Bath Selection Guide

Compact series

Model	Range	Stability	Depth	Features	Page
6330	35 °C to 300 °C	±0.005 °C at 100 °C ±0.015 °C at 300 °C	234 mm 9.25 in	Small benchtop footprint. Optional cart includes storage space.	96
7320	–20 °C to 150 °C	±0.005 °C at –20 °C ±0.005 °C at 25 °C	234 mm 9.25 in	Small 9.2-liter (2.4-gallon) tank. Uniformity ±0.005 °C.	
7340	–40 °C to 150 °C	±0.005 °C at –40 °C ±0.005 °C at 25 °C	234 mm 9.25 in	Low temperature calibrations. Metrology-level performance.	
7380	–80 °C to 100 °C	±0.006 °C at –80 °C ±0.010 °C at 0 °C	178 mm 7 in	Achieves –80 °C in less than 130 minutes. Quiet operation.	
7312	–5 °C to 110 °C	±0.001 °C at 0 °C	496 mm 19.5 in	Maintains two TPW cells. Compact, quiet.	17
6331	40 °C to 300 °C	±0.007 °C at 100 °C ±0.015 °C at 300 °C	457 mm 18 in	18 in of depth with just 16 liters of fluid. RS-232 included.	94
7321	–20 °C to 150 °C	±0.005 °C at –20 °C ±0.005 °C at 25 °C	457 mm 18 in	Perfect for LIG thermometers with optional kit. Quiet operation.	
7341	–45 °C to 150 °C	±0.005 °C at –40 °C ±0.005 °C at 25 °C	457 mm 18 in	Fast temperature changes. Access opening accommodates many thermometers.	
7381	–80 °C to 110 °C	±0.006 °C at –80 °C ±0.005 °C at 0 °C	457 mm 18 in	Stability of ±0.006 °C or better over full range. Compatible with MET/TEMP II software.	

Standard baths

Model	Range	Stability	Depth	Features	Page
7060	–60 °C to 110 °C	±0.0025 °C at –60 °C ±0.0015 °C at 25 °C	305 mm 12 in	Reaches –60 °C with standard refrigeration.	100
7080	–80 °C to 110 °C	±0.0025 °C at –80 °C ±0.0015 °C at 25 °C	305 mm 12 in	Best combination of stability and ultralow temperatures.	
7100	–100 °C to 110 °C	±0.008 °C at –100 °C	337 mm 13.25 in	No external cooling for –100 °C.	
7008	–5 °C to 110 °C	±0.0007 °C at 25 °C	331 mm 13 in	Large tank for larger mass immersion. Maintains standard resistors.	102
7011	–10 °C to 110 °C	±0.0008 °C at 0 °C ±0.0008 °C at 25 °C	305 mm 12 in	Self-contained refrigeration. Best-priced ultrastable, cooled bath.	
7012	–10 °C to 110 °C	±0.0008 °C at 0 °C ±0.0008 °C at 25 °C	457 mm 18 in	Maintains up to 4 WTP cells for weeks. Large access: 162 x 292 mm (6.3 in x 11.5 in).	
7037	–40 °C to 110 °C	±0.002 °C at –40 °C ±0.0015 °C at 25 °C	457 mm 18 in	Lowest-temperature deep-well bath. Mercury cell maintenance bath.	
7040	–40 °C to 110 °C	±0.002 °C at –40 °C ±0.0015 °C at 25 °C	305 mm 12 in	Self-contained single-stage refrigeration. Digital controller.	
6020	40 °C to 300 °C	±0.001 °C at 40 °C ±0.005 °C at 300 °C	305 mm 12 in	Broad range to 300 °C. Optional RS-232 and IEEE-488 interface.	104
6022	40 °C to 300 °C	±0.001 °C at 40 °C ±0.005 °C at 300 °C	464 mm 18.25 in	Deep tank for SPRT or LIG thermometers. Optional fluid level adapter.	
6024	40 °C to 300 °C	±0.001 °C at 40 °C ±0.005 °C at 300 °C	337 mm 13.25 in	Larger access opening and tank size for higher throughput.	
6050H	40 °C to 550 °C	±0.002 °C at 200 °C ±0.007 °C at 500 °C	305 mm 12 in	Better stability than sand baths. High temperatures, low gradients.	106

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Special application

Model	Range	Stability	Depth	Features	Page
6054	50 °C to 300 °C	±0.003 °C at 100 °C ±0.005 °C at 300 °C	610 mm 24 in	Maintains constant fluid level.	108
6055	200 °C to 550 °C	±0.003 °C at 200 °C ±0.01 °C at 550 °C	432 mm 17 in	Includes LIG sighting channel.	
7007	−5 °C to 110 °C	±0.001 °C at 0 °C ±0.003 °C at 100 °C	610 mm 24 in	Large, 7-inch-diameter working space.	
7009	0 °C to 110 °C	±0.0007 °C at 25 °C	331 mm 13 in	Largest capacity with 4.8-cubic foot (167-liter) working area and 0.7 mK stability.	110
7015	0 °C to 110 °C	±0.0007 °C at 25 °C	331 mm 13 in	Ultrastable for maintaining resistors. Large access and workspace. Splash- and spill-resistant lid.	
7108	20 °C to 30 °C	±0.004 °C	203 mm 8 in	Peltier cooling means no compressor and quieter performance. Maintains standard resistors.	
7911A2	0 °C	±0.002 °C	203 mm 8 in	Easy and affordable zero-point source for calibrating temperature sensors.	112

Other

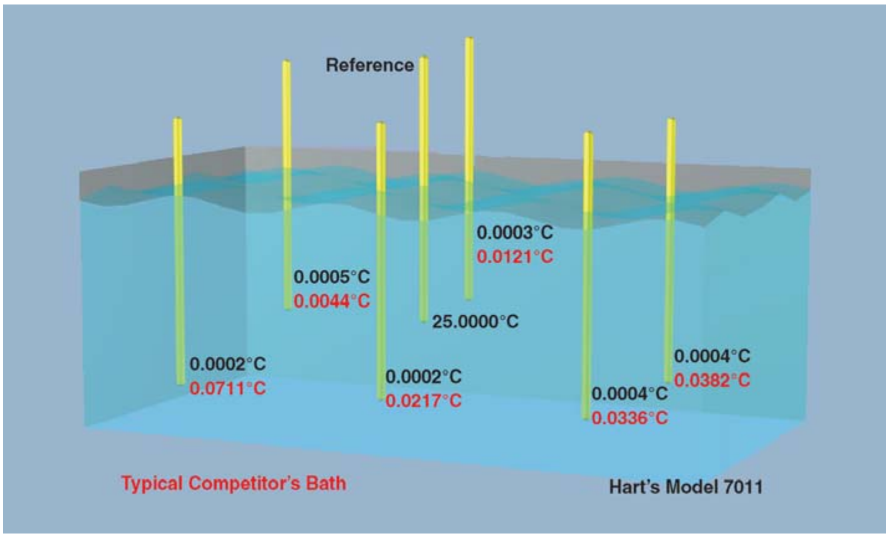
Item	Description	Page
Bath Accessories	Stands, rods, and clamps to suspend and support your probes and thermometers	107
Bath Fluids	Silicone oils, salt, and cold fluids in convenient, small quantities.	114
Rosemount Bath Controllers	Model 7900 controller designed by Hart integrates the features of Hart's 2100 controller and can be used in place of the Rosemount 915 controller with Rosemount-designed baths.	118
Hart Bath Controllers	Model 2100 and 2200 controllers can be integrated with homemade baths or other heat sources to achieve performance levels approaching Hart baths.	119

Note: See page 130 for portable Micro-Baths.

Buying the right bath

During a European trip we visited a lab struggling through the lab accreditation process. The hold-up was their bath. They had already tested baths from two manufacturers. The first bath didn't meet specs and the maker would not rectify the situation, so the bath was returned. The second bath maker delivered a working bath, but when the accreditation auditor tested the bath he downgraded the lab's accuracy class because they couldn't meet the required stability and uniformity levels.

Most bath manufacturers tell you as little as possible about their baths' performance. In fact, a few years ago one of our competitors used to tell people that high bath stability wasn't even necessary for accurate calibrations. Some still don't publish stability specs, and some are so elusive about the meaning of their specs that you can only conclude they've got something to hide.



Deviations from a central reference temperature taken in water with a 1/4-inch-diameter PRT at 25 °C.

Lab accreditation

Accreditation guidelines published by NVLAP specify that the temperature stability and uniformity of the bath fluid should be at least *10 times better* than the required uncertainty of the sensor being calibrated. If you're testing a sensor with a modest specification of ±0.1 °F over its whole range, your bath must be stable and uniform to ±0.01 °F. Translated to Celsius, this figure becomes ±0.005 °C, and you find yourself in need of a bath with performance to the third decimal place *at each of the temperatures you must test.* Several issues are involved in selecting a bath, and each item impacts your calibrations.

Stability

Stability is a measure of the bath's control performance. How well does it maintain a constant temperature? Short-term instability is normally seen as an oscillation around the control point with its peaks defined in a "2-sigma" or "±" statement. If the temperature of the bath fluid is changing during your measurements, you can't get reliable calibration results. Short-term stability is therefore absolutely crucial. Ask about short-term stability and define short-term as lasting at least 15 minutes. Less than that can prove very frustrating.

Long-term stability (over several hours, days, or weeks) is a convenience issue. If your work requires an exact or absolute value, say 25.000 °C, and the bath has long-term drift, you must readjust the control set-point and wait for equilibration (attainment of short-term stability) before each use. So you really need to know both short-term and long-term stability before you know if a bath will meet your needs. Long-term instability normally takes the form of drift in a single direction, but in some baths it may be seen as a long-term oscillation.

A bath's stability will vary at different temperatures. Most baths perform best at temperatures close to ambient. The colder or hotter the set-point, the less stability. Too many sellers give you only one spec at or near ambient. Some give a single stability spec and don't ever mention that it applies only to one temperature or a narrow range. Ask about stability over the whole range that interests you.

Bath fluid also affects stability. The higher a fluid's viscosity and the lower its heat capacity, the larger the effect on stability. In addition to asking the temperature, ask what fluid was used when the spec was taken. For example, at 37 °C a bath will be more stable with water as the medium. If you're going to use oil, expect somewhat larger instability. If your oil has high viscosity at 37 °C, expect even greater degradation in stability.

Uniformity

A bath can have good stability but poor uniformity. The bath must be homogenous in temperature throughout the test zone where you'll make your comparison measurements. When you place two or more thermometers in the fluid, they should be at the same temperature during your measurement. The uniformity spec defines the peak value for this error source. The more probes you're testing, the larger the test zone, and the more important uniformity becomes.

Uniformity depends mostly on the mixing of the bath fluid. Does the bath use a circulator pump for mixing? If it does, are there thermal flow patterns in the bath that interfere with uniformity? Ask about both vertical and horizontal gradients.

In a laminar flow bath (one where the fluid is stirred in a circular pattern), there may be no horizontal gradient, but because the fluid is not mixed vertically, there are gradients between different depths in the bath. This is a problem if your reference probe and the probes under test are not the same length. For example, if you're testing 3-inch-long probes and your standard is a 19-inch SPRT, you've got a problem. You can only immerse the test probes to 3 inches, but if you immerse the SPRT to only 3 inches you don't have sufficient depth to avoid stem effects and light piping that will affect the measurement made by the SPRT. If you properly immerse the SPRT and your bath suffers from vertical gradients, you won't be measuring the temperature at the 3-inch depth of your probes under test.

Equilibration blocks

Accreditation guidelines recommend the use of a metal equilibration block to improve short-term stability during the measurement. It's certainly true that a block can increase the stability of your measurements.

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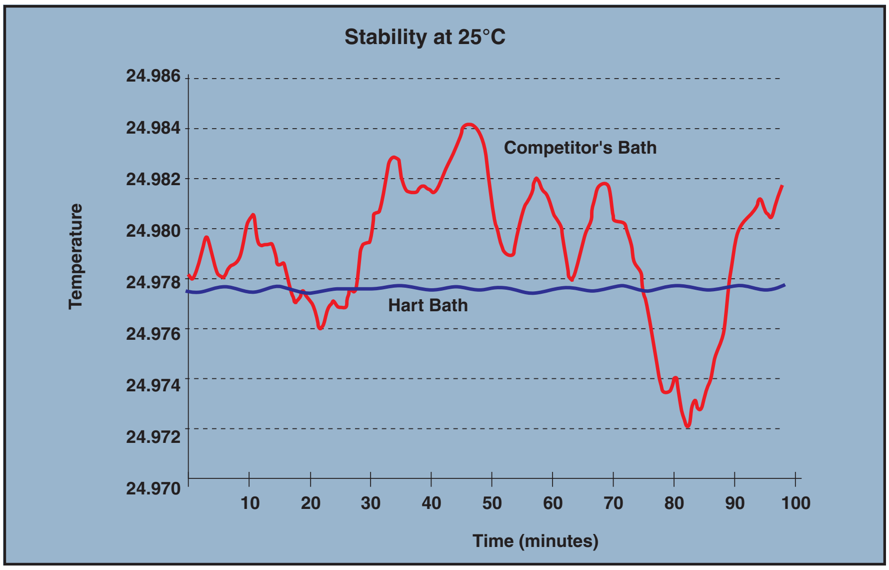
However, a block can be inconvenient. The fixed location and diameter of its holes eliminate the flexibility of a bath to readily test any size or shape of thermometer. You'll need a new block for each probe type. Placing the probes in the block and the block in the bath is somewhat less convenient than simply dipping the probes directly in the liquid. Blocks also oxidize, and silicone oil will thicken and stick in the bottom of the holes. Regular cleaning is required to ensure continued performance levels. If you're testing many probes at a time, a block may not even work for you. It would be difficult to construct a block to properly test 20 thermometers at a time.

Evaluate your bath purchase on specifications taken directly in the bath's fluid. If you're given performance graphs, ask if a block was used. In your lab you can always add a block for the most critical measurements. Remember: *the bath that performs the best without a block will also be the bath that performs the best with a block.*



Hart baths can achieve stability better than 1 mK for extended periods of time.

Temperature range

The advertised temperature range of a bath is not necessarily the practical usable range. For example, a bath with a published range of –80 °C to 150 °C can be a bit misleading. The bath may operate over that temperature range, but currently there's no fluid to match that whole range. Those fluids that perform best at –80 °C will evaporate too rapidly long before they get to 100 °C, much less 150 °C.

An oil bath with an advertised range of 35 °C to 300 °C will be limited by the silicone oil you put in it. A good 300 °C oil will be too viscous to deliver good performance below about 80 °C, so with that fluid the bath's range is 80 °C to 300 °C. In another example, a Hart salt bath works quite well at 40 °C with the right fluid. But salt is molten only above 150 °C.

In addition to fluid, other factors mechanically limit a bath's range. These include refrigeration, insulation, heater types, and other design issues. Refrigeration gases break down above 150 °C, thus limiting the life of the system. If a refrigerated bath is advertised with a higher range, ask if you must remove the cooling coil above a certain temperature. Some baths are advertised with ranges from –80 °C to 300 °C in a single bath. However, the refrigeration gases or coils must be removed before going to the higher end of the temperature range.

We could probably design a single bath that could operate from –100 °C to 500 °C. Besides the high price for such a bath, there would be no point. You would have to drain, clean, and refill the bath at least three times during a calibration run in order to cover that range. The best solution to cover –100 °C to 500 °C is at least three baths with three different fluids. This way each bath design is optimized for performance in the range of the fluid you would use. You'll get the best stability and uniformity while tripling your throughput.

Can you ask too many questions?

It's not likely that a manufacturer will have a test file covering every temperature and fluid combination that interests you, but you can look for representative numbers. How many numbers will they give you? The more the better.

If a salesman says his bath's stability spec of ±0.005 °C applies to the whole range, ask for a graph at several temperatures. If you're buying a bath for use at 300 °C and the maker can't give you performance data above 100 °C, you need to be skeptical.

If a salesman talks about "calibration accuracy" instead of bath performance, ask for specific stability and uniformity data taken in the bath fluid. Finally, ask for a money-back guarantee of the performance. If you can't get what you need from the bath when it's in your lab, you need to know your supplier will be there for you.