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Technical Brochure

for

PROGAUGE™ Automatic Well Test Equipment

Effective: February 20, 2009

- Fully Automatic Oil/Water/Gas Well Testing Under True Production Conditions
- Rapid Testing Through Self-Adaptive Sequencing Algorithms
- New Levels Of Oil & Water Gauging Accuracy
- Mass Rate Measurements Automatically Compensate For Temperature and Entrained Gasses
- Specially Designed For Low Oil/High Water Production Wells
- Sequences Up To 60 Wells
- Highest Quality Components And Fabrication
- Robust And Reliable
- Advanced Gauge Data Statistical Analysis
- Networkable For Centralized Data Collection And Control
- Completely Sealed System Measurement
- Open And Flexible System Testing Configuration
- Easy To Use Operator Interface
- Uses Proven Measurement Technology

Well Testing

The need for accurate and timely well production data is critical. The extremely erosive and harsh environments in which well pumping systems operate create constant, and many times, rapid equipment failure. In the constant effort to stem production declines, oil operators invest substantial resources in well maintenance. For steam drives and waterfloods, well servicing is frequently the highest non-energy cost. Still, determining the performance from various well servicing activities remains a problem to be answered to ensure that individual well performance is its highest. Now more than ever, accurate, reliable, and frequent well testing is the most important tool for maximizing oil production and optimizing reservoir management, while ensuring the lowest operating costs.

Current well testing systems available today vary greatly in method, features, and components. Each design has its particular strength, but each is also beset with significant limiting characteristics.

Design Philosophy

PROGAUGE, by ProGauge Technologies, Inc., was developed using the advantages of proven production measurement system designs, married to highly accurate and robust instrumentation, and sophisticated control algorithms to produce state-of-the-art accuracy and reliability, under the most stringent conditions.

The **PROGAUGE** system was designed to test producing wells under true operating conditions while eliminating fugitive emissions. Total fluid flow rate is measured while the oil and gas components are accumulated. The innovative collection chamber's internal design reduces the total accumulation volume required for an accurate oil and gas sample. Adaptive process-control rules automatically adjust each well's test duration to produce the optimum sample size for each well. These **PROGAUGE** characteristics provide fast and accurate testing of even low oil rate wells.

In addition to accuracy, the **PROGAUGE** well test system is designed for extremely reliable operation and low maintenance. Only highly accurate and durable components are incorporated. Measurement devices are full-line-size with no moving parts, and are based on proven and stable technology. Liquid control devices are high performance ball valves for tight shutoff and long life.

Complementing accurate and reliable testing is sophisticated data analysis. Individual well production trends are retained in memory and analyzed for consistency. Based on a well's historical variation, any gauge that represents abnormal conditions is identified so that special action can be taken. Using this consistency calculation technology, the performance of the entire test measurement system can be analyzed for further improvement.

Automatic well test systems, along with stringent reliability characteristics, must seamlessly integrate into your automatic data collection process, requiring minimum human intervention for operation or data collection. The volume of data generated by even a few testing units can consume significant resources in data collection, archiving, and analysis. The **PROGAUGE** system minimizes manual data manipulation by using open-architecture PLC devices that are fully networkable using generally used communication protocols.

System Components

Production Testing Hardware

- vertical produced fluid collection and separation vessel with proprietary internal design that enhances separation and single phase fluid withdrawal
- high accuracy Coriolis mass-flow meter
- dielectric water cut measurement probe
- high quality 2-way ball valves with carbon steel bodies, stainless steel trim, with actuation
- process control equipment that provides all sequencing logic and mathematical calculations, typically the flexible and widely supported Allen-Bradley ControlLogix platform.
- fabricated complete with all necessary piping and cable components onto a modular skid

Well Selection Manifold

- well flowline termination piping
- dual, opposed 2-way well selection ball valves with electric actuation with position feedback
- manual isolation ball valves
- main group, test, and lease water headers
- fabricated complete with all necessary piping and conduit components

Construction Features

The vessel and its associated piping are of welded construction, which conform to ASME piping code B31.3 (normal service). All equipment is integrated into a single concentrated package.

- production testing assembly and manifolds are small in size
- well selection manifolds are modular, allowing less than the full 60 well capacity, or incremental future expansion to 60 wells
- low pressure well test skid vessel and piping are rated for 250 psig @ 150° F service
- high pressure test system, rated for 400 psig @ 400° F, is suitable for steam fractured wells
- test vessel, manifolds, and piping will be coated with a zinc-rich primer and enamel top coat paint consistent with your color requirements

Operating Features

- as many as 60 wells may be tested by a basic **PROGAUGE** station
- well test times are based on the time it takes to accumulate a measureable oil sample to produce maximum accuracy in the least duration of time. Typically, total test time for a 1000 Bbl/Day (gross), 200 Bbl/Day (oil) well can be less than 60 minutes
- test times have configurable minimum and maximum durations
- the order of well testing is dynamically adapted, based on production volumes, with provisions for field-level or remote manual override
- each well's 10 most recent production tests are retained and available for local or remote display, and statistical analysis
- by the separation of fluid phases prior to measurement, the **PROGAUGE** system provides the following full fluid analysis:
 - free gas - total rate, non-condensable vapor rate, steam vapor rate, NC vapor fraction
 - oil emulsion – rate, water cut, gas cut
 - free water rate
- the system's most recent 50 gauges are retained for display and/or remote transmission
- local operator interface terminal provides all control and operating values, the last 50 tests, and manual well test selection. This interface is designed for simplicity and easy use
- monitoring capability for well and test fluid temperatures
- measurement of production and supply fluid pressures
- full supervisory control capability

Performance

Again, the use of proven components, fabrication standards, and design innovation provide the highest oil and water measurement accuracy.

- fluid mass, density, and temperature measurement is done with a single Coriolis flow meter providing 0.15% flow accuracy, 100:1 turndown, and high reliability
- oil and water determinations are made with a capacitance probe having proven accuracy and high long-term stability and maintainability
- PLC process controls for open access, precision mathematical capability, and external communication ports
- sophisticated control and calculation logic automatically determine test time and order
- typical net oil and gross measurement accuracy is better than $\pm 3\%$ of rate, with an absolute imprecision of 1 bbl/day, even with 10 bbl/day wells

Options

The above describes the characteristics of the basic **PROGAUGE** system. Additional features and enhancements can be initially requested, added by ProGauge Technologies, Inc. or by you after installation. Some typical options are:

- well selection manifolds
- fluid heater
- remote communication over radio, wire, or phone lines using all Allen-Bradley protocols, MODBUS, custom, or customer specified
- complete system design including remote data communication, central graphics monitoring, control, and integration with legacy data systems
- collection of additional field data, such as injection well data, etc, around the well test site for display and remote collection
- custom well gauge averaging or other statistical analysis
- higher pressure test systems
- higher well density systems
- integral water pump
- non-standard manufacturers' equipment

Services

ProGauge Technologies can provide additional engineering and construction services to support the customer's well testing requirements. Such services include, but are not limited to:

- complete field installation and startup
- specialized user training
- custom system engineering

1- Automatic Well Test unit general technical specifications

- a) High accuracy Ametek Drexelbrook oil cut measurement device.
- b) Coriolis type mass flow metering, Micro-Motion CMF for high accuracy and turndown.
- c) Automatic valving consisting ball valves, CS body, 316 Stainless steel ball and stem, TFM seats, ANSI class 600, Designed to ANSI B16.34, B16.25, B16.11, MSS SP25 with electrical actuation on liquid and gas lines.
- d) Internal level transmitter, Rosemount Dual Rod Radar, flange mounted to top of vessel.
- e) Rosemount pressure transmitter.
- f) Rosemount RTD and temperature transmitter.
- g) Turck modular armored cable and fittings installed on vessel instrumentation and control devices.
- h) Okonite armored cable installed for higher powered devices, such as a water supply pump.
- i) Allen-Bradley 1756-L62 ControlLogix PLC w/ 4MB memory, 1756-ENBT Ethernet gateway, 1756-DNB DeviceNet, and 1756 I/O, 1492 AB wiring, outdoor enclosure, and 12" PanelView+ 1250 High-Brite color LCD operator terminal display outdoor viewable.
- j) Fully managed industrial Ethernet /IP switch optimized for A-B PLC communication with IGMP snooping.
- k) A vertical produced fluid collection and separation vessel with proprietary internal design that enhances separation and three-phase measurement, skid mounted.
- j) Welded construction conforming to ASME code B31.1 (normal service duty).
- k) 7-stage centrifugal water pump with 3 HP explosion proof motor

2- List of deliverables

Operating Manual including manufacturers IMO's
Drawings
Material certifications of pipe and ball valves (if requested by customer at time of order)
Hydrotest report
Quality assurance checksheets
Radiograph reports

4- Fabrication and delivery period

Typical project duration for material procurement, fabrication, and testing is approximately 14-16 weeks ARO. Order will be considered valid when an acceptable Purchase Order is received. Expedited orders will ship (12) weeks ARO from Bakersfield, California, U.S.A.

5- Factory Testing and Customer Acceptance,

Full functional testing of the operation of the equipment will be performed at the completion of fabrication and will be accessible to the customer for witnessing and validation before shipment. In addition, the customer will be notified upon the completion of fabrication for the purpose of inspection of the equipment so that it meets customer's standards. Customer shall delineate items requiring modification for ProGauge to complete prior to shipment. Customer's acceptance as mechanically and electrically complete is required before shipment.

6- Warranty,

Products manufactured by ProGauge Technologies, Inc. are warranted only to the extent that ProGauge Technologies will furnish replacement parts, F.O.B. job site, or, at our option, will refund the purchase price of any product which, when installed and used as recommended by ProGauge Technologies and in accordance with the best installation and operating practices and techniques, is proven to be defective in material or workmanship within (1) year from the date of shipment thereof, provided ProGauge Technologies are given immediate written notice of the defect and an opportunity to inspect the same. Products sold by ProGauge Technologies, Inc. which are manufactured by others are warranted only to the extent of, and are limited to, the warranty of the manufacturer.

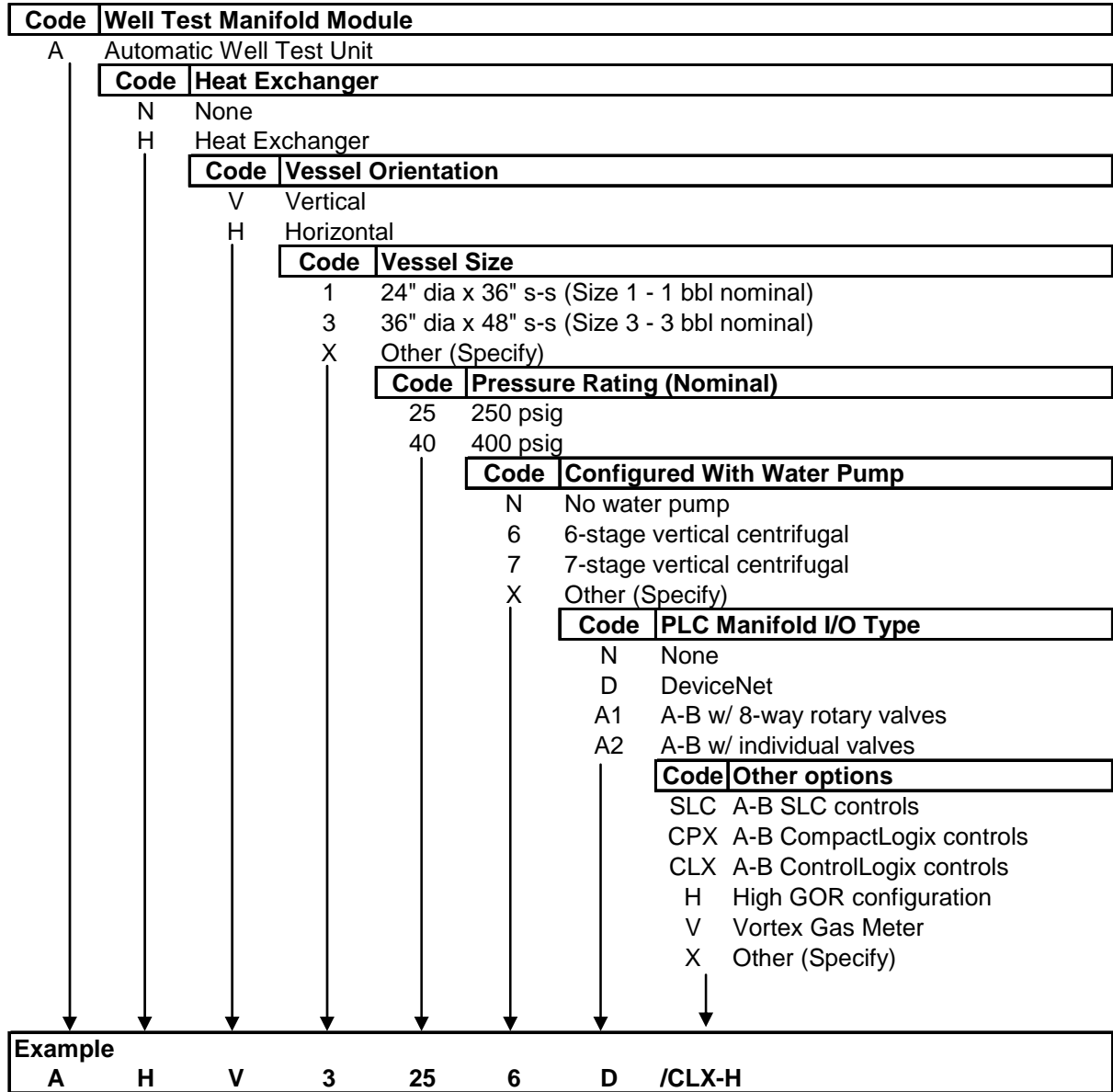
7- Rights to use of design,

The **PROGAUGE** Well Testing System is covered by United States Patents, and by United States copyright laws. ProGauge Technologies hereby agrees to provide assistance to Customer to allow the integration of the **PROGAUGE** Well Testing System into Customer operations, but no license to reuse concepts, designs or computational algorithms is granted to Customer, its successors or assigns. All rights and concepts presented and provided to Customer regarding the **PROGAUGE** Well Testing System, including, but not limited to, design, operation, control or analysis, are the exclusive property of ProGauge Technologies, Inc., and may not be reproduced for, revealed or otherwise provided to unauthorized personnel, or to any contract personnel of Customer for any purpose, without the express written permission of ProGauge Technologies. Upon commitment to purchase, Customer acknowledges and agrees to these rights and limitations.

Thank you for the opportunity to quote ProGauge equipment,

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PROGAUGE Well Test System Ordering Information



PROGAUGE™

High GOR - High Volume Well Test Vessel General Specifications

1. Size –

Vessel: 24" dia. X 36" seam to seam, approximately 2 bbls. Volume.
Overall: 78.375" deep x 61.625" wide x 108" high
Weight: 4570# estimate.

2. Vessel Rating –

ASME design rating: 400 PSIG @ 400°F.
Insurer/Underwriter: Hartford Steam Boiler Inspection & Insurance Co.

Vessel is ASME certified and fully tested. It is of ASME code design, and includes safety relief device for vessel rating and code certification documentation U1A and UA.

3. Power –

Controls: 240VAC @ 40A.
Water Pump: 190 - 460V 50 Hz

4. External Piping Interconnections –

Production inlet: 2" sch. 40 bevel weld end
Production outlet: 2" sch. 40 bevel weld end
Pumpout water inlet: 2" sch. 40 bevel weld end
Pressure relief outlet: 2" 300 # Rupture Disc

5. Pressurized Water Source Requirements –

Pressure: at least 30 PSIG
Rate: 10 GPM during pumpout steps, ~20 GPM during purging.
Quality: < 100 PPM oil and grease maximum allowable
Temperature: between 80°F and 200°F

6. Controller Communication Protocols –

Ethernet: TCP/IP & Ethernet/IP on 10/100baseT Ethernet using Allen-Bradley messaging and drivers. Managed Ethernet switch is optimized for Ethernet/IP communication and incorporates IGMP snooping to manage broadcast messages.

PROGAUGE™

High GOR – Size 3 Well Test Vessel General Specifications

7. Size –

Vessel: 36" dia. X 48" seam to seam, approximately 5 bbls. Volume.
Overall: 60" deep x 209" wide x 164" high
Weight: 5570# estimate.

8. Vessel Rating –

ASME design rating: 250 PSIG @ 400°F.
Insurer/Underwriter: Hartford Steam Boiler Inspection & Insurance Co.

Vessel is ASME certified and fully tested. It is of ASME code design, and includes safety relief device for vessel rating and code certification documentation U1A and UA.

9. Power –

Controls: 240VAC @ 40A.
Water Pump: 190 - 460V 50 Hz

10. External Piping Interconnections –

Production inlet: 4" ANSI 300 RF flange
Production outlet: 4" ANSI 300 RF flange
Pumpout water inlet: 2" ANSI 300 RF flange
Pressure relief outlet: 2" ANSI 300 RF flange

11. Pressurized Water Source Requirements –

Pressure: at least 5 psig
Rate: 15 GPM during pumpout steps, ~20 GPM during purging.
Quality: < 100 PPM oil and grease maximum allowable
Temperature: between 80°F and 200°F

12. Controller Communication Protocols –

Ethernet: TCP/IP & Ethernet/IP on 10/100baseT Ethernet using Allen-Bradley messaging and drivers. Managed Ethernet switch is optimized for Ethernet/IP communication and incorporates IGMP snooping to manage broadcast messages.