



Report No. 987

**Temperature
Proficiency Testing Program**

Round Two

February 2017

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P O Box 7507 NSW 2128, Australia

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1. Foreword

This report summarises the results of an interlaboratory comparison on a Digital Temperature Indicator System with PRT Probe calibration by laboratories.

The exercise was conducted from April 2014 to July 2016 by Proficiency Testing Australia (PTA). The Program Coordinator was Dr M Li. This report was authorised by Mr P Briggs, PTA, General Manager.

The main aim of the program was to assess laboratories' abilities to competently perform the prescribed calibration. Interlaboratory comparison provides objective evidence that laboratories are competent and that they can achieve the level of accuracy for which they have nominated. It also provide a means for improving the quality and performance of laboratories.

2. Program Features and Design

Each laboratory was randomly allocated a unique code number for the program to ensure confidentiality of results. Reference to each laboratory in this report is by code number only. Please note that where laboratories reported more than one set of results, the laboratory code number is reported with letter "A" and "B" etc.

Laboratories were provided with the "Instructions to Participants" and "Results Sheet" (refer Appendix B and C).

Participants were provided with one Hart Scientific Model 1522 Digital Temperature Indicator System S/No: A26315 with PRT Probe S/No:493356.

Eight laboratories from Australia participated in the program, with all laboratories submitting results.

Results (as reported by participants) with corresponding summary statistics are presented in Appendix A for each testing point for each laboratory.

3. Reporting by Participants

Laboratories were asked to report their test results on a proforma "Results Sheet" (refer Appendix C). The participating laboratories were asked to report uncertainties at 95% confidence levels.

4. Reference Values

The reference values for the Temperature Indicator System were based on the calibration results provided by the National Measurement Institute (NMI), Australian Government at the beginning of the program.

5. Summary of Results

A summary of the results returned by the participating laboratories, compared to the reference values, appears in Appendix A in the tables.

The general technical comments appear in Section 6.

In accordance with international practice, measurement performance has been assessed on the basis of an E_n ratio for each measurement. The E_n ratios are calculated using a standard statistical technique for comparing values and are derived from the following expression:

$$E_n = \frac{Lab - Ref}{\sqrt{(U_{Lab})^2 + (U_{Ref})^2}}$$

where Ref is the values measured by NMI, U_{Lab} is the laboratory's reported uncertainty of measurement at a 95% confidence level, and U_{Ref} is the uncertainty associated with the Ref at a 95% confidence level. U_{Ref} is estimated from the uncertainty associated with the NMI measurement results.

6. PTA Comments

The majority of the results of the participating laboratories are consistent with each other and with the reference values. The table of E_n ratios in Appendix A show good agreement amongst all laboratories.

The variation between laboratories seems random, with a good spread of positive and negative E_n ratios, which indicates that the reference artefact does not contain any significant bias. Where $|E_n|$ ratios are greater than 1.0, these all seem to be in error in the same direction, confirming the lack of bias in the reference instrument.

From the ten sets of reported results, 80% (8 sets of results) were considered satisfactory i.e. $|E_n| < 1.0$.

Two sets of results generated an $|E_n|$ ratio greater than 1, including results from laboratory codes 6 and 7.

The interlaboratory comparison results may provide evidence to support the level of competency that the participating laboratories can achieve in temperature measurements.

Initial and final resistance values at the ice point were not reported, they should be included in the next round.

All labs did not follow the instruction to report the IP and coefficients.

Some laboratories subtracted measured data from the nominal values (Lab 4, Lab 5 and Lab 7). Some laboratories subtracted measured values from reference values (Lab 1, Lab 3, Lab 6 and Lab 8).

One laboratory had some typing errors (Lab 2A reported correction at 120°C as 0.006 °C rather than -0.006 °C).

It is recommended that values of $|E_n| \geq 1.0$ are investigated and that corrective actions are taken by the laboratories concerned.

7. Reference

[1] *Guide to Proficiency Testing Australia (2016)*. (This document is located on the PTA website at www.pta.asn.au under Programs / Documents).

APPENDIX A

Summary of Reported Results

SUMMARY OF REPORTED RESULTS

TEMPERATURE ROUND TWO

NOMINAL (°C)	REFERENCE (°C)		LAB 1 (°C)				LAB 2A (°C)				LAB 2B (°C)				LAB 2C (°C)			
	CORR.	U _{REF}	CORR.	U _{LAB}	LAB - REF	En	CORR.	U _{LAB}	LAB - REF	En	CORR.	U _{LAB}	LAB - REF	En	CORR.	U _{LAB}	LAB - REF	En
0	-0.011	0.006	-0.008	0.006	0.00	0.35	-0.004	0.221	0.007	0.03	-0.006	0.221	0.005	0.02	-0.006	0.24	0.005	0.02
40	-0.014	0.006	-0.011	0.020	0.00	0.14	0.003	0.221	0.017	0.08	0.005	0.221	0.019	0.09	-0.006	0.24	0.008	0.03
80	-0.016	0.006	-0.014	0.020	0.00	0.10	-0.002	0.221	0.014	0.06	0.000	0.221	0.016	0.07	-0.006	0.24	0.010	0.04
120	-0.018	0.006	-0.014	0.030	0.00	0.13	0.006	0.228	0.024	0.11	-0.004	0.228	0.014	0.06	-0.006	0.24	0.012	0.05
160	-0.020	0.006	-0.010	0.030	0.01	0.33	-0.007	0.228	0.013	0.06	-0.007	0.228	0.013	0.06	-0.008	0.24	0.012	0.05
200	-0.021	0.006	-0.011	0.080	0.01	0.12	-0.003	0.228	0.018	0.08	-0.004	0.228	0.017	0.07	-0.008	0.24	0.013	0.06
240	-0.023	0.006	-0.007	0.080	0.02	0.20	-0.004	0.228	0.019	0.08	-0.010	0.228	0.013	0.06	-0.007	0.24	0.016	0.07
280	-0.024	0.006	-0.006	0.080	0.02	0.22												
320	-0.025	0.006	0.004	0.080	0.03	0.36												
360	-0.025	0.006	0.008	0.080	0.03	0.41												
400	-0.025	0.006	0.012	0.080	0.04	0.46												
420	-0.025	0.006	0.013	0.080	0.04	0.47												

- Notes:**
- Reference Laboratory: National Measurement Institute Ref No: RN133144.
 - Uncertainties of measurement are at a 95% confidence level.
 - $$E_n = \frac{\text{LAB} - \text{REF}}{\sqrt{(U_{\text{LAB}}^2 + U_{\text{REF}}^2)}}$$
 Values of $|E_n| \geq 1.0$ require investigation.
 - Reference Value: calibration values before artefact distribution.
 - Confidentiality: Refer to Guide to Proficiency Testing Australia (2016).

SUMMARY OF REPORTED RESULTS

TEMPERATURE ROUND TWO

NOMINAL (°C)	REFERENCE (°C)		LAB 3 (°C)				LAB 4 (°C)				LAB 5 (°C)			
	CORR.	U _{REF}	CORR.	U _{LAB}	LAB - REF	En	CORR.	U _{LAB}	LAB - REF	En	CORR.	U _{LAB}	LAB - REF	En
0	-0.011	0.006	-0.007	0.03	-0.002	-0.05	0.00	0.02	0.011	0.53	-0.007	0.010	0.004	0.34
40	-0.014	0.006	-0.010	0.03	-0.003	-0.10	-0.01	0.21	0.004	0.02	0.040	0.800	0.054	0.07
80	-0.016	0.006	-0.014	0.03	-0.006	-0.20	-0.05	0.24	-0.034	-0.14	-0.040	0.800	-0.024	-0.03
120	-0.018	0.006	-0.011	0.03	-0.002	-0.07	-0.07	0.28	-0.052	-0.19	-0.320	0.800	-0.302	-0.38
160	-0.020	0.006					-0.07	0.31	-0.050	-0.16	0.320	0.800	0.340	0.42
200	-0.021	0.006					-0.14	0.40	-0.119	-0.30	-0.100	0.800	-0.079	-0.10
240	-0.023	0.006					0.02	0.46	0.043	0.09				
280	-0.024	0.006												
320	-0.025	0.006												
360	-0.025	0.006												
400	-0.025	0.006												
420	-0.025	0.006												

- Notes:**
- Reference Laboratory: National Measurement Institute Ref No: RN133144.
 - Uncertainties of measurement are at a 95% confidence level.
 - $$E_n = \frac{\text{LAB} - \text{REF}}{\sqrt{(U_{\text{LAB}}^2 + U_{\text{REF}}^2)}}$$
 Values of $|E_n| \geq 1.0$ require investigation.
 - Reference Value: calibration values before artefact distribution.
 - Confidentiality: Refer to Guide to Proficiency Testing Australia (2016).

SUMMARY OF REPORTED RESULTS

TEMPERATURE ROUND TWO

NOMINAL (°C)	REFERENCE (°C)		LAB 6 (°C)				LAB 7 (°C)				LAB 8 (°C)			
	CORR.	U _{REF}	CORR.	U _{LAB}	LAB - REF	En	CORR.	U _{LAB}	LAB - REF	En	CORR.	U _{LAB}	LAB - REF	En
0	-0.011	0.006	-0.857	0.035	-0.846	-23.82	0.3	0.9	0.31	0.35	-0.022	0.030	-0.01	-0.36
40	-0.014	0.006	0.161	0.036	0.175	4.79	0.7	0.5	0.71	1.43	-0.027	0.030	-0.01	-0.42
80	-0.016	0.006	0.372	0.036	0.388	10.63	1.0	0.5	1.02	2.03	-0.031	0.030	-0.02	-0.49
120	-0.018	0.006	0.236	0.037	0.254	6.78	1.0	0.5	1.02	2.04	-0.038	0.030	-0.02	-0.65
160	-0.020	0.006	-0.253	0.038	-0.233	-6.06	-0.2	0.5	-0.18	-0.36				
200	-0.021	0.006	-1.173	0.039	-1.152	-29.19	-0.5	0.5	-0.48	-0.96				
240	-0.023	0.006	-2.703	0.043	-2.680	-61.73	-1.2	0.5	-1.18	-2.35				
280	-0.024	0.006	-4.855	0.036	-4.831	-132.37	-1.2	0.5	-1.18	-2.35				
320	-0.025	0.006	-7.449	0.107	-7.424	-69.27	-1.3	0.5	-1.28	-2.55				
360	-0.025	0.006	-10.638	0.041	-10.613	-256.13	-1.2	0.5	-1.18	-2.35				
400	-0.025	0.006	-14.396	0.056	-14.371	-255.16	-1.2	0.5	-1.18	-2.35				
420	-0.025	0.006	-16.496	0.059	-16.471	-277.74	-1.1	0.5	-1.08	-2.15				

Notes: 1. Reference Laboratory: National Measurement Institute Ref No: RN133144.

2. Uncertainties of measurement are at a 95% confidence level.

3.
$$E_n = \frac{\text{LAB} - \text{REF}}{\sqrt{(U_{\text{LAB}})^2 + (U_{\text{REF}})^2}}$$
 Values of $|E_n| \geq 1.0$ require investigation.

4. Reference Value: calibration values before artefact distribution.

5. Confidentiality: Refer to Guide to Proficiency Testing Australia (2016).

APPENDIX B

Instructions to Participants

TEMPERATURE MEASUREMENT (ROUND 2) PROFICIENCY TESTING PROGRAM INSTRUCTIONS TO LABORATORIES

EQUIPMENT

A Hart Scientific Model 1522 Digital Temperature Indicator System S/No: A26315 with PRT Probe S/No: 493356.

MEASUREMENT TO BE CARRIED OUT

Consider this as a job for a normal customer. The proficiency test items should be treated as a routine sample. Use techniques and equipment that will allow you to report your measurements and uncertainties to your Calibration and Measurement Capability (CMC).

Please do NOT adjust any settings, dismantle or attempt any maintenance or rectification. Please do NOT anneal the thermometer and calibrate in the “as received” condition.

The instrument should be switched on at least one hour before use. Tests should be performed with an ambient temperature of $21.0^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$.

Measure the resistance at ice point (0°C). Calibrate from 0°C to 420°C in 40°C steps. Remeasure the resistance at ice point (0°C). Use the attached Results Sheet to record the readings.

1. Measure as received Ice point (IP) report.
2. Record the as received stored coefficients (confirming had not been altered or corrupted).
3. Report coefficients and IP to coordinator for instructions to proceed.
4. Anneal probe at 20°C . above maximum temperature for 2 hours.
5. Repeat IP measurement.
6. Repeat steps 4 and 5, until IP change less than 5mK.
7. Proceed with the calibration as per local practice.
8. Submit results by at 40°C interval (IP, 40, 80, 120, 160, 200, 240, 280, 320, 360, 400 and 420°C) using the provided Table.

Only use the provided power supply (not to use any other power supply or batteries) to operate the artefact.

Dr Michael Li
Proficiency Testing Australia
7 Leeds St, Rhodes NSW 2138

DOCUMENTS TO BE SUBMITTED

Within **two weeks** of receipt of the artefact, the participant is requested to return the artefact and results sheet to:

FINAL REPORT

A final report will be issued at the end of the program with each laboratory only identified by a **confidential code number**.

GENERAL INFORMATION

For general information, please contact Dr Michael Li, PTA,

Tel: +61 2 9736 8397 Fax: +61 2 9743 6664

Web: www.pta.asn.au E-mail: mli@pta.asn.au

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APPENDIX C

Results Sheet



Lab Code

**TEMPERATURE (ROUND 2)
PROFICIENCY TESTING PROGRAM
RESULTS SHEET**

Hart 1522 Digital Indicator System and PRT
Serial No. A26315, 493356

NOMINAL (°C)	LAB (°C)		
	Actual Temperature	Correction	Uncertainty
0			
40			
80			
120			
160			
200			
240			
280			
320			
360			
400			
420			

Laboratory Name:

Temperature (°C):

Testing Officer:

Report Date:

End of Report

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