



## Controlled Pressure Drilling<sup>®</sup> Fluid Systems

Air drilling. Underbalanced drilling. Managed pressure drilling. Weatherford's CPD<sup>®</sup> fluids maximize drilling performance and security in controlled pressure situations. We offer a comprehensive approach that integrates thorough evaluation, testing and field experience to enable...

A better way to **Drill**



**Weatherford<sup>®</sup>**

# Flexible fluids.



**You might think** that drilling fluids for air drilling, underbalanced drilling, managed pressure drilling, or other CPD® applications are simple drilling mud variants. But nothing could be further from the truth. *CPD* uses systems of compressible fluids (air, mist, foam and two phase fluids), engineered blends of gases and liquids. These systems can be designed for any density and pressure requirement, and they carry drill cuttings, using either velocity or rheology for maximum flexibility. Weatherford engineers these complex drilling fluid systems to perform to demanding specifications in difficult environments. These systems play a key role in giving you the best well you can get for your money:

- Increased rate of penetration
- Minimized formation damage
- Greatly reduced nonproductive time
- Better horizontal or extended-reach wells
- Enhanced well productivity



**To meet your performance goals,** our *CPD* fluids must perform many tasks and do them all well:

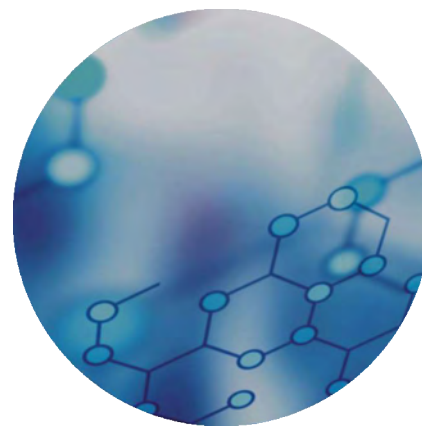
- **Create and maintain foam for low-pressure drilling situations.** With densities of 1 to 5 ppg, our patented foam drilling systems include several recyclable and non-recyclable water-based foams plus the new Oleofoam™ system, the only commercial oil-based foam drilling system in the market today. Ideal for water-sensitive formations, the *Oleofoam* system generates foam at ultra-low concentrations and can be recycled with minimal maintenance, using our Hydrobreak™ defoamer.



- Inhibit corrosion in highly oxygenated fluids.** Membrane nitrogen used in CPD® drilling applications may be 5 to 8 percent oxygen, and even highly purified cryogenic nitrogen has enough oxygen to cause corrosion beyond acceptable rates. Our patented CorrFoam 1 corrosion control technology passivates downhole metallurgy for a corrosion rate near zero, even at elevated temperatures. And our Triplex<sup>SM</sup> service uses the synergistic effects of three chemistries to protect against corrosion and pitting in geothermal and other hostile environments up to 500°F (260°C).
- Stabilize shale and other sensitive formations.** Shale is infamous for swelling and squeezing off the pipe or fracturing and sloughing into the hole—and the lower circulating pressures in CPD systems can sometimes magnify these problems. Weatherford's highly effective shale inhibitors give you a choice of control mechanisms that will work for almost every type of sensitive formation.
- Carry cuttings to the surface.** Without suspended particulates, CPD fluids must rely on viscosity or velocity to carry cuttings. But getting adequate velocity is not always possible and can be expensive. The engineered rheology of our foam drilling systems generates the viscosity to carry cuttings on the fly. By varying the type and concentration of viscosifiers and foaming agents, we can vary the fluid properties as needed for a particular application and well geometry.
- Handle special drilling environments.** Weatherford holds a number of key patents for hydrogen sulfide scavengers, and our technology can enable CPD operations even in sour wells. In oil reservoirs the formation of **emulsions** can cause separation problems, but our choice of additives for preventing and/or breaking emulsions overcomes this challenge. Our complete line of specialty chemicals allows us to evaluate your specific situation to determine the best remedy.



Membrane Nitrogen Unit



# Augmenting the additives.

In many cases Weatherford's fluid chemistry makes the difference between a successful CPD® project and a well that is simply undrillable.



Weatherford's San Antonio, Texas, research facility engineers all the chemistry for our CPD projects, researches new CPD solutions, and supports our manufacturing facility at the same location. The facility has a full fluids lab, an expansive corrosion lab and complete analytical capabilities, including a scanning electron microscope, x-ray diffraction, x-ray fluorescence and more.

**Anyone can buy additives off the shelf** from a reputable chemical company. But making sure these additives work together in a CPD project is not so easy!

Our scientists continually develop and test new fluid chemistries for challenging CPD projects, and their research results in a continuing flow of industry-leading solutions. We conduct our own additive research and development at the Weatherford R&D facility in San Antonio and manufacture our products at one of the company's worldwide facilities. Our full range of excellent individual products will work separately or together to solve nearly any problem you can throw at us.

## Integrated engineering.

Weatherford's CPD fluid design is a critical part of our overall well construction process and uses our proprietary engineering modeling software to determine the best fluid parameters for drilling the well. Engineering compressible fluids is a complex challenge, but our Wunderdrill™ fluid modeling and design program uses actual fluid data to calculate precise foam properties, hydraulics and friction factors. It's an important component of managing bottomhole pressure in real time for optimal underbalanced or managed pressure drilling performance.





# Applied analysis.

One reason Weatherford leads the industry in CPD® services is the depth of our expertise. Our engineered systems approach draws not only on the San Antonio facility but also on the capabilities of these Weatherford geoscience groups.

**Hycal Energy Research Laboratories.** As a laboratory-based reservoir production and engineering consultancy, Hycal is one of the world's largest commercial labs of its type. Hycal specializes in

- reservoir characterization, simulation and optimization;
- formation damage testing and simulation at reservoir temperatures, pressures and conditions (including H<sub>2</sub>S and CO<sub>2</sub> gases);
- evaluation of potential interactions between treating chemicals, formation fluids and formation rock to ensure compatibility.

**OMNI Laboratories.** The world's second-largest core analysis facility adds important components to Weatherford's multidisciplinary geoscience and engineering capability, including one of the industry's most experienced teams of geologists, engineers and technicians. OMNI specializes in

- complete core management services;
- rock mechanics testing and research;
- specialized core flow testing for drilling and completion fluids.

**Advanced Geotechnology.** AG specializes in the application of petroleum geomechanics to solve challenging problems from near-wellbore across the entire geological basin. AG can use chemistry information from Weatherford's San Antonio facility, core data from OMNI, and formation damage analysis from Hycal to provide a comprehensive model of the wellbore characteristics and the reservoir. Services include

- wellbore stability analysis;
- fractured reservoir characterization and modeling;
- coupled thermal geomechanical reservoir simulation;
- unconventional gas studies, including coalbed methane, gas hydrates and gas shales;
- caprock and casing integrity studies.



Digital SEM Lab at OMNI Facility

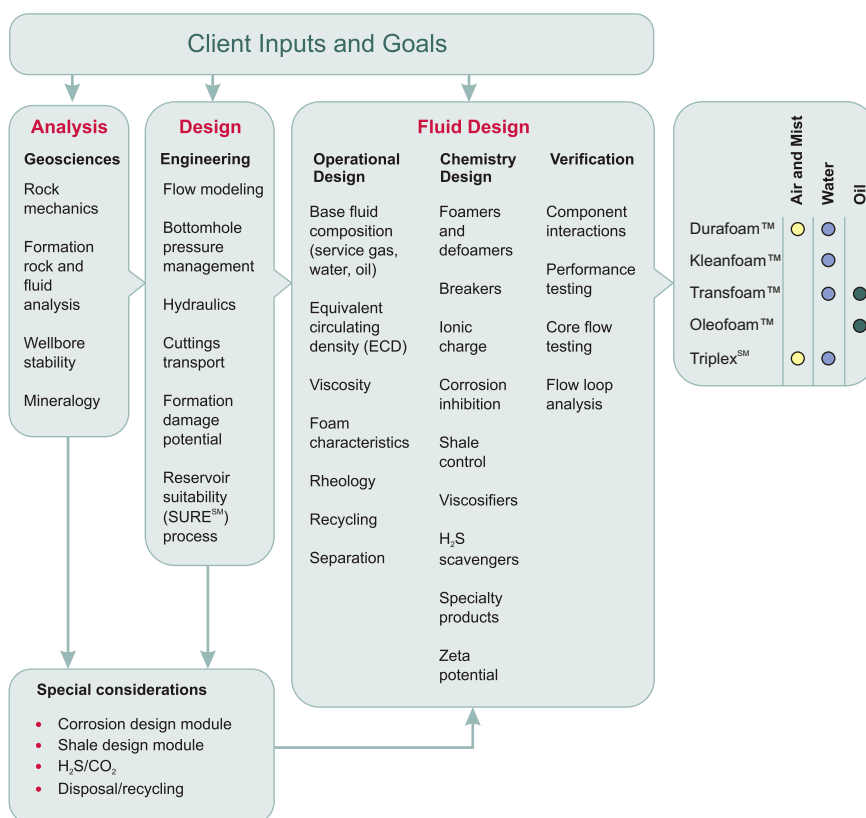


# Systematically scientific.



**CPD<sup>®</sup>** success depends on a lot more than just having all the pieces. It's about making everything work together to give you the best well you can get for your money, anywhere in the world.

Our *CPD* fluid selection process is a scientific and systematic approach designed to prevent problems and nonproductive time.



Weatherford's CPD® group provides the technology, techniques and support to safely drill wells, whether you need to drill faster, reduce nonproductive time, or enhance well production and reservoir recovery. We provide you with *a better way to drill* through our industry exclusive products and services that include:

**Evaluation** expertise to quantify potential *CPD* benefits · Controlled pressure **engineering** experience for better well planning · Project **execution** expertise with *CPD* project managers, wellsite engineers and supervisors and equipment specialists · Largest fleet of surface and subsurface pressure control **equipment** · Performance tracking **experience** for continual improvements · Optimization process tuned for **exploitation**.

**Contact your authorized Weatherford representative today**, or visit us at [weatherford.com/CPD](http://weatherford.com/CPD), to learn how Weatherford's *CPD* fluids can maximize drilling performance and security for your wells.

A better way to drill

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**Weatherford®**

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