

Full details of time signals for chronometer calibration were published annually for 1903 onwards (*New Zealand Nautical Almanacs*). They were usually prepared in October of the previous year, so did not necessarily include late changes. For example, the Lyttelton time ball service was terminated at the end of 1934, but was still noted in the 1935 *Almanac* with the following entry:

At Lyttelton time-signals are supplied by dropping the time ball on the time ball tower at 4h., G.M.T. The ball is dropped by direct signal from the observatory at Wellington. The signal is made on Tuesdays and Fridays only,

Owing to the absence of a return signal to the Dominion Observatory, the accuracy of the Lyttelton signal cannot always be relied upon. The note "Reported unreliable 1927" is to be added to the existing note concerning the time ball on the chart.

This was a repeat of entries in previous years. There was no Lyttelton entry in the 1936 *Almanac*.

Transcriptions from successive *New Zealand Nautical Almanacs* demonstrate changes in the sequences of time lights that were used between 1912 and 1937. Photographs and newspaper articles show how the lights were deployed and operated.

2 TIME BALLS IN WELLINGTON AND AUCKLAND

2.1 Time Balls in Wellington

The time ball service at Wellington started in March 1864 using the first official observatory in New Zealand. The apparatus was supplied by Sandys & Co of London and used a rack and pinion system for hoisting. It was installed at the Customs House. Accurate determination of longitude at the time ball and observatory locations was a particular challenge; the drop time was adjusted when improved estimates of longitude became available. Announcements of the time ball drop were published in the *New Zealand Times*, usually every one or two weeks. The ball was dropped daily with a local newspaper announcement when star transit observations had allowed increased precision for chronometer-rating purposes (*List of Time Signals*, 1880; extracts included in Kinns, 2017: 71). Otherwise, the drop was regulated using observatory clocks, with time extrapolated from preceding transit observations. The usual accuracy was better than one second. The service had to be withdrawn from time to time, when repairs became necessary.

The last notice of a time ball drop at the Customs House location was in February 1882, prior to a long period of waterfront redevelopment (Shipping, 28 February 1882):

The time ball may be used to-day for rating chronometers. A chronometer true on Greenwich time would show 12h 30m when the ball drops. Any difference is error, plus or minus, of the chronometer.

After prolonged discussion that included the possibility of a time ball on Mount Victoria, re-erection of a time ball at a different harbour location was announced in November 1888. The original time ball had been destroyed, but the mechanical apparatus had been saved. A new ball was manufactured, apparently using the design for Lyttelton (Kinns, 2017: 76). The first notice in the *New Zealand Times* concerning drop of the time ball at its new location at the head of Waterloo Quay was in January 1889 (Late Shipping, 21 January 1889):

CHRONOMETER-RATING NOTICE. The time-ball may be used to-day for rating chronometers. The ball will drop precisely at noon, New Zealand mean time, equivalent to 11hr 30min Greenwich mean time. Any difference on 11hr 30min shown by a chronometer at the moment of the signal will be the error, plus or minus, of the chronometer. Colonial Observatory, Wellington.

This notice followed star transit observations and did not mention that it was a new time ball service, so the ball may have been in use for some time before that. The newspaper announcement was usually repeated every one or two weeks. The early notices stated that noon, New Zealand time was equivalent to 11hr 30min, Greenwich Mean Time. This should have been 12hr 30min, Greenwich Mean Time (0.30 am at Greenwich on the same day as the NZ signal). At that time, GMT was based on noon at Greenwich for astronomical purposes.

The incorrect notice re-appeared on several occasions, but was corrected during April (Late Shipping, 13 April 1889):

COLONIAL OBSERVATORY. Chronometer-rating Notice. The time-ball may be used to-day for rating chronometers. The ball will drop at noon precisely, at which hour a chronometer set to Greenwich Mean Time should show 12h. 30m. Any difference will be the error of the chronometer, fast or slow on Greenwich Mean Time. T. KING, Observer. Colonial Museum, Wellington.

The apparatus was destroyed by fire in March 1909. Tenders for a new system were obtained from various potential suppliers in England, but the time ball was never replaced (Kinns, 2017: 78). Instead, time lights were introduced in February 1912.

2.2 Time Balls in Auckland

Auckland never established a reliable time ball service, despite provision of a weekly service for

mariners by a public-spirited citizen between August 1864 and June 1866. Various proposals to establish a service for mariners were made from 1874 onwards, but foundered through lack of budgetary provision for the necessary apparatus and skilled staff, as well as problems in finding a suitable location in a rapidly growing city. A time ball was finally installed on the Harbour Board building in 1901 and started operation in September, with the following announcement (Time Ball, 1901):

Harbour Board Offices, September 6th, 1901. Notice is hereby given that the Time Ball erected at the Offices of the Board, Quay-street, will be Hoisted every day (Sundays and holidays excepted) at 11.50 a.m. and Dropped at 12 Noon, Colonial Mean Time (same time as observed in the town). By order of the Board. J. M. BRIGHAM, Secretary.

The signal was unreliable and the service was withdrawn in 1902. Complaints from ships' masters led to various attempts to re-establish a service (Kinns, 2017: 88). These included unsuccessful modifications to the external dropping arrangement. Finally, another time ball was erected on the new Ferry Building in 1912, but the service only started in April 1915, again proved to be unreliable and was soon discontinued. The time ball was replaced by time lights in October 1915.

3 TIME LIGHT SIGNAL ENTRIES IN NEW ZEALAND NAUTICAL ALMANACS

The first specific entry concerning time light signals is believed to have been in the 1913 *Almanac* (not seen by the author), although their introduction had been heralded in the previous edition (1912 *Almanac*: 209).

The entry for Wellington in the 1914 *Almanac*, published in October 1913, is transcribed below. It is similar to a newspaper announcement in February 1912 (Ships and Shipping, 22 February 1912), suggesting that the timings of individual lights had not been altered between February 1912 and October 1913.

3.1 Entry for Wellington in the 1914 Edition

Time-signal and General Service Arrangements. - There is an astronomical observatory at Wellington on Battery Hill, in the Botanical Gardens, 418ft. above sea level, in latitude 41° 17' 3.76" S. and longitude 174° 46' 4.0" E. = 11h. 39m. 4.27s. From the tower of this observatory a time-signal by electric lights has been established.

At 1 p.m. on chronometer rating-days a galvanometer signal for rating chronometers is sent from the observatory to the Public Telegraph Office, Customhouse Quay, Wellington, and to the Dominion Museum, Wellington. The needle moves at 1 p.m. exactly of New Zealand standard mean time, when a chrono-

meter set to Greenwich mean time should show 13h. 30m. Any difference will be the error of the chronometer at Greenwich mean time.

At 9 p.m. on chronometer rating-days correct time is also signalled from the observatory by means of electric lights. A *green* light is switched on at about 8.45 p.m., a *red* one at about 8.55 p.m. and a *white* one at about 8.59 p.m., and all the lights are switched off at 9 p.m. exactly of New Zealand standard mean time. The preparatory switching-on of the lights must be considered as only approximately correct, and must not be used for rating chronometers. The correct time for rating is given by switching-off the lights simultaneously at 9 p.m. The lights are now shown from a flagstaff in a vertical line one over the other; the lower light *green*, middle light *red*, and upper light *white*.

3.2 Entry for Wellington in the 1915 Edition

The following text is taken from the 1915 *Almanac*. At the time of publication in October 1914, it was anticipated that a new time ball service would be operating in Auckland during 1915. The Wellington time light signals were now being repeated on four successive hours from 8 pm to 11 pm. Also, the switching on of the individual lights had been changed from 15, 5, 1 minutes to 50, 10, 5 minutes before the hour:

Time Service. – 1. *Accurate Time Signals.* – On days when accurate time signals are given, the flag T of the international code will be hoisted on the Observatory flagstaff about midday.

(a.) When the flag is flying, chronometers may be compared with a galvanometer in the public telegraph office, Featherstone Street. The galvanometer is controlled by the Observatory clock, and is deflected every hour of New Zealand mean time.

(b.) Time signals are given by three vertical electric lights erected on the Observatory flagstaff. The bottom light is *green*, and is 30 ft. above the ground; the middle light is *red*, and is 36 ft. above the ground; the top light is *white*, and is 42 ft. above the ground.

The green light is shown at 50 minutes, the red light at 10 minutes and the white light at 5 minutes to the hour; all three lights are extinguished simultaneously at the hour. The switching-on of the lights must be considered as only approximately correct; the correct time is given by switching off the three lights. This signal is given at 8, 9, 10 and 11 p.m. of New Zealand mean time.

The corresponding Greenwich mean time and New Zealand civil mean time of these signals are as under:-

| | G.M.T. | | | N.Z.C.M.T. | | | |
|-------------------------|---------------|----|----|---------------|----|----|------|
| | H. | M. | S. | H. | M. | S. | p.m. |
| Green light switched on | 19 | 40 | 0 | 7 | 10 | 0 | * |
| Red light switched on | 20 | 20 | 0 | 7 | 50 | 0 | * |
| White light switched on | 20 | 25 | 0 | 7 | 55 | 0 | * |
| All lights switched out | 20 | 30 | 0 | 8 | 0 | 0 | † |
| | * Approximate | | | † Time signal | | | |

And similarly at each succeeding hour until 23 h. 30m. G.M.T.
N.Z.M.T. 11h. 0m. 0s.

3.3 Entries in the 1916 Edition

The time light service for Auckland was operational by the end of 1915 and was included in the 1916 edition. The separate entries for Auckland (1916 *Almanac*: 255) and Wellington (1916 *Almanac*: 291-292) are transcribed below. In 1916, the Wellington time light signals were advanced by one hour, so the time was now signalled at 7, 8, 9 and 10 pm. The time was signalled in Auckland at 9 pm only. The basic arrangement of lights was the same at both locations: three lights at 6ft. intervals; green lowest, red middle, white top. The lights were switched on at 50, 10 and 5 minutes before the hour, as at Wellington from 1915.

3.3.1 Entry for Auckland

Time Signals. – The time ball has been discontinued and a system of night signals has been adopted. Not less than two guaranteed time signals per week will be given at 9 p.m. On those days when such signals are to be given, a red flag will be hoisted on the tower of the Ferry Buildings from 4 p.m. to 4.30 p.m. The following lights will be used on the flag-staff of the Ferry Buildings when such signals are given:-

Green light switched on 8.10 p.m.
Red light switched on 8.50 p.m.
White light switched on at 8.55 p.m.

All lights switched off 9 p.m. – 21h. 30m. 0s. G.M.T. These lights will be in a vertical line, 6 ft. apart, the green light being the lowest.

3.3.2 Entry for Wellington

Time Service. – 1. *Accurate Time Signals.* – On days when accurate time signals are given, the flag T of the international code will be hoisted on the Observatory flagstaff about midday.

(a.) When the flag is flying, chronometers may be compared with a galvanometer in the public telegraph office, Featherstone Street. The galvanometer is controlled by the Observatory clock, and is deflected every hour of New Zealand mean time.

(b.) Time signals are given by three vertical electric lights erected on the Observatory flagstaff. The bottom light is green, and is 30 ft. above the ground; the middle light is red, and is 36 ft. above the ground; the top light is white, and is 42 ft. above the ground.

The green light is shown at 50 minutes, the red light at 10 minutes and the white light at 5 minutes to the hour; all three lights are extinguished simultaneously at the hour. The switching-on of the lights must be considered as only approximately correct; the correct time is given by switching off the three lights. This signal is given at 7, 8, 9 and 10 p.m. of New

Zealand mean time.

The corresponding Greenwich mean time and New Zealand civil mean time of these signals are as under:-

| | G.M.T. | | | N.Z.C.M.T. | | | | |
|-------------------------|--------|----|----|------------|----|----|------|---|
| | H. | M. | S. | H. | M. | S. | | |
| Green light switched on | 18 | 40 | 0 | 6 | 10 | 0 | p.m. | * |
| Red light switched on | 19 | 20 | 0 | 6 | 50 | 0 | " | * |
| White light switched on | 19 | 25 | 0 | 6 | 55 | 0 | " | * |
| All lights switched out | 19 | 30 | 0 | 7 | 0 | 0 | " | † |

* Approximate † Time signal

And similarly at each succeeding hour until 22 h. 30m. G.M.T.

N.Z.M.T. 10h. 0m. 0s.

Approximate Time Signals. – When owing to bad weather or other causes accurate time signals cannot be given, approximate ones will be given; but in these cases the flag will not be hoisted and the *green* light will not be shown. On application to the Observatory the error of these signals can usually be obtained.

3.4 Entries in the 1917 Edition

Entries in the 1917 edition were essentially the same as in 1916. The entry for Auckland included an additional statement:

When the Time Signal is expected, but does not come through, the red light will remain burning till 9h. 5m. p.m., thereby notifying shipping that the signal has not been received.

3.5 Entries in the 1918 Edition

The entries in the 1918 *Almanac* were similar to those in 1916 and 1917, but timings at Auckland had been brought forward by 30 minutes. The signal sequence at Wellington was now given three times at 7.30, 8.30 and 9.30 pm, rather than four times at 7, 8, 9 and 10 pm. NZMT.

3.5.1 Entry for Auckland

The following lights will be used on the flag-staff of the Ferry Buildings when such signals are given:-

Green light switched on 7.40 p.m.
Red light switched on 8.20 p.m.
White light switched on at 8.25 p.m.

All lights switched off 8.30 p.m. – 21h. 0m. 0s. G.M.T. These lights will be in a vertical line, 6 ft. apart, the *green* light being the lowest.

When the Time Signal is expected, but does not come through, the red light will remain burning till 8h. 35m. p.m., thereby notifying shipping that the signal has not been received.

3.5.2 Entry for Wellington

The green light is shown at 50 minutes, the red light at 10 minutes and the white light at 5 minutes to the hour; all three lights are extinguished simultaneously at the hour. The switching-on of the lights must be considered as only approximately correct; the correct time is given by switching off the three lights. This signal is given at 7.30, 8.30, 9.30 p.m. of New Zealand mean time.

The corresponding Greenwich mean time and New Zealand civil mean time of these signals are as under:-

| | G.M.T. | | | N.Z.C.M.T | | | | |
|-------------------------|---------------|----|----|---------------|----|----|------|---|
| | H. | M. | S. | H. | M. | S. | p.m. | * |
| Green light switched on | 19 | 10 | 0 | 6 | 40 | 0 | " | * |
| Red light switched on | 19 | 50 | 0 | 7 | 20 | 0 | " | * |
| White light switched on | 19 | 55 | 0 | 7 | 25 | 0 | " | * |
| All lights switched out | 20 | 0 | 0 | 7 | 30 | 0 | " | † |
| | * Approximate | | | † Time signal | | | | |

The signal is repeated at 21 hours and 22 hours G.M.T. corresponding to 8.30 and 9.30 p.m. N.Z.M.T.

3.6 Entries in the 1928 Edition

By 1928 the signal was no longer repeated on successive hours (1928 *Almanac*: 131). Also, there was a clear distinction at Wellington between days when the signal was supervised personally and when it was automatic. The lights were now being switched on at 20, 10 and 5 minutes before the signal at 8.30 pm New Zealand mean time. GMT had been rebased to midnight for all purposes on 1 January 1925, so that NZMT was now 11h. 30m. ahead of GMT.

CHRONOMETER RATING TIME-SIGNALS BY LIGHTS.

System. – Three lights, vertically disposed six feet apart, green below, white above and red between. The green shows 20 mins, the red 10 mins, and the white 5 mins before the signal. Simultaneous extinction of all lights at 8.30 pm N.Z.T. (09 00 00 G.M.T.) is the time-signal. Supplied every Tuesday and Friday evening.

Auckland. – From flagstaff atop Ferry Buildings. Should telegraphic transmission from Wellington fail, the red light will continue until 8.35 pm. (This time-signal is considered unreliable.)

Wellington. – From Observatory flagstaff. Modified signals, without the green light and not under personal supervision, are supplied on Monday, Wednesday and Thursday evenings.

3.7 Entries in the 1933 to 1936 Editions

Entries in the 1933 to 1936 editions were identical, but showed changes in the timing sequence from earlier years. The lighting sequence was 50, 10 and 5 minutes before the signal at Auckland, but 20, 10 and 5 minutes at Wellington. The entry concerning time lights is shown below.

TIME-SIGNALS BY LIGHTS.

AUCKLAND.

At Auckland time-signals are supplied from the flagstaff on the Ferry Buildings by extinguishing three electric lights at 9h., G.M.T. The lights are shown vertically, 6 ft. apart, white uppermost, red in the centre, and green below. The green light is shown 50 minutes, the red 10 minutes, and the white 5 minutes before the signal. Simultaneous extinction of the lights at 9h., G.M.T. is the time-signal. Should

the signal fail, the red light will continue burning until 9h, 05m., G.M.T.

The lights are extinguished by direct signal from the Observatory, Wellington, on Tuesdays and Fridays.

WELLINGTON.

At Wellington time-signals are supplied from the flagstaff at the Dominion Observatory, 416 ft. above mean sea level, by extinguishing three electric lights at 9h., G.M.T. The lights are shown vertically, 6 ft. apart, with white uppermost, 42 ft. above the ground, red in the centre and green below. The green light is shown 20 minutes, the red 10 minutes and the white 5 minutes before the signal. Simultaneous extinction of the lights at 9h., G.M.T. is the time-signal. The green light is used only on Tuesdays and Fridays. On the other nights of the week the signals are not personally supervised and the green light is not used.

On New Zealand Government holidays the green light is not used.

3.8 Final Entries in the 1937 Edition

The final entries concerning time light signals were in 1937 (1937 *Almanac*: 130). A note was added to the 1936 entry to confirm that delay in the telegraph signal to Auckland was very small. The green light was no longer used at Wellington and the service was now fully automated; occasional signal failures were anticipated. The additional entries were:

AUCKLAND.

... The lights are extinguished by direct signal from the Observatory, Wellington, on Tuesdays and Fridays. Tests recently carried out by the Auckland Harbour Board indicate that the time taken by the telegraph signal operating the lights to reach Auckland from Wellington is less than one-tenth of a second.

WELLINGTON.

... The lights are *white* and *red*, shown vertically, 6 ft. apart, with *white* uppermost, 42 ft. above the ground. The *red* light is shown 10 minutes and the *white* 5 minutes before the signal. Simultaneous extinction of the lights at 9h., G.M.T. is the time-signal. The lights are operated automatically, but as they are not supervised, failures sometimes occur through unforeseen causes.

There were no entries concerning time lights in the 1938 *Almanac*, confirming that the service had been terminated during 1937.

4 WELLINGTON TIME LIGHTS

4.1 First Announcement

The first announcement including time light signals at Wellington appears to have been published in the *New Zealand Times* (Ships and Shipping, 22 February 1912). Earlier announcements in 1912 concerned galvanometer signals

only (Ships and Shipping, 5 January 1912, for example). The February announcement is transcribed below.

HECTOR OBSERVATORY, WELLINGTON. Latitude 41deg 17min 3.76sec south. Longitude 11hr 39min 4.27sec east of Greenwich. Height above 1909 mean sea level, 418 feet. CHRONOMETER RATING NOTICE. At 1 p.m. to-day a galvanometer signal for rating chronometers will be sent from the Observatory to the Public Telegraph Office, and to the Dominion Museum. The needle will move at 1 p.m. exactly of New Zealand standard mean time, when a chronometer set to Greenwich mean time should show 13hr 30min. Any difference will be the error of the chronometer on Greenwich mean time. At 9 p.m. correct time will also be signalled from the Observatory by means of electric lights. A green light will be switched on at about 8.45 p.m., a red one at about 8.55 p.m., and a white one at about 8.59 p.m., and all lights will be switched off at 9 p.m. exactly of New Zealand standard mean time. The preparatory switching on of



Figure 2: Dominion Observatory, about 1920 (courtesy: Friends of the Wellington Botanic Garden).

the lights must be considered as only approximately correct, and must not be used for rating chronometers. The correct time for rating will be given by switching off the lights simultaneously at 9 p.m. C.E. ADAMS, Government Astronomer.

4.2 Wellington Time Light Article

A comprehensive article about time signals was published in the *Evening Post* (Correct Time, 9 July 1921). It included a brief description of how the time light signals in Auckland were operated from Wellington. The tenor of the article is illustrated by the following extracts:

Beside the Observatory near the Kelburn tramway power-house there is a pole, on which in the evening lights shine out, and at times are suddenly extinguished. The curious and uninformed wonder what they are for; shrewder folk set their watches by them and become qualified to criticise the town clocks. The lights

are time-signals, operated from carefully guarded clocks in the Observatory, and their chief duty is not to rectify watches in the city, but to help mariners ...

The heart of the system is a small telescope on horizontal supports, which enable it to be aimed up or down, but not sideways. The axis is placed east and west, so that the telescope always points to the meridian. It enables its user to observe exactly when any star crosses the meridian, and carefully prepared tables are available showing the times when various stars are in that position ... The determination of the time by "observing the meridian passage" is only accurate if the mounting of the telescope, which stands on a concrete base, is faultless; but it hardly ever is. Once in a while the axis on which the telescope turns, may be truly east and west or truly level, but its position is always changing slightly through the elasticity of the earth's crust and the effects of solar heat, tidal strains, and other causes. Consequently, though a very little time is needed to make an observation, a much longer time must be spent on each occasion in carefully checking the accuracy of the mounting so as to find the error of the instrument ...

This article opened with a reference to the time signals and it may close with an explanation of them, and a reference to the latest addition to the time service, the wireless signal. There are three lights in the visual signal, the lowest green, the next red, and the top white. At 50 minutes before the hour to be signalled, the green light is turned on; at 10 minutes to the hour, the red one is lit; and at 5 minutes to the hour, the white one. These times are close enough for ordinary clock-setting purposes, but the three go out together as nearly as possible on the exact stroke of the hour and it is the extinction that constitutes the marine time signal. The signal is given each evening unless the clocks are believed to be too inaccurate for the work, and then the signal is given without the use of the green light. Three signals are made – one at 7.30 p.m., one at 8.30, and one at 9.30, corresponding exactly to 8 a.m., 9 a.m., and 10 a.m., Greenwich time. Just before the "9 a.m." signal is sent on Tuesdays and Fridays, a telegraph line to Auckland is cleared of traffic, and an electrical impulse from the observatory puts out a set of signal lights on the Ferry Building.

4.3 Wellington Time Light Photographs

Figure 2 shows the arrangement of time lights at Wellington, on a mast next to the Dominion Observatory buildings. The photograph was published in about 1920 and was included in a comprehensive article about the history of structures in Wellington Botanic Garden (Tomlinson, 2015). Tomlinson also described earlier observatory buildings and apparatus, including photographs of the transit telescope that had been located near the first time ball in 1864.

Recently, the early history of Wellington astronomy has been explored in depth (Orchiston, 2016a, 2016b). The Dominion Observatory, known until 1925 as the Hector Observatory, was built in Wellington Botanic Garden during 1907. The photograph was certainly taken before 1926, when the building was extended. A cropped version of the same photograph was included in a factsheet about the observatory (Dominion Observatory, 2007).

The photograph in Figure 3 also preceded building redevelopment and was taken in about 1925. A low-definition image accompanied a lengthy article in the *Evening Post* about operation of the Dominion Observatory (In Starry Skies, 27 December 1930). The original photograph has not been found, but the extended buildings are obvious. The article included comment about the time light signals:

At the Observatory, there is a mast with coloured lights arranged vertically, green (bottom), red, white (top). On Tuesday and Friday nights these are all lit up and are extinguished by means of the clock at 9 hours G.M.T. On other nights only the red and white lights are visible before extinction.

Figure 4 shows an unusually clear image of

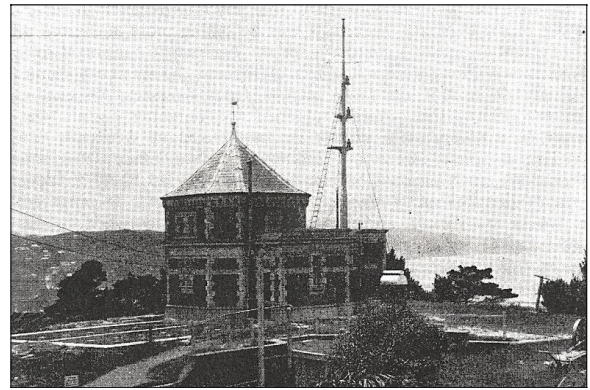


Figure 3: Dominion Observatory, circa 1925 (courtesy Geophysics Division, DSIR)

the lights themselves, with the newly completed Meteorological Office in the foreground (*Evening Post* original photographic prints and postcards). The photograph was taken during 1930. The physical arrangement of lights appears to be unchanged from earlier images.

Figure 5 shows the layout of the Dominion Observatory buildings and time lights in 1935, from a different aspect. This is a detail from an aerial view of Kelburn and Wellington Botanic Garden. The Meteorological Office building is in the foreground.



Figure 4: Detail from a 1930 photograph showing the time lights and part of the Dominion Observatory (courtesy: Evening Post Collection, Alexander Turnbull Library, Wellington, EP-2845-1/2-G).



Figure 5: The upper Botanic Garden, circa 1935 (courtesy: Alexander Turnbull Library, Wellington, PAColl-5927-32).

5 AUCKLAND TIME LIGHTS

5.1 The Change from a Time Ball to Time Lights

The following notice was published in the *Auckland Star* on 17 August 1915 (Time Signals: a New Proposal):

Another attempt probably will be made by the Auckland Harbour Board to provide time signals for the harbour. At to-day's meeting of the Board a letter was received from the acting Government astronomer approving of the proposal for two time signals per week at 9 p.m. Usually signals of guaranteed accuracy were provided on three nights a week at Wellington, and he felt fairly safe in promising two for Auckland.

The harbourmaster (Captain Sergeant) recommended that the signals should be given only on those nights when the observatory could

guarantee them. The Government Astronomer should notify the Board by telegram at 2 p.m. on the days when he could guarantee the signals. When such telegram was received a red flag should be hoisted on the tower of the Ferry Buildings from 4 p.m. to 4.30 p.m., notifying shipping that a guaranteed time signal would be given that night. At least two guaranteed signals per week should be given at 9 p.m. and the following lights shown from the flagstaff of the Ferry Buildings. - Green light switched on at 8.10 p.m., red light at 8.50 p.m., white light at 8.55 p.m. All lights switched off at 9 p.m.

The Harbourmaster further recommended, that the present time ball-signals should be discontinued at once owing to their irregularity, and the night signals commenced as soon as the mechanism had been installed.

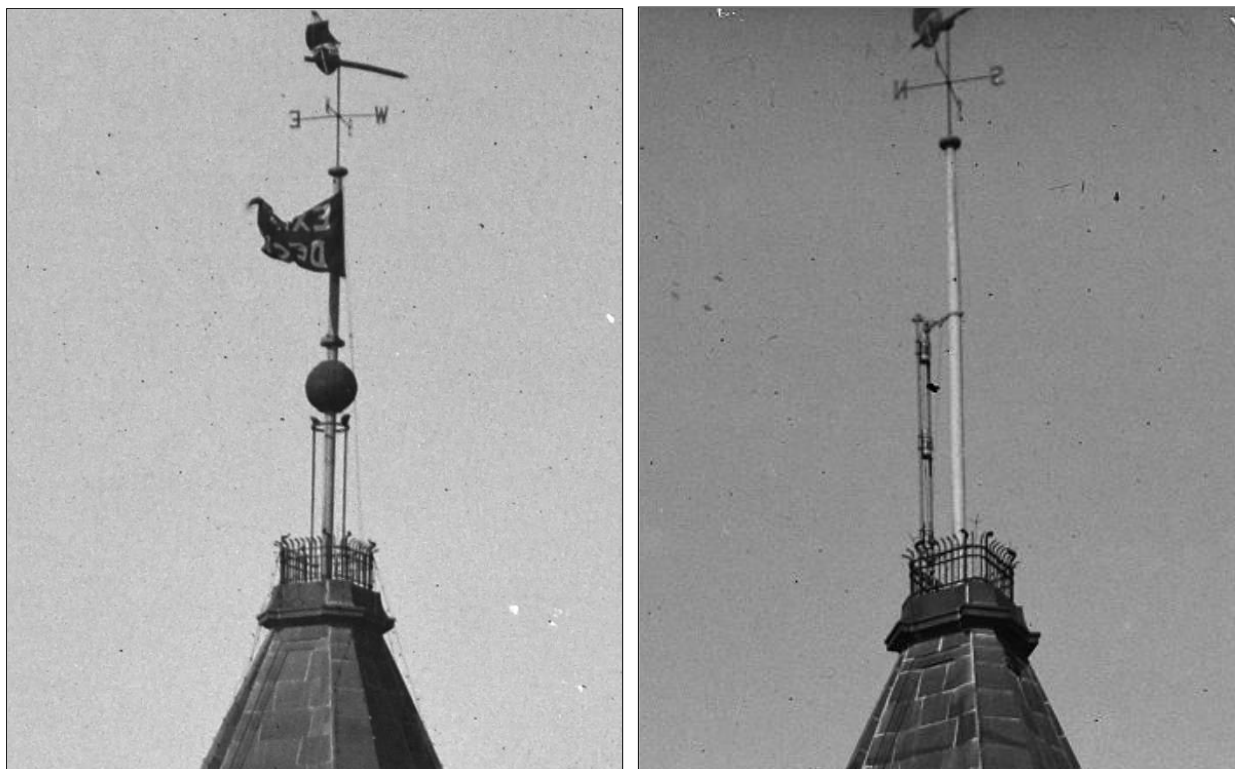


Figure 6: Time signals on the Ferry Building: (a) time ball, 8 April 1913; (b) time lights, 29 December 1915.

5.2 Auckland Time Light Photographs

Figure 6(a) shows the time ball on the Ferry Building, resting on supports while the building awaited installation of the clock (The Auckland Ferry Building on 8 April 1913, detail). Figure 6(b) shows the time lights at the end of 1915; they were attached to the mast that had previously been used to support the time ball (The Auckland Ferry Building on 29 December 1915, detail). The same arrangement of lights can be seen in photographs of the Ferry Building up to 1937.

Figure 7 shows a 1923 photograph by Henry Winkelmann of the Ferry Building, with time lights in place, and the turreted Harbour Board Building on the opposite side of the road to the right. The Ferry Building remains an important Auckland landmark, but the Harbour Board building, which supported the 1901 time ball, was later demolished to make way for new building development.

5.3 Announcements in 1937

An article was published in the *New Zealand Herald*, anticipating withdrawal of the Auckland time light service on 31 July 1937 (Visual Time Signals, 23 June 1937). It was actually decided to continue the service for another three months and it operated for the last time on 29 October, when the article was reprinted in a modified form (Visual Time Signals, 29 October 1937).

Both newspaper articles contained a number of significant errors concerning time ball provis-

ion at Auckland, suggesting that other details may not be reliable. They stated that lights in 1937 had been switched on at 45, 30 and 15 minutes before the signal at 8.30 pm. This contradicted the 1937 *Almanac* which stated that the lights in Auckland were switched on at 50, 10 and 5 minutes before the signal at 09.00 GMT (8.30 pm NZMT). The second *New Zealand Herald* article is transcribed below.

Dating back to the early days of Auckland shipping - with one break of 15 years [*sic*] - visual Greenwich mean time signals on the waterfront, made for the purpose of enabling ships' navigators to compare their chronometers with Greenwich time, will operate for the last time this evening. The apparatus, located on the staff of the Ferry Building since 1915, has been displaced by the general use of wireless time signals.

Since October 1, 1915, a system of electric lights on the staff on the Ferry Building tower, operated from the Dominion Observatory, Wellington, has given visual time signals to shipping at Auckland on Tuesday and Friday nights. After a red flag in the day has indicated that observations have been taken a green light appears on the staff at 8.15 p.m., New Zealand summer time, which corresponds to 8.15 a.m., Greenwich mean time. The green light is followed by the appearance at 15-minute intervals of a red and a white light, and the three lights show for a further 15 minutes [*sic*]. The instant at which they disappear indicates 9 a.m. at Greenwich, or 9 p.m., New Zealand summer time. From the early days of the port until 1900 [*sic*] a ball dropped on a staff on the



Figure 7: Looking south east from Princes Wharf 22 December 1923, showing the Ferry Building on the left (courtesy: Sir George Grey Special Collections, Auckland Libraries, W614).

Auckland Harbour Board building served as a time signal. The signal was discontinued from 1900 until January, 1915 [sic], when the ball was used on the Ferry Building tower, being dropped daily at 1 p.m. The present electric light system was substituted in the following October. Although the ball and light signals with their visibility over a considerable distance, formed a very practical aid to mariners for adjustment of chronometers, the frequent radio time signals have naturally been found more convenient.

5.3.1 Errors in 1937 Announcements

The following summary of errors has been derived by comparing statements in the 1937 announcements with the known history of Auckland time balls (Kinns, 2017).

(1) A time ball was installed on the Harbour Board Building during 1901 and became operational during September 1901. There was no time ball on that building during the nineteenth century. Unofficial time balls had existed in Auckland from 1864, but they did not provide an official service for chronometer calibration.

(2) The ball on the Harbour Board building ceased to provide an official time signal in August 1902, because the service was unreliable. Various attempts were made to re-establish time ball operation, which included modifications to the dropping arrangement, but they were unsuccessful.

successful.

(3) There was no official time ball service in Auckland from August 1902 until April 1915, a gap of about 13 years. A new time ball, with a different drop arrangement, had been installed on the new Ferry Building in 1912, but various technical and management problems meant that announcement of the new service was delayed until April 1915. The new service again proved to be unreliable and it was abandoned in favour of a time light service.

6 CONCLUSIONS

The signalling of exact time using an array of lights appears to have been unique to New Zealand. It was a simple and effective solution for calibration of marine chronometers when transmission of time signals by wireless was in its infancy.

Time lights were operational at the Dominion Observatory in Wellington during February 1912 and on the Ferry Building in Auckland during October 1915. The Auckland lights were a direct replacement for an unreliable time ball, but the last time ball in Wellington had been destroyed by fire in March 1909, almost three years before the time lights became operational. During the intervening period, galvanometer signals were provided for calibration of marine chronometers. The Wellington lights were immediately

adjacent to the main observatory buildings, but those in Auckland were operated using telegraph signals from Wellington. The time light service was withdrawn during 1937, when wireless signals had become almost universally available for civil and navigation purposes; other signal arrangements had been rendered obsolete.

An array of three lights, spaced by 1.8m (6ft.), was used at both locations. The physical arrangement of lights remained unchanged until the signals were withdrawn in 1937. The uppermost light was white, the middle light was red and the lowest was green. The green light was illuminated first, followed by the red light and finally the white light. They were then switched off simultaneously at the designated signal time. It was always emphasized that the times for switching on were approximate and that extinguishing of lights was the actual signal.

During the early years, the whole sequence at Wellington was repeated at hourly intervals during the evening, but this was simplified later to one sequence only. Specific signals were provided to indicate that the control clocks at Wellington had been calibrated using recent star transit observations, so that the time light signal provided the highest possible accuracy for chronometer rating. Developments and changes between 1912 and 1937 have been traced by reference to different editions of the *New Zealand Nautical Almanac* and newspaper announcements.

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