



Australian Government
Geoscience Australia



AN UPDATE ON LEGAL TRACEABILITY OF GPS POSITIONS IN AUSTRALIA

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Background

- With the growing societal dependency on GPS, **the need** for the legal traceability of GPS positions with respect to the Geocentric Datum of Australia 2020 (GDA2020) has become increasingly apparent
- **Objective:** to ensure consistency of positions derived from private and government Continuously Operating Reference Stations (CORS)
- Geoscience Australia maintains an appointment as **a legal metrology authority** in accordance with the National Measurement Act 1960

National Measurement System and traceability of measurement

- The governing Commonwealth legislation is The [National Measurement Act 1960](#)
- The National Measurement Institute (NMI) administers the Act
- National Association of Testing Authorities Australia (NATA), responsible for laboratory accreditation
- Standards Australia, responsible for standards specifications

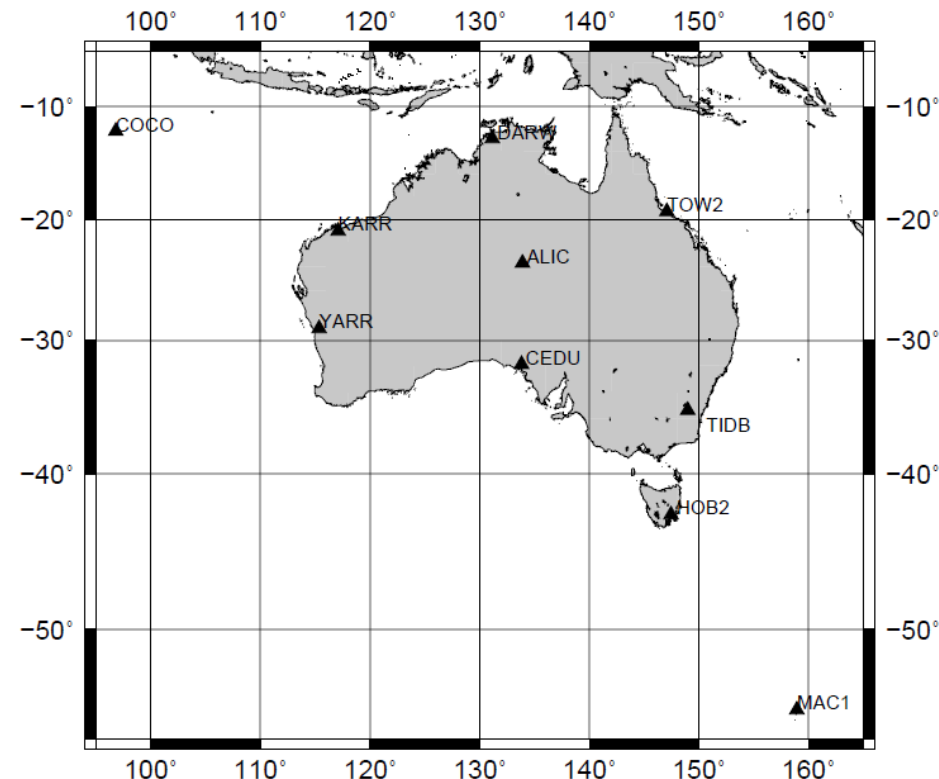
Geoscience Australia's role in the national measurement system

- To operate the AFN to appropriate standards
- To ensure that key continuous GNSS reference sites across Australia are appropriately linked to the AFN

History of recognized-value standards of measurement in the Australian Fiducial Network (AFN)

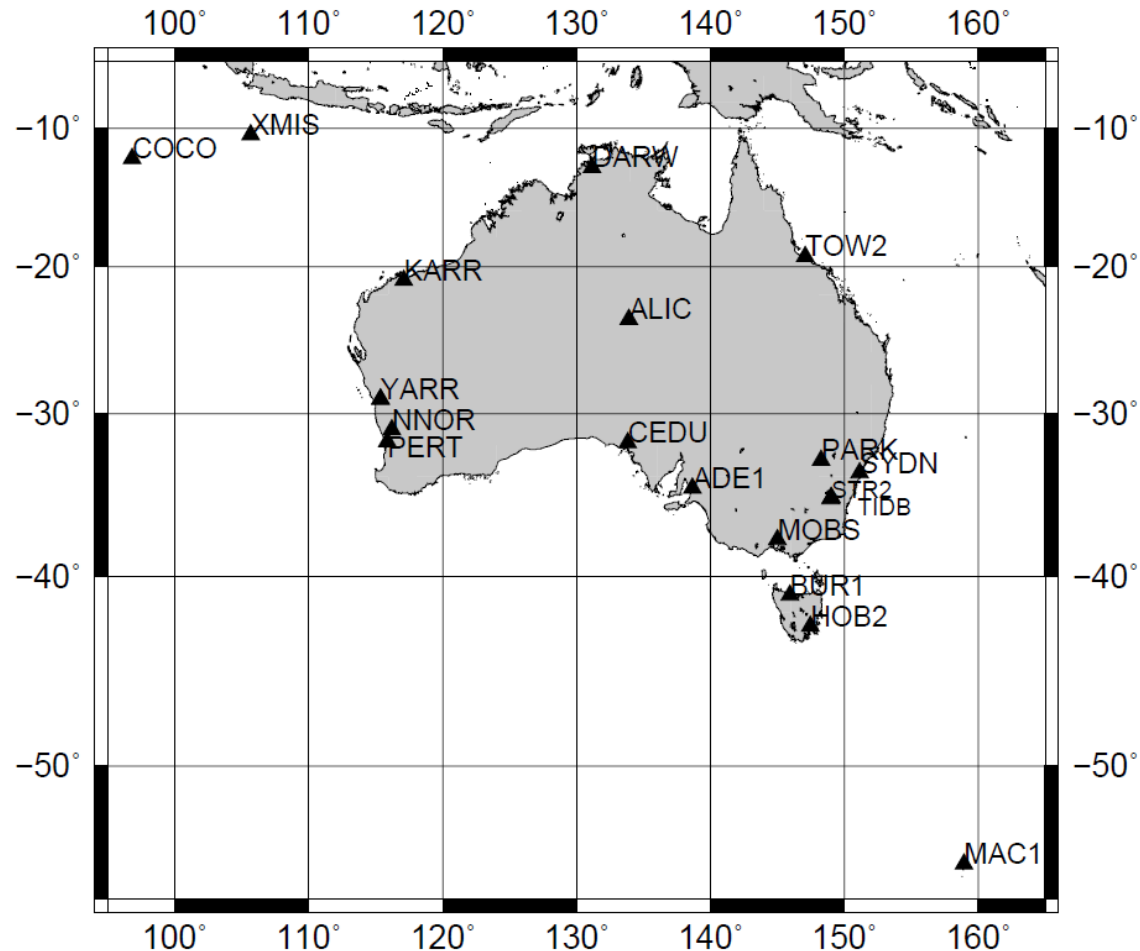
First determined in 1998, so-called GDA94 (see Government Gazette 1998), computed from data observed in 1992, 1993 and 1994, including

- ✓ seven mainland Australia stations
- ✓ one Tasmanian station and
- ✓ stations on Macquarie Island and Cocos Island



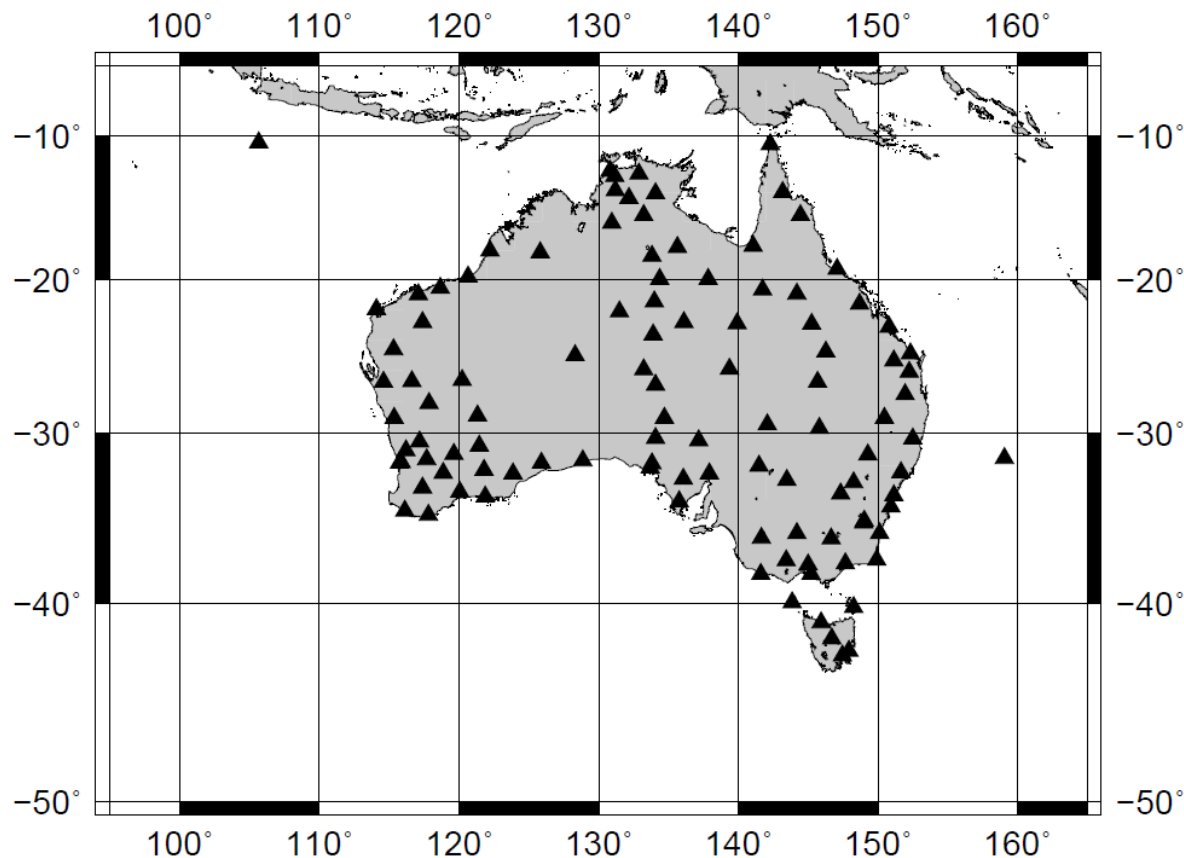
History of recognized-value standards of measurement in the Australian Fiducial Network (AFN)

- In 2012, updated AFN coordinates of 21 stations were adopted directly from ITRF 2008 then subsequently transformed to GDA94 (ITRF1992@1994)



Recognized-value standards of measurement in the Australian Fiducial Network (AFN) –GDA2020

- 109 extended AFN sites across Australian plate with GDA2020 (ITRF2014@2020.0)



Recognized-value standards of measurement in the Australian Fiducial Network (AFN) –GDA2020



National Measurement (Recognized-Value Standard of Measurement of Position) Determination 2017

I, Dr R. Bruce Warrington, Chief Metrologist, National Measurement Institute, make the following determination.

Dated 11 October 2017

R. BRUCE WARRINGTON

Dr R. Bruce Warrington
Chief Metrologist

Recognized-value standards of measurement in the Australian Fiducial Network (AFN) – GDA2020

Schedule 1—Recognized-value standards of measurement in the Australian Fiducial Network

Note: See sections 6 and 7.

Site	Coordinates (m) at 2020.0			Coordinate Uncertainty (m)			Velocity (m / year)			Velocity Uncertainty (m / year)		
	<i>X</i>	<i>Y</i>	<i>Z</i>	<i>u</i> (<i>X</i>)	<i>u</i> (<i>Y</i>)	<i>u</i> (<i>Z</i>)	<i>V_X</i>	<i>V_Y</i>	<i>V_Z</i>	<i>u</i> (<i>V_X</i>)	<i>u</i> (<i>V_Y</i>)	<i>u</i> (<i>V_Z</i>)
Ceduna (SA)	-3753473.1960	3912741.0310	-3347959.6998	0.0244	0.0249	0.0229	-0.0421	0.0024	0.0501	0.0002	0.0002	0.0002
Manton Dam (NT)	-4091359.6096	4684606.4258	-1408579.1371	0.0098	0.0105	0.0072	-0.0355	-0.0137	0.0576	0.0002	0.0001	0.0002
Mt Stromlo (ACT)	-4467103.2062	2683039.4818	-3666948.7613	0.0100	0.0080	0.0090	-0.0367	0.0006	0.0452	0.0002	0.0002	0.0002
Sydney (NSW)	-4648240.8666	2560636.4510	-3526317.7982	0.0107	0.0082	0.0093	-0.0352	-0.0015	0.0453	0.0002	0.0002	0.0002
Tidbinbilla (ACT)	-4460996.9609	2682557.0875	-3674442.6411	0.0104	0.0082	0.0093	-0.0368	0.0007	0.0452	0.0002	0.0002	0.0002
Hobart (TAS)	-3950072.2586	2522415.3710	-4311637.4095	0.0094	0.0079	0.0098	-0.0395	0.0083	0.0411	0.0002	0.0002	0.0002
Melbourne (VIC)	-4130636.7623	2894953.1442	-3890530.2534	0.0098	0.0083	0.0094	-0.0393	0.0042	0.0448	0.0002	0.0002	0.0002
Parkes (NSW)	-4554255.2088	2816652.4429	-3454059.6981	0.0107	0.0085	0.0093	-0.0363	-0.0015	0.0467	0.0002	0.0002	0.0002
Hillarys (WA)	-2355572.1203	4886093.2099	-3343993.6599	0.0081	0.0112	0.0091	-0.0478	0.0106	0.0491	0.0002	0.0001	0.0002
Bundaberg (QLD)	-5125977.5335	2688801.2479	-2669890.2146	0.0113	0.0082	0.0082	-0.0311	-0.0105	0.0490	0.0002	0.0002	0.0002

Calculation of global Cartesian coordinates at an epoch t

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_t = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{2020} + (t - 2020) \begin{bmatrix} V_X \\ V_Y \\ V_Z \end{bmatrix}$$

This model is valid for 15 years either side of the Reference Epoch:

$$|t - 2020| \leq 15$$

- Reference epoch: 2020.0
- Reference frame: GDA2020 (realization of ITRF2014)
- Reference Ellipsoid: GRS80
- Uncertainties: 95% confidence interval

The recognised-value standard of measurement of position

The recognized-value standard of measurement of position to the extended AFN, including 109 stations that met each of the following criteria:

- ✓ operated by Geoscience Australia or similar agency;
- ✓ located on the Australian Tectonic Plate, within Australia's jurisdiction and on a high quality survey monument; and
- ✓ have plate motion model residuals less than 1 mm / yr

Certificate of NATA approved accreditation facility

- GA is the only agency appointed as a legal metrology authority under the National Measurement Act, 1960, to provide legal chain of position traceability

Scope of Accreditation



ACCREDITATION NO: 15002

Geoscience Australia

Geodesy Section
Geodesy and Seismic Monitoring Branch
Cnr Jerrabomberra Avenue and Hindmarsh Drive
SYMONSTON ACT 2609

CONTACT: Mr Nicholas Brown
PHONE: (02) 6249 9831 FAX: (02) 6249 9929 MOBILE:
EMAIL: Nicholas.Brown@ga.gov.au
WEB SITE: www.ga.gov.au

FACILITIES: Normally not available for public testing

This laboratory complies with the requirements of ISO/IEC 17025 (2005)
The uncertainty of measurement is reported as an expanded uncertainty having a level of confidence of 95% unless stated otherwise

1.10 Survey and alignment equipment

.10 Position

Verification of the position of Continuously Operating Reference Stations (CORS) monuments located within Australia and its territories relative to the Geocentric Datum of Australia (GDA)

with least uncertainties of measurement of -

0.007 m horizontal;
0.015 m vertical

Accreditation No: 15002
(Scope Last Changed 05/07/17)

Quality Policy

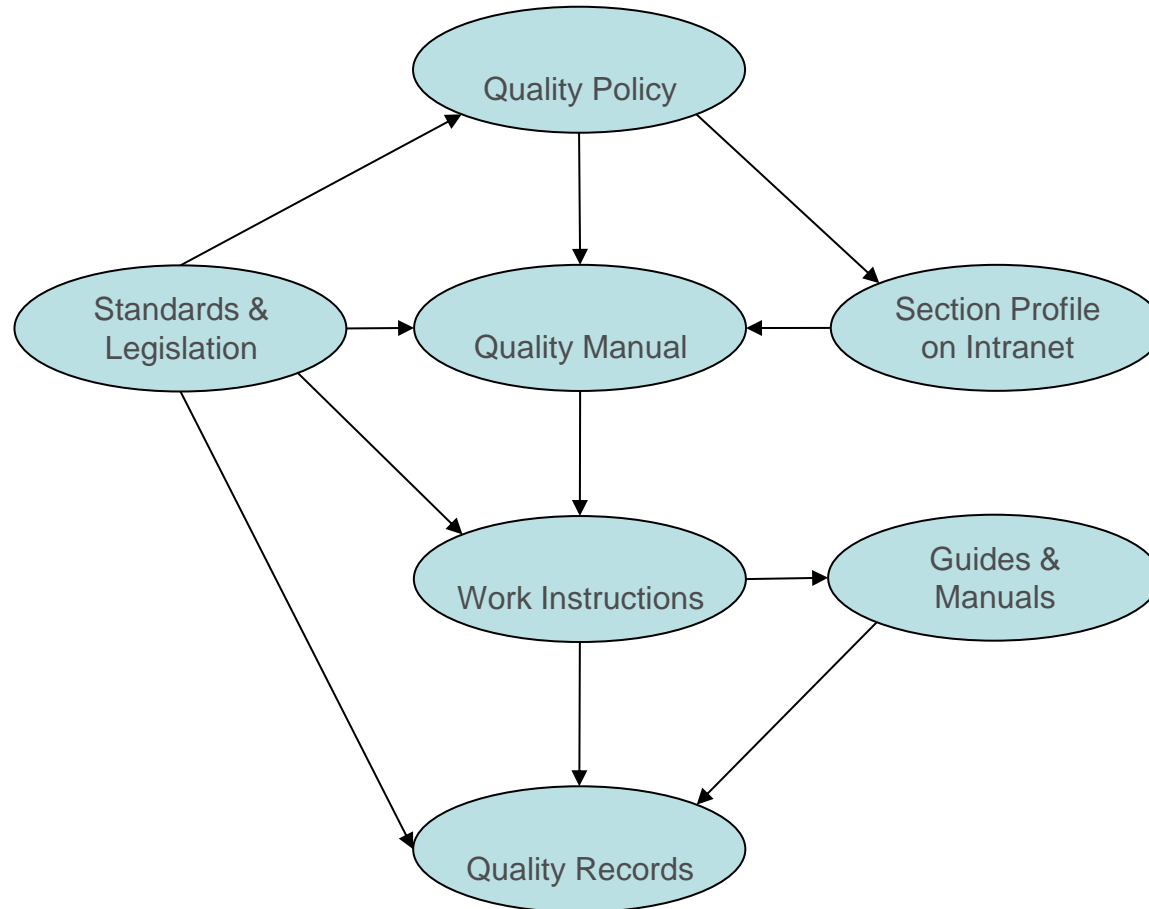
The principal objective is to provide customers with GDA2020 verified positions of CORS site that is in accordance with the requirements of:

- National Measurement Act 1960;
- National Measurement Regulations 1999;
- National Measurement Guidelines 1999; and
- National Measurement Institute's Verifying Authorities Handbook

Quality Policy

- Reassessment visits by NATA at **three year intervals** for assessment against the AS ISO/IEC 17025:2005 general requirements for the competence of calibration and testing laboratories standard
- Midway between each reassessment visit NATA conducts a **surveillance visit**
- Following each NATA reassessment visit **NMI** assesses the GA for continuing appointment as a **verifying authority for position**

Structure of quality management system in GA



The basic requirements for reg 13 position certification

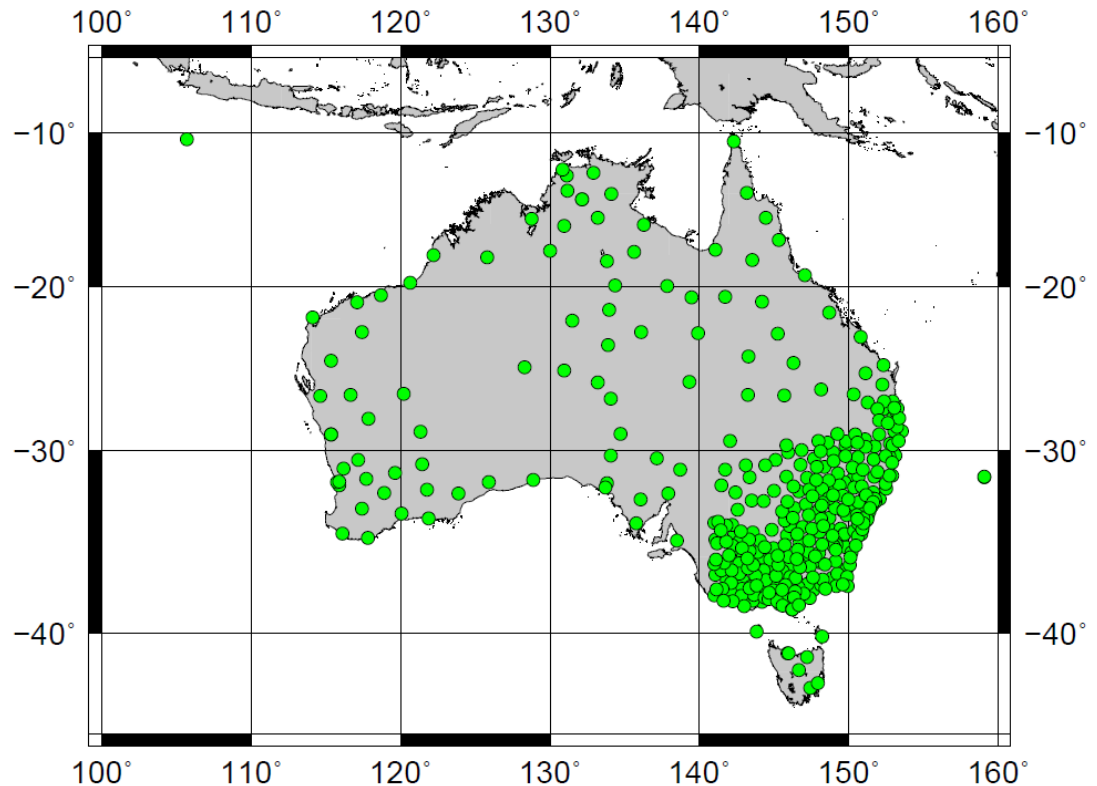
1. Requested by CORS owner or a signed consent letter issued by the owner
2. CORS is one of the APREF CORS network
3. A summary file signed by CORS owner containing all the metadata associated with CORS, including:
 - Antenna type and serial number (refer to IGS Central Bureau for IGS standard naming convention, see the link igsceb.jpl.nasa.gov/igsceb/station/general/rcvr_ant.tab).
 - Site description
 - Antenna offset measurement.

Solution quality control

- **Internal validation:** daily coordinates repeatability RMS
 - ✓ < 5 mm horizontal
 - ✓ < 10 mm vertical
- **External validation:** comparing with the IGS combined analysis weekly solutions after helmert transformation
 - ✓ < 5 mm horizontal
 - ✓ < 10 mm vertical
- **External validation:** checking the GDA2020 solution against the Recognized-value of AFN after helmert transformation
 - ✓ < 7 mm horizontal
 - ✓ < 15 mm vertical

Re-issuing reg13 certificates for all APREF sites in Australian plate

- Bernese v5.2 software
- Conforms to the IERS 2010 conventions
- IGS final products
- IGS14 of ITRF2014
- up to date igs14.atx



Example of re-issuing reg13 certificate



Australian Government
Geoscience Australia

Certificate of Verification of a Reference Standard of a Position-Measurement in Accordance with Regulation 13 of the National Measurement Regulations 1999 and the National Measurement Act 1960

Name of Verifying Authority:

Name: Geodesy Section
Organisation: Geoscience Australia
Address: Corner Jerrabomberra Ave and Hindmarsh Drive, Symonston ACT 2609 Australia
Telephone: (02) 6249 9111
Email: geodesy@ga.gov.au

Client detail:

Name: Ryan Ruddick
Organisation: Geodesy Section, Geoscience Australia
Address: Symonston ACT 2609 Australia
Telephone: (02) 6249 9426
Email: Ryan.Ruddick@ga.gov.au
Date of request: 24 October 2017

Description and denomination of standard of measurement:

The measurement was undertaken using an antenna LEIAR25.R3 NONE (International GNSS Service antenna naming convention) with the serial number 09370001 and refers to a point located 0.0015 m below the antenna reference point. This antenna is attached to a steel plate on 0.5 metre tall concrete pillar on bedrock via a 5/8 inch spigot thread. The station (4 character ID: ALIC) is located at Alice Springs in Northern Territory, and has the inscription National Geodetic Fiducial Network AU012. The certificate was determined using data from 03 September 2017 to 09 September 2017 inclusive. Analysis was undertaken following the procedures detailed in Geoscience Australia's GPS Analysis Manual for the Verification of Position issue 2.1. The reference number of this certificate is ALIC11122017.

Permanent distinguishing marks:

Exempt under Regulation 16 (4)

Date of verification: 11 December 2017

Date of expiry of certificate: 11 December 2022



Accredited for compliance with ISO/IEC 17025. Accreditation No. 15002.

Value of standard of measurement:

Station (4 character ID): ALIC

South Latitude and its uncertainty of value:

23° 40' 12.39658" ± 0.00023" (0.007 m)

East Longitude and its uncertainty of value:

133° 53' 7.87784" ± 0.00023" (0.007 m)

Elevation above Ellipsoid and its uncertainty of value:

603.236 ± 0.017 m

Geocentric Datum of Australia (GDA2020) coordinates referred to the GRS80 ellipsoid being in the ITRF2014 reference frame at the epoch 2020. The uncertainties are calculated in accordance with the principles of the ISO Guide to the Expression of Uncertainty in Measurement (1995), with an interval estimated to have a confidence level of 95% at the time of verification. The combined standard uncertainty was converted to an expanded uncertainty using a coverage factor, k, of 2.

Details of any relevant environmental or other influence factor(s) at the time of verification:

Uncertainty of the coordinates of the recognized-value standard of measurement of position (i.e. GDA2020); and Uncertainty due to instability of the GPS antenna mounting and modelling of the antenna phase centre variations.

Signature:

11 December 2017

Dr John Dawson
NATA approved signatory

Section Leader
Geodesy and Seismic Monitoring Branch
Geoscience Australia

Signature:

11 December 2017

Mr Gary Johnston
Geoscience Australia approved signatory

Branch Head
Geodesy and Seismic Monitoring Branch
Geoscience Australia

Being a person, or a person representing a body, appointed as a verifying authority under Regulations 71 and 73 of the National Measurement Regulations 1999 in accordance with the National Measurement Act 1960, I hereby certify that the above standard is verified as a reference standard of measurement in accordance with the Regulations, by the above-named authority.

Summary

- GPS position traceability in Australia is ensured by comparing all computed solutions against the recognized-value standard for position of the AFN
- Quality control via the structured maintenance and continual improvement process
- As of February 2018, total 420 Reg 13 certificates re-issued with GDA2020 across Australia region
- Website link: <http://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/regulation-13-certificates>

ftp://ftp.ga.gov.au/geodesy-outgoing/gnss/pub/reg13/reg13_GDA2020/



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Questions?

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