The Post-Loss Radio Signals

As with Dr. Jantz's findings, the patterns and relationships emerging from the data show that TIGHAR has answered the 81 year old question: what really happened to Amelia Earhart?

Beyond Betty

Fifteen year-old Betty Klenck's transcription of the desperate pleas for help she heard on her family radio in July 1937 have been featured in books, articles, and television documentaries as a remarkable record of perhaps the last communication from Amelia Earhart and Fred Noonan. The references to accurate information that Betty could not possibly have otherwise known leave little doubt that she heard a genuine distress call sent from the Electra on the reef at Gardner Island (now Nikumaroro).

Betty's Notebook describes a scene so clearly authentic and so emotionally powerful that her experience tends to overshadow the other fifty-six credible signals heard in the days following the Electra's failure to arrive at Howland Island. However, in truth, those receptions constitute a body of evidence far stronger than Betty's alone.

Similar to the castaway bone measurements analyzed by forensic anthropologist Richard Jantz, the post-loss radio signals constitute historically documented quantitative data that can be scientifically analyzed. As with Dr. Jantz's findings, the patterns and relationships emerging from the data show that TIGHAR has answered the 81 year old question: what really happened to Amelia Earhart?

The Post-Loss Radio Signals – Who, What & Where

Who Was Listening?

Early on the afternoon of July 2, 1937, the U.S. Navy Hydrographic Office in San Francisco put out an "all ships, all stations" bulletin announcing that the Earhart plane had failed to arrive at Howland Island and was presumed down at sea. At the time, it was assumed that the plane could transmit if afloat, so the Navy broadcast gave Earhart's primary frequencies and asked all parties to listen for her.[1]

Consequently, in the following days and nights, everyone listening for possible messages from the missing airplane was tuned to one of her two primary frequencies, 3105 and 6210 kHz. By international agreement, only U.S registered aircraft were permitted to send voice signals on those wave lengths. Except for the Coast Guard cutter *Itasca* which had special permission to try to contact Earhart, the Electra was the only legal source for transmissions on 3105 or 6210 in the Central Pacific, so anything heard was regarded as being possibly from Earhart.

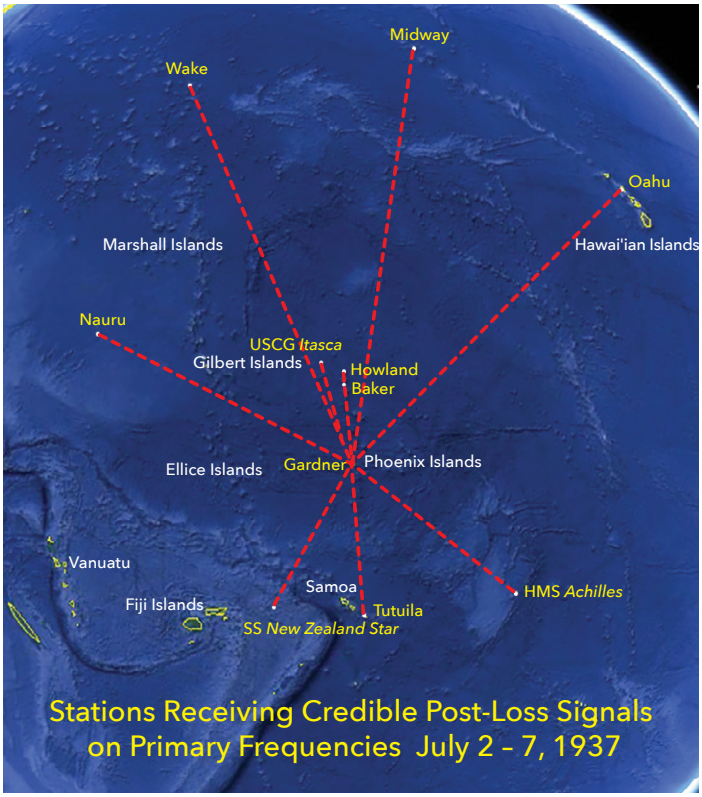
Who Was Hearing?

Fully fifty of the fifty-seven credible post-loss receptions were heard by U.S. government or professional commercial operators listening on the primary frequencies. They included U.S. Navy, U.S. Coast Guard, and Royal Navy radiomen aboard ships; U.S. Navy Radio Wailupe, Hawaii; Navy Radio Tutuila, American Samoa; U.S. Coast Guard Headquarters, Honolulu; licensed amateurs employed by the U.S. Department of Interior on Howland and Baker Islands; PanAmerican Airways radio direction finding stations on Oahu, Midway, and Wake Islands; and the Amalgamated Wireless station on the island of Nauru.

What Were They Hearing?

The quality of the signals they heard was poor. Pacific distances are great and the Electra's radios were intended for communication within a few hundred miles. Many stations heard only a background "carrier wave" indicating that someone, somewhere, was transmitting on Earhart's frequency. Often, the signal was "modulated"

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indicating the presence of a voice component, but in most cases the words were unintelligible (although in a few messages Earhart's voice was recognized). Sometimes the sending transmitter was turned off and on at regular intervals to create crude "dashes" (Earhart had no Morse code sending key), often in response to messages sent to Earhart asking her to do just that. On only one occasion was Morse code heard but the message was fragmentary, cryptic, and sent in "extremely poor keying."[2] Neither Earhart nor Noonan was adept at Morse code.

Where Were the Signals Coming From?

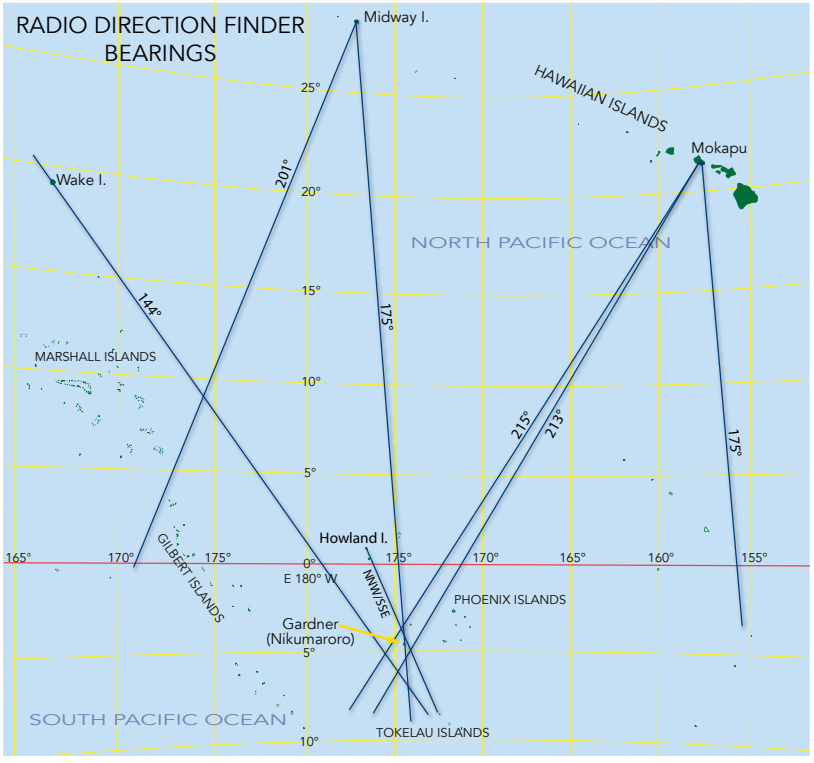
There is no doubt about the origin point for the most credible signals. The quality of receptions generally decreased as the distance from Gardner Island increased. Stations closest to Gardner Island typically heard an unintelligible voice message while, at the same moment, a station thousands of miles away heard only the underlying "carrier wave" signal. On only one occasion – at Baker Island, the station closest to Gardner – did an operator hear a strong, clear voice signal with the plane's call sign.[3]

Five of seven directional bearings taken on credible post-loss transmissions cross in the immediate vicinity of Gardner Island.[4] The only transmitter anywhere near Gardner – on Hull Island, 140 nautical miles to the east – was capable of sending only code and is known to have been inoperable in July 1937.[5]

Accidental Witnesses

The experience of hearing Amelia Earhart's anguished descriptions of her plight was unique to people who stumbled upon her calls by accident. When the Electra's microphone was keyed, in addition to the selected primary frequency, the transmitter also put out "harmonics" (multiples) of those wavelengths. High harmonic frequencies "skip" off the ionosphere and can carry great distances, but clear reception is unpredictable. A handful of credible voice receptions are known to have been heard on harmonic frequencies by private citizens who happened upon the signal while cruising the shortwave dial of their home radio.

Scattered across North America and unknown to each other, each listener was astonished to suddenly hear Amelia Earhart pleading for help. They alerted family members, local authorities, or local newspapers. Some were investigated by government authorities and found to be believable. Others were dismissed at the time and only recognized many years later. Although few in number, the harmonic receptions provide an important glimpse into the desperate scene that played out on the reef at Gardner Island.



Of Babies and Bathwater

In a report written after the search for Earhart had failed, the commanding officer of the Coast Guard cutter *Itasca* categorically dismissed all of the reported post-loss signals. He described the directional bearings taken by Pan American as coming from "some place in the Pacific." Ignoring the many receptions heard and logged by professional operators, including radiomen aboard his own ship, he declared the receptions by amateurs to be "all probably criminally false." He explained that "*Itasca* signals calling Earhart, the March of Time program and other signals were interpreted as from Earhart" and asserted that "All available land areas were searched therefore Earhart plane was not on land." He concluded it was "extremely doubtful that Earhart ever sent signals after 0846, 2 July."[6]

There was, in fact, no ground search of any land area. It is true that there were a number of hoaxes, but it is also true that some reported civilian receptions were investigated by government authorities and found to be believable. None of the calls to Earhart was mistakenly interpreted as coming from Earhart. *Itasca* was the only station authorized to transmit on Earhart's frequency and the cutter's calls were carefully logged. At no time did a transmission to Earhart coincide with a suspected signal from Earhart. The March of Time radio program was broadcast on July 8, by which time the credible distress calls had ceased.[7]

The blanket denial of the post-loss signals in Coast Guard and Navy after-action reports, while inexcusable, is perhaps understandable. To say otherwise would be to admit that the searchers had possibly left Earhart and Noonan to die on some forgotten island. Many, including Earhart's husband George Putnam and her technical advisor Paul Mantz, remained convinced that was exactly what happened.

Doing What Was Not Done

TIGHAR has done what was not done in the wake of the failed search: a comprehensive, objective evaluation of the post-loss radio signal phenomenon. To be fair, TIGHAR has resources that were not available in 1937. In the 1990s, TIGHAR Senior Researcher Dr. Randy Jacobson created a digital database of more than 2,000 Navy and Coast Guard log entries and official messages, making it possible for TIGHAR to construct an accurate, hour-by-hour chronology of what transpired and who-knew-what during the planning, conduct, and aftermath of the fatal flight.

The discovery of Betty's Notebook in 2000 inspired an effort to find, catalog, and analyze all of the alleged receptions of post-loss signals from Earhart. Dozens of TIGHAR members scoured the Jacobson database, historical correspondence, and newspaper archives, ultimately tracking down and documenting 120 reports of post-loss receptions. By 2011, TIGHAR Senior Researcher Bob Brandenburg and Executive Director Richard Gillespie had completed a "Catalog and Analysis of Radio Signals During The Search for Amelia Earhart in July 1937."[8]

The Catalog assigned chronological numbers to each signal and analyzed its credibility using a sophisticated computer program known as ICEPAC.[9] Brandenburg calculated the statistical probability that a reported signal, if sent from the Earhart Electra at Gardner Island, would be heard at the receiver site on the reported date and time. Gillespie and Brandenburg considered qualitative factors such as reported message content to further refine the assessment of each alleged reception. If the Electra proved to be the most likely source for the signal, the message was judged to be Credible. If there were insufficient data to make an assessment, a signal's credibility was listed as Uncertain. If a reception was disqualified it was labeled Not Credible. The study found that 57 of the 120 reported signals were Credible, 25 were of Uncertain credibility, and 38 were Not Credible.[10]

With the credible signals identified, it was immediately apparent that their timing was not random. Over a period of six days, July 2 to July 7, the transmissions were heard – with two exceptions – only during hours of darkness in the Central Pacific. High frequency radio waves propagate best at night, but cooler temperatures during hours of darkness were probably the biggest motivating factor for transmitting mostly at night.

Sending radio distress calls from the Electra parked on the reef at Gardner Island presented Earhart with a dilemma. The radios relied on the aircraft's batteries, but battery power was needed to start the generator-equipped starboard engine to recharge the batteries. If the lost fliers ran down the batteries sending distress calls they wouldn't be able to start the engine. The only sensible thing to do was to only send radio calls when the engine was running and charging the batteries. But on the reef, the tide comes in and the tide goes out. TIGHAR's hypothesis would only work if the credible signals were sent when the water level was low enough – less than 26 inches – for the propeller tip to clear.

To test the hypothesis, Brandenburg used hind-casted tidal levels and reef height data collected in a survey done by the 2007 Niku V expedition team to plot the credible post-loss signals against the hour-by-hour water levels in the area on the reef TIGHAR had identified as the plane's probable location. The correlation was astounding. Conditions at Gardner were not considered in determining which signals are credible, and yet – night after night - the credible transmissions occurred only when the water level was low enough for the prop to clear.

Graphs depicting the relationship between signal times and water levels were published in Brandenburg's paper "Time and Tide" in the February 2013 issue of *TIGHAR Tracks*.

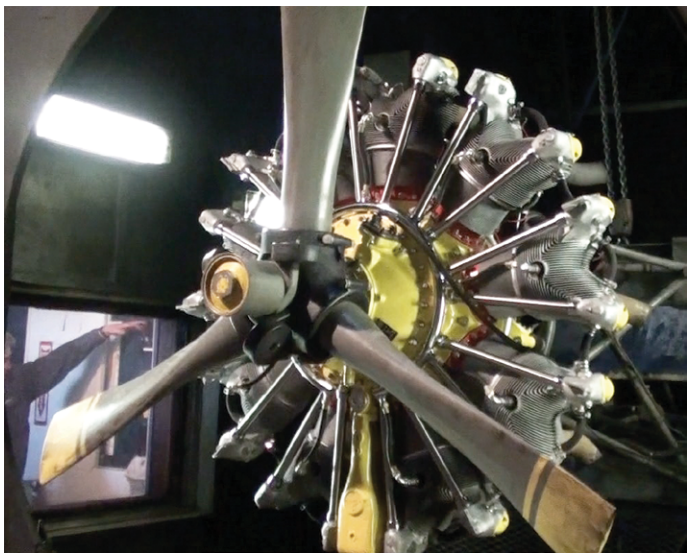
Of Forests and Trees

The 2011 Post-Loss Radio Signals Catalog and Analysis is a valuable resource but because the quantity of data presented and analyzed is so large it can be difficult to appreciate the significance of what was happening. A new Post-Loss Radio Signals Catalog and Analysis 2.0 (page 8) presents a simplified chronology of the signals keyed to the original catalog. Augmented graphs and short summary narratives make the story the signals tell more accessible.

Patterns

The new catalog divides the signals into groups according to newly identified patterns. Most (88%) of the credible receptions occurred during the first three nights after the flight disappeared. On each night, the credible signals occurred during periods of low water on the reef. What we recently realized is that, on each of the three nights, the signals follow a consistent and predictable sequence. There are "active" periods of time lasting about an hour during which credible receptions are heard, followed by "silent" periods when no credible signals are heard. The "silent" periods always last over an hour, and typically last about an hour and a half, then the pattern repeats until high tide or daylight.

The reason for the silent periods is not known, but research has revealed a logical hypothesis. As early as July 3, 1937, Earhart's technical advisor Paul Mantz suggested that the distress calls were being sent from one of the islands in the Phoenix Group. Asked whether the plane would have enough fuel to run an engine to re-charge the batteries, he told a journalist that sufficient amperage to charge the batteries could be achieved by running the right-hand, generator equipped engine at 900 RPM burning less than six gallons of fuel per hour.[11] In 2009, TIGHAR – with the cooperation of Covington Aircraft Engines in Okmulgee, Oklahoma – checked Mantz's statement by experimentation using the same type of engine and generator as Earhart's Electra. We found that 900 RPM was, indeed, the minimum needed to charge the battery. The fuel flow, at 6.4 gallons per hour, was slightly higher than Mantz's estimate.



Pratt & Whitney R-1340 Wasp on test stand at Covington Aircraft Engines, Okmulgee, OK for TIGHAR tests in 2009.

The R-1340 is an air-cooled engine. According to engineers at Covington, airflow generated by the prop at 900 RPM is not sufficient to keep cylinder head and oil temperatures within acceptable levels. After a period of time, the engine will overheat and have to be shut down for cooling before re-starting. The active/silent pattern exhibited by the post-loss signals seems about right for heating up and cooling down, but to thoroughly test the hypothesis we'll want to check that by direct experimentation. It should be a simple matter of running a stationary R1340 at 900 RPM in ambient temperatures similar to typical night time temperatures at Nikumaroro.

Aboard and Ashore

We can be sure that Earhart and Noonan were aboard the Electra during the active periods, and the new graphs designate those times. We can also be sure that temperatures aboard the metal aircraft parked in the sun during the day would encourage seeking shade, food and water ashore during daylight hours. When the lost fliers waded ashore and when they returned to the aircraft would depend upon their physical condition and what risks they were willing to take.

While the reef surface where the plane landed is smooth and has only a thin skim of water at low tide, the coral closer to shore is jagged, slippery, pitted, and always covered with several inches or more of water. Walking on the reef is best done slowly and with a stout walking stick. Sharks patrol where the water depth is greater than about 20cm. Crossing the reef at any state of the tide in the dark would be foolhardy.



Looking shoreward at low tide from the plane's presumed location, the treacherous nature of the reef surface close to shore is not apparent.



As soon as there is enough water on the reef, the Blacktips begin hunting.

Credible Beyond a Reasonable Doubt

The new study has added a category: Credible Beyond a Reasonable Doubt (CBRD). In a criminal prosecution, conviction requires evidence that is "beyond a reasonable doubt" – evidence so compelling that no other logical explanation can be derived from the facts. As detailed in the new analysis, many of the post-loss receptions meet that standard.

Continuing Research

The post-loss signal data should also provide clues about the final portion of the flight, but mining the data for that information is complicated. From our experiments at Covington in 2009, we can calculate how much fuel it took to run the engine for sufficient periods to keep the batteries charged. That information will tell us how much fuel the aircraft must have had remaining upon arrival at Gardner. We know the window of time on the morning of July 2 when the water level on the reef was low enough to permit landing. We also know the the aircraft's approximate speed and rate of fuel consumption in a range of power settings.

Senior Research Bob Brandenburg is constructing a digital mathematical model that will automatically calculate fuel remaining upon arrival based upon the input of a wide range of variables. Assuming only that the island was not yet in sight at the time of the last known in-flight transmission to *Itasca*, we should be able to define the range of places the Electra could have been at that moment.

Notes

1 Randy Jacobson, The Jacobson Database, page 306.

2 Message 125 in the new study.

3 Message 51 in the new study

4 RDF Analysis.

5 Eric Bevington, *The Things We Do For England – If Only England Knew* (Salisbury, Wiltshire: Acorn BookWork, 1990), p. 25.

6 CDR Warner Thompson, USCG, Radio Transcripts Earhart Flight, p. 105.

7 https://tighar.org/wiki/The_March_of_Time

8 Robert Brandenburg, Signal Catalog.

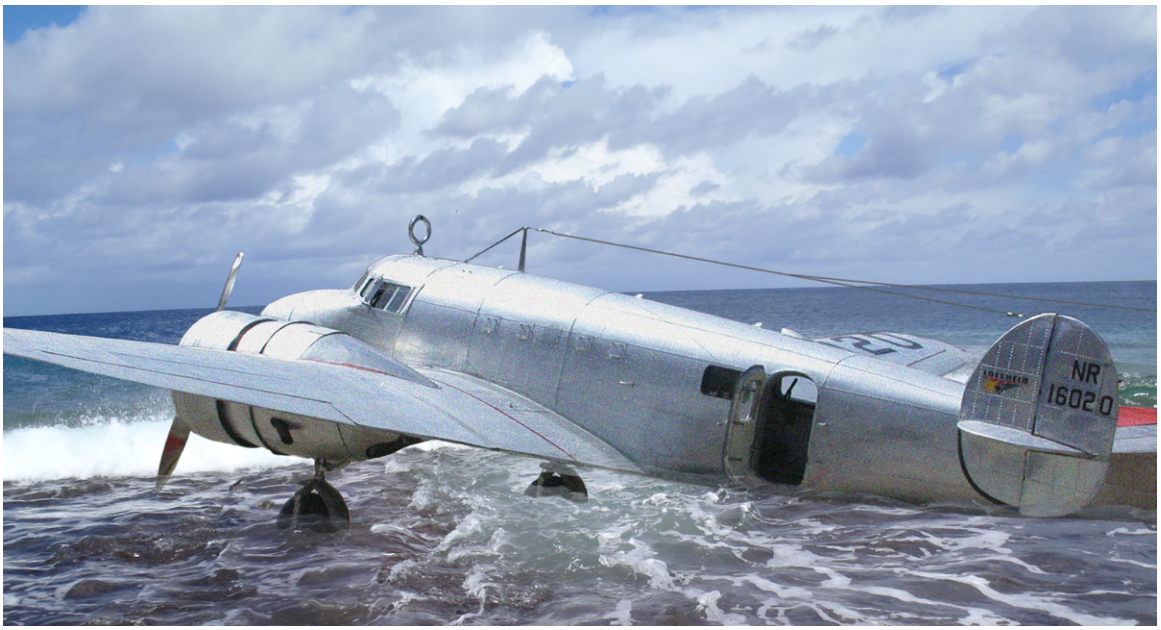
9 Ionospheric Communications Enhanced Profile Analysis and Circuit Prediction (ICEPAC) computer program developed by the U.S. Department of Commerce Institute for Telecommunication Sciences

10 Brandenburg, Signal Catalog.

11 "Plane's Letters Heard on Radio at Los Angeles," *New York Herald Tribune*, July 5, 1937, p. 2.

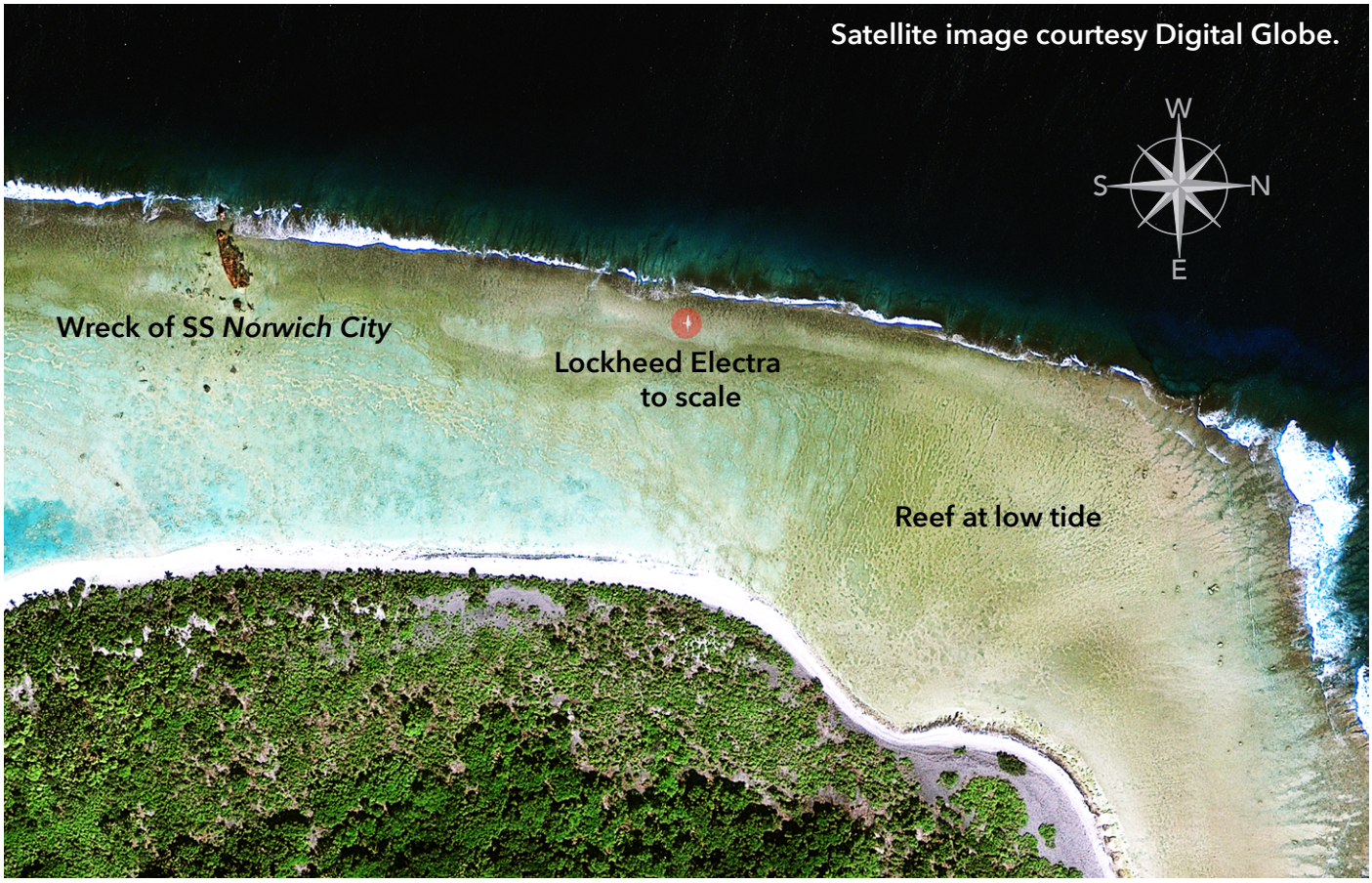
Post-loss Radio Signals Catalog and Analysis 2.0

by Richard Gillespie & Robert Brandenburg

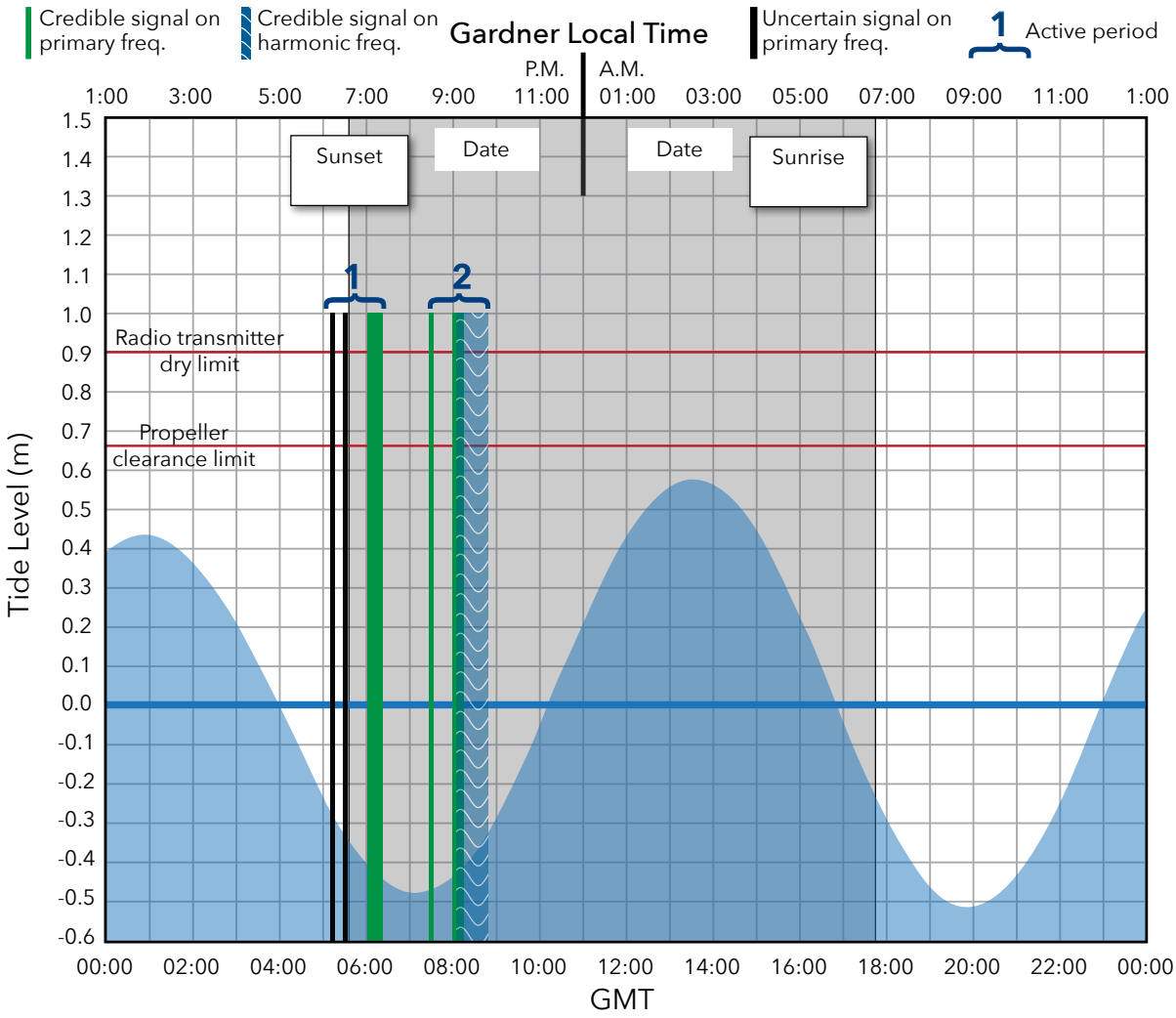


Presumed Aircraft Location

For the purposes of this study the aircraft is presumed to have been stationary on the reef roughly 400 meters north of the shipwreck.

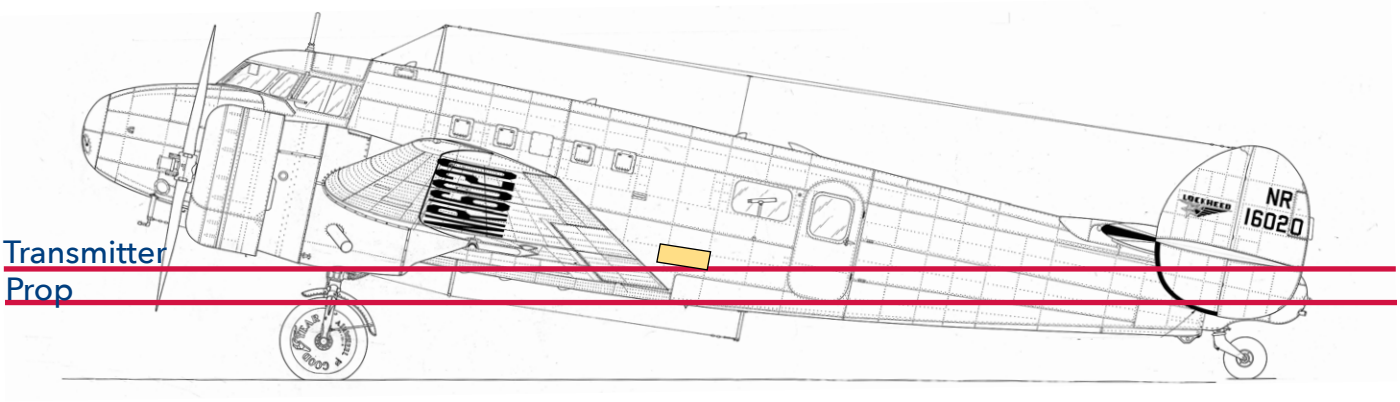


Reading the Graphs



Each graph depicts a 24-hour day centered on midnight. Periods of darkness at Gardner Island are shown in gray with times denoting sunrise and sunset. Tidal water levels on the reef are shown in waves with a heavy blue line showing when the reef would be dry in flat calm conditions. Red lines designate when the water level would be too high to run an engine and when the water would reach the transmitter in the cabin.

- Credible signals heard on primary frequencies are shown as vertical green lines.
- Signals of Uncertain credibility as shown as black lines.
- Signals heard on harmonic frequencies are shown as blue patterned lines.
- Active periods are numbered.

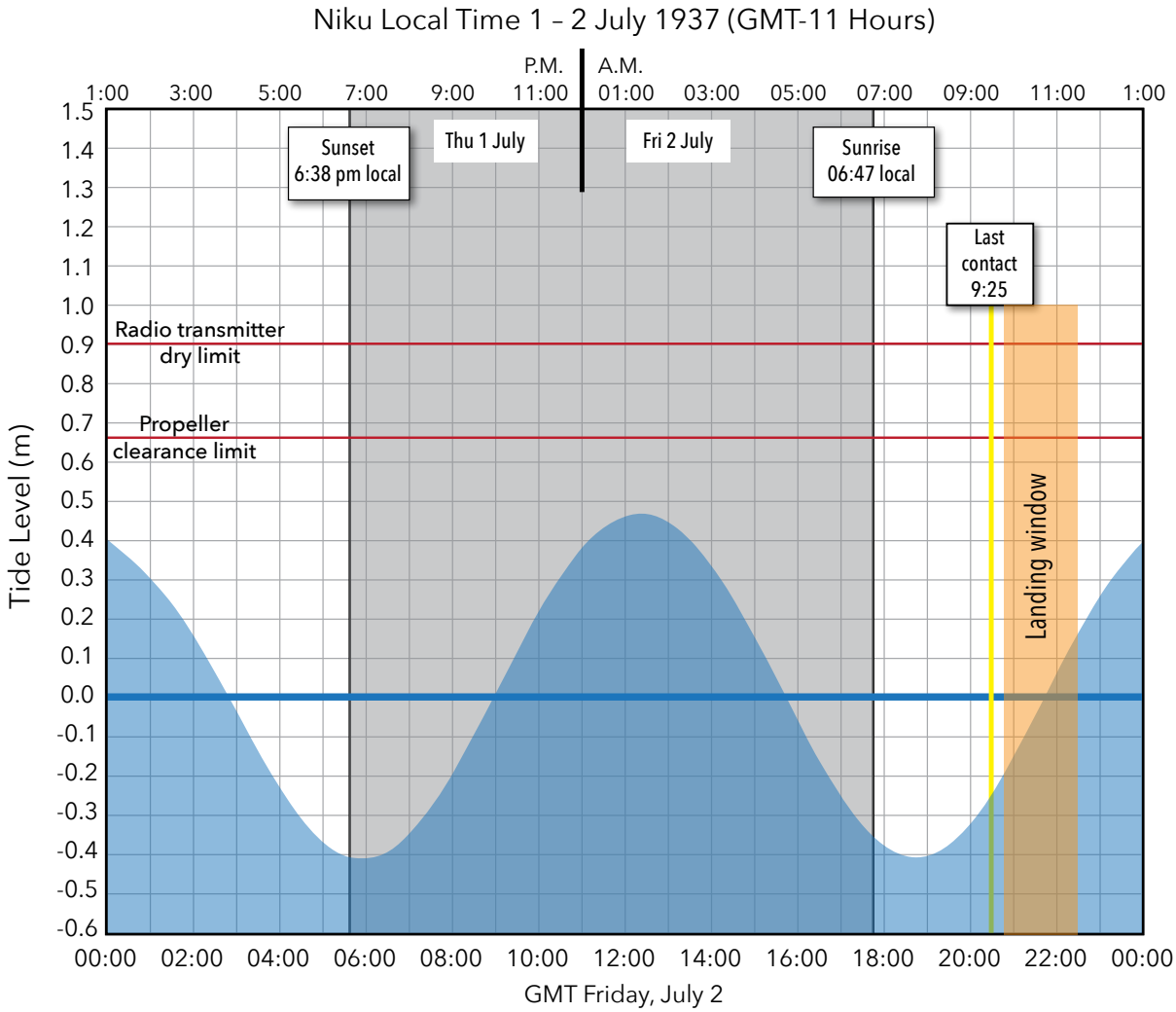


Reading the Tables

Number	Date	Time	Frequency	Probability	Credibility
17	July 2	7:00pm	Primary	94%	Credible
HMS *Achilles* hears dashes in response to *Itasca's* request for dashes on 3105.					

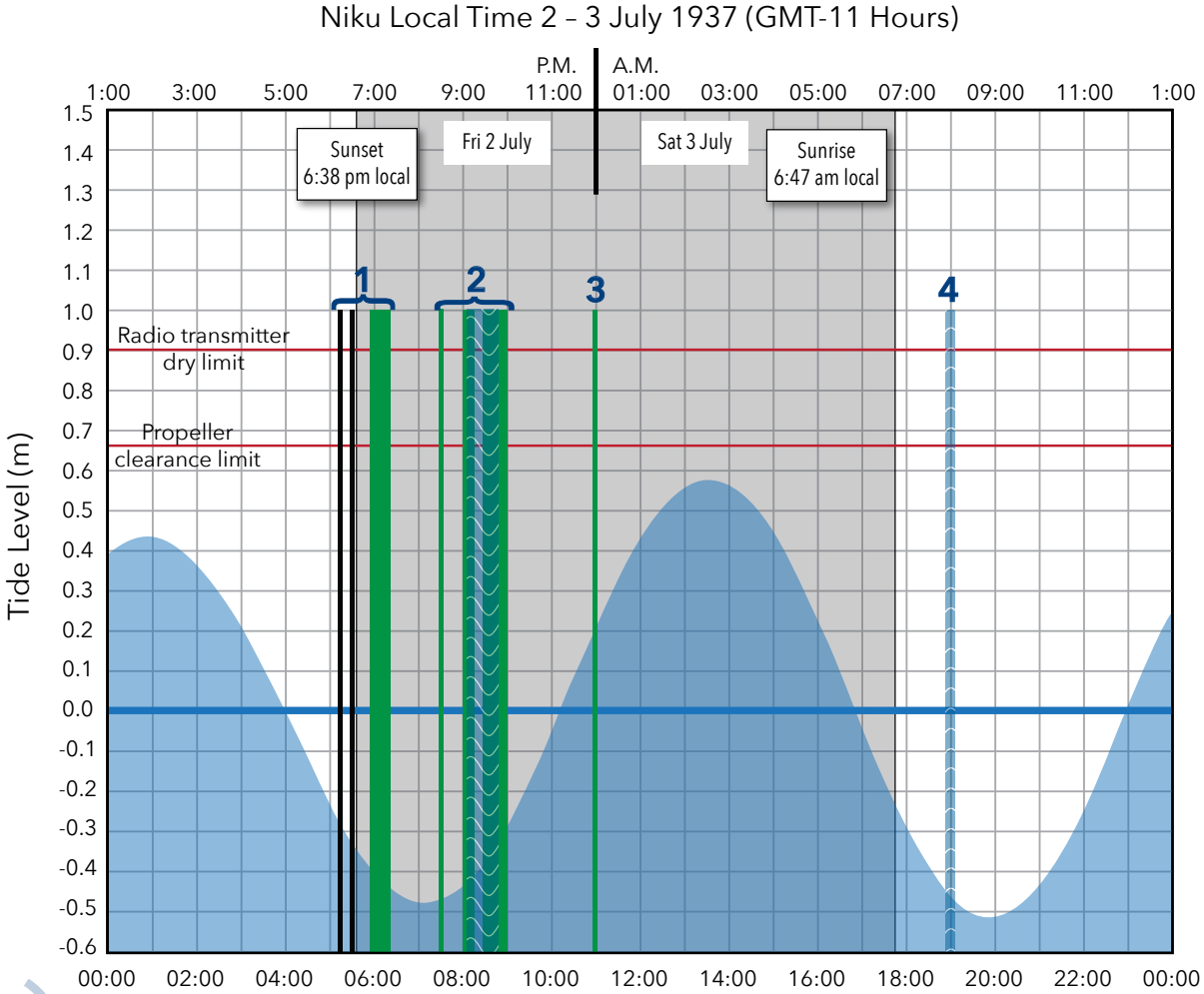
- Number is the message number in the "Catalog and Analysis of Radio Signals During The Search for Amelia Earhart in July 1937."
- Date and Time are for Gardner Island
- Frequency is either Primary or Harmonic
- Probability is the calculated probability that the reported signal, if sent from the Earhart Electra at Gardner Island, would be heard at the receiver site.
- Credibility is the assessed credibility that the signal was sent from the Electra

Arrival – Friday, July 2, 1937



Itasca hears the last inflight transmission from Earhart at 9:25 a.m. Gardner time (8:55 a.m. *Itasca* time, not 8:46 a.m. as is often reported). The message contains no mention of an island in sight, so the aircraft is not yet in visual range of Gardner. The earliest the aircraft could reasonably arrive is, therefore, roughly 9:45am. At that time, the reef is dry but the tide is coming in. Based upon the aircraft's landing speed and tire size, the water level on the reef must be no more than 6 inches (.15m) for a safe landing, The arrival window closes at about 11:30am.

July 2/3, 1937



First Active Period: 6:17 p.m. to 7:10 p.m. Friday, July 2, 53 minutes

Ships and shore stations around the Central Pacific have been listening for Earhart since mid-afternoon when the U.S. Navy in San Francisco sent out an "all ships all stations" bulletin announcing that the flight was presumed to be down, and asking that everyone monitor her frequencies for possible signals. Nobody hears anything until it starts to get dark, when both *Itasca* and the PanAm station in Hawai'i start hearing weak signals. Shortly after sundown, the *Itasca* radio operator hears a voice he believes to be Earhart's, but he can't make out what she is saying. He asks her to send dashes to confirm it is her. Three stations – *Itasca*, HMS *Achilles*, and SS *New Zealand Star* – hear dashes in response. *Itasca* then hears more dashes and the word "Earhart."

Recognition of Earhart's voice by the *Itasca* operator and the reception by three stations of a response to *Itasca's* request for dashes makes it **Credible Beyond a Reasonable Doubt** that these signals are coming from Earhart.

Number	Date	Time	Frequency	Probability	Credibility
9	July 2	6:17 pm	Primary	45%	Uncertain
PanAm Mokapu hears a steady carrier on 3105, no discernable voice					

Number	Date	Time	Frequency	Probability	Credibility
10	July 2	6:30 pm	Primary	99%	Uncertain
Itasca hears weak unreadable voice on 3105					

Number	Date	Time	Frequency	Probability	Credibility
14	July 2	6:55 pm	Primary	57%	Uncertain
PanAm Mokapu hears a steady carrier on 3105, no discernable voice.					

Number	Date	Time	Frequency	Probability	Credibility
15	July 2	6:55 pm	Primary	99%	**CBRD**
Itasca logs "We hear her on 3105 Kcs now, very weak and unreadable voice."					

Number	Date	Time
16	July 2	7:00pm
Having heard what he believes is a transmission from Earhart, the *Itasca* radio operate sends a voice message on 3105 and a code message on 7500 asking her to send a series of long dashes.		

Number	Date	Time	Frequency	Probability	Credibility
17	July 2	7:00 pm	Primary	94%	**CBRD**
HMS *Achilles* hears dashes in response to *Itasca*'s request for dashes on 3105.					

Number	Date	Time	Frequency	Probability	Credibility
18	July2	7:00 pm	Primary	94%	**CBRD**
New Zealand Star also hears dashes on 3105.					

Number	Date	Time	Frequency	Probability	Credibility
19	July 2	7:04 pm to 7:06 pm	Primary	99%	**CBRD**
Itasca hears dashes on 3105.					

Number	Date	Time	Frequency	Probability	Credibility
21	July 2	7:07 pm to 7:10 pm	Primary	99%	**CBRD**
Itasca hears unreadable signals, then dashes, then the word "Earhart," then more unreadable signals on 3105.					

Silent Period 7:10 pm to 8:27 pm – 1 hour 17 minutes.



Second Active Period – 8:27 p.m. to 10:00 p.m. Friday, July 2, 1 hour 33 minutes

Narrative

Later that evening, there is another burst of activity. Again, dashes are heard and Earhart's voice is recognized, this time by the Amalgamated Radio operator on the island of Nauru who had heard her inflight calls the night before. At the same time, unbeknownst to the searchers, Texas housewife Mabel Larremore stumbles upon a harmonic frequency and hears Amelia describe being "down on an uncharted island, small, uninhabited." The plane was "part on land, part in water." Her reception coincides with Nauru's recognition of Earhart's voice. Both are **Credible Beyond a Reasonable Doubt.**

Number	Date	Time	Frequency	Probability	Credibility
26	July 2	8:27 pm	Primary	6%	Credible
Coast Guard Hawai'i hears dashes on 3105.					

Number	Date	Time	Frequency	Probability	Credibility
27	July 2	9:00 pm	Primary	28%	Credible
Coast Guard Hawai'i hears dashes on 6210.					

Number	Date	Time	Frequency	Probability	Credibility
28	July 2	9:00 pm to 9:45 pm	Harmonic	.83%	**CBRD**
Mabel Larremore in Amarillo, Texas hears Earhart say, "Plane down on an uncharted island. Small, uninhabited." The plane was partially on land, part in water. She gave the latitude and longitude of her location. Mabel listened to her for 30-45 minutes.… her navigator Fred Noonan was seriously injured. Needed help immediately. She also had some injuries but not as serious as Mr. Noonan."					

Number	Date	Time	Frequency	Probability	Credibility
29	July 2	9:31 pm	Primary or Second Harmonic	88%	**CBRD**
The night before, the radio operator on the island of Nauru, listening on 6210, had heard Earhart announce that she saw a "ship in sight ahead" as she passed south of the island en route to Howland. Now he heard "fairly strong signals, voice not intelligible, no hum of plane in background but voice similar to that emitted from the plane in flight the previous night.					

Number	Date	Time	Frequency	Probability	Credibility
30	July 2	9:33 pm	Primary	89%	Uncertain
Itasca hears weak, unreadable voice on 3105.					

Number	Date	Time	Frequency	Probability	Credibility
32	July 2	9:37 pm	Primary	89%	Uncertain
Itasca still hearing weak voice on 3105					

Number	Date	Time	Frequency	Probability	Credibility
34	July 2	9:43 pm	Primary or Second Harmonic	88%	Credible
Nauru again hears "fairly strong signals, voice not intelligible, no hum of plane in background but voice similar to that emitted from the plane in flight the previous night" on 6210.					

Number	Date	Time	Frequency	Probability	Credibility
35	July 2	9:43 pm	Primary	89%	Credible
Itasca still hearing weak voice on 3105					

Number	Date	Time	Frequency	Probability	Credibility
36	July 2	9:54 pm	Primary or Second Harmonic	88%	Credible
For a third time, Nauru hears "fairly strong signals, voice not intelligible, no hum of plane in background but voice similar to that emitted from the plane in flight the previous night" on 6210.					

Number	Date	Time	Frequency	Probability	Credibility
37	July 2	10: 00pm	Primary	89%	Uncertain
Itasca still hearing weak voice on 3105.					

Silent Period 10:00pm to 11:57pm – 1 hour 57 minutes



Third Active Period: single reception 11:57 p.m. Friday, July 2

Just before midnight, Coast Guard Headquarters in Honolulu hears dashes on 3105. No one else hears anything., The single transmission is sent as the tide is coming in.

Number	Date	Time	Frequency	Probability	Credibility
41	July 2	11:57pm	Primary	.7%	Credible
Coast Guard Hawai'i hears long dashes on 3105.					



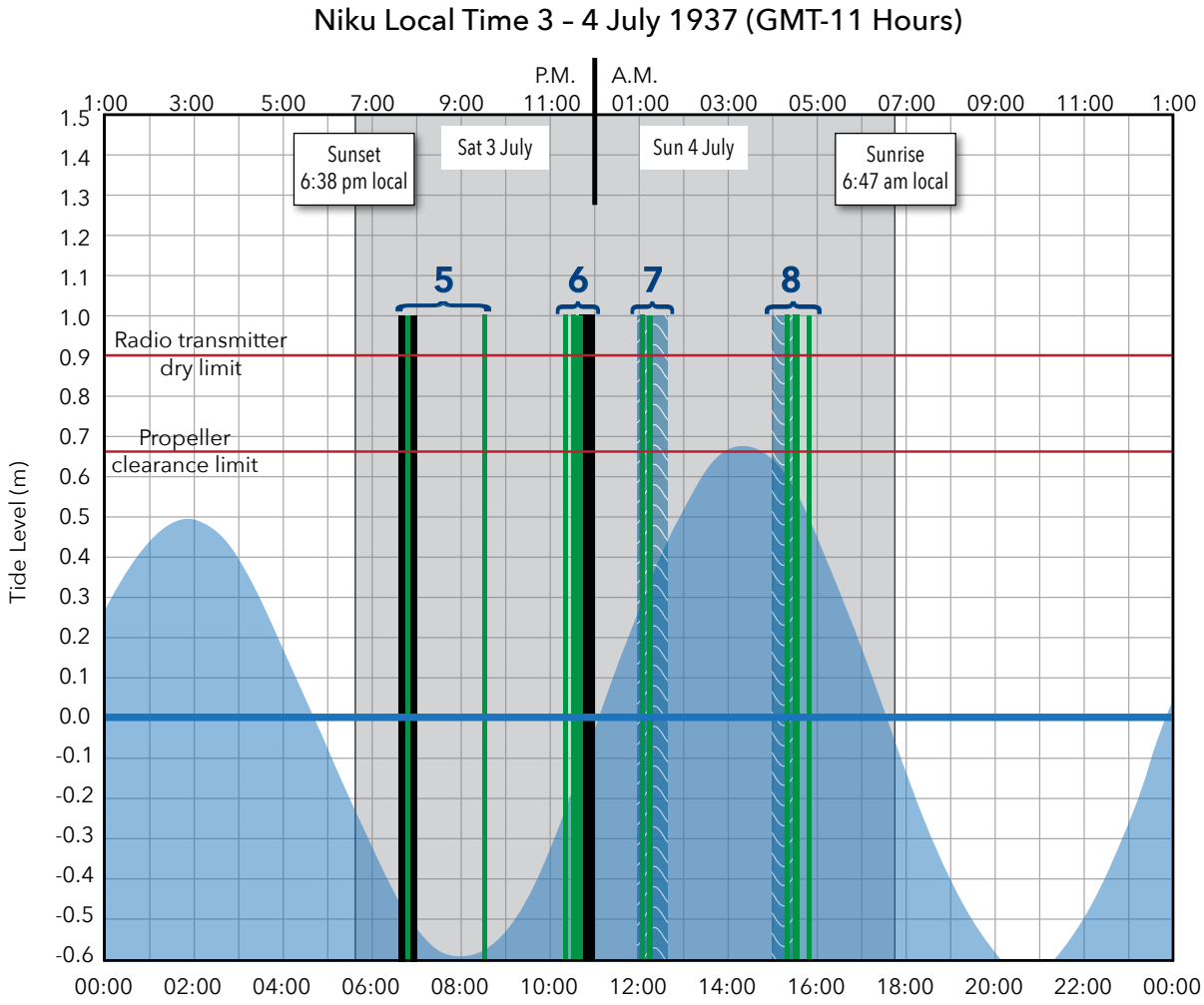
Fourth Active Period: single reception 8:00 a.m. Saturday July 3

No further signals are heard for the rest of the night, possibly because Earhart and Noonan are getting some much-needed sleep. The next morning, Nina Paxton of Ashland, KY, hears Earhart on a harmonic.

Paxton waited a week to report her experience to the local newspaper and, in later years, made repeated attempts to publicize her story, embellishing it with new and often outlandish details, but her initial account is credible.

Number	Date	Time	Frequency	Probability	Credibility
47	July 3	8:00am	Harmonic	.03%	Credible
Nina Paxton in Ashland, Kentucky hears Earhart say “KHAQQ calling” “down in ocean,” then “on or near little island at a point near …,” then something about “directly northeast,” and “our plane about out of gas. Water all around. Very dark.” Then something about a storm and that the wind was blowing, “Will have to get out of here,” “We can’t stay here long.”					

July 3/4, 1937



Fifth Active Period – 7:45 p.m. to 9:34 p.m.
Saturday, July 3, 1 hour 49 minutes

The most significant message during this active period is a call heard by the Department of Interior radio operator on Baker Island. At 7:50 pm on July 3, he “Heard Earhart plane QSA 4 R7.” Strength 4 on a scale of 1 to 5, and Readability 7 on a scale of 1 to 9 is a strong, clear signal. He reported the reception to the operator on Howland who, in turn, passed it on to *Itasca*. No specific content was recorded but the high reported quality of the signal and the operator’s unequivocal statement that it came from the Earhart plane makes it **Credible Beyond a Reasonable Doubt**.

Later that evening, the Coast Guard Hawaiian Section picked up on a suggestion Earhart’s husband had made the night before: “Radio station KGU Honolulu offers to broadcast whatever desired on theory Earhart plane may be able to receive. Suggest use this means for aiding in search and sending encouragement to occupants of plane.”

Arrangements for a special broadcast to Earhart were made with NBC affiliate KGU and with Honolulu’s other major commercial station, KGMB. Earhart was known to be familiar with both stations from her previous flights, and it was not unreasonable to suppose that she might be listening for news of efforts to come to her aid.

At 9:33 pm Gardner Time KGU made their broadcast asking Earhart to respond. A minute later the Pan American direction finder station at Mokapu Point hears a faint carrier signal on 3105.

Number	Date	Time	Frequency	Probability	Credibility
50	July 3	7:45 pm	near Primary	87%	Uncertain
Itasca hears weak signal, possible voice modulation, 3110 kcs.					

Number	Date	Time	Frequency	Probability	Credibility
51	July 3	7:50 pm	Primary	96%	**CBRD**
The radio operator on Baker Island, 30 miles south of Howland, hears "Earhart plane Strength 4 Readability 7." No content reported.					

Number	Date	Time	Frequency	Probability	Credibility
52	July 3	7:53 pm	Primary	96%	Uncertain
Itasca hears weak signal.					

Number	Date	Time	Frequency
54	July 3	9:33pm	Commercial Broadcast
The NBC affiliate in Honoluolu, KGU Radio, sends broadcast asking Earhart to transmit on 500, 3105, or 6210.			

Number	Date	Time	Frequency	Probability	Credibility
55	July 3	9:34 pm	Primary	.09%	Credible
The PanAm station at Mokapu hears a faint carrier on 3105 but can't distinguish words.					

Silent Period 9:46 pm to 11:22 pm, 1 hour 36 minutes



Sixth Active Period: 11:22 p.m. July 3 to 12:00 a.m., Saturday, July 3, 38 minutes

The idea that using powerful commercial stations in Hawai'i to reach out to Earhart seemed to be working. Later that evening KGMB made a broadcast which brought responses heard by several stations. The poor quality of the reported responses to the KGMB broadcast is in line with the low probability of clear receptions of signals sent from Gardner. A male voice heard by U.S. Navy Radio Wailupe at 11:31pm suggests that Noonan is functioning rationally.

Number	Date	Time	Frequency
60	July 3	11:00pm	Commercial Broadcast
The powerful commercial station KGMB Radio in Honolulu makes a broadcast asking Earhart to send dashes.			

Number	Date	Time	Frequency	Probability	Credibility
63	July 3	11:22	Primary	.55%	Credible
The PanAm station at Mokapu hears two long dashes and possible voice on 3105.					

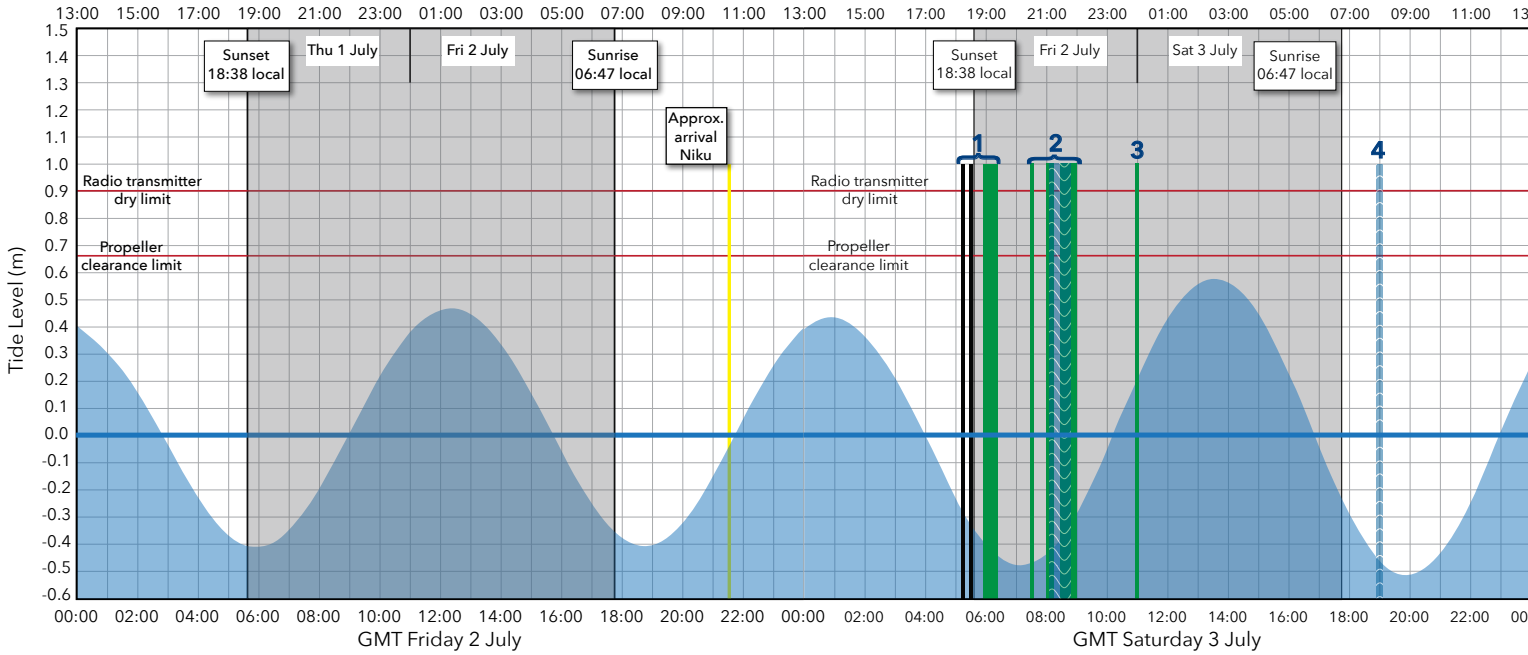
Number	Date	Time	Frequency	Probability	Credibility
64	July 3	11:31	Primary	.4%	Credible
U.S. Navy Radio at Wailupe near Honolulu hears a carrier on 3105 and a male voice say "31," but the rest was unreadable. At the same time, the PanAm station at Mokapu hears a carrier but no voice.					

Number	Date	Time	Frequency	Probability	Credibility
65	July 3	11:31 pm to 12:00 am	3105	.76%	Uncertain
The Pan American station at Mokapu hears a carrier that come and goes.					

Number	Date	Time	Frequency	Probability	Credibility
66	July 3	11:35	Primary	4%	Credible
KGMB repeats its broadcast to Earhart. U.S. Navy Radio Wailupe, PanAm Mokapu, and Coast Guard Radio Hawai'i all hear carrier and voice on 3105 at end of the broadcast.					

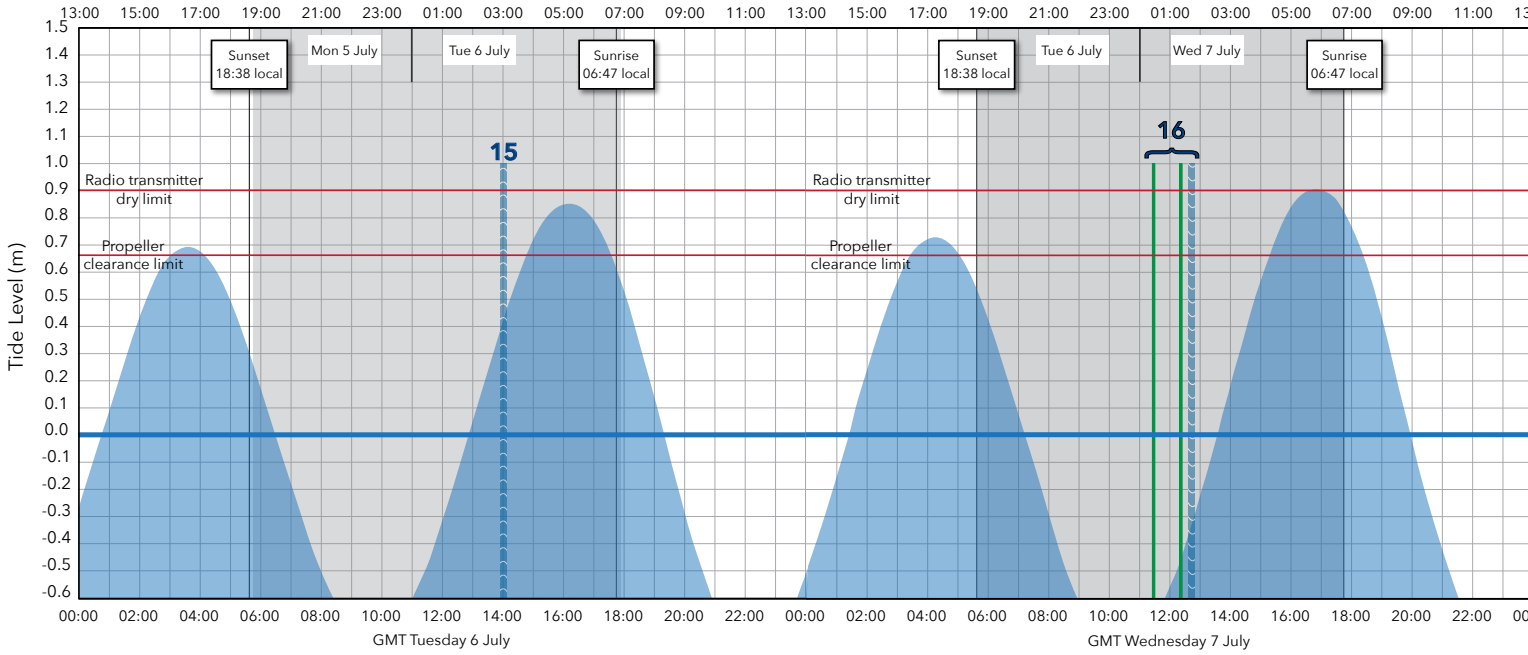
Silent Period 12:00 am to 1:00 am July 4 – 1 hour

Niku Local Time 1 – 2 July 1937 (GMT-11 Hours)

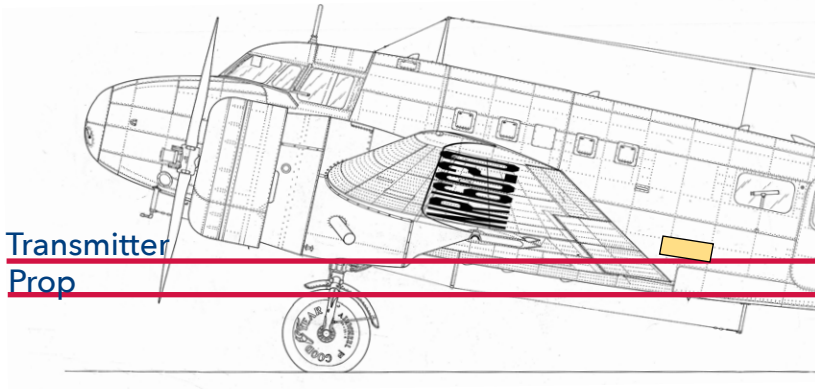


Niku Local Time 2 – 3 July 1937 (GMT-11 Hours)

Niku Local Time 5 – 6 July 1937 (GMT-11 Hours)

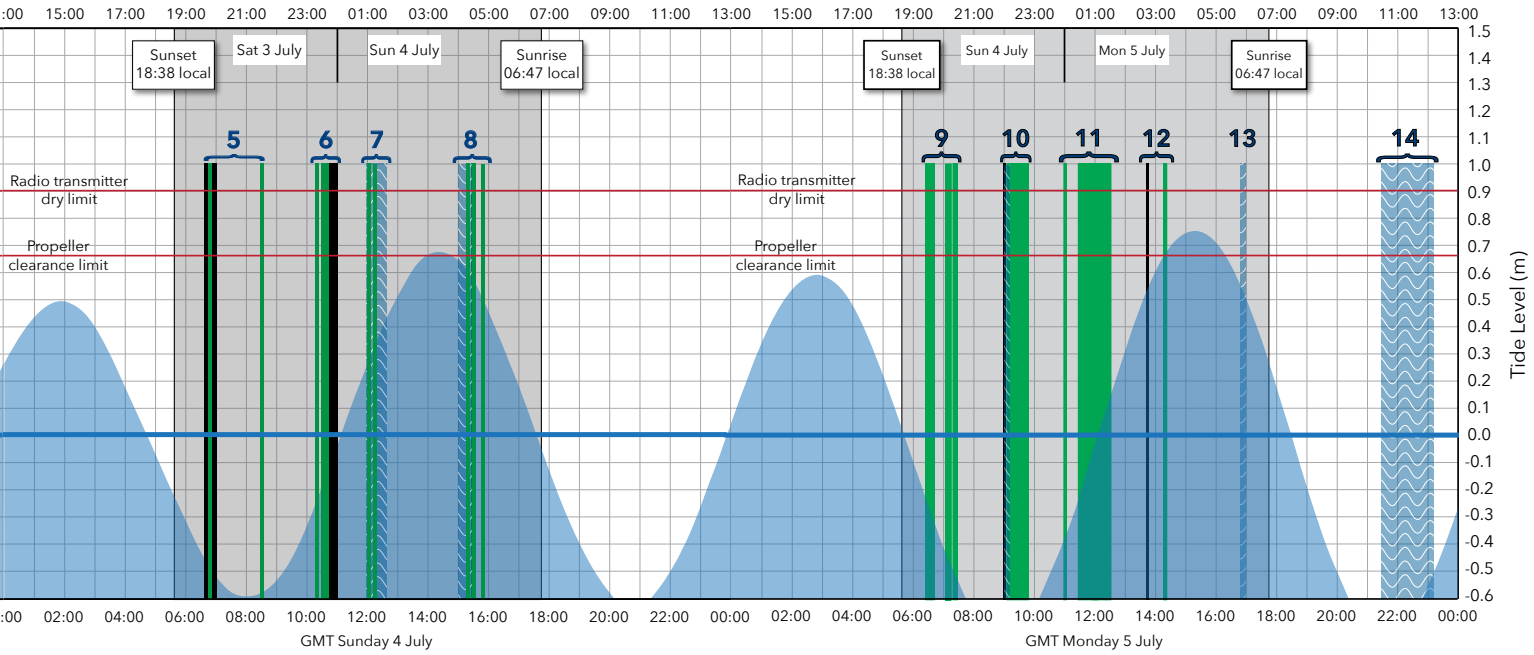


Niku Local Time 6 – 7 July 1937 (GMT-11 Hours)



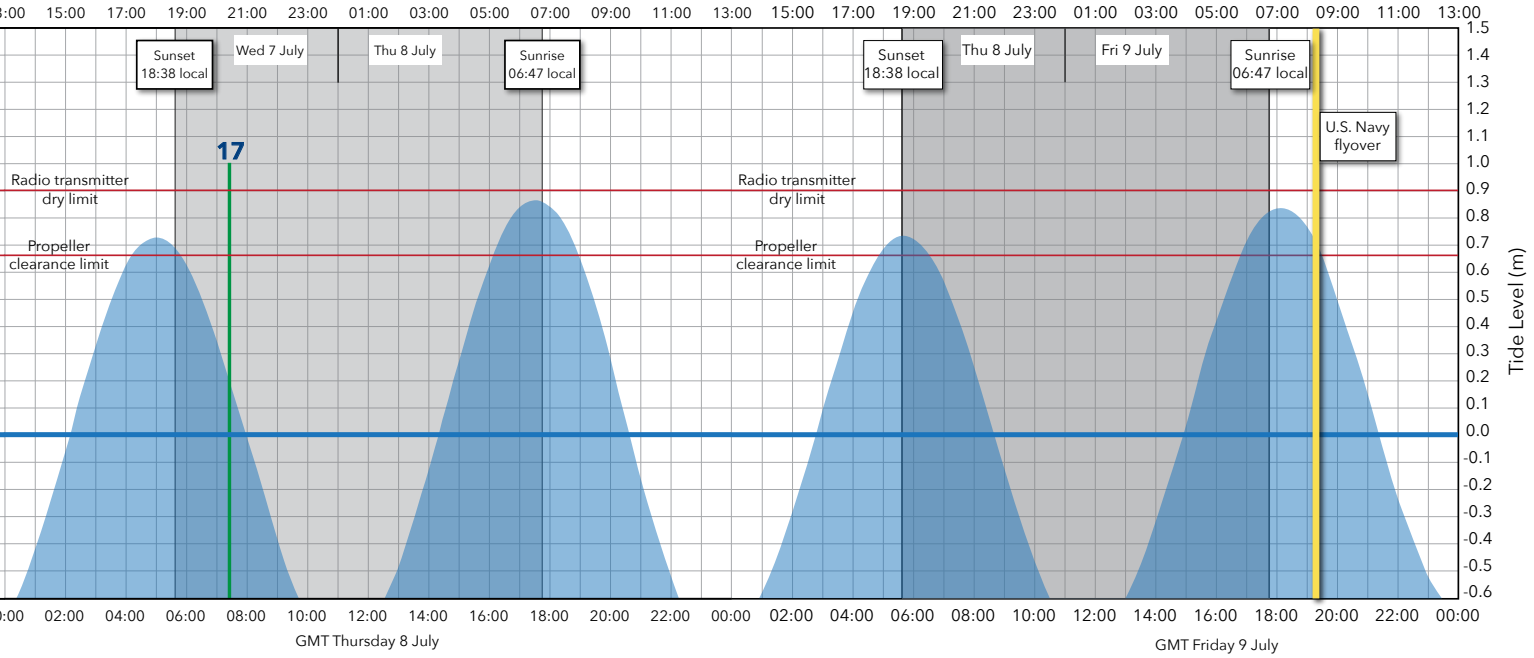
edible Signals

Niku Local Time 3 – 4 July 1937 (GMT-11 Hours)

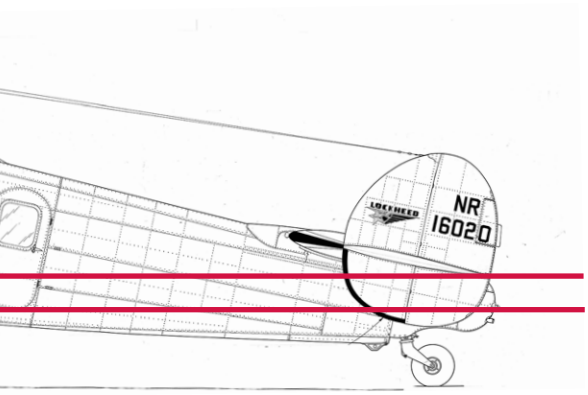


Niku Local Time 4 – 5 July 1937 (GMT-11 Hours)

Niku Local Time 7 – 8 July 1937 (GMT-11 Hours)



Niku Local Time 8 – 9 July 1937 (GMT-11 Hours)



Seventh Active Period: 1:00 a.m. to 1:30 a.m., Sunday, July 4, 30 minutes

As in the previous active period, stations distant from Gardner are hearing poor quality signals and a man's voice.

Number	Date	Time	Frequency	Probability	Credibility
76	July 4	1:00 am	Primary	.21%	Credible
Coast Guard Hawai'i hears a carrier signal on "about 3105 kHz," lasting one minute, with speech identified as a man's voice.					

Number	Date	Time	Frequency	Probability	Credibility
77	July 4	1:15 am	Primary	.0079%	Credible
The PanAm station at Wake Island hears an intermittent male voice, of "rather wobbly characteristics."					

Number	Date	Time	Frequency	Probability	Credibility
78	July 4	1:00 am to 1:30 am	Primary or Second Harmonic	18%	Uncertain
A Mr. Donaldson in Hawai'i hears several signals on his Zenith shortwave receiver. He said he heard a man's voice say "31.05," "31.07," and "KHAQQ," and then "62.05," "100," and "help."					

Silent Period 1:30 am to 4:00 am, July 4 - 2 hours 30 minutes

Eighth Active Period: 4:00 a.m. to 4:53 a.m., Sunday, July 4, 53 minutes

At 4:00 a.m. Gardner Time on July 4, Dana Randolph, a 16 year-old African American boy in Wyoming, hears Earhart say her ship is on a reef when the authorities are all assuming that the plane is afloat somewhere near Howland. At the same moment Randolph was hearing Earhart, Mrs. Ernest Crabb, a housewife in Toronto, was hearing an exchange between a woman and a man she believed to be Amelia Earhart and Fred Noonan. In the Pacific, the Pan American direction finding station at Mokapu Point, Hawai'i, hears a weak carrier on 3105 and gets a bearing of 213° which passes close to Gardner Island. The multiple simultaneous receptions and the bearing make these signals **Credible Beyond a Reasonable Doubt.**

Number	Date	Time	Frequency	Probability	Credibility
81	July 4	4:00 am to 4:25 am	Harmonic	1.6%	**CBRD**
Dana Randolph in Rock Springs, Wyoming hears, "This is Amelia Earhart. Ship is on a reef south of the equator. Station KH9QQ." The woman then began to give her location, but the signal faded out before it was given. This sequence was repeated an unknown number of times during a 25 minute period.					

Number	Date	Time	Frequency	Probability	Credibility
82	July 4	4:00 am	Harmonic	.9%	**CBRD**
Mrs. Ernest Crabb in Toronto, Ontario hears fragments of a conversation between a woman and a man she believes to be Amelia Earhart and Fred Noonan					

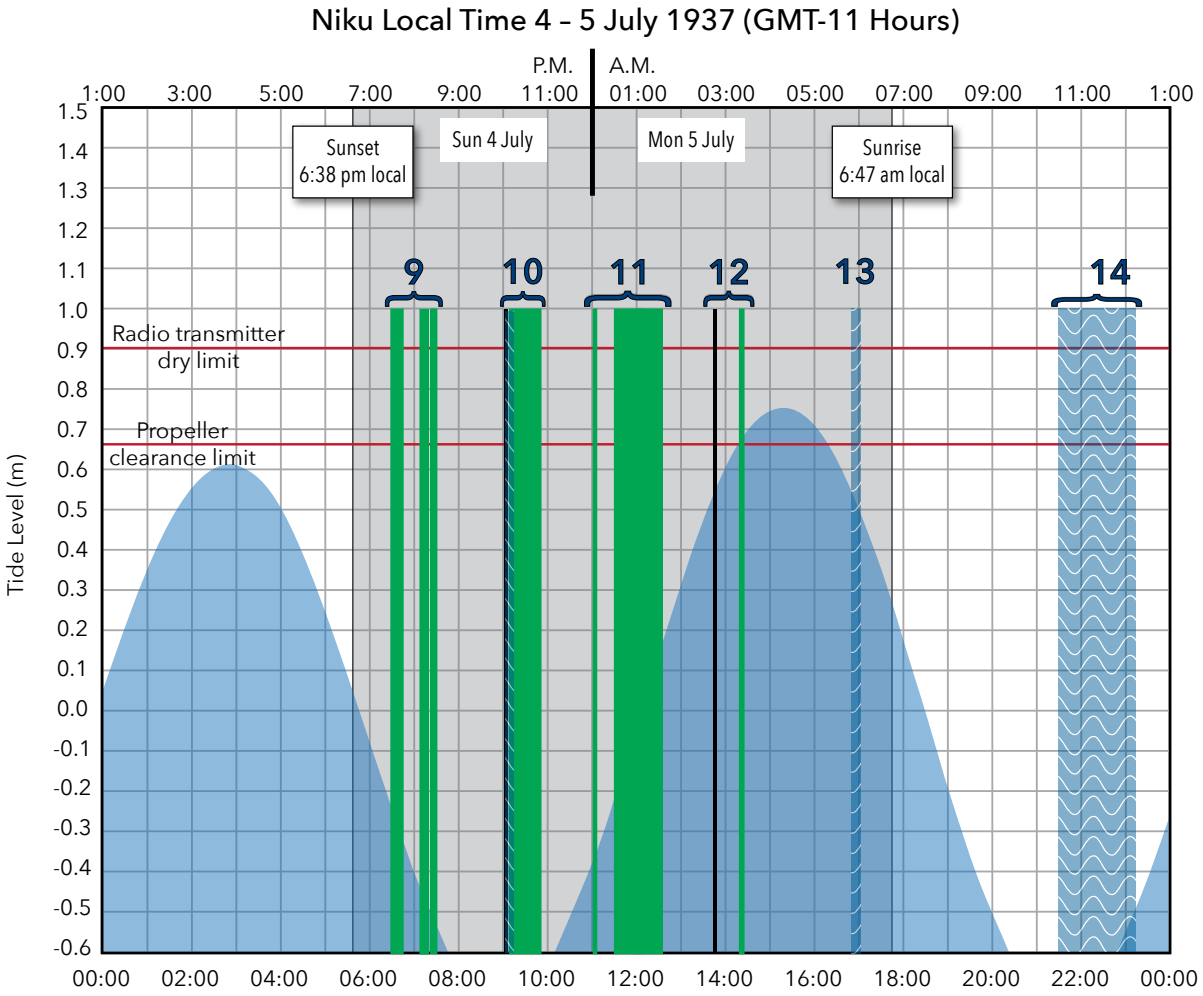
Number	Date	Time	Frequency	Probability	Credibility
83	July 4	4:12 am	Primary	.037%	Credible
The PanAm stations at Mokapu and Midway Island hear a faint broad voice signal on 3105. Mokapu gets a bearing of 175° but there is no potential source for a signal on that bearing.					

Number	Date	Time	Frequency	Probability	Credibility
84	July 4	4:32 am to 4:30 am	Primary	.9%	Credible
The PanAm station at Mokapu hears a weak carrier on 3105 and gets a bearing of 213°.					

Number	Date	Time	Frequency	Probability	Credibility
85	July 4	4:53 am	Primary	.66	Credible
PanAm Midway hears a faint signal on 3105.					

July 4/5, 1937

Ninth Active Period: 7:30 p.m. to 8:31 p.m.
Sunday July 4, 1 hour, 1 minute



KGMB again makes a broadcast to Earhart, this time asking her to send 4 dashes. Multiple stations hear dashes in response. The closer a station is to Gardner, the higher the probability and the stronger the signal. PanAm Midway hears a man's voice. A second directional bearing from PanAm Mokapu passes close to Gardner. The multiple responses to KGMB and the bearing make these signals **Credible Beyond a Reasonable Doubt.**

Number	Date	Time	Frequency	Probability	Credibility
100	July 4	7:30 pm	Primary	20%	**CBRD**
KGMB makes a broadcast asking Earhart to send 4 dashes. PanAm Mokapu immediately hears 4 dashes on 3105. Mokapu asks KGMB to repeat the broadcast to verify the response. They hear two dashes immediately following the second broadcast and get an approximate bearing of 215° on the source of the dashes. The bearing passes close to Gardner.					

Number	Date	Time	Frequency	Probability	Credibility
101	July 4	7:30 pm	Primary	20%	**CBRD**
Coast Guard Hawai'i hears dashes on 3105 in response to the KGMB broadcast.					

Number	Date	Time	Frequency	Probability	Credibility
102	July 4	7:38 pm	Primary	1.5%	CBRD
The PanAm station on Midway hears a faint, wobbly, short duration voice signal and gets a poor bearing of approximately 201°. A man's voice is distinctly heard but is too weak to be understood or identified.					

Number	Date	Time	Frequency	Probability	Credibility
103	July 4	8:00 pm to 8:04 pm	Primary	86%	CBRD
KGMB makes another broadcast asking Earhart to send 4 dashes. U.S. Navy Radio in Tutuila, American Samoa, 630 miles south of Gardner, immediately hears a series of four dashes on 3105.					

Number	Date	Time	Frequency	Probability	Credibility
104	July 4	8:14 pm to 8:16 pm	Primary	86%	CBRD
U.S. Navy Radio Tutuila again hears a series of four dashes					

Number	Date	Time	Frequency	Probability	Credibility
105	July 4	8:27pm to 8:31pm	Primary	86%	CBRD
U.S. Navy Radio Tutuila hears a series of 8 dashes, four of which are very strong. They also hear unintelligible voice.					

Number	Date	Time	Frequency	Probability	Credibility
107	July 4	8:30pm	Primary	.000075%	Credible
Coast Guard San Francisco Division hears *Itasca* calling Earhart in code on 3105 and shortly afterward hears a carrier on 3105 kHz.					

Silent Period 8:31 p.m. to 10:07 p.m. July 5, 1 hour 36 minutes.



Tenth Active Period: 10:07 p. m. to 10:52 p.m., Sunday, July 4, 45 minutes.

Howland and Baker, the stations closest to Gardner, hear the plane calling *Itasca* on 3105. They cannot reply because they are not permitted to transmit on 3105. *Itasca* is farther away and hears nothing. Howland hears a man's voice but a few minutes later a private citizen in Hawai'i hears "Tell husband all right," so Earhart is apparently also taking a turn at the mic.

Number	Date	Time	Frequency	Probability	Credibility
113	July 4	10:07 pm to 10:33 pm	Primary	84%	Uncertain
Howland hears a carrier signal with a man's voice on 3105.					

Number	Date	Time	Frequency	Probability	Credibility
114	July 4	10:08 pm	Primary	88%	Credible
Howland hears a man's voice, very weak on 3105.					

Number	Date	Time	Frequency	Probability	Credibility
115	July 4	10:10 pm	Primary	85%	Credible
Baker Island hears a voice transmission from KHAQQ (Earhart's call sign) to NRUI (*Itasca*) "a short while ago."					

Number	Date	Time	Frequency	Probability	Credibility
117	July 4	10:16 pm	Primary	85%	Credible
Howland hears Earhart calling *Itasca* on 3105. Baker also hears the Earhart plane but no content is reported.					

Number	Date	Time	Frequency	Probability	Credibility
118	July 4	10:16 p.m.	Harmonic	5%	Credible
Howard Coons in San Francisco hears "Still alive. Better hurry. Tell husband all right."					

Number	Date	Time	Frequency	Probability	Credibility
121	July 4	10:48 p.m. to 10:52 p.m.	Primary	10%	Credible
PanAm Wake hears a voice signal of good intensity and well modulated but wavering badly suddenly come on 3105.					

Silent Period from 10:52 p.m. July 5 to 12:05 a.m. July 5, 1 hour 13 minutes.



Eleventh Active Period: 12:05 a.m to 1:36 a.m., Monday, July 5, 1 hour 31 minutes

Shortly after midnight Gardner Time, the Coast Guard radio operator on Howland Island hears a carrier wave on 3105. Using the high-frequency direction finder originally intended to help guide the plane to Howland, he gets a bearing on the signal, but the experimental unit does not have a compass rose on the antenna. He uses a pocket compass to get the direction. The signal is coming from either the NNW or SSE. There is no potential source for the signal to the NNW.

At the same moment, the Pan American direction finding station on Midway gets a bearing of 175° on a "strong carrier" on 3105. The signal continues for two hours. Both bearings indicate the signal is coming from the vicinity of Gardner Island.

During the same period, the Pan American direction finding station on Wake Island hears an unsteady voice signal that starts strong at Strength 5 and gradually fades to Strength 2. A directional bearing of 144° crosses the other bearings near Gardner Island. The approximate origin point of the signals is now triangulated by five bearings – 213° and 215° from Mokapu, SSE from Howland, 175° from Midway, and 144° from Wake.

Over a period of an hour from 12:30 a.m. to 1:30 a.m. Gardner Time on July 5, three operators at the U.S. Navy Radio facility in Wailupe near Honolulu hear fragments of a message in "poorly keyed" morse code on 3105: "281 NORTH HOWLAND CALL KHAQQ BEYOND NORTH DONT HOLD WITH US MUCH LONGER ABOVE WATER SHUT OFF." They report the reception to Coast Guard headquarters who then pass the information to *Itasca*.

The bearings and the coinciding code message are **Credible Beyond a Reasonable Doubt**.

Number	Date	Time	Frequency	Probability	Credibility
123	July 5	12:05 a.m.	Primary	78%	**CBRD**
Howland hears unidentified continuous wave signal. No call sign was heard. A direction finder bearing of either south-southeast or north-northwest was obtained using a magnetic compass. At the same moment, the PanAm station on Midway gets a bearing of 175°.					

Number	Date	Time	Frequency	Probability	Credibility
125	July 5	12:30 a.m. to 1:30 a.m.	Primary	.6%	**CBRD**
Three operators at U.S. Navy Radio Wailupe near Honolulu repeatedly hear poorly-sent code interpreted as "281 NORTH HOWLAND CALL KHAQQ BEYOND NORTH DONT HOLD WITH US MUCH LONGER ABOVE WATER SHUT OFF"					

Number	Date	Time	Frequency	Probability	Credibility
126	July 5	1:00 a.m.	Primary (assumed)	20%	Credible
An unnamed licensed amateur in Melbourne, Australia hears a "strange" signal, presumably in code, but did not perceive until the caller "signed off" that it was "Mrs. Putnam."					

Number	Date	Time	Frequency	Probability	Credibility
129	July 5	1:23 a.m. to 1:36 a.m.	Primary	.06%	**CBRD**
The PanAm station at Wake Island hears an unsteady voice signal that starts strong at Strength 5 and gradually fades to Strength 2. A directional bearing of 144° from Wake is believed to be reasonably accurate.					

Silent Period 1:36 a.m. to 2:50 a.m. July 5 – 1 hour 14 minutes



Twelfth Active Period: 2:50 a.m. to 3:19 a.m., Monday, July 5, 29 minutes

At 3:17am, Coast Guard Headquarters in San Francisco hears Itasca's call sign in Morse code followed by four dashes. This is the only credible message sent in code, other than the "281" message heard by Wailupe earlier that night. The dashes are followed by a man's voice. Itasca was not transmitting at this time.

Number	Date	Time	Frequency	Probability	Credibility
138	July 5	2:50 am	Primary	.97%	Uncertain
PanAm Mokapu hears a carrier on again briefly, not long enough to get a bearing.					

Number	Date	Time	Frequency	Probability	Credibility
139	July 5	3:17 am to 3:19 am	Primary	.7%	Credible
Coast Guard San Francisco hears "NRUI" (*Itasca's* call sign) on 3105 in Morse code followed almost immediately by 4 dashes of approximately 4 to 5 seconds duration, with spaces of the same length. Shortly afterward a carrier was heard, and a man's voice. The only distinguishable English was the letter "I," at the end of the transmission. *Itasca* was not transmitting at this time.					

Silent Period 3:19 am to 6:00 am, 2 hours 41 minutes

From 3:20 a.m. to 5:30 a.m. the water level on the reef is too deep to run the engine.



Thirteenth Active Period: Single reception, 6:00 a.m., Monday, July 5.

At 6:00am, about 45 minutes before sunrise on Gardner Island, Mrs. Ernest Crabb in Toronto again hears "muffled and indistinct" snatches of dialogue between a man and woman she believes are Earhart and Noonan. Mrs. Crabb is the only person to hear receptions on a harmonic on more than one occasion.

Number	Date	Time	Frequency	Probability	Credibility
140	July 5	6:00am	Harmonic	.004%	Credible
Mrs. Ernest Crabb hears another exchange between a man and a woman she believes to be Noonan and Earhart.					

Silent Period from 6:00am to 10:30am July 5 – 4 hours 30 minutes



Fourteenth Active Period: Single reception, 10:30 a.m. to 12:15 a.m. Monday, July 5,1 hour 45 minutes

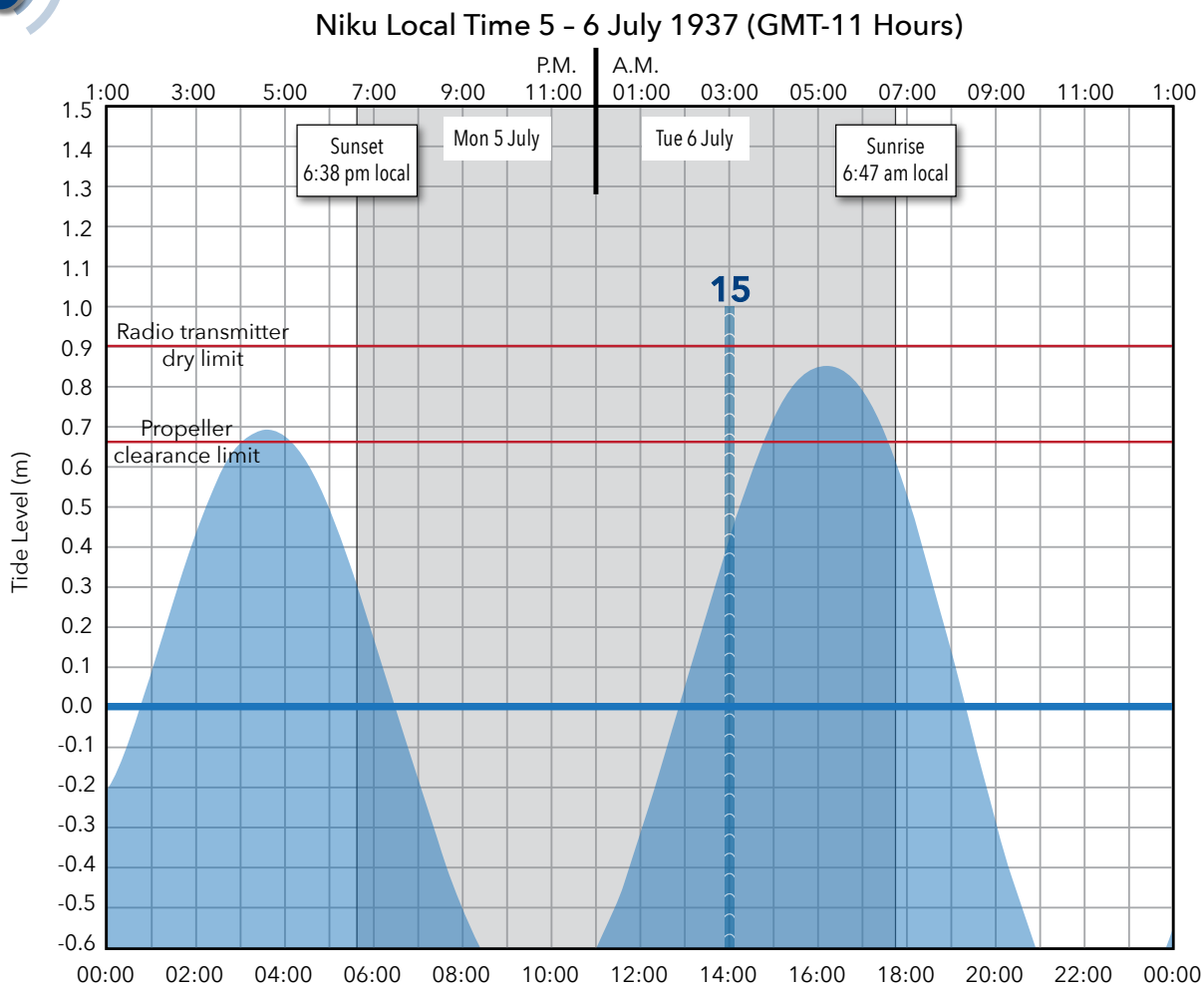
Betty Klenck did not write down, nor could she later remember, what day she heard Amelia, but early in the reception she heard Amelia say, "Here, put your ear to it," apparently telling Noonan to listen to something on the headphones. July 5 is the only day that *Itasca* was transmitting to Earhart at that particular time.

The pleas Betty heard are more desperate than the more informational content of earlier messages and, for the first time, Noonan is clearly behaving in an irrational manner. Betty's notations include information that she could not possibly have had unless she was hearing an actual transmission from Earhart. Her reception is **Credible Beyond a Reasonable Doubt**. For a complete transcript of Betty's reception see Betty's Notebook.

Number	Date	Time	Frequency	Probability	Credibility
141	July 5	10:30am	3105	NA	NA
Itasca calls Earhart in code on 3105.					

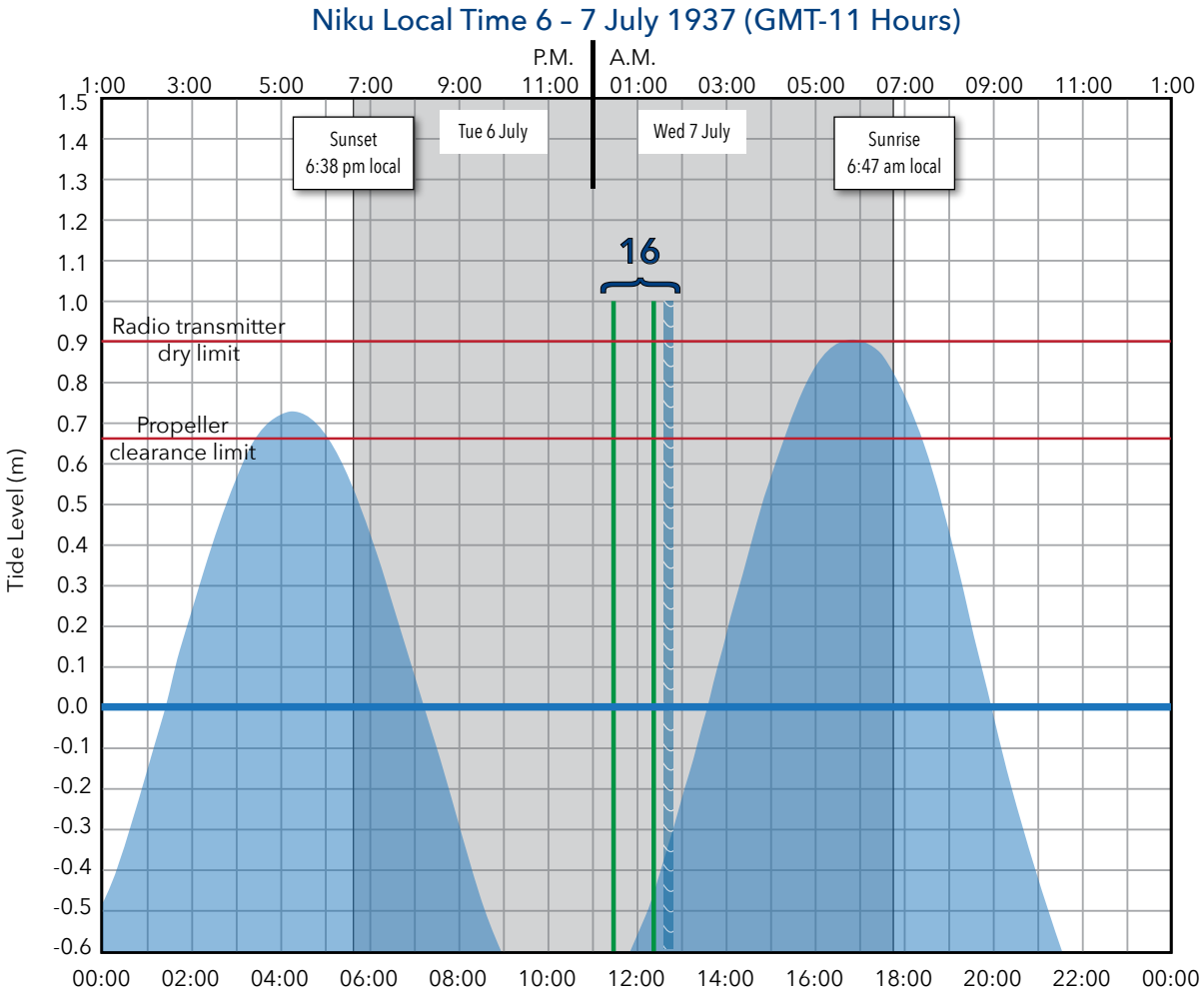
Number	Date	Time	Frequency	Probability	Credibility
142	July 5	10:30 am to 12:15 pm	Harmonic	13%	**CBRD**
Betty Klenck in St. Petersburg, Florida hears Earhart calling for help and trying to deal with an irrational Fred Noonan.					

Fifteenth Active Period: Single reception, 3:00 a.m., Monday, July 5.



At 3:00am the next morning, Mrs. Crabb again hears the man and woman.

Number	Date	Time	Frequency	Probability	Credibility
161	July 6	03:00 pm	Harmonic	.3%	Credible
Mrs. Ernest Crabb again hears “Scraps of conversation in the voices of a man and a woman ...”					



July 6/7, 1937

Sixteenth Active Period: 12:25 a.m. to 1:30 a.m., Wednesday, July 7, 55 minutes.

Two receptions of weak voice receptions after midnight by Howland are followed by a harmonic reception by Thelma Lovelace in St. Stephen, New Brunswick. The near simultaneous occurrence and the content of the Lovelace message makes these receptions **Credible Beyond a Reasonable Doubt.**

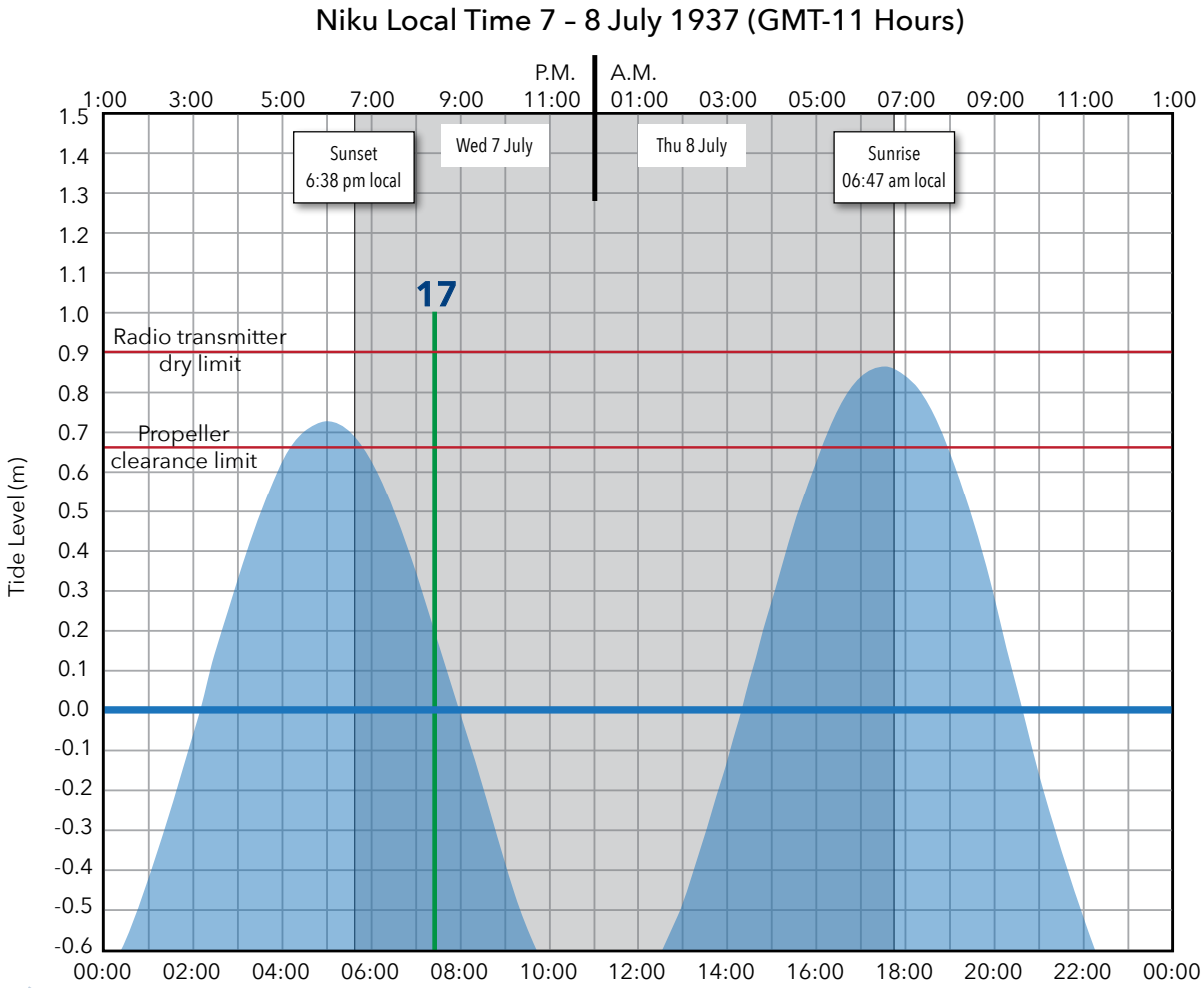
According to calm water tidal calculations, the water level at the plane's presumed location reached the transmitter in the cabin at 6:00am the next morning. With the transmitter disabled, no further messages would be possible.

Number	Date	Time	Frequency	Probability	Credibility
167	July 7	12:25 am	Primary	50%	Credible
Howland hears two long dashes on 3105 with weak voice in background.					

Number	Date	Time	Frequency	Probability	Credibility
169	July 7	1:20am	Primary	50%	Credible
Howland hears a weak carrier, with modulation – voice was heard.					

Number	Date	Time	Frequency	Probability	Credibility
170	July 7	1:30am	Harmonic	.04%	**CBRD**
Thelma Lovelace of St. Johns, New Brunswick hears "Can you read me? Can you read me? This is Amelia Earhart. This is Amelia Earhart. Please come in." Earhart then give her latitude and longitude, which Thelma wrote in a book, and continued: "we have taken in water, my navigator is badly hurt; (repeat) we are in need of medical care and must have help; we can't hold on much longer."					

July 7/8, 1937



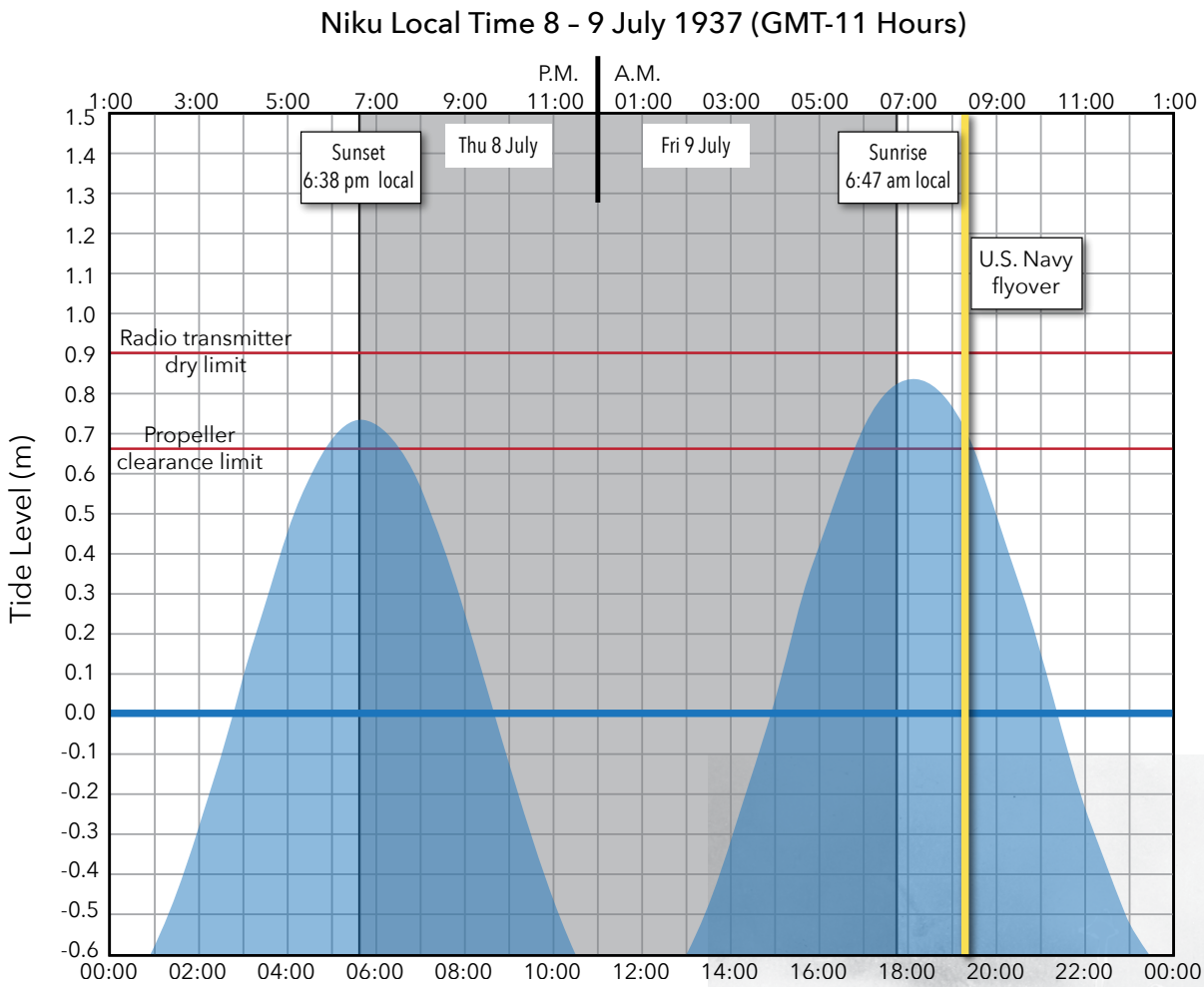


Seventeenth Active Period – single reception

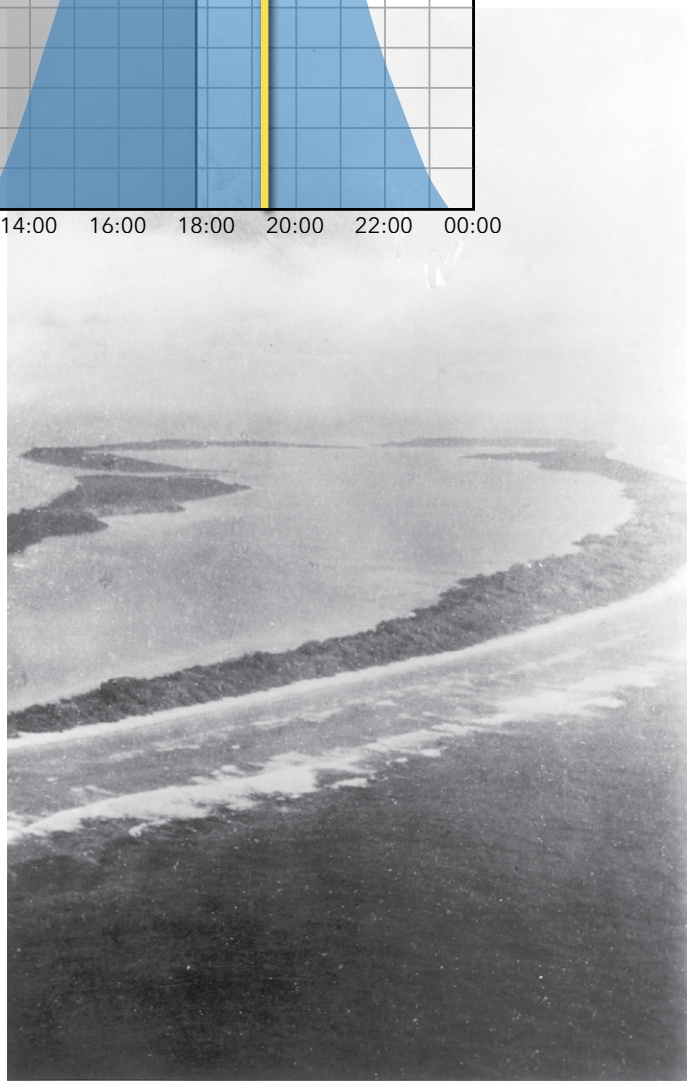
At 8:18pm on July 7, the operator on Howland Island hears a weak signal and "talk of Earhart." but according to tidal calculations the transmitter should no longer be operational. Howland may have been hearing faint snatches of a transmission by an aircraft on the U.S. west coast commenting on the Earhart search.

Number	Date	Time	Frequency	Probability	Credibility
175	8:18pm	July 7	Primary	89%	Credible
Howland hears "Weak radiotelephone signals. Talk of Earhart."					

July 8/9, 1937



No credible signals were received by anyone on Thursday, July 8 or Friday July 9. At some time between 1:30 a.m. on Wednesday, July 7, when the last Credible Beyond a Reasonable Doubt transmission was sent, and the morning of Friday, July 9, the Electra was washed over the reef edge into the ocean where it broke up and sank. When three U.S Navy search planes from the battleship USS *Colorado* flew over Gardner Island on the morning of Friday, July 9, no aircraft was seen. The tide was high and a photo shows significant surf running over the reef.



Clues in the Content

The credible post-loss messages that include intelligible information tell a consistent and evolving story that spans the days and nights between the plane's landing on the reef and its loss to the sea.



The Bevington Photo, taken October 15, 1937, shows what appears to be the wreckage of one of the Electra's landing gear assemblies on the edge of the reef about 400 meters northeast of the Norwich City shipwreck. Photo courtesy Rhodes House Library, Oxford University, England

On The Reef

All of the messages describe situations consistent with the plane having landed on the reef. Message 81 (heard by Dana Randolph on July 4) specifically says the "ship is on a reef." Message 142 (Betty Klenck on July 5) describes the plane surrounded by knee-deep water and includes what appear to be references to *Norwich City*. Message 28 (heard by Mabel Larremore on July 2) has the plane "partly on land, part in water." Message 47 (Nina Paxton on July 3) says the plane is "down in ocean" – "on or near little island at a point near…." and then something about "directly northeast." The language sounds confused and contradictory but could be an attempt to describe the plane's location relative to the shipwreck.

The Uncharted Island

Earhart made several attempts to describe her location. In Message 28 (heard by Mabel Larremore on July 2) she said she was "down on an uncharted island, small, uninhabited." Message 47 (Nina Paxton on July 3) says the plane is "down in ocean" – "on or near little island…". Message 81 (heard by Dana Randolph on July 4) has the plane "on a reef southeast of Howland." Message 125 (the "281 message on July 5) contains the cryptic incomplete phrases "281 North" and "beyond north." In none of the messages is Earhart reported to have said the name of the island.

However, on at least three occasions – Message 28 (heard by Mabel Larremore on July 2), Message 81 (heard by Dana Randolph on July 4), Message

142 (Betty Klenck on July 5) and Message 170 (Thelma Lovelace on July 7) – Earhart sent her latitude and longitude coordinates. Unfortunately, the numbers have not survived. Larremore jotted down the coordinates and had no trouble locating the island on a map the next day, but by the time she came forward with her story she had lost her notes and couldn't remember the name of the island she found on the map. Randolph missed the coordinates when the signal faded out, and Betty Klenck's attempt to transcribe the numbers she heard is hopelessly garbled. Lovelace wrote the coordinates in a book but, like Larremore, by the time she came forward with her story in 1990 she had lost the book.

In 1937 there were no "uncharted islands" in the Pacific. The only way Earhart could know the latitude and longitude of the island but not its name is if the chart Noonan had been using to plot their course to Howland Island did not cover the area indicated by the coordinates.

No one knows what chart Noonan used, but the map the U.S Navy selected to manage the 1937 search is just such a chart. Now archived at the National Archives, San Bruno, California, "Hydrographic Office Strategic Planning Chart 5050 No. 3" covers a large portion of the route from Lae, New Guinea to Howland Island, but the bottom edge of the chart ends at 2° 30′ south of the Equator. Gardner Island is well off the chart 4° 32′ south of the Equator. During the search, when it became apparent that the radio bearings taken by Pan American and the Coast Guard were converging on a point that was off the bottom of the chart, naval authorities at Pearl Harbor expanded the map by cutting a strip off the top portion, flipping it over, and gluing it on to the bottom. They then extended the latitude and longitude lines by hand and drew in McKean and Gardner Islands.

H.O. 5050 No. 3 was not classified and was commonly available. If Noonan selected the same chart as the Navy, in following the Line of Position southeastward trying to find Howland he and Earhart literally flew off the map. That night, Noonan could use his sextant to get their latitude and longitude and know they were southeast of Howland but with no map to plot it on, the name of the island would be a mystery. The best they could do was mention the island's only unique feature – the wreck of the Norwich City.

Injuries

Message 28 (heard by Mabel Larremore on July 2), Message 142 (Betty Klenck on July 5), and Message 170 (Thelma Lovelace on July 7) describe a medical emergency that grows more desperate over time. Larremore on July 2 heard Earhart say Noonan was "seriously injured" and "needed help immediately." Amelia had "some injuries but not as serious as Mr. Noonan's." A man's voice was heard in several credible messages on July 3 and 4, suggesting that Noonan, although injured, was at least lucid, but by July 5 his condition had deteriorated. In Betty Klenck's transcription, Amelia seems to be in pain from what may have been an ankle injury (misheard as "uncle"). Noonan, however, is delirious and panicky. The nature of his injury is nowhere mentioned but Betty thought he may have struck his head.



In this Acme News Pictures photo published July 22, 1937 – four days after the search was called off – the pasted-on section can be seen at the bottom of the chart. Original caption:

SEARCH THEY PLANNED FOR AMELIA WAS IN VAIN

Rear Admiral Orin G. Murfin, right, and Cmdr. W. A. Heard shown working on chart of the Pacific Ocean in the "Plotting Room" of Headquarters of the 14th Naval District, Pearl Harbor, Honolulu, where they directed the search for Amelai Earhart and Fred Noonan, her navigator. Naval planes combed more than 300,000 square miles in the fruitless search for the famous aviatrix and her navigator Admiral Murfin said.

Photo Courtesy of Remember Amelia, the Larry C. Inman Historical Collection on Amelia Earhart.

Two days later, Lovelace heard Earhart say "My navigator is badly hurt; my navigator is badly hurt; we are in need of medical care and must have help."

There is no way Lovelace could have known what Larremore or Klenck had heard.

The reported injuries invite many questions. Were their injuries sustained in the landing or did they occur later? They landed mid-morning on Friday and by 9:00pm Saturday night they were both hurt. The aircraft was equipped with lap belts but not shoulder harnesses. An abrupt stop could result in Noonan striking his head on the instrument panel, but the aircraft clearly remained intact enough to run the starboard engine and in none of the messages does Earhart mention damage to the aircraft. Another possible source of injury is the reef itself. Coral cuts, unless treated with antibiotics (not commonly available in 1937), quickly become infected. If Noonan fell on the slippery, jagged coral during their presumed first transit to and from the shore some time during the day on July 2, the resulting untreated and worsening infection could explain his apparent delirium by the time Betty Klenck heard him on July 5. He was still alive two days later. Was he able to get ashore or was Earhart forced to leave him in the plane when it went into the ocean some time before the Navy search planes arrived on July 9?

Earhart's possible ankle injury and resultant swelling could explain why parts of only one woman's shoe and only one man's shoe were found with her bones at the castaway campsite in 1940. There was no sign of Noonan.

Rising Water, Rising Anxiety

Another distinct pattern in the content of intelligible receptions is the abrupt and growing concern about rising water beginning just after midnight on July 5. Previous messages had been largely informational with Earhart attempting to describe where they were and that they urgently needed medical help. Message 118, heard by Howard Coons at dead low tide on July 4, even sounds guardedly optimistic. "Still alive. Better hurry. Tell husband all right." But two hours later, as the tide was coming in, three U.S. Navy operators near Honolulu began hearing Message 125, a cryptic fragmentary message sent in poorly-keyed code.

281 NORTH HOWLAND CALL KHAQQ
BEYOND NORTH DONT HOLD WITH US
MUCH LONGER ABOVE WATER SHUT OFF

The message came in over a period of an hour and the words, as reported, were all run together, but it is the first message to imply that rising water would soon force them to stop transmitting. This was the highest tide since the plane arrived and would be the first time the water level on the reef at the plane's presumed location exceeded the 26 inch (.675m) propeller clearance limit.

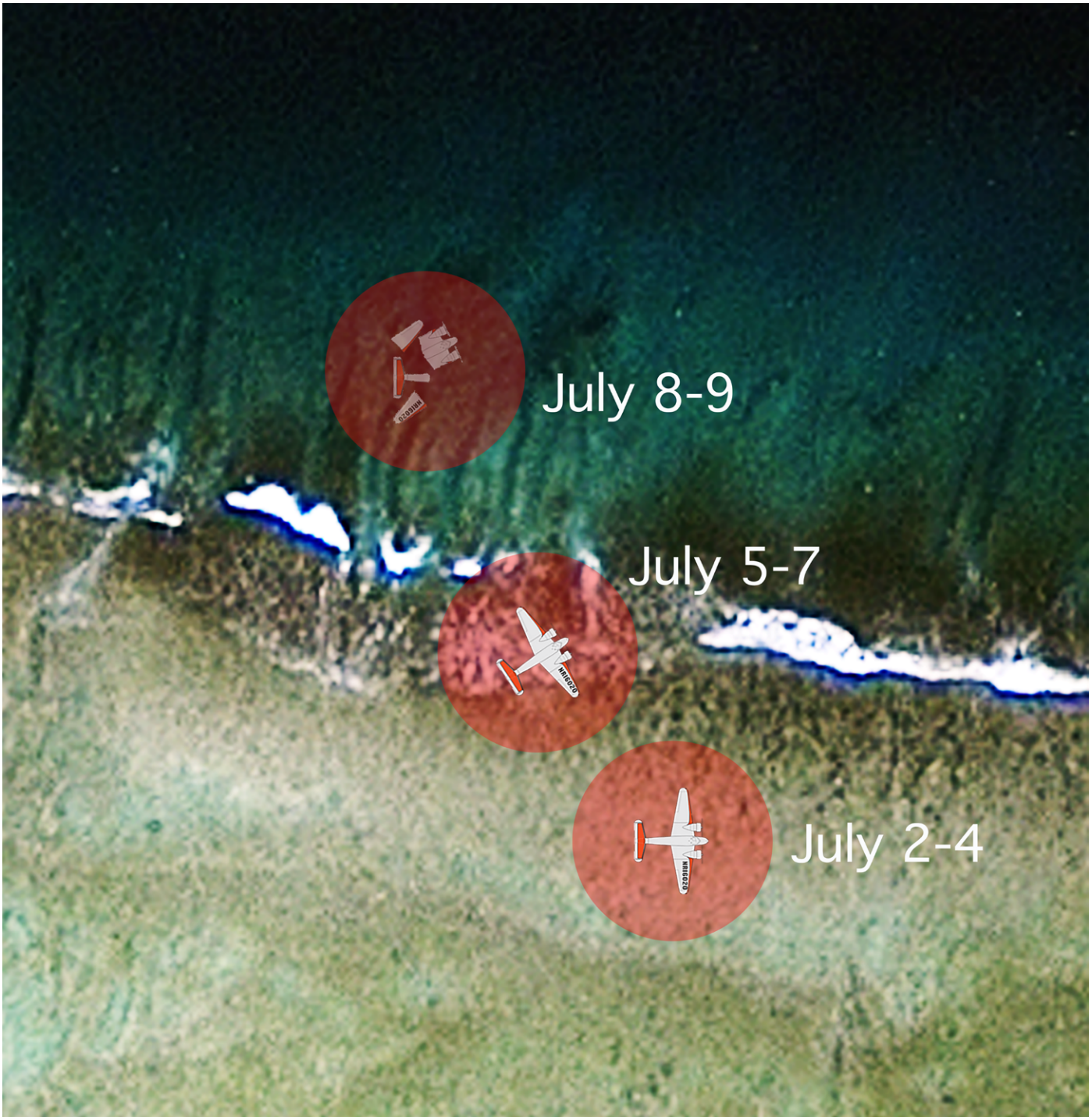
A two-minute signal, Message 139, was received on 3105 by Coast Guard HQ San Francisco just as the water reached the prop tips. *Itasca*'s call sign in code, NRUI, was followed by four dashes and then a brief voice transmission but only the word "I" was intelligible.

By the time Betty Klenck heard Message 142 late the next morning, the situation had become more dire. Her transcription is sprinkled with phrases like "waters high," "help us quick," "send us help," "It's going…," "waters knee deep – let me out," "knee deep over." The repeated concern about the water being "knee deep" is not random. Knee deep is about 21 inches – just shy of the propeller clearance limit.

By the end of the reception at 12:15 p.m., Betty had the impression that "the plane was slipping" and yet, according to the tide graph, the reef at the plane's presumed location should still be dry. The only apparent explanation for the discrepancy is that the plane has moved into deeper water and is no longer at the location reflected in the tidal charts.

After Betty's reception, no further transmissions are heard until 3:00am the next day, July 7. Message 161, the third harmonic reception reported by Mrs. Ernest Crabb, occurred when the water at the plane's earlier presumed location is nearly 16 inches deep, but the plane has moved to where the water at that time is almost certainly deeper than the propeller clearance limit. If Mrs. Crabb's third reception is genuine it was sent on battery power alone. The same may also be true of the messages in Active Period 16. In the final transmission, Message 170, Thelma Lovelace hears Earhart say "We have taken in water … we can't hold on much longer."

Earhart was right. The tide that peaked four hours later, about 45 minutes before sunrise on July 7, was the highest to date – certainly high enough to flood the transmitter and possibly high enough to send the Electra over the edge into the surf where it broke up, leaving behind the wreckage of one its landing gear assemblies jammed in the reef. Earhart somehow made it to shore and survived for a time as a castaway. Noonan's fate is unknown.



No one can say precisely where the aircraft was from moment to moment, but this general progression fits the available data. The wrecked landing gear assembly remained jammed in the reef-edge until at least mid-October 1937 when it was accidentally photographed by Eric Bevington. The degree to which the aircraft broke up in the surf is unknown, but much of the wreckage seems to have remained in relatively shallow water long enough to be noticed and partially salvaged by the settlers who first arrived in December 1938. Part of a wing was reportedly seen on the reef in the late 1950s.