Planning)
- Permitting (Strategy)
- Project Management

Project Goals and Approaches

- **Goals:**
  - Finalize Contracting Requirements with Univ. of KY Purchasing
  - Prepare Permit Application for timely EPA review using hybrid of EPA Guidance Doc #83; Frio CO2 test Permit, Duke Edwardsport, and Point Daniel, MS document
    - EPA Meeting Scheduled for August 12th Region IV Atlanta
    - Assist Permit Team in compiling required technical Documents
    - Compile final copies for distribution and submittal
  - May incorporate some of EPA's recent regulatory guidance on long-term CO2 storage wells

- **Approaches:**
  - Integrate all geologic data on deep reservoirs and assess interval capability
  - Request additional funding from Sandia CO_2 contacts, industry; National Lab partners, etc. for Contributions in specific areas, seismic, testing, logging, tracers, etc.

Class V—CO2 Wells Permitting Background

- **General Info:**
  - Not many of these wells permitted, KY is second deepest one that I know of after Mississippi Point Daniel Project (permitted via MDEQ with EPA Region IV review, assistance)
  - No specific Template, historical EPA approach, using Class V well framework with Class I (more stringent) Siting, Well Construction and Monitoring Standards for CO2 injection
  - EPA Region IV Atlanta has primacy for Class V Experimental Technology wells.
  - EPA Guidance Document #83 was released last year to address CO2 permitting for test wells, not meant for long term storage wells.
  - CO2 Permit Application precedents set with:
    - Frio CO2 test Permit – TCEQ w/(EPA Region VI overview); c.2004
    - EPA Guidance Doc #83;, c. 4/2007
    - Duke Edwardsport, IN (EPA Region V), c.2008
    - Point Daniel, MS document (MDEQ) w/(EPA Region IV overview) c.2007
  - Must Protect Lowermost USDW and use Non-Endangerment Standard
  - Project uniqueness, visibility require more data than the minimum

Class V Permit Major Sections and Components

I. Project Background and Administrative Information
II. Geology, subsurface, hydrogeology, economic
III. Reservoir Modeling, Area of Review Investigation
IV. Well Design, Drilling Program and Construction Plan
V. Injection Test Plan
VI. Monitoring Program

- Interaction with EPA and Kentucky Division of Oil and Gas Conservation, close coordination, email updates on drilling, testing
- Obtain Well Certification, MIT and Authorization for fluid and CO_2 Injection
- Compile and Submit Final Well Report with Drilling, Testing results
- Update Permit with final well Logs, amended maps, compiled core data, formation data as courtesy and knowledge base

Permitting Issues

- Timely EPA review, coupled with addressing technical comments, and slow deliberate structural nature of UIC process (Class I permits ~2-3 yrs)
  - notice of Intent to Approve Permit (30 days),
  - Comment Period (30 days) and
  - Public Hearing time (10-30 days);
  - all of which may stretch beyond the Consortium's anticipated Well Drilling Spud Date
- EPA Staff is stretched thin, has many areas focused in Region IV, Florida Municipal sewage Wells, MS hazardous waste wells, CO2 test and long term storage wells, Water Storage, Aquifers, etc. (Assistance from Region VI)
- EPA technical comments on UIC Permits, may incorporate new portions of recently released EPA regulations governing long-term storage of CO2 as precedent setting areas for implementing in the field —*not likely*
- Class V Permit can be Conditional on additional well design add-ons with more stringent standards —*requires more time to address*
- Add-on of more monitoring, longer term program to address effects on the well —*requires more time to address*

Class V Permit Components

I. Project Background and Administrative Information

- Describe experiment, test objective, Goals, the Consortium, State Funding Grant, etc.
- Provide Applicant, Operator Information
- Provide Maps of location, topographic, land use, aerial photo
- Identify Surface landowners under test acreage/lease, adjacent impacted owner, and identify mineral owners underlying tract, and those affected by CO2 or injectate fluid extent
- Provide Financial Assurance, etc. as Operator
- Provide Public Outreach, Community meetings on Project, benefits, goals, etc. use drawings, maps, etc. to communicate
- Discuss impact of project on community, small amount of CO2, on water resources, land usage—limited footprint

Class V Permit Components

II. Geology, subsurface, hydrogeology, economic

- Geology and Hydrogeology Type Log of Subsurface Formations
- Regional Geology description of setting, all formations from surface to Injection and Total Depth (TD)
- Stratigraphy, Cross Sections, dip, strike, with project location and anticipated formations thickness, structure, etc.
- Review and discussion of seismic lines if open and available
- Identification of area faulting, lateral formation continuity, formation velocity identification
- Depth to Basement, Mt Simon, Knox, etc.
- Local Geology, Structure, Stratigraphy, Petrophysical analysis
- Injection Zone, Interval description and designation
- Identification of Confining zone, overlying seals, USDW protection
- Hydrogeology of aquifers, water resources, < 10,000 mg/l
- Seismicity evaluation from NGDC
- Surface geology, karst description, soils, and economic minerals, formations.

Class V Permit Components

III. Reservoir Modeling, Area of Review Investigation

- Reservoir modeling, input parameters of Injection Interval, Zone, and Confining Zone seals
- Permeability effects of CO2 injection into a brine-filled reservoir
- Transmissibility, fluid level, gradient, formation frac gradient,
- Address geologic and boundary conditions
- Model of residual CO2 saturation for 300 tons injected into reservoir
- Predictions of pressure and plume size, area impacts
- Area of Review identification of drilled and abandoned wells in a 0.25 mile radius from proposed injection test well (consider larger area ~1-2 miles) for diligence and investigation
- CO2 description, properties, surface, downhole, temp, etc.

Class V Permit Components

IV. Well Design, Drilling Program and Construction Plan

- Proposed Well Design—TD, Casing program, specifications, well completion interval information, Schematic of Proposed Well Construction
- Proposed Well Drilling Program, Prognosis
  - Step-by-step procedure, conductor to surface hole, TD,
  - Casing Depths, & USDW protection (< 10,000 mg/l)
  - Drilling fluids plan
- Contingencies for Drilling, Injection Testing
  - Stuck pipe, lost circulation, safety, H2S monitoring, notification plan, safety
  - Coring, Logging, Sampling plan for Borehole, well logs, cores, cased hole, Injection-Confining Zone specialized Logging, testing
- Completion Plan—compatibility of well tubulars, cement to CO2 exposure, address corrosion effects in short term testing, cementing program.
- Notification of KY O&G Conser. and EPA at key well milestones, Surface Casing, Cementing, Coring Points, Logging Point, H2S encounter.

Class V Permit Components

V. Injection Test Plan

- Selection of Injection Packer System, Tubulars
- Mechanical Integrity of Well Completion
- Formation and Well Stimulation Plan (if required)
- Safety Plan, HASP for injection, CO2 handling
- Proposed surface and downhole system of fluid and CO2 injection procedures, and surface handling, schematic
- Test plan, with CO2 monitoring objectives
- Record of Operating parameters—baseline testing
  - MASIP, Injection Rate, Pressure Limitations, Frac Gradient, Fluid Density, Total Volume
- Field contingencies, documentation and reporting of results

Class V Permit Components

V. Monitoring

- Well MIT Certification, proper well construction per approved permit and plan
- Cement Bond Log proving interval isolation, baseline temperature log (pre-injection)
- Test is protective of USDW
- Ambient and Continuous monitoring of pressure, pre-test to post-test
- Mitigation plan for potential leaks, etc.
- Additional Monitoring, optional—soil gas sampling, baseline water well sampling pre-test, post-test
- Secure well, potential temporary abandonment
- Final Well Closure Plan
- Site restoration, cleanup

Summary of Key Points

- Aug 12th Permit Meeting with EPA to determine if additional Class V or I permit components required, specific to Region or 'hot' buttons
- Seek commitment from EPA to turn Permit around quickly to meet Jan-Feb drilling rig and spud date commitment—difficult to secure rig in today's climate
- Complete Permit materials and submit mid-late Sept 2008, providing EPA a 1-2 month window to complete Permit and address comments, deficiencies, etc., all well before the proposed spud date.
- Describe limited nature of test with CO2 amount < 300 tons and limited injected volume fluid to "prove" an interval(s) in the wellbore.
- Site Monitoring and sufficient Casing set to protect USDWs.
- Invitation to EPA to attend Coring, Drilling, Logging events on the borehole, place group on daily rig status email distribution list
  - Offer webcam for events on the rig remotely, via a web-based password log-in to monitor test well progress, etc.
- Commitment to Data Sharing once evaluation, testing is complete
- Presentation and Meeting with EPA to share test results, later publication of findings, etc.

Project Management

- Decisions on Permit Compilation, roles, responsibilities, final edit, preparation, etc.
- Contract, group responsibilities
- Other items?

Thank You!!

We thank you for awarding and selecting Sandia as Project Manager

and

We look forward to working closely with all of you on this interesting project while assisting and incorporating some of our knowledge in injection and CO_2 test wells throughout the U.S.

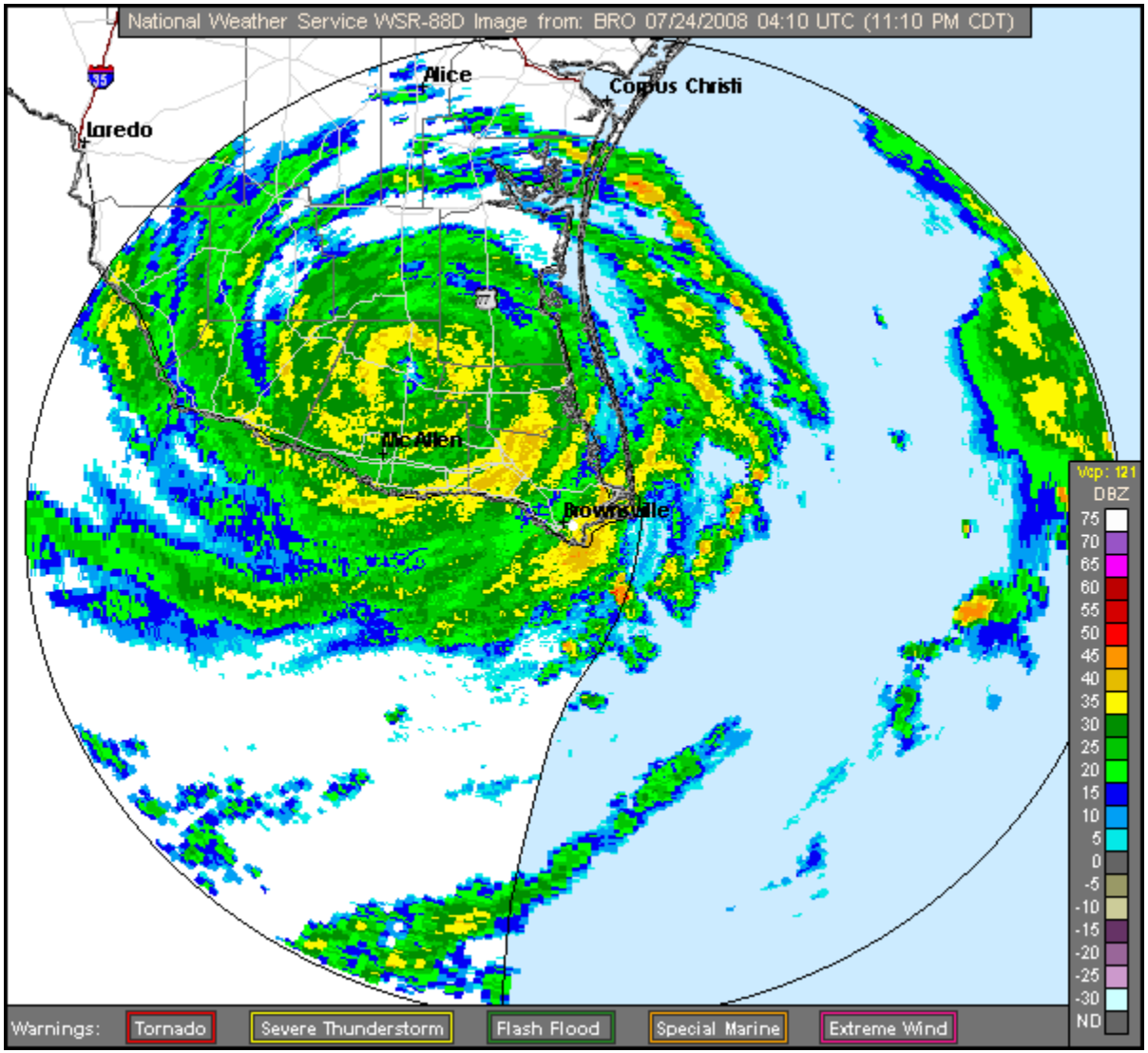
Active CO_2 Projects:

WestCarb AZ;

WestCarb Thornton CA Field;

Denbury Resources Cranfield Phase II and III

Hello Dolly….Good-Bye Dolly



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Sandia Remote Monitoring System

BEG Frio Project and Denbury Resources Cranfield Phase II, III