TESTING & PRODUCTION SERVICES

Well-Test Design and Analysis Services

Delivering reliable well-test data through industry-leading expertise, equipment, and software

Weatherford®

A better design yields better data

We help you make the most of your well test with powerful software and decades of experience.

Well testing can make or break your field. Primarily a means for discovering pressure, permeability, and productive capacity, well testing also serves as a guide for producing an asset. While the right data helps to maximize overall production rates, the wrong data can lead to early depletion.

The right data begins with solid design. Backed by 30 years of experience, we offer a unique well-test service that leverages our powerful design and analysis packages, including WellFlo®, PanSystem®, and ReO® software. Our well-test engineering processes preview critical design parameters, which allows us to customize a program that maximizes the potential and efficiency of the test.

By removing the guesswork from the design process, we provide a testing regimen that meets the exact needs of your asset—a test neither too long nor too short. We then execute the test safely and efficiently, which gives you the quality data and the analysis you need to make informed production decisions for your asset.

We reduce testing uncertainty

Permeability can be a catch-22. You need an estimate of permeability to prescribe a flow test regimen, which provides—among other data—the actual formation permeability.

Because core samples are often unavailable, nearby well permeability comparisons are frequently inaccurate, and logs are sometimes unreliable, a typical well test design often starts with an educated guess.

Our proprietary design software package replaces guesswork with mathematics. Using the system's nodal analysis techniques, our technicians can provide an initial permeability estimate from the first flow period of a DST. Here the real-time wellhead pressure data is converted to downhole pressure using a vertical lift model and then this data is used, in real time, to obtain the preliminary permeability estimate. Using this value, the duration of the second (major) flow period is designed "on the fly" to achieve the requisite depth of investigation.

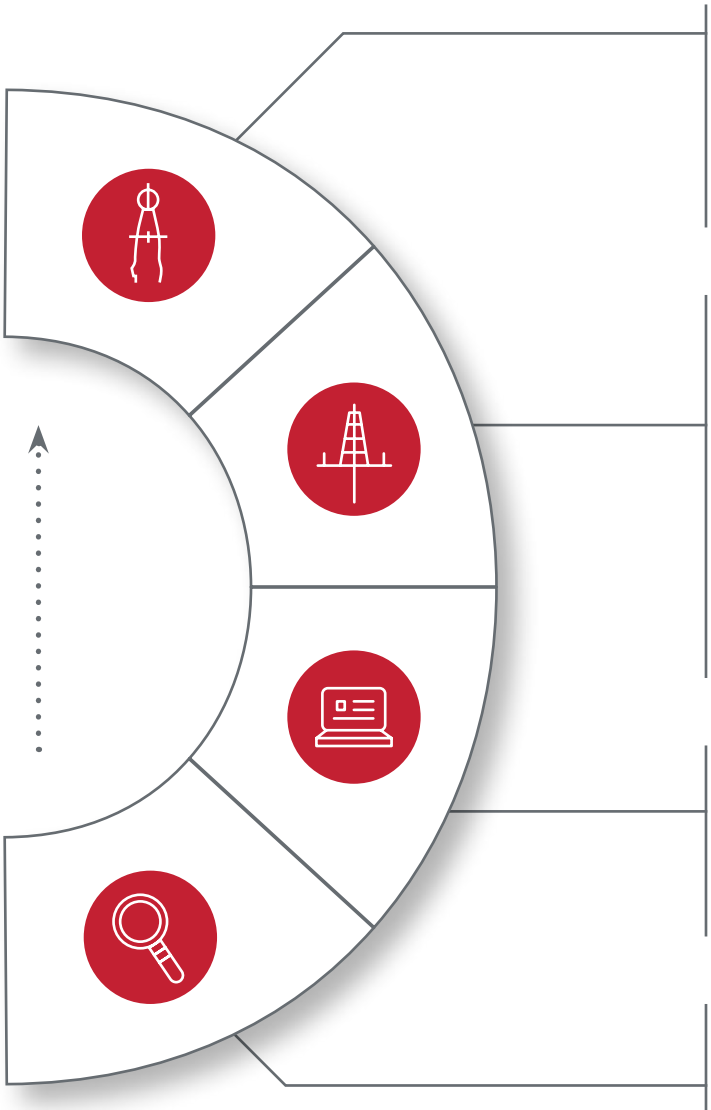
Our Well-Test Design and Analysis Service Advantage

- Delivers a customized, comprehensive testing and analysis plan
- Supports well- and reservoir-level testing for exploration, appraisal, and development wells
- Provides the test length needed for each well—no more, no less
- Delivers usable data that enables informed reservoir management decisions
- Uses field-proven WellFlo, PanSystem, and ReO modeling and analysis software
- Provides design for complex testing, including reservoir compartmentalization
- Reduces uncertainty in testing regimen

Experience and technology drive our well-test design and analysis services

We offer design and analysis expertise for any stage of production, from exploration to appraisal to development wells. Combined with our extensive portfolio of well-testing and production services equipment, we deliver actionable data that informs your reservoir production decisions.

We perform thousands of jobs per year globally that include well cleanups, frac flowbacks, in-line production tests, exploration, appraisal, drillstem, production and extended well tests. We customize and deliver an effective and efficient well test using our four-phased approach:



Design the well test

No two well tests are exactly alike. For each well, we collaborate with your reservoir engineering team to design a test that best suits the operating conditions. Leveraging our design software packages, we develop a test plan that provides the data you need to make informed reservoir management decisions and maximize recovery.

Execute the plan

Based on the test design, we select equipment from our extensive portfolio of well testing technologies and pair it with our experienced technicians. Our products and services include wellhead and surface process equipment, multiphase flow metering systems, drillstem test tools, slickline services, tubing-conveyed and wireline-perforating systems, openhole and cased-hole logging, surface and downhole data acquisition, real-time secure data transmission, PVT (pressure, volume, temperature) sampling, and laboratory services. All equipment, services, and personnel conform to Weatherford health and safety standards.

Analyze the data

Once the test is complete, our experts use Weatherford proprietary PanSystem® and PanMesh well-test analysis applications. These software systems provide a detailed analysis, validation, and interpretation of the test data along with reservoir-management recommendations.

Assess the project

Finally, we conduct a post-analysis review. We aim to ensure that we have met your reservoir assessment and management objectives, and that we also have relevant data that will help optimize future tests in the same reservoir.

We test in any stage of reservoir development

Our extensive portfolio of equipment, technology, and expertise delivers actionable well-test data in exploration, appraisal, and development wells.

Exploration and appraisal wells

We assess the commercial potential of the reservoir through fluid properties, PVT flow rates, permeability, and more. Among the technologies used to execute and analyze well tests are formation testers, drillstem test (DST) tools, and proprietary software applications.

- Assess the commercial potential of the reservoir
- Determine reservoir boundaries, including the drainage area
- Characterize the reservoir
- Obtain formation fluid data to inform future drilling and completion decisions

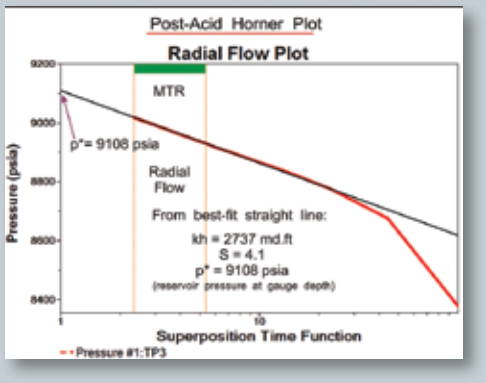
Development wells

We can help to optimize field performance, diagnose production problems, and ensure compliance with environmental regulations. We offer both traditional three-phase test separators and advanced in-line multiphase testing packages, which help to ensure data accuracy without interrupting production.

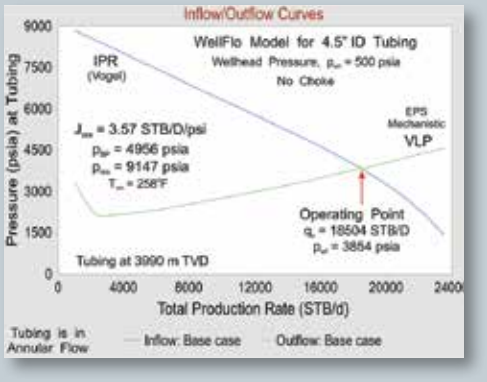
- Optimize well and field performance
- Diagnose production-related problems
- Evaluate the effectiveness of stimulation treatments
- Validate export meters
- Ensure compliance with environmental regulations

Well testing can save on completion costs

The value of a well test often ranges beyond permeability and field performance. A client in Iraq sought to determine reservoir pressure, average permeability, and how the skin factor responded to acid stimulation. The diagram on the left shows the Horner plot from a well test with a pre- and post-acid buildup. The skin factor change between the pre- and post-acid buildup was negligible, which meant that another stimulation technique, such as a skin bypass fracture, would be necessary. Combined with the well performance plot shown on the right, the well test provided valuable reservoir characterization data, including the optimal form of completion.



Horner plot



Performance plot

We serve the global industry through training

We cultivate and share our expertise through training. Our series of modular, case-study-driven courses teach our technicians and third-party specialists how to design effective well tests and how to interpret test data.

Our courses—incorporating 20 years of input from operators and service companies—continually include new developments in well-test design and analysis. These courses are held at Weatherford training centers throughout the world, including our dedicated training site in Edinburgh, U.K., and at client facilities, by request.

Course 1: Well-Test Analysis (Introductory/Intermediate Level)

- Constant pressure boundary effects (gas cap and strong aquifer)
- Gas-well testing
- Pressure transient analysis in drawdown and buildup
- Semi-infinite system late transient analysis (fault effects)
- Steady-state radial flow theory
- Well-test design
- Wellbore storage and type-curve analysis

Course 2: Well-Test Analysis (Advanced Level)

- Advanced well-test design
- Deconvolution
- Fractured wells
- Horizontal wells
- Multiphase flow and gas condensate well testing
- Radial composite systems: injection well falloffs
- Variable rate situations, including permanent downhole gauge (PDG) application

Course 3: Well-Test Interpretation in Complex Reservoirs

- Advanced fault interpretation
- Dual-porosity behavior (naturally fractured reservoir)
- Layered well testing
- Limited entry and double permeability systems
- Non-ideal wellbore storage
- Numerical methods, using PanMesh software
- Dual-cell compartmentalized systems

We wrote the book on well-test design and analysis

With 40 years of well testing and reservoir engineering experience, Dr. George Stewart serves as Chief Reservoir Engineer at Weatherford. Before joining the company in 2004, Dr. Stewart held several roles at Heriot-Watt University's Institute of Petroleum Engineering since its inception, including senior lecturer (1975–1978), department head (1981–1986), and adjunct professor (1986–present). He authored the Pressure Transient Analysis series, which includes two books—*Volume I: Well Test Design & Analysis and Volume II: Formation Testing and Well Deliverability with Complex Reservoir Material Balance,* available through PennWell® Books.

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The Weatherford well-test design and analysis service delivers reliable well-test data through industry-leading expertise, equipment, and software. To learn how our services and technologies can work for you, contact your authorized Weatherford representative, or visit us at **weatherford.com/contact-us**

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