North Sea CRI Operations
Designed & Operated by DCDC Founders

British Petroleum – North Sea (Andrew)
Kerr McGee – North Sea Ninan–Central
Kerr McGee – North Sea Ninan–South
Total – North Sea (Alwyn)
Total – Dunbar
Talisman – North Sea – Clyde
Talisman – North Sea – Claymore
Talisman – North Sea – Fullmore
Shell – North Sea (Auck)
Shell – North Sea (Brent Bravo)

Over 400 Projects completed by us, over 6 MillionBbls Waste Injected successfully, not including Water
World Wide Reinjection Projects Designed/operated by DCDC
Founds of DCDC Experience

- First to inject successfully in many countries
- Usually only one injection point, if failed, finished
- Have always found a subsurface strata we could dispose waste successfully and did so
- Took over/Fixed other’s CRI Unit/project
- In many country projects with no previous wells drilled, used seismic data to design disposal project
- Have had over 40 CRI projects ongoing around the world, at one time, while planning others
Founders of DCDC Standouts

- BP Andrew N. Sea: Set Drilling Record in North Sea
- Exxon Russia: No drilling data to design from, Caught all cuttings on offshore Jack Up Rig until annulus created to dispose cuttings in.
- Phillips Alaska: Ran pat. Injection string on Cook Inlet intermediate casing string
- Unocal GOM: Drilled/injected 1 mile of hole in 24 hours
ASME International

PETROLEUM DIVISION

American Society of Mechanical Engineers

To

Apollo Services, Inc.

for

Apollo Cuttings Reinjection System

5-7-97

Date

Chair, Petroleum Division
### Some Case History Highlights by founders of DCDC

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Type</th>
<th>Rate</th>
<th>System</th>
<th>Quantity</th>
<th>Equipment/Note</th>
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</thead>
<tbody>
<tr>
<td>Amerada Hess</td>
<td>North Dakota, Land</td>
<td>Tight Sandstone</td>
<td>48,452</td>
<td>tbg/perf</td>
<td>Pit</td>
<td>2700 B/d 1</td>
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<tr>
<td>Hunt Oil</td>
<td>South Louisiana, Land</td>
<td>Loose Sandstone</td>
<td>675,000</td>
<td>tbg/perf</td>
<td>Pit</td>
<td>3500 B/d 10</td>
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<tr>
<td>Numerous Operators (1,7)</td>
<td>Gulf of Mexico</td>
<td>Sand/Shale Intervals</td>
<td>1,200,000</td>
<td>tbg/perf/annular, MLS, depleted zones</td>
<td>12 1/4</td>
<td>280 FPH 18</td>
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<tr>
<td>Numberous Operators</td>
<td>Gulf of Mexico</td>
<td>Sand/Shale Intervals</td>
<td>2,300,000+</td>
<td>Annular</td>
<td></td>
<td>300 FPH 85</td>
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<tr>
<td>Shell U.K. (6)</td>
<td>Brent Bravo North Sea</td>
<td>Clay/Sandstone</td>
<td>132,476</td>
<td>Annular</td>
<td>16</td>
<td>200 FPH 7</td>
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<tr>
<td>BP U.K. (5,7)</td>
<td>BP Andrew North Sea</td>
<td>Sand/Shale</td>
<td>137,476</td>
<td>tbg/perf/annular</td>
<td>16</td>
<td>250 FPH 9</td>
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<td>BP Venezuela (7)</td>
<td>Barge Clean Out</td>
<td>Claystone/Geologic Upthrust</td>
<td>56,000</td>
<td>Annular</td>
<td>16</td>
<td>1500 B/d n/a</td>
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<tr>
<td>Phillips Alaska (4,7)</td>
<td>Cook Inlet Alaska</td>
<td>Sand/Coal/Shale</td>
<td>48,279</td>
<td>Injection String</td>
<td>12 1/4</td>
<td>150 FPH 4</td>
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<tr>
<td>Unocal/Spirit Energy (7,1)</td>
<td>Gulf of Mexico (offshore)</td>
<td>Sand/Shale</td>
<td>12,724</td>
<td>Annular</td>
<td>12 1/4</td>
<td>1 Mile/24 Hrs. 10</td>
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<td>Enron India (7)</td>
<td>Offshore India</td>
<td>Imperable Claystone</td>
<td>32,472</td>
<td>tbg/perf/annular</td>
<td>12 1/4</td>
<td>400 FPH 6</td>
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<tr>
<td>Pan Canadian/Nova Scotia (7,2,1)</td>
<td>North Atlantic</td>
<td>Imperable Shale/Clay</td>
<td>24,274</td>
<td>tbg/perf</td>
<td>12 1/4</td>
<td>200 FPH 3</td>
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<tr>
<td>Conoco (7,1)</td>
<td>Gulf of Mexico</td>
<td>Sand/Shale</td>
<td>18,275</td>
<td>Mud Line Suspension</td>
<td>6 1/2</td>
<td>Rig Trash 1</td>
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<td>Unocal/Thailand (7)</td>
<td>Gulf of Thailand</td>
<td>Tight Sandstone</td>
<td>4,671</td>
<td>depleted zone tbg/perf</td>
<td>n/a</td>
<td>Hg Prod Slud 1</td>
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<tr>
<td>Numerous Operators</td>
<td>Gulf of Mexico</td>
<td>Depleted Sandstone</td>
<td>74,387</td>
<td>tbg/perf</td>
<td>n/a</td>
<td>NORM/LSA 16</td>
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<td>BP Wytah Farm (3,7)</td>
<td>South of England, Land</td>
<td>Sand</td>
<td>12,476</td>
<td>3000 ft Horizontal tbg/perf</td>
<td>17 1/2</td>
<td>200 FPH 2</td>
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<tr>
<td>Shell Sakhalin</td>
<td>Offshore Sakhalin</td>
<td>Sand</td>
<td>187,354</td>
<td>Disposal Well/Annular</td>
<td>17 1/2</td>
<td>200 FPH 6</td>
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<tr>
<td>Exxon Sakhalin</td>
<td>Offshore Sakhalin</td>
<td>Fine, Soft Sand/Clay Mix</td>
<td>14,723</td>
<td>Annular</td>
<td>12 1/4</td>
<td>200 FPH 1</td>
</tr>
</tbody>
</table>

*1 Vacuum Assist 2 Monitoring Pkg, Fully automated, single lift Pkg 3 Co-mingle Production and Slurry 4 tbg injection string on side surface casing allowed injection of drill cuttings immediately after drilling out from under surface 5 North Sea record of 2200 Barrels of cutting slurry processed and injected 6 Reel Mechanical Engineering Award #27 7 Opening
Drill Cutting Re-Injection System
Cuttings Slurrification Unit designed and operated by founders of DCDC
Shell - North Sea Brent CRI Unit by DCDC
CRI Design Format

- Regulatory regime, top side, environment and subsurface
- Type of Rig or Platform, place equipment, utilities, inj. Line setup for zero discharge and collection of waste’s
- Annular, tbg/depleted zone, disposal well
- Subsurface Disposal Strata
- Disposal point Verses production or fresh water zone, fracture’s or faulting and well’s to be drilled
- Hole Size/Drill Rate/Volume to be injected
- Required Safe Injection Pressure
- Casing/Cement Design/path
- Topside design
- Installation/, Operations Plan and Contingencies
DCDC Experienced Foundation provides Highest Drill Rates, Uptime, Lower Cost Disposal, and Slurry Placement Assurance, Since 1987

- Install, Commission, Initiate Injection Test, Compare to Expected Formation Reaction, Adjust if necessary
- Ongoing Monitoring/Adjustment/ and Slurry Placement Assurance
- Monthly/End of Well Reports and Follow Up
- Suspend or Plug Injection Conduit, End Report

Survey Rig, Design Surface Equipment/Interface
- Prepare Detail Procedures Manual including pumping program, displacements, pressure profiles, ISIP’s, Drawdown’s, Contingencies,
- Initial Injection Test Procedures, Slurry Rheology/Particle Size Requirements, Preventative Maintenance, Monitoring Reports, Chain of Command, Permit, Well Construction, Feasibility Study, Contingencies, etc.
- Personnel Selection/Training/Support
- Regulatory Permits, Logistics/Customs Requirements

Research all Offset Well Data, Seismic Data, Wells, Faults, Production, Fractures in area of injection, geology of area
- Review Regulatory Regime and Operator Requirements
- Review Future well drilling plans
- Prepare inputs for Proprietary Fracture Model, Test different Injection Zones, Determine best practices approach, make recommendations
- Outputs are used to design disposal well, and/or review future and existing well construction, cementing, develop procedures

Experienced, Focussed Management review all data, run Models, and are involved in preparing the operations procedures manual, disposal design, Rig Survey, surface equipment design/interface, Personnel Selection and Training, therefore, are completely familiar and Client has One party Responsibility, Our Program has worked since 1987!
Our fracture modeling is done by an experienced CRI operations manager, who is working on your project team.

- Mathematical Basis of Typical CRI Fracture Models
- Design to stimulate production - High Injections Rates
- Uses brittle large particles
- No particles size distribution
- High in fluid horsepower
- Short in duration
- Excellent fluid properties - Low Fluid Loss

DCDC's model is just the opposite.

Our proprietary model is developed over 23 years, and millions of Bbls. Of slurry injected all over the world in all types of formations, with our proprietary method's, a major difference is we do not use Hi Horsepower and lose control of the slurry placement.
Disposal Regime Input Data

- Formation Lithology
- Mechanical and chemical properties
- Fracture Gradient Profile
- Pore Pressure Curve
- Anticipated Csg. /Csg. Cement Design
- Existing Wells/Csg./Cement Design in the area of planned CRI
- Geology of the area
- Formation/Resistivity logs
Disposal Regime
Output Data

➢ Cuttings Injection Rates/Pressures
➢ Disposal Profile
➢ Slurry Particle Size/Rheology
➢ Disposal Formation
➢ Confining Formation/cmt. required
Typical Slurry Properties

Viscosity: 50 - 80 funnel visc. (Sec./qt.)
Solids Ratio: 20 - 30%
Weight: 10.5 - 12.5 ppg
Particle Size: 100 micron or smaller (90%)
Retort Oil: .5 - 2% oil; if oil mud cuttings
Yield Point: 20 - 25 lbs./100 sq.ft.
A Major Difference in DCDC verses other CRI service Companies is our ability to Grind and Inject Ahead of the Rig rate, at less than 90 Micron, others can only do 200 micron, which is too large!
Fracture Profiles
Vertical Width Profiles
Annular Injection Profile

- Prepared Cuttings Slurry
- Confining Layer
- Surface Casing
- Injected Slurry
- Injection Zone
- Intermediate Casing
- Production Hole
Some Re-injection Options

1. Injecting into 20 x 13 3/8 inch annulus
2. Injecting into 13 3/8 x 2 5/8 inch annulus
3. Re-inject above reservoir then drill to TD and produce
4. Injecting inside 9 5/8 inch dedicated disposal well
5. Injecting inside 7 inch below reservoir
N. SEA CRI Economics
Brent Bravo Summary

<table>
<thead>
<tr>
<th>Well</th>
<th>Total Barrels of Slurry Re-injected</th>
<th>Documented Cost to Run C.R.I.</th>
<th>Total Cost per Barrel of Slurry Re-injected</th>
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<tbody>
<tr>
<td>BB-32-S3</td>
<td>10,919</td>
<td>64,559.64</td>
<td>5.91</td>
</tr>
<tr>
<td>BB-14-S1</td>
<td>9,155</td>
<td>101,729.64</td>
<td>11.11</td>
</tr>
<tr>
<td>BB-19-S2</td>
<td>4,414</td>
<td>78,469.66</td>
<td>17.78</td>
</tr>
<tr>
<td>BB-01-S1</td>
<td>12,773</td>
<td>53,528.48</td>
<td>4.19</td>
</tr>
<tr>
<td>BB-01-S2</td>
<td>7,267</td>
<td>45,833.86</td>
<td>6.31</td>
</tr>
<tr>
<td>BB-01-S3</td>
<td>9,034</td>
<td>94,131.72</td>
<td>10.42</td>
</tr>
</tbody>
</table>

The average cost per barrel (Over 6 wells) = 8.18
The average cost per tonne (Over 6 wells) = 42.87
Injection Pressure and Cumulative Volume Comparative Graph

- Cumulative Volumes
- Pressures

- Prepare Equipment for Start Up
- Start of 12-1/4" hole Section
- End of 12-1/4" hole Section
- Start of 8-1/2" hole Section
- End of 8-1/2" hole Section