Australia's National Time Signal Service – Callsign VNG

VNG was Australia's national time signal service, and operated on 2500, 5000, 8638, 1298, and 16000 kHz.

VNG broadcast time in binary coded decimal, during seconds 21-58. It also broadcast DUT-1 information during seconds 1-16. Tones were usually of 1 kHz. VNG also broadcast a spoken time signal as well.

It was shut down December 31, 2002, due to a lack of funding.

Many scientific and astronomical users of the service were somewhat inconvenienced at the shutdown, and daytime reception of overseas time signal services from Australia is generally thought of as rather poor as the nearest time signal services are BPM in China and WWVH (or WWV) from the United States.

For some 23 years, Radio VNG was broadcast from Lyndhurst, Victoria. It was funded by Telstra (formerly Telecom Australia). See the 1973 leaflet attached.

Following the closure of Radio VNG in October 1987, a VNG Users Consortium was formed to re-establish Radio VNG and to collect donations from former users to dismantle, pack and transfer the transmitting equipment to a new location. More than $10 000 was raised and the equipment was relocated to AirServices Australia's (formerly the Civil Aviation Authority) International Transmitting Station in Llandilo, NSW (position 33°42'52"S, 150°47'33"E). The Australian Surveying and Land Information Group (AUSLIG, now known as the National Mapping Division, Geoscience Australia), agreed to finance the operation of Radio VNG on a partial cost recovery basis from users.

As part of its responsibility of coordinating the national measurement system, the National Standards Commission took over the funding of Radio VNG in November 1992 and on 12 January 1993 became the owner of the transmitting licence. The NSC funded AirServices Australia to operate and maintain Radio VNG. The NSC also funded CSIRO to monitor the accuracy of the Radio VNG transmissions and carry out other functions related to the national time system and Coordinated Universal Time (UTC).

Refer to the attached NSC leaflet of September 2002, for more details.
http://tufi.alphalink.com.au/time/nsc_vng_leaflet.pdf - refers.
http://www181.pair.com/otsw/VNG.html - has photos.

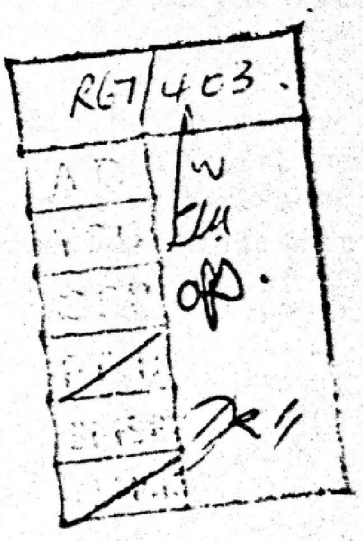
(As an aside note the initials on the front of the 1973 leaflet. They are:

JDL - Joe Lines
SLK - Syd Kirkby
OJB - Bobroff
DRH - Dave Hocking)

AUSTRALIAN POST OFFICE

STANDARD FREQUENCY & TIME SIGNAL SERVICE

VNG.



TIME AND FREQUENCY STANDARDS SECTION,
A P O RESEARCH LABORATORIES,
59 LITTLE COLLINS STREET,
MELBOURNE, VICTORIA, 3000
AUSTRALIA

STANDARD FREQUENCY AND TIME SIGNAL SERVICE

VNG, LYNDHURST, VICTORIA, AUSTRALIA

Information Bulletin 16th April, 1973

The Australian Post Office provides standard frequency and time signal broadcasts in the high frequency radio band from its radio station at Lyndhurst, Victoria. This service, which uses the call-sign VNG, transmits precise time signals and radio frequencies to a schedule designed to provide an Australia-wide coverage and is widely used by surveyors, navigators and scientists, etc. for astro-navigation, position fixing, precision timing and reference frequency applications. This bulletin describes the main features of the VNG service and provides some background information on the UTC system of time-keeping which is the basis of both civil and precise time.

SCHEDULE OF FREQUENCIES

TIMES OF EMISSION			FREQUENCY kHz
UT	AEST	AEDT	
0945-2130	0945-0730	2045-0830	4 500
2245-2230	0845-0830	0945-0930	7 500
2145-0930	0745-1930	0845-2030	12 000

UT :Universal Time, i.e. referred to the Greenwich meridian.
AEST :Australian Eastern Standard Time.
AEDT :Australian Eastern Daylight (Summer) Time.
Carrier Power :10 kW on all frequencies.
Transmitter Location :Lyndhurst, Victoria,
Latitude 38° 03.3'S Longitude 145° 15.7'E

TIME SIGNALS

Seconds markers are transmitted by double-sideband amplitude modulation of the carrier and consist of various length bursts of 1000 Hz tone. The start of a tone burst, which commences at a zero-crossing of the sine wave (increasing carrier power), marks the start of a seconds interval.

TIME CODE

Seconds markers are normally 50 milliseconds of 1000 Hz.

Seconds markers 55 to 58 are 5 milliseconds of 1000 Hz,

Seconds marker 59 is omitted.

Minute marker(seconds marker 60)is 500 milliseconds of 1000 Hz.

During the 5th, 10th, 15th, etc., minutes, seconds markers 50 to 58 are 5 milliseconds of 1000 Hz.

During the 15th, 30th, 45th and 60th minutes a station identification announcement is given without interruption to the time signals.

During the first 15 seconds of each minute, a group of emphasised seconds markers (emphasised by 50miliseconds of 900 Hz tone immediately following the normal seconds markers), known as the DUT1 code, denotes the deviation of astronomical time, UT1, from the time signals.

ANNOUNCEMENT

The announcement gives station identification (call-sign and frequencies) in English and is approximately 30 seconds long finishing approximately 10 seconds before each quarter hour. The speech is "notched" to allow the seconds markers to continue and has spectral components around 1000 Hz reduced to avoid erroneous operation of tuned-relay time signal receivers.

DUTI CODE

The group of emphasised seconds markers indicate the deviation between the Earth's angular positional time scale, UT1, and the UTC time signals. The values transmitted are known as DUT1 and are predictions of the deviation determined to the nearest 0.1 second. DUT1 is in the sense UT1-UTC, i.e., a positive value of DUT1 indicates that astronomical time is advanced on the time signals.

Magnitude of DUT1 is given by the number of consecutive emphasised seconds markers, each one representing 0.1 second.

Sign of DUT1 is positive when the first emphasised marker of a group is seconds marker 1(i.e. the marker following the minute marker).
Sign of DUT1 is negative when the first emphasised marker of a group is seconds marker 9.
DUTI is zero if no seconds markers are emphasised.

ACCURACY

Carrier frequencies and 1000 Hz tone as emitted are maintained within 1 part in 10^{10} of the A.P.O. standard of frequency(24 hour average value). As received, the accuracy may be degraded to the order of 1 part in 10^{7} due to the ionosphere.

Time interval as emitted (i.e. elapsed time between any two seconds, markers) has the same accuracy as the carrier frequencies except for intervals which include step adjustments.

Time-of-day as emitted is maintained within 100 microseconds of the A.P.O. standard of Co-ordinated Universal Time, UTC(APO). As received, the signals may exhibit jitter of the order of 1 millisecond r.m.s. due to the ionosphere.

The A.P.O. standard referred to above is based on caesium beam frequency and time standards at the Research Laboratories in Melbourne. This standard is maintained such that its value of frequency and time interval is within a few parts in 10^{12} of the international definition of time interval. Time-of-day signals generated by the A.P.O. standard are maintained within about 100 microseconds of the international standard of Co-ordinated Universal Time as determined by the Bureau International de l'Heure and known as UTC(BIH).

FREQUENCY AND TIME GENERATING EQUIPMENT

The generating equipment is at Lyndhurst and includes precision quartz oscillators, frequency synthesizers, time code generators, announcing machines and supervisory alarms.

A very low frequency signal, sent via landline from the A.P.O. standard in Melbourne, controls the frequency of the operative quartz oscillator within one part in 10^{11}. Regular visits with a portable clock ensure that the VNG signals typically remain within 20 microseconds of UTC(AP0).

CO-ORDINATED UNIVERSAL TIME (UTC)

Co-ordinated Universal Time (UTC) is the time scale used for standard time signal transmissions and civil time (e.g. UTC plus 10 hours gives Australian Eastern Standard Time). Time intervals in this scale are maintained constant by reference to atomic standards of time interval but the time-of-day (or instant) of the scale is adjusted by occasional steps of precisely one second to keep the UTC scale close to astronomical time.

Interval

The basic time interval in the UTC scale is the second, one of the fundamental quantities in the International System (SI) of units. The second is defined as the duration of 9,192,631,770 periods of a particular atomic transition of the caesium 133 atom and the length so chosen is related to an astronomically derived second of universal time of the year 1900 known as the ephemeris second. Modern caesium beam time standards generate time interval which is extremely close to the definition and a group of independently operated caesium beams, co-ordinated by the Bureau International de l'Heure (B.I.H.), forms International Atomic Time, IAT.

Instant

The instant of the UTC scale, i.e., the moment at which a seconds interval starts, is displaced by an integral number of seconds from the instant of IAT to keep UTC within about 0.7 second of the astronomically-derived scale of Universal Time known as UT1 (a scale which is tied to the Earth's rotation and which is used in surveying and, navigating). Because of the non-uniformity of UT1, occasional step adjustments of precisely one second. (known as leap second adjustments)are applied to UTC to maintain the two scales within about 0.7 second.

Leap Second Adjustments

These adjustments are made, as determined by the B.I.H., at the end of a month but preferably as the last second of 30th June or 31st December UTC (at present, one or two adjustments are made each year). The sequence of seconds markers at the time of the insertion of a leap second is that 2359:59 UTC is followed by 2359:60 UTC. This instant marks the start of the leap second which terminates at 0000:00 UTC on the first day of the following month (the last minute of the chosen month is 61 seconds, long). In the VNG time code, both the start and finish of the leap second is marked by a long marker. The sequence is therefore : 5 ms tone bursts for seconds markers 50 to 58, no signal for seconds marker 59 and 500 ms tone bursts for 2359:60 and 0000:00 UTC (this last instant being 1000:00 AEST). Advance announcement of the occurrence of a leap second is included in the VNG station identification announcement and is mailed to time signal users.

Obtaining UT1 from UTC

UT1 is an important time scale in those fields where is necessary to determine one's position on the Earth (e.g. surveying and navigation). It is, in fact, a measure of the angular position of the Earth about its axis of rotation (it is identical with Greenwich Mean Time, GMT, as used in the Nautical Almanac). UTC is therefore kept within 0.7 second of UT1 (by the step adjustments explained above) so that the time signals may be used as a first approximation to UT1. For those users who require better precision, the DUT1 code is transmitted with the VNG time signals to give UT1-UTC to the nearest 0.1 second. Therefore, adding the value of DUT1 to the UTC time of an event gives the event's UT1 time with an uncertainty of ±0.05 second which is sufficient precision for many surveying and navigating purposes.

INFORMATION

General information such as schedules, frequencies, QSL cards, etc., may be obtained from:

STATION VNG,
C/- ASSISTANT DIRECTOR-GENERAL,
RADIO BRANCH,
POSTMASTER-GENERAL'S DEPARTMENT,
57 BOURKE STREET,
MELBOURNE, VIC. 3000

Technical enquiries relating to standard frequency and time matters, may be directed to:

APO RESEARCH LABORATORIES,
TIME AND FREQUENCY STANDARDS SECTION,
59 LITTLE COLLINS STREET,
MELBOURNE, VIC. 3000

COURTESY: Laurie McLean

National Standards Commission

12 Lyonpark Road North Ryde NSW 2113 Australia PO Box 282 North Ryde NSW 1670 Australia Phone (61 2) 9856 0300 Fax (61 2) 9856 0399

Leaflet No 15
September 2002

Radio VNG: Australia's Standard Frequency and Time Signal Service

Introduction

Radio VNG is Australia's standard frequency and time signal service. For many years people and organisations throughout Australia have made use of the timing signals broadcast by Radio VNG. These timing signals may be used for purposes such as surveying, geophysics and navigation. Radio VNG users include seismologists, astronomers, upper atmosphere physicists, surveyors, geophysicists studying the Earth's magnetic field and amateur radio operators. This service forms part of Australia's technological infrastructure by providing a signal of moderate accuracy (1 millisecond) that can be readily accessed with relatively inexpensive equipment. It is also used to confirm any ambiguities inherent in more precise methods of time comparison.

Radio VNG
Australia's Standard Frequency and Time Signal Service

Background

For approximately 23 years, Radio VNG was broadcast from Lyndhurst, Victoria. It was funded by Telstra (formerly Telecom Australia) and the monitoring and research were conducted by their research laboratories at Clayton, Victoria.

In late 1986 the Precise Time Working Group (now the National Time Committee), under the auspices of the Commission, learned of the impending closure of Radio VNG and conducted a survey to ascertain the usage of the service and the scientific and economic impact of its closure. The survey results showed that there was extensive and diverse usage of the service throughout the community; usage which, by the very nature of its application, was difficult to quantify economically.

Following the closure of Radio VNG in October 1987, the Commission convened a seminar to investigate what provisions needed to be made for an intermediate accuracy time service and to consider the extent to which the provisions for high accuracy time comparisons were meeting Australia's needs.

Several alternatives to Radio VNG were discussed but each was found to have significant disadvantages in terms of accessibility and cost compared with Radio VNG's time service. It was recommended by the many participants at the meeting that Radio VNG be reinstated; that the service be recognised as part of Australia's technological infrastructure and be funded by the Federal Government. At this time no single department or authority was identified to fund the operation of Radio VNG.

VNG Users Consortium

The VNG Users Consortium was formed to re-establish Radio VNG and to collect donations from former users to dismantle, pack and transfer the transmitting equipment to a new location.

More than $10 000 was raised and the equipment was relocated to AirServices Australia's (formerly the Civil Aviation Authority) International Transmitting Station in Llandilo, NSW. The Australian Surveying and Land Information Group (AUSLIG, now

known as the National Mapping Division, Geoscience Australia), agreed to finance the operation of Radio VNG on a partial cost recovery basis from users. Initially, there were both technical and licensing problems, all of which have since been resolved.

Further details of the VNG Users Consortium are given in Appendix I.

The Present Situation

As part of its responsibility of coordinating the national measurement system, the Commission took over the funding of Radio VNG in November 1992 and on 12 January 1993 became the owner of the transmitting licence. The Commission also administers the National Measurement Act 1960 and the Regulations empowered under it. These Regulations define the units of measurement used for legal purposes in Australia, including the units of measurement for time.

Currently, the Commission funds AirServices Australia to operate and maintain Radio VNG. The Commission also funds CSIRO to monitor the accuracy of the Radio VNG transmissions and carry out other functions related to the national time system and Coordinated Universal Time (UTC).

The most recent improvements to the Radio VNG time service were the addition of a talking clock that went to air on 15 January 1992, and a 1 kW 2.5 MHz transmission which began on 7 October 1992, to improve reception in the Sydney metropolitan region. Additional transmitters have also been acquired to provide backup to the existing system. A digital voice announcing machine, with no moving parts replaced the less reliable tape cartridge machines in early 1994.

Further technical details of the operation of Radio VNG are given in Appendix II. Details of the binary coded decimal (BCD) time code format which incorporates time of day and the day number in the year are given in Appendix III.

Radio VNG will to cease to operate from 31 December 2002.

Further Information

The following information leaflets also contain information related to this topic:

No 8 The Australian National Time System
No 27 Daylight Saving
No 28 Calendars
No 32 Leap Seconds

Appendix I
VNG Users Consortium

The VNG Users Consortium was formed as a subcommittee of the Precise Time Working Group (now the National Time Committee) of the Commission because of users dismay at the closure of Radio VNG in October 1987. The objective of the Consortium was to re-establish and maintain a national high frequency standard frequency and time signal service.

At their inaugural meeting on 25 February 1988 the organisers wrote to all known Radio VNG users requesting contributions towards the cost of acquiring the Radio VNG plant and reinstating the service. The response was heart warming. Private individuals (many of whom were not paid for the activities for which they used Radio VNG) contributed up to $100 out of their own pockets, and some organisations contributed up to $2000 to try to save this national facility. This enabled the VNG Users Consortium to pay for the relocation of Radio VNG from Clayton in Victoria to what was then the Civil Aviation Authority's International Transmitting Station at Llandilo, NSW, in June 1988.

As a result of users being willing to contribute money to save the service, AUSLIG (now known as the National Mapping Division, Geoscience Australia) agreed to meet the costs of setting up at Llandilo and to cover the running costs on a partial recovery basis from users. The role of the VNG Users Consortium was to raise some of this money, to represent users interests to various Government bodies, to answer queries, and to verify reception reports (QSLs). The Consortium also negotiated with the Department of Transport and Communications and the Royal Australian Navy for extra frequencies for Radio VNG, as its old ones were now in the wrong part of the radio frequency spectrum.

As a result of protracted efforts over several years, Radio VNG now transmits on five frequencies instead of the original three! Other contributions by the Consortium include provision of station identification announcements, the addition of a talking clock, and the purchase of the first 2.5 MHz transmitter and a new AWA digital announcing machine.

The Commission took over the recurrent funding of Radio VNG on a non-cost recovery basis in 1992. This has taken much of the burden off Consortium volunteers, who have always done their work unpaid in their own time. The Commission now issues most of the QSLs, though the VNG Users Consortium also answers queries where appropriate. The Consortium still provides the voice announcements and represents users interests to the Commission through its National Time Committee.

The VNG Users Consortium is eager to continue to collect financial contributions for contingencies and to enable them to have the means to promote Radio VNG's importance to the Government in the event that its continued operation again comes into question. After all, Radio VNG would have been history if people had not been prepared to dig into their own pockets. Money is a powerful way of showing that we really do care! If you would like to help, or if you would like any further information on the VNG Users Consortium please contact

Dr Marion Leiba
Honorary Secretary
VNG Users Consortium
GPO Box 1090
Canberra, ACT 2601
Tel: (61 2) 6231 9476 (home)

Appendix II
Radio VNG Technical Details

Location

Radio VNG is broadcast from the AirServices Australia, International Transmitting Station, located at Llandilo, NSW, position 33°42'52"S, 150°47'33"E.

Transmitters

The service employs STC double sideband, full carrier AM, HF broadcast transmitters. The 2.5 MHz service uses a STC 4SU55A/S transmitter whilst the 5 MHz, 8.638 MHz, 12.984 MHz and 16 MHz services employ STC 4SU48B transmitters.

Frequencies, Power and Emission Mode

The transmitter frequencies, powers and transmission modes are:

2.5 MHz	1 kW, emission mode to be advised
5 MHz	10 kW, emission mode 6K00B9W
8.638 MHz	10 kW, emission mode 3K00A1A
12.984 MHz	10 kW, emission mode 3K00A1A
16 MHz:	5 kW, emission mode 6K00B9W

Note: 8.638 MHz and 12.984 MHz are frequencies on loan from the Royal Australian Navy.

Antennae

2.5 MHz	monopole (vertical antenna)
5 MHz	Wells quadrant antenna
8.638 MHz	delta-matched quadrant antenna with a single wire per arm
12.984 MHz	delta-matched quadrant antenna with a single wire per arm
16 MHz:	delta-matched quadrant antenna with a single wire per arm

Transmission Schedule

2.5 MHz	continuous
5 MHz	continuous
8.638 MHz	continuous
12.984 MHz	continuous
16 MHz:	2200–1000 UTC

Voice Station Identification Announcement

This is provided on the 2.5 MHz, 5 MHz and 16 MHz services only using an AWA digital voice recorder. It is given during the 15th, 30th, 45th and 60th minutes without interruption to the time signal. The speech is 'notched' to allow seconds markers to continue and has spectral components around 1000 Hz removed to avoid erroneous operation of tuned relay time circuits.

Morse Station Identification

This is provided on the 8.638 MHz and 12.984 MHz frequencies only. It is given during the 15th, 30th, 45th and 60th minutes without interruption to the time signals. VNG is transmitted in slow morse at a frequency of approximately 400 Hz up to six times per minute. Broken idents may occur at the beginning and end of the minute.

Reception Reports

All correspondence, including reception report and requests for reception reports (QSLs), should be addressed to:

Radio VNG
National Standards Commission
PO Box 282
North Ryde, NSW 1670

The reports should be sufficiently detailed to permit verification. Return postage, preferably in the form of an International Reply Coupon (or US$1) would be appreciated from other than VNG Users Consortium members.

Talking Clock

This gives Coordinated Universal Time as UTC(ATC) each minute, immediately after the minute marker. It operates on 2.5 MHz, 5 MHz and 16 MHz services only.

Time Delay Through Transmitters

The timing of Radio VNG time signal pips is done prior to transmission. Users who wish to obtain the greatest accuracy could benefit by taking into account the delays introduced by

the transmitters. The time delay for the 5 MHz, 8.638 MHz, 12.984 MHz and 16 MHz services is 190 μs. The delay associated with the 2.5 MHz is to be advised.

Accuracy and Traceability

The time and frequency information broadcast by Radio VNG is traceable to the standards maintained by the Telstra Research Laboratories at Clayton, Victoria. The carrier frequencies and 1 kHz tone broadcast by Radio VNG are within 1 part in 10^{11} of Telstra's frequency standard (24 hour average value).

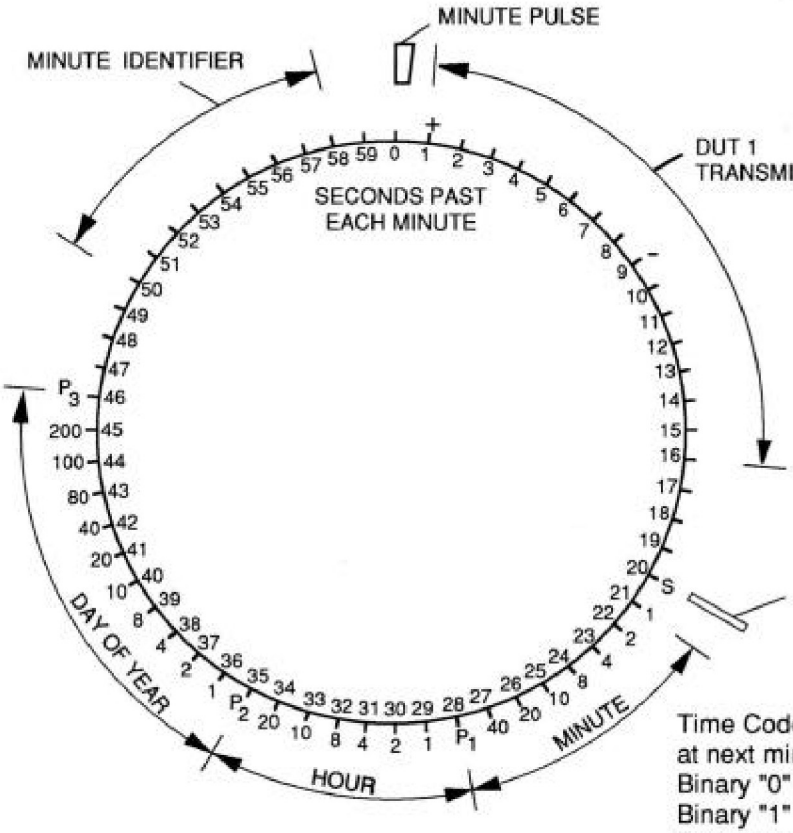
The time interval information has the same accuracy as the carrier frequencies except for intervals which are subject to routine step adjustments.

The time of day information is maintained within 100 μs of UTC(ATC) and is typically within 10 μs of UTC(ATC). In turn UTC(ATC) is within approximately 50 μs of UTC.

Unfortunately due to effects such as ionospheric jitter the accuracy of the frequency information received from the Radio VNG broadcasts may be degraded to around 1 part in 10^7. The time signal accuracy is typically of the order of 1 millisecond.

Appendix III
Radio VNG Time Code Format

Seconds markers normally 50 ms of 1000 Hz.
Seconds markers 55 - 58 are 5 ms of 1000 Hz.
Seconds markers 59 is omitted.
Minute marker is 500 ms of 1000Hz.
During the 5th, 10th, 15th, etc. minute,
seconds markers 50 - 58 are 5 mS of 1000Hz.



Normal seconds markers of 1000 Hz, emphasised by 50 ms of 900 Hz. Tone immediately follows.

Seconds Marker 20 has 200 ms duration. Designates the start of the time information.

Time Code Transmission (UTC)- valid at next minute.
Binary "0" 100 ms duration
Binary "1" 200 ms duration
Parity check Bits P_1, P_2, P_3
Counting binary 'ones' of each group plus the corresponding parity bit gives an even number.