

# The U.S. EPA/NIST Program to Phase-Out Mercury-in-Glass Thermometers Used in Industrial and Laboratory Applications

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## Abstract

In 2006, the Quicksilver Caucus, a coalition of State environmental associations, requested that United States government agencies and standards organizations collaborate together to reduce the industrial and laboratory use of Hg thermometers.

- ASTM International found over 850 standards with references to Hg thermometers.
- NIST and the EPA are providing science-based support to assist in the transition of ASTM standards to allow for the use of alternative thermometers

As part of that support, the EPA and NIST completed a pilot study to phase out the use of Hg thermometers in petroleum field activities

- A NIST developed protocol to compare Hg and alternative thermometers was implemented at two petroleum product distribution terminals
- Observations from these tests provided valuable information for understanding measurement differences encountered in the field

## Outcomes from the EPA and NIST work

### Web-based user-friendly guidelines

- Replacement of Mercury Thermometers
- Selecting Alternatives to Mercury-Filled Thermometers
- Verification Methods to Alternatives to Mercury-Filled Thermometers, Including Research on Ice and Steam Points
- Non-Mercury Thermometers for Validating Autoclave Operating Temperatures
- What is Traceability?

### Web-based videos

- Alternative Thermometers
- Ice Melting Point
- Steam Point
- Traceability



### Alternative thermometer testing

- Intrinsically-safe alternative thermometers field tested at two Refined Product Terminals (RTPs)



### Notes and Disclaimer:

- thanks to those companies who donated thermometers (analog and digital) for this work
- any commercial products identified in this poster does not constitute endorsement by NIST

## Field Testing at Refined Product Terminals

- Phase I** Repeatability of thermometers at NIST
- Phase II** Field testing of protocol and thermometers
- Phase III** "Closing-the-Loop" Measurements at NIST

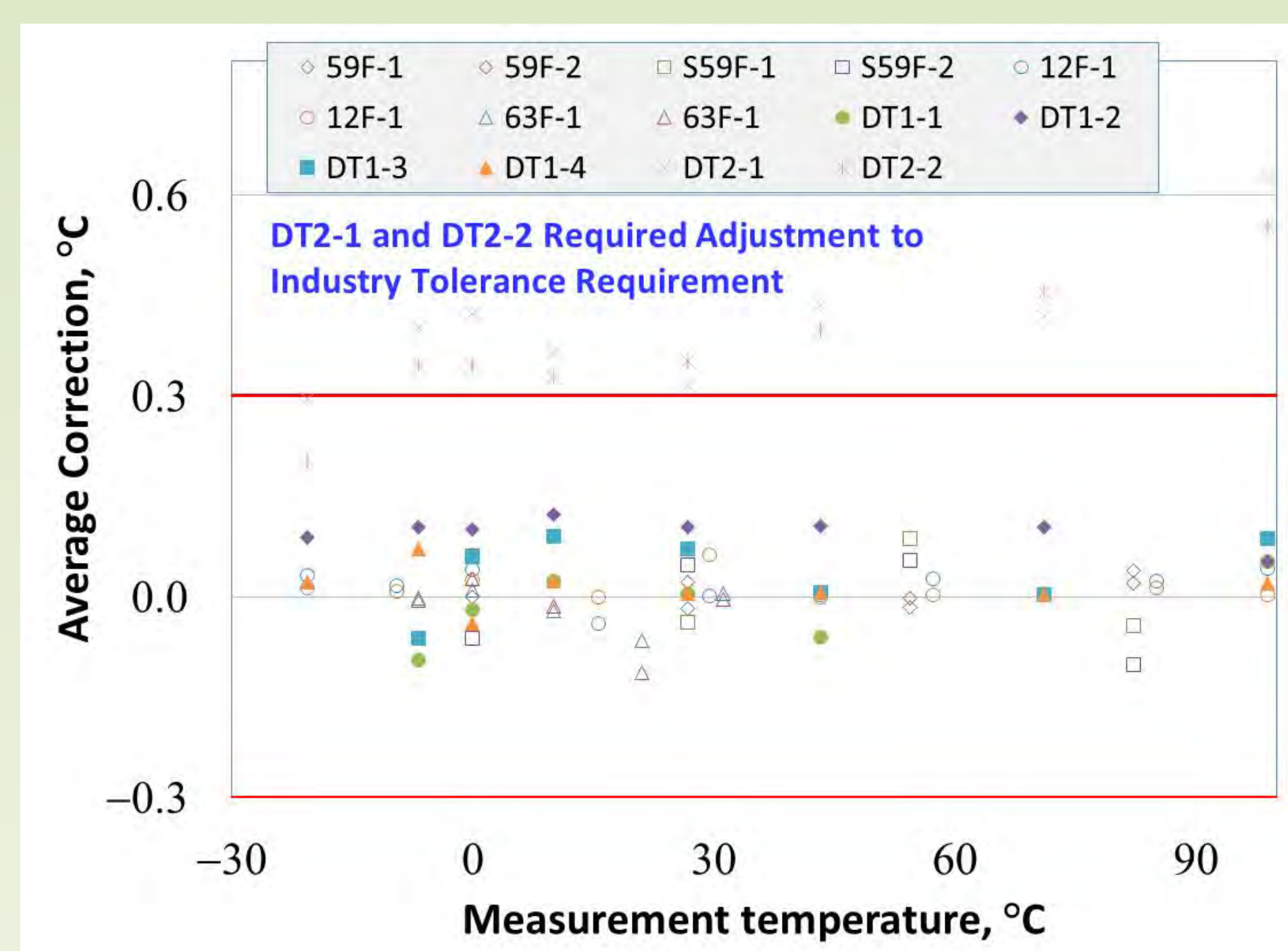
## Phase I: Alternative Thermometers

| Thermometer Type | Thermometer Designation | Range and Graduation/Resolution |
|------------------|-------------------------|---------------------------------|
| Hg               | 59F-1, 59F-2            | 0 F to 180 F in 1 F             |
| Hg               | 12F-1, 12F-2            | -5 F to 215 F in 1 F            |
| Hg               | 63F-1, 63F-2            | 8 F to 89 F in 0.2 F            |
| Organic          | S59F-1, S59F-2          | 0 F to 180 F in 1 F             |
| Digital          | DT1-1                   | -10 C to 188 C in 0.1 C         |
| Digital          | DT1-2                   | -40 C to 204 C in 0.1 C         |
| Digital          | DT1-3                   | -10 C to 188 C in 0.1 C         |
| Digital          | DT1-4                   | -40 C to 204 C in 0.1 C         |
| Digital          | DT2-1, DT2-2            | -50 F to 400 F in 0.1 F         |

## Repeatability testing protocol performed at NIST

- Thermometers cycled through full calibration cycle 3 times
- Measurements performed by two NIST metrologists
- Temperature range of -21 C to 99 C

## Phase I: NIST Laboratory Results



## Phase II: Field Testing of Protocol and Thermometers

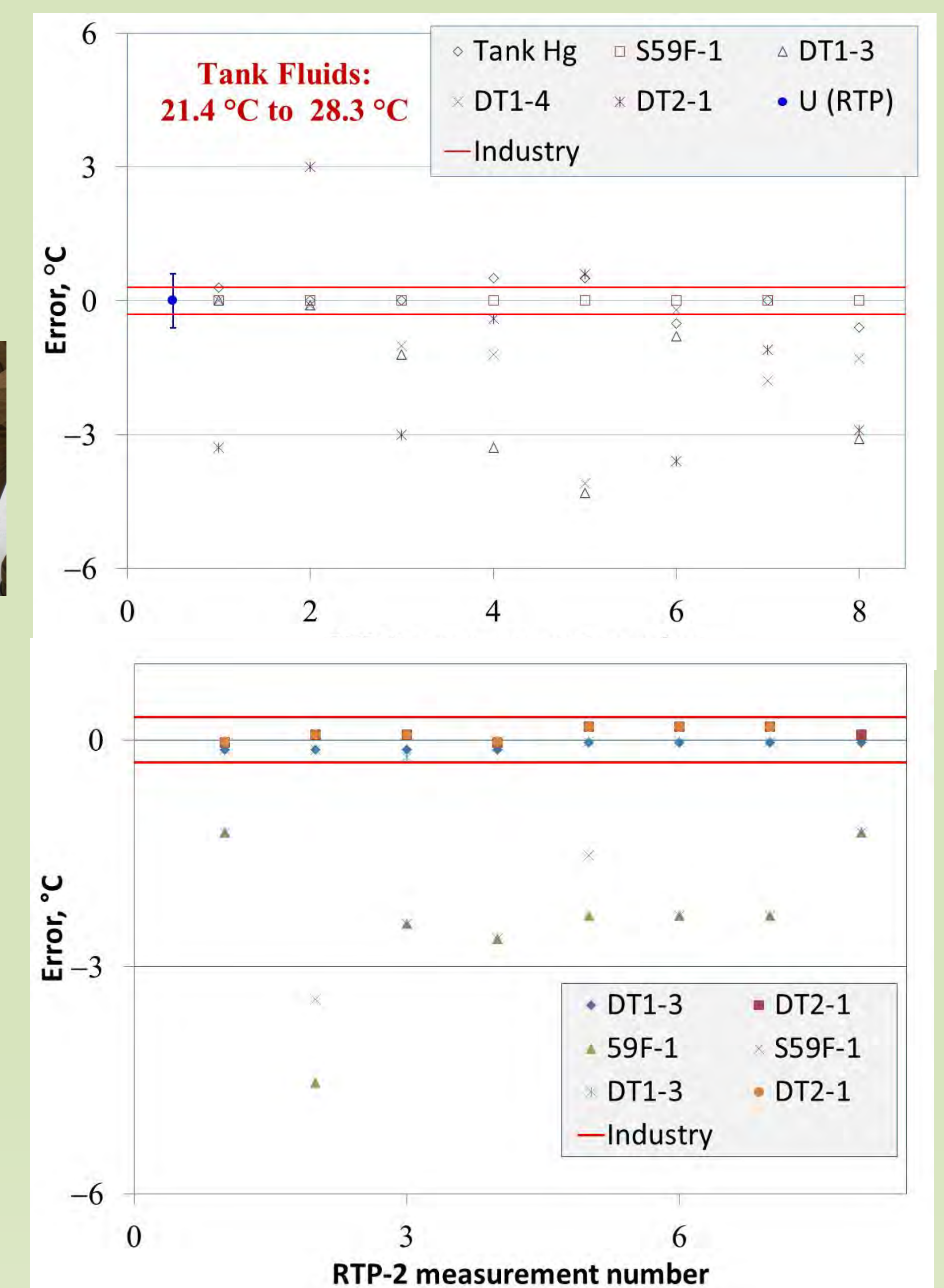
### Protocol to field-test thermometers at RTPs

- Measurement instructions and data-collection worksheets
  - 8 measurement sets performed once per week
- Feasibility of different technicians measuring several thermometers
- Survivability of transfer standards (e.g. thermometers)
- Different measurement conditions
  - Time of day / night
  - Gasoline and Ethanol
  - Weather conditions

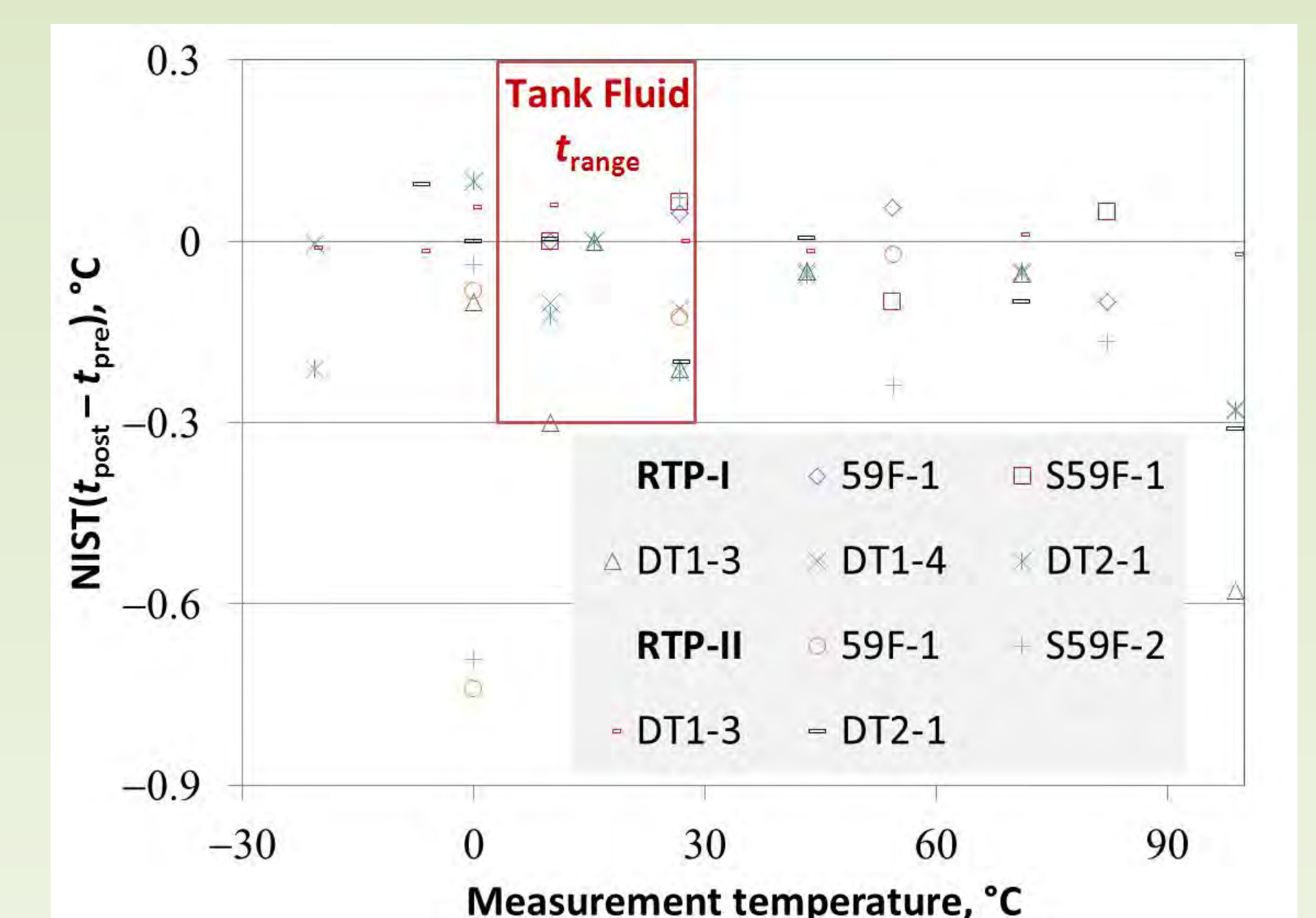


| Thermometers Tested at RTPs |                     |
|-----------------------------|---------------------|
| Hg                          | 59F                 |
| Organic                     | S59F                |
| Digital                     | DT1-3, DT1-4, DT2-1 |

## Phase II: Results from RTP-1 and RTP-2



## Phase III: "Closing-the-Loop" Measurements at NIST



## Notes From the Field

### Thermometer field measurements needs improvement

- Analog Thermometers
  - RTP-1: ±0.6 C field measurement resolution
  - RTP-2: Drain time only 5 minutes for Organics
- Digital Thermometers
  - RTP-1: results reflect staff training issues
  - RTP-2: results reflect NIST & EPA metrologists capabilities

### Digital thermometer manufacturers need to solve various issues

- Ergonomics, EMI, Training tutorials – online videos