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9170 Series Metrology Well Calibrators

Technical Data

- Best-performing industrial heat sources (accuracy, stability, uniformity) in the world
- Immersion depth to 203 mm (8 in)
- Optional ITS-90 reference input reads PRTs to ±0.006 °C
- Temperature range from –45 °C to 700 °C

Every once in a while, a new product comes around that changes the rules. It happened when we introduced handheld dry-wells. It happened when we introduced Micro-Baths. Now we've combined bath-level performance with dry-well functionality and legitimate reference thermometry to create Metrology Wells.

With groundbreaking new proprietary electronics from Fluke's Hart Scientific Division (patents pending), Metrology Wells let you bring lab-quality performance into whatever field environment you might work in. New analog and digital control techniques provide stability as good as ±0.005 °C. And with dual-zone control, axial (or "vertical") uniformity is as good as ±0.02 °C over a 60 mm (2.36 in) zone. (That's 60 mm!) Such performance doesn't exist anywhere else outside of fluid baths.

In short, there are six critical components of performance in an industrial heat source (which the European metrology community explains, for example, in the document EA-10/13): calibrated display accuracy, stability, axial (vertical) uniformity, radial (well-to-well) uniformity, impact from loading, and hysteresis. We added a seventh in the form of a *legitimate* reference thermometer input and created an entirely new product category: Metrology Wells.

(By the way, Metrology Wells are the only products on the market supported by published specifications addressing *every* performance category in the EA-10/13. Our specs aren't just hopes or guidelines. They apply to every Metrology Well we sell.)

Display accuracy

Dry-wells are typically calibrated by inserting a calibrated PRT into one of the wells and making adjustments to the calibrator's internal control sensor based on the readings from the PRT. This has limited value because the unique characteristics of the reference PRT, which essentially become "calibrated into" the calibrator, are often quite different from the thermometers tested by the calibrator. This is complicated by the presence of significant thermal gradients in the block and inadequate

Built-In Reference Thermometry!

Fluke's Hart Scientific Division has been making the world's best thermometer readout devices for quite some time. Our Super-Thermometer, *Black Stack,* and Tweener thermometers are well-known everywhere. Now we're making our proprietary Tweener measurement circuitry available directly in a heat source — our new Metrology Wells.

This optionally built-in input accepts 100-, 25-, and 10-ohm PRTs. It reads thermometer probes accurately from ±0.006 °C at 0 °C to ±0.027 °C at 661 °C, not including errors from the probe. It is compatible with every PRT sold by Hart and connects to Metrology Wells via a 5-pin DIN connector.

Two things dramatically differentiate the Tweener circuit from the measurement electronics built into many dry-wells. First, it accepts unique ITS-90 characterization coefficients from reference thermometers, which allow you to take full advantage of the accuracies of those thermometers. Second, it comes with a traceable, accredited calibration, providing you full confidence in the integrity of its measurements.

Nothing beats a Hart Metrology Well for industrial thermal performance. And nothing beats a Tweener measurement for built-in reference thermometry.

sensor immersion into blocks that are simply too short.

Metrology Wells are different. Temperature gradients, loading effects, and hysteresis have been minimized to make the calibration of the display much more meaningful. We use only traceable, accredited PRTs to calibrate Metrology Wells and our proprietary electronics consistently demonstrate repeatable accuracy more than ten times better than our specs, which range from ±0.1 °C at the most commonly used temperatures to ±0.25 °C at 661 °C.

For even better accuracy, Metrology Wells may be ordered with built-in electronics for reading external PRTs with ITS-90 characterizations. (See sidebar, Built in Reference Thermometry, above.)

Stability

Heat sources from Hart have long been known as the most stable heat sources in the world. It only gets better with Metrology Wells. Both low-temperature units (Models 9170 and 9171) are stable to ±0.005 °C over their full range. Even the 700 °C unit (Model 9173) achieves stability of ±0.03 °C. Better stability can only be found in fluid baths and primary fixed-point devices. The "off-the-shelf controllers" used by most dry-well manufacturers simply can't provide this level of performance.

Axial uniformity

The EA-10/13 document suggests that dry-wells should include a zone of maximum temperature homogeneity, which extends for 40 mm (1.54 in), usually at the bottom of a well. Metrology Wells, however, combine our unique electronics with dual-zone control and more well depth than is found in dry-wells to provide homogeneous zones over 60 mm (2.36 in). Vertical gradients in these zones range from ±0.02 °C at 0 °C to ±0.4 °C at 700 °C.

What's more, Metrology Wells actually have these specifications published for each unit, and we stand by them. We even offer a specially-constructed PRT for testing axial uniformity (models 5662 and 5663).

Radial uniformity

Radial uniformity is the difference in temperature between one well and another well. For poorly designed heat sources, or when large-diameter probes are used, these differences can be very large. For Metrology Wells, we define our specification as the largest temperature difference between the vertically homogeneous zones of any two wells that are each 6.4 mm (0.25 in) in diameter or smaller. The cold units (9170 and 9171) provide radial uniformity of ±0.01 °C and the hot units (9172 and 9173) range from ±0.01 °C to ±0.04 °C (at 700 °C).

Loading

Loading is defined as the change in temperature sensed by a reference thermometer inserted into the bottom of a well after the rest of the wells are filled with thermometers, too.

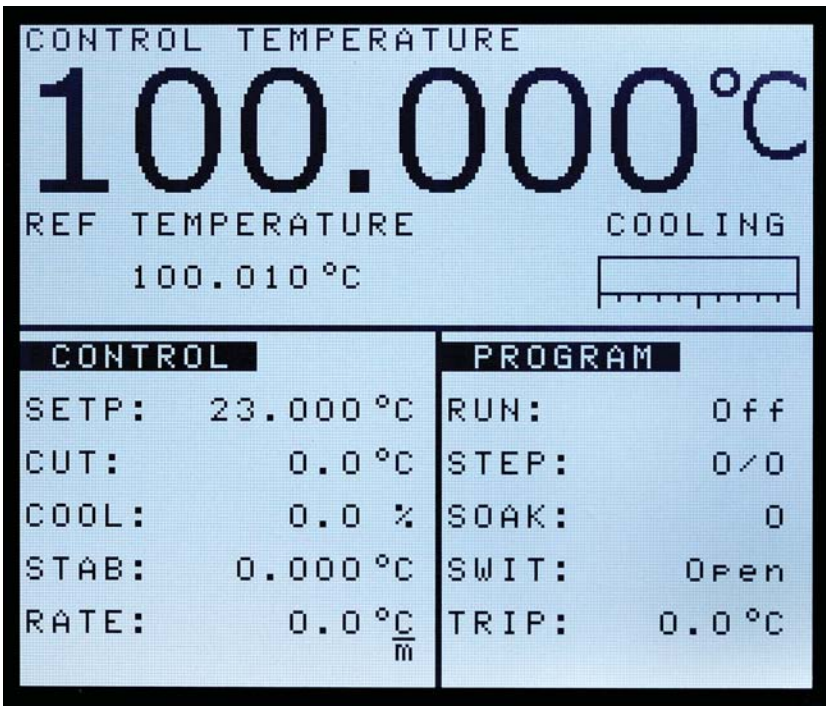
For Metrology Wells, loading effects are minimized for the same reasons that axial gradients are minimized. We use deeper wells than found in dry-wells. And we utilize proprietary dual-zone controls. Loading effects are as minimal as ±0.005 °C in the cold units.

Hysteresis

Thermal hysteresis exists far more in internal control sensors than in good-quality reference PRTs. It is evidenced by the difference in two external measurements of the same set-point temperature when that temperature is approached from two different directions (hotter or colder) and is usually largest at the midpoint of a heat source's temperature range. It exists because control sensors are typically designed for ruggedness and do not have the "strain free" design characteristics of SPRTs, or even most PRTs. For Metrology Wells, hysteresis effects range from ±0.025 °C to ±0.07 °C.

Immersion depth

Immersion depth matters. Not only does it help minimize axial gradient and loading effects, it helps address the unique immersion characteristics of each thermometer tested in the heat source. Those characteristics include the location and size of the actual sensor within the probe, the width



Metrology Well displays offer all the information needed to perform calibrations — control and reference probe temperatures, heating and cooling status, set-point temperature, stability criteria, and more.

and thermal mass of the probe, and the lead wires used to connect the sensor to the outside world. Metrology Wells feature well depths of 203 mm (8 in) in the Models 9171, 9172, and 9173. The Model 9170 is 160 mm (6.3 in) deep to facilitate temperature of –45 °C.

Other great features

A large LCD display, numeric keypad, and on-screen menus make use of Metrology Wells simple and intuitive. The display shows the block temperature, built-in reference thermometer temperature, cutout temperature, stability criteria, and ramp rate. The user interface can be configured to display in English, French, or Chinese (French and Chinese to be implemented in 2006).

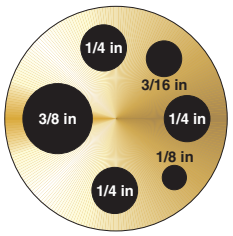
All four models come with an RS-232 serial interface and the Model 9930, Interface-*it* software. All are also compatible with Model 9938 MET/TEMP II software for completely automated calibrations of RTDs, thermocouples, and thermistors (Metrology Wells with built-in reference input options will be compatible with MET/TEMP II in early 2006).

Even without a PC, Metrology Wells have four different preprogrammed calibration tasks that allow up to eight temperature set points with "ramp and soak" times between each. There is an automated "switch test" protocol that zeros in on the "dead-band" for thermal switches. And a dedicated °C/°F button allows for easy switching of temperature units.

Any of six standard inserts may be ordered with each unit, accommodating a variety of metric- and imperial-sized probe diameters. (See inset at right.) And Metrology Wells are small enough and light enough to go anywhere.

9170

The Model 9170 achieves the lowest temperatures of the series, reaching –45 °C in normal room conditions. The 9170 is stable to ±0.005 °C over its full temperature range (up to 140 °C) and has 160 mm (6.3 in) of immersion depth. With axial uniformity of ±0.02 °C and radial uniformity of ±0.01 °C, this model delivers exceptional uncertainty budgets and is perfect



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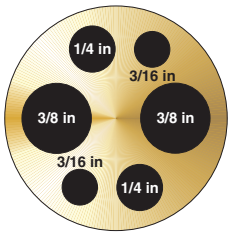

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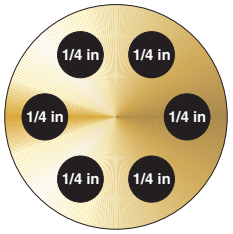

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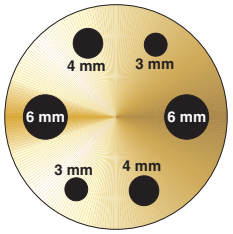

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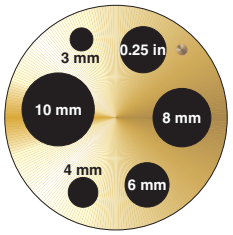

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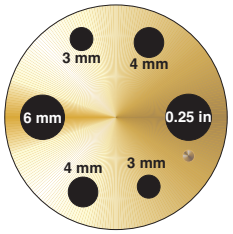

Insert "F"

The Metrology Well family consist of four models (Model 9170, 9171, 9172, and 9173) which, combined, cover a temperature range of –45 °C to 700 °C.

for a variety of pharmaceutical and other applications.

9171

If you need more depth, the Model 9171 provides 203 mm (8 in) of immersion over temperatures from –30 °C all the way to 155 °C with full-range stability of ±0.005 °C. Just like the 9170, this dry-well has exceptional axial and radial uniformity. The display of the 9171 is calibrated to an accuracy of ±0.1 °C over its full range.

9172

The Model 9172 provides temperatures from 35 °C to 425 °C with a calibrated display accurate to ±0.2 °C at 425 °C. In addition to exceptional accuracy, the 9172 is stable from ±0.005 °C to ±0.01 °C, depending on temperature. With 203 mm (8 in) of immersion, the 9172 significantly reduces stem conduction errors at high-temperatures.

9173

For work between 50 °C and 700 °C, the Model 9173 provides unmatched performance. The 9173 has a display accuracy of ±0.25 °C at 700 °C and an immersion depth of 203 mm (8 in). Stability and uniformity performance of this unit are enough to dramatically reduce uncertainty budgets for calibrations of thermometers at high temperatures.

Of course, there's still a place in the world for dry-wells or "dry block" calibrators. In fact, Hart makes and will continue to make some of the best performing, portable, fast dry-wells in the world. There's still nothing better for a quick test of industrial temperature sensor performance.

We just can't resist the urge, though, to keep coming up with breakthrough product designs that can dramatically impact the ways people work and the results they see. For the absolute best performance in a portable temperature source, Metrology Wells raise the standard to an entirely new level.

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Specifications

	9170	9171	9172	9173
Range (at 23 °C ambient)	–45 °C to 140 °C (–49 °F to 284 °F)	–30 °C to 155 °C (–22 °F to 311 °F)	35 °C to 425 °C (95 °F to 797 °F)	50 °C to 700 °C[†] (122 °F to 1292 °F)
Display Accuracy	±0.1 °C full range		±0.1 °C at 100 °C ±0.15 °C at 225 °C ±0.2 °C at 425 °C	±0.2 °C at 425 °C ±0.25 °C at 660 °C
Stability	±0.005 °C full range		±0.005 °C to 100 °C ±0.008 °C to 225 °C ±0.01 °C to 425 °C	±0.005 °C to 100 °C ±0.01 °C to 425 °C ±0.03 °C to 700 °C
Axial Uniformity (60 mm)	±0.1 °C at –45 °C ±0.04 °C at –35 °C ±0.02 °C at 0 °C ±0.07 °C at 140 °C	±0.025 °C at –30 °C ±0.02 °C at 0 °C ±0.07 °C at 155 °C	±0.05 °C at 100 °C ±0.1 °C at 225 °C ±0.2 °C at 425 °C	±0.1 °C at 100 °C ±0.25 °C at 425 °C ±0.4 °C at 700 °C
Radial Uniformity	±0.01 °C full range		±0.01 °C at 100 °C ±0.02 °C at 225 °C ±0.025 °C at 425 °C	±0.01 °C at 100 °C ±0.025 °C at 425 °C ±0.04 °C at 700 °C
Loading Effect (with a 6.35 mm reference probe and three 6.35 mm probes)	±0.02 °C at –45 °C ±0.005 °C at –35 °C ±0.01 °C at 140 °C	±0.005 °C at –30 °C ±0.005 °C at 0 °C ±0.01 °C at 155 °C	±0.01 °C full range	±0.02 °C at 425 °C ±0.04 °C at 700 °C
Hysteresis	±0.025 °C		±0.04 °C	±0.07 °C
Well Depth	160 mm (6.3 in)	203 mm (8 in)		
Resolution	0.001 °C			
Display	LCD, °C or °F, user-selectable			
Key Pad	Ten key with decimal and +/- button. Function keys, menu key, and °C / °F key.			
Cooling Time	44 min: 23 °C to –45 °C 19 min: 23 °C to –30 °C 19 min: 140 °C to 23 °C	30 min: 23 °C to –30 °C 25 min: 155 °C to 23 °C	220 min: 425 °C to 35 °C 100 min: 425 °C to 100 °C	235 min: 700 °C to 50 °C 153 min: 700 °C to 100 °C
Heating Time	32 min: 23 °C to 140 °C 45 min: –45 °C to 140 °C	44 min: 23 °C to 155 °C 56 min: –30 °C to 155 °C	27 min: 35 °C to 425 °C	46 min: 50 °C to 700 °C
Size (height x width x depth)	366 x 203 x 323 mm (14.4 x 8 x 12.7 in)			
Weight	15 kg (33 lb)	15 kg (33 lb)	13.2 kg (29 lb)	15 kg (33 lb)
Power	115 VAC (±10%), 6.3 A, or 230 VAC (±10%), 3.15 A		115 VAC (±10%), 10 A, or 230 VAC (±10%), 5 A	
Computer Interface	RS-232 Interface with 9930 Interface-*it* control software included			
Traceable Calibration (NIST)	Data at –45 °C, 0 °C, 50 °C, 100 °C, and 140 °C	Data at –30 °C, 0 °C, 50 °C, 100 °C, and 155 °C	Data at 100 °C, 150 °C, 250 °C, 350 °C, and 425 °C	Data at 100 °C, 200 °C, 350 °C, 500 °C, and 660 °C

[†]Calibrated to 660 °C; reference thermometer recommended at higher temperatures.

Specifications	**Built-in Reference Input**	
Temperature Range	–200 °C to 962 °C (–328 °F to 1764 °F)	
Resistance Range	0 Ω to 400 Ω, auto-ranging	
Characterizations	ITS-90 subranges 4, 6, 7, 8, 9, 10, and 11 Callendar-Van Dusen (CVD): R_0, α, β, δ	
Resistance Accuracy	0 Ω to 20 Ω: 0.0005 Ω 20 Ω to 400 Ω: 25 ppm	
Temperature Accuracy (does not include probe uncertainty)	**10 Ω PRTs:** ±0.013 °C at 0 °C ±0.014 °C at 155 °C ±0.019 °C at 425 °C ±0.028 °C at 700 °C	**25 Ω and 100 Ω PRTs:** ±0.007 °C at –100 °C ±0.006 °C at 0 °C ±0.011 °C at 155 °C ±0.013 °C at 225 °C ±0.019 °C at 425 °C ±0.027 °C at 661 °C
Resistance Resolution	0 Ω to 20 Ω: 0.0001 Ω 20 Ω to 400 Ω: 0.001 Ω	
Measurement Period	1 second	
Probe Connection	4-wire with shield, 5-pin DIN connector	
Calibration	NVLAP accredited (built-in reference input only), NIST-traceable calibration provided	

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Ordering Information

9170 Metrology Well

9170-*X*	Metrology Well, –45 °C to 140 °C, w/INS*X*
9170-*X*-R	Metrology Well, –45 °C to 140 °C, w/INS*X*, w/Built-In Reference

X in the above model numbers to be replaced with A, B, C, D, E, or F as appropriate for the desired insert. See the illustration on page 3 and listing below.

9170-INSA	Insert "A", 9170, Al, Misc Holes
9170-INSB	Insert "B", 9170, Al, Comparison Holes
9170-INSC	Insert "C", 9170, Al, 0.25-inch Holes
9170-INSD	Insert "D", 9170, Al, Metric Comparison Holes
9170-INSE	Insert "E", 9170, Al, Misc Metric Holes, w/0.25-inch Ref Hole
9170-INSF	Insert "F", 9170, Al, Metric Comparison Holes, w/0.25-inch Ref Hole
9170-INSZ	Insert "Z", 9170, Al, Blank
9170-CASE	Case, Carrying, 9170–3 Metrology Wells
9170-DCAS	Case, Transportation with Wheels, 9170–3 Metrology Wells

9171 Metrology Well

9171-*X*	Metrology Well, –30 °C to 155 °C, w/INS*X*
9171-*X*-R	Metrology Well, –30 °C to 155 °C, w/INS*X*, w/Built-In Reference

X in the above model numbers to be replaced with A, B, C, D, E, or F as appropriate for the desired insert. See the illustration on page 3 and listing below.

9171-INSA	Insert "A", 9171, Al, Misc Holes
9171-INSB	Insert "B", 9171, Al, Comparison Holes
9171-INSC	Insert "C", 9171, Al, 0.25-inch Holes
9171-INSD	Insert "D", 9171, Al, Comparison Metric Holes
9171-INSE	Insert "E", 9171, Al, Misc Metric Holes, w/0.25-inch Ref Hole
9171-INSF	Insert "F", 9171, Al, Metric Comparison Holes, w/0.25-inch Ref Hole
9171-INSZ	Insert "Z", 9171, Al, Blank
9170-CASE	Case, Carrying, 9170–3 Metrology Wells
9170-DCAS	Case, Transportation with Wheels, 9170–3 Metrology Wells

9172 Metrology Well

9172-*X*	Metrology Well, 35 °C to 425 °C, w/INS*X*
9172-*X*-R	Metrology Well, 35 °C to 425 °C, w/INS*X*, w/Built-In Reference

X in the above model numbers to be replaced with A, B, C, D, E, or F as appropriate for the desired insert. See the illustration on page 3 and listing below.

9172-INSA	Insert "A", 9172, Brass, Misc Holes
9172-INSB	Insert "B", 9172, Brass, Comparison Holes
9172-INSC	Insert "C", 9172, Brass, 0.25-inch Holes
9172-INSD	Insert "D", 9172, Brass, Metric Comparison Holes
9172-INSE	Insert "E", 9172, Brass, Misc Metric Holes, w/0.25-inch Ref Hole
9172-INSF	Insert "F", 9172, Brass, Metric Comparison Holes, w/0.25-inch Ref Hole
9172-INSZ	Insert "Z", 9172, Brass, Blank
9170-CASE	Case, Carrying, 9170–3 Metrology Wells
9170-DCAS	Case, Transportation with Wheels, 9170–3 Metrology Wells

9173 Metrology Well

9173-*X*	Metrology Well, 50 °C to 700 °C, w/INS*X*
9173-*X*-R	Metrology Well, 50 °C to 700 °C, w/INS*X*, w/Built-In Reference

X in the above model numbers to be replaced with A, B, C, D, E, or F as appropriate for the desired insert. See the illustration on page 3 and listing below.

9173-INSA	Insert "A", 9173, Al-Brnz, Misc Holes
9173-INSB	Insert "B", 9173, Al-Brnz, Comparison Holes
9173-INSC	Insert "C", 9173, Al-Brnz, 0.25-inch Holes
9173-INSD	Insert "D", 9173, Al-Brnz, Comparison Metric Holes
9173-INSE	Insert "E", 9173, Al-Brnz, Misc Metric Holes, w/0.25-inch Ref Hole
9173-INSF	Insert "F", 9173, Al-Brnz, Metric Comparison Holes, w/0.25-inch Ref Hole
9173-INSZ	Insert "Z", 9173, Al-Brnz, Blank
9170-CASE	Case, Carrying, 9170–3 Metrology Wells
9170-DCAS	Case, Transportation with Wheels, 9170–3 Metrology Wells

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