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TIGHAR Tracks

A Publication of The International Group for Historic Aircraft Recovery

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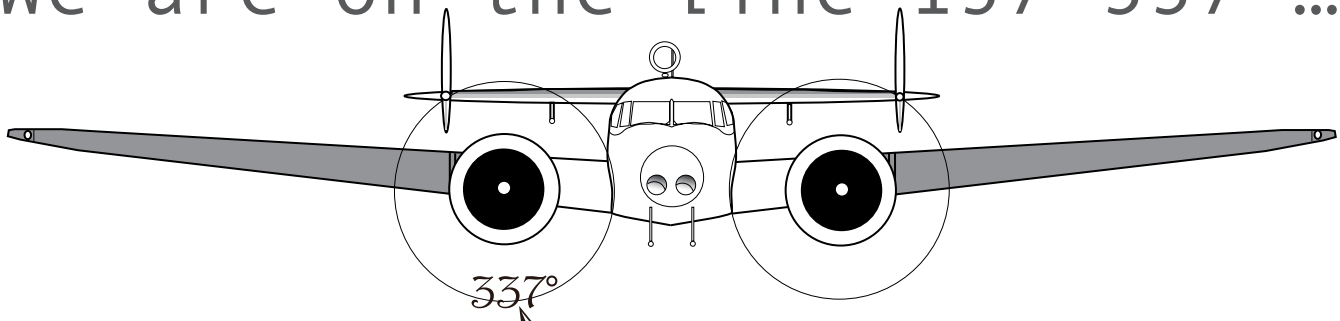
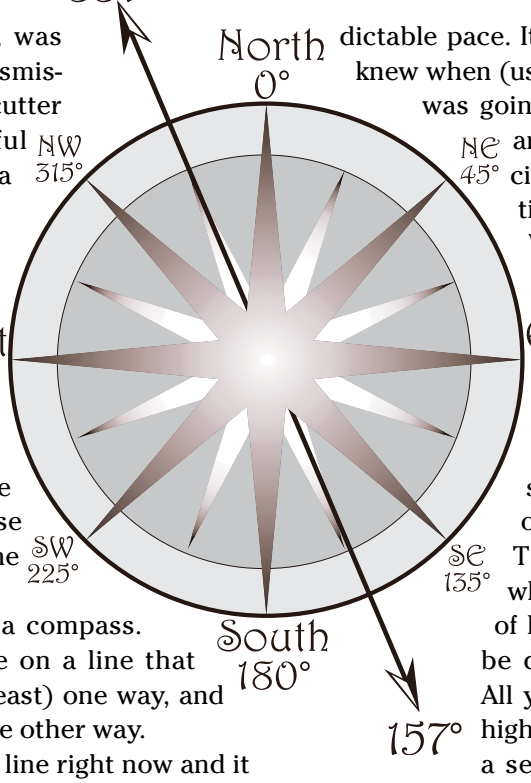
We are on the line 157 337 …



That phrase, heard at 08:43 a.m., was part of the final inflight radio transmission received by the Coast Guard cutter *Itasca*. It was the only meaningful position report received from Amelia Earhart on the morning of July 2, 1937. In it is contained a wealth of information about what she and her navigator knew – and what they didn't know – about where they were, what they had done to get there, and what options were available to them to try to save their airplane and their lives. Understanding those few words is essential to solving the riddle of their disappearance.

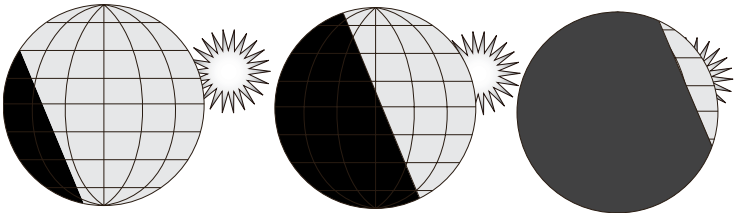


The numbers refer to degrees on a compass. Amelia was saying that they were on a line that points 157 degrees (roughly southeast) one way, and 337 degrees (roughly northwest) the other way.

Of course, you are on a 157 337 line right now and it can't tell you anything about where you are, but Amelia did not say "We are on a line …." She said, "We are on the line…" because, on the morning on July 2, 1937 in the Central Pacific "the line 157 337" had special significance.

We all know that the sun rises in the east and that the dawn, the line between night and day, marches westward at a steady, predictable pace. It stands to reason then, that if you knew when (using Greenwich Mean Time) the sun was going to appear in London, New York, and Los Angeles, you could tell which city you were in just by noting what time the sun came up – couldn't you? Well, no, not really. You might be in London, England but you could also be in Edinburgh, Scotland or Paris, France or anywhere along that line where the sun comes up at that same time; but at least you'd be quite sure that you were not in New York or L.A.

That dawn line is an example of what is known to navigators as a Line of Position (LOP). In fact, an LOP can be derived from any heavenly body. All you need is a way to measure how high in the sky an object is (that's what a sextant does), and a book of tables (known as an almanac) to tell you exactly when things are supposed to be where. At night you can "shoot" several stars and get several Lines of Position. Where they cross is where you are. Bingo – you're a celestial navigator. Now let's go back to the morning of July 2, 1937 in the Central Pacific.



Note: the dawn line is not, of course, a sharp demarcation, black and white, on the earth's surface because the refraction of the earth's atmosphere causes the light to scatter over a wide area.

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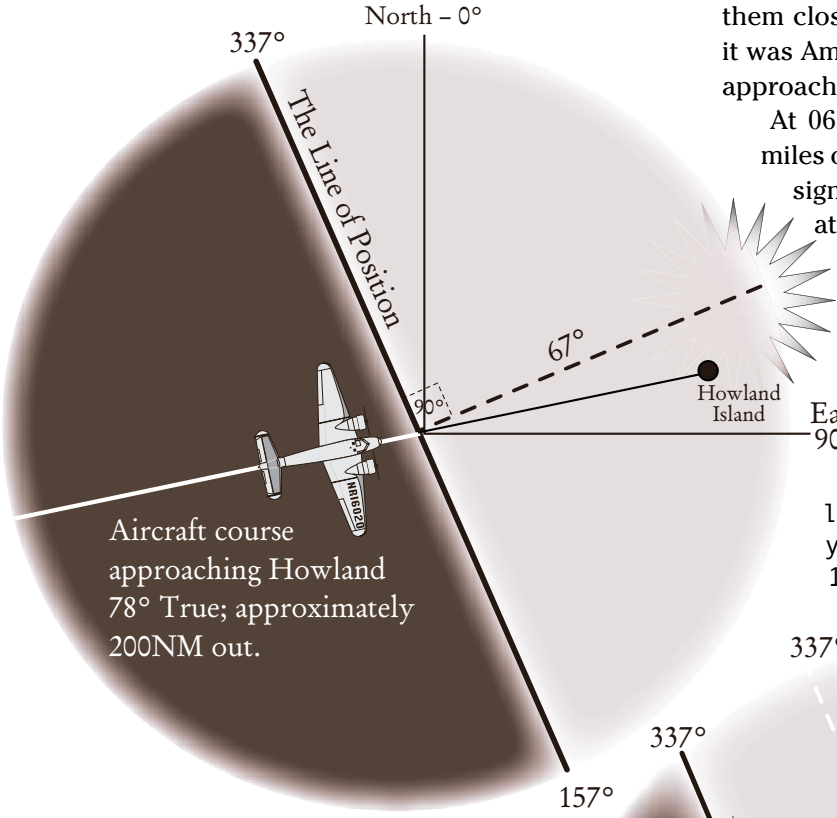
We lied about the sun coming up in the east. It doesn't – not exactly anyway. It actually comes up in a slightly different direction every day, and it climbs at an angle so the direction is constantly shifting, but the good news is that it's all predictable. That morning it came up at 67 degrees, and because a Line of Position is always at a right angle to the observed celestial body, the line to be derived from the rising sun was – you guessed it – 157/337. By noting the time that the sun came up, Amelia's navigator, Fred Noonan, could draw a 157/337 line on his map and know that they were somewhere on that line. But wait a minute. Amelia's "We are on the line 157 337…" message was received about two and a half hours <u>after</u> sunrise at Howland Island. If Earhart's statement was based upon Noonan "shooting" the sun at that time, the line would have been more like 150/330. What's going on?



It's really not at all mysterious. Noonan was employing a textbook procedure for finding an island using a single Line of Position. Here's how it works.

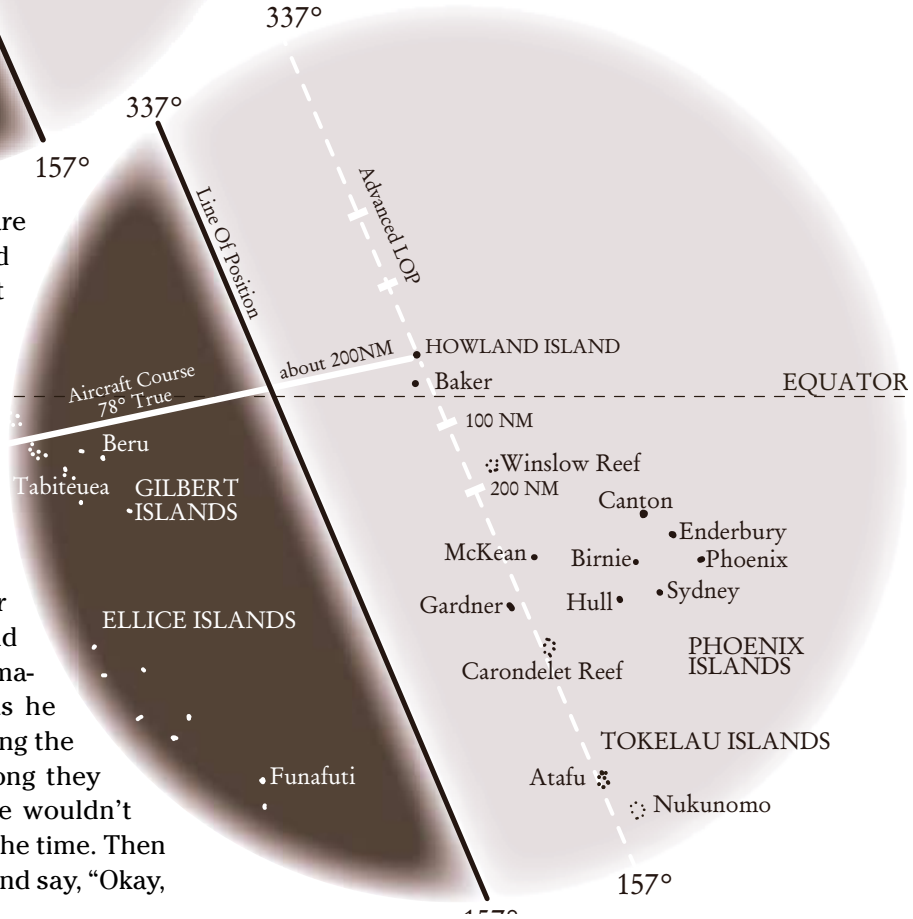
First of all, it's important to remember that Noonan knew that the rising sun would give them a 157/337 line. He had that information back in Lae, New Guinea as soon as he knew what day they were going to be making the flight. The only question was how far along they would be when the sun came up, and he wouldn't know that until he saw the sun and noted the time. Then he could draw his 157 337 line on his map and say, "Okay, we're somewhere on this line." All he had to do then was to draw another 157/337 line that passed through Howland Island and measure the distance between the two parallel lines. With a good idea of how fast they were going it was a simple matter to predict at what time they would reach the "advanced" LOP.

Of course, knowing where they were in an east/west sense was not good enough. To find tiny Howland Island it was essential that they know if they were north of, south of, or right on, course. That's what Radio Direction Finding was supposed to do. Noonan's job was to get them close – within, say, a couple hundred miles – and it was Amelia's job to use the radio to fine tune the final approach. That's where things went haywire.

At 06:15 a.m. Earhart said that she was about 200 miles out and asked the *Itasca* to take a bearing on her signal. No reply. She tried again half an hour later at 06:45. Still no response to her call. Unbenownst to her, the *Itasca* was hearing her just fine but they were unable to get a bearing on her and she was not receiving their replies.

An hour later, at 07:42, Earhart transmitted:

"We must be on you, but cannot see you – but gas is running low. Have been unable to reach you by radio. We are flying at 1,000 feet."



Had she been talking on the telephone instead of a radio she might have said, "Fred's watch says that we have reached the advanced LOP but we can't see the island. We must be either too far north or too far south, but now we're starting to burn into our four hour fuel reserve. We know that you are somewhere on this 157/337 line but we have been unable to reach you by radio so we have not been able to get a bearing and we don't know which direction to turn. We've descended down to 1,000 feet to get below this scattered deck of clouds so we can look for the island." Still she heard nothing in reply.

Fifteen minutes later she decided to try something different. Instead of asking the *Itasca* to take a bearing on her signals, she would try to take a bearing on theirs using her own Radio Direction Finder – if she could just hear something. At 07:58 she said:

> We are listening* but cannot hear you. Go ahead with a long count on 7500, either now or on the scheduled time on half hour.

(Amelia was using Greenwich Time so, for her, it was 19:28.)

Itasca did not have the capability of sending a voice message ("a long count") on 7500 kilocycles but they immediately sent a series of Morse code letter "A"s – dit,dah; dit,dah, dit, dah….

For the first time, Earhart's headphones delivered something more than static. The letter A was the prearranged signature for code signals from the *Itasca* and she must have been thrilled to have confirmation that they were at least within radio range of their destination. However, any elation she felt was short-lived because it quickly became apparent her Direction Finder would not give her the direction from which the received signals were coming.

At 08:00 she said:

> We received your signals but unable to get a minimum. Please take a bearing on us and answer on 3105 with voice.

Then she sends long dashes on 3105. She has given up trying take a bearing on the *Itasca* and has gone back to trying to get them to take a bearing on her – but it's just not working. *Itasca* replies that they can't take a bearing on such a high frequency but, of course, AE hears nothing.

So here she is, on the advanced LOP. She knows that Howland Island is somewhere on this 157/337 line, close enough for the *Itasca* to hear her radio calls, but that could be several hundred miles. What to do now? Turn left? Turn right? By happy coincidence, Howland is not the only island on the 157/337 line. Although there is no land to the northwest of Howland for thousands of miles, just forty miles to the southeast is Baker Island, another U.S. possession and, like Howland, occupied by Department of the Interior "colonists." About 350 nautical miles down the line is Gardner Island, a British possession. And far, far down the line – over 600 nautical miles – is Atafu, also known as Duke of York Island. Of course, the island they want to reach, and hope to reach, is Howland – the only place in the entire Central Pacific where there is an airfield – but the fate to be avoided at all costs is running out of gas over the open ocean. The most reasonable course of action is obvious: fly northwestward (337°) along the line for a short way to see if Howland is nearby in that direction. If it is not, turn around and proceed southeastward (157°) until you come to an island. If you're lucky it will be Howland. If it's Baker you'll know where you are and still have enough fuel to reverse course again and fly to Howland. If it's Gardner, chances are that you won't have enough fuel to double back all the way to Howland, but at least you won't go in the drink and you may even be able to land safely, figure out what's wrong with the radio and call for help. If it's Atafu, it means that you hit the advanced LOP much further south of course than you thought, but it's still land.

It is important to understand that a decision to fly southeastward on the advanced LOP was not a decision to abandon hope of reaching Howland and proceed to an alternate destination. On the contrary, it was the only available course of action for trying to find Howland that also virtually guaranteed a landfall of some kind even if it wasn't Howland. In that context, Earhart final inflight radio message heard by the *Itasca* at 08:43 makes sense:

> We are on the line 157 337. We will repeat this message. We will repeat this on 6210 kilocycles. Wait.

This, like her previous transmissions, was heard on 3105 kilocycles. Having had no luck hearing replies to those transmissions she was going to try her other frequency. But after a moment, suddenly, unexpectedly, and contrary to what she just said, she was back on 3105 saying something that was logged as a "questionable" transmission:

> We are running on line north and south.

Nothing further was heard on 6210 or 3105. Some believe that the silence meant that the aircraft ran out of fuel at that moment, giving Earhart not even enough time

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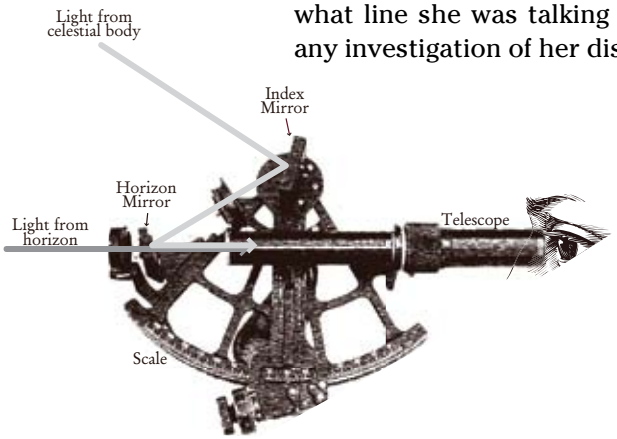
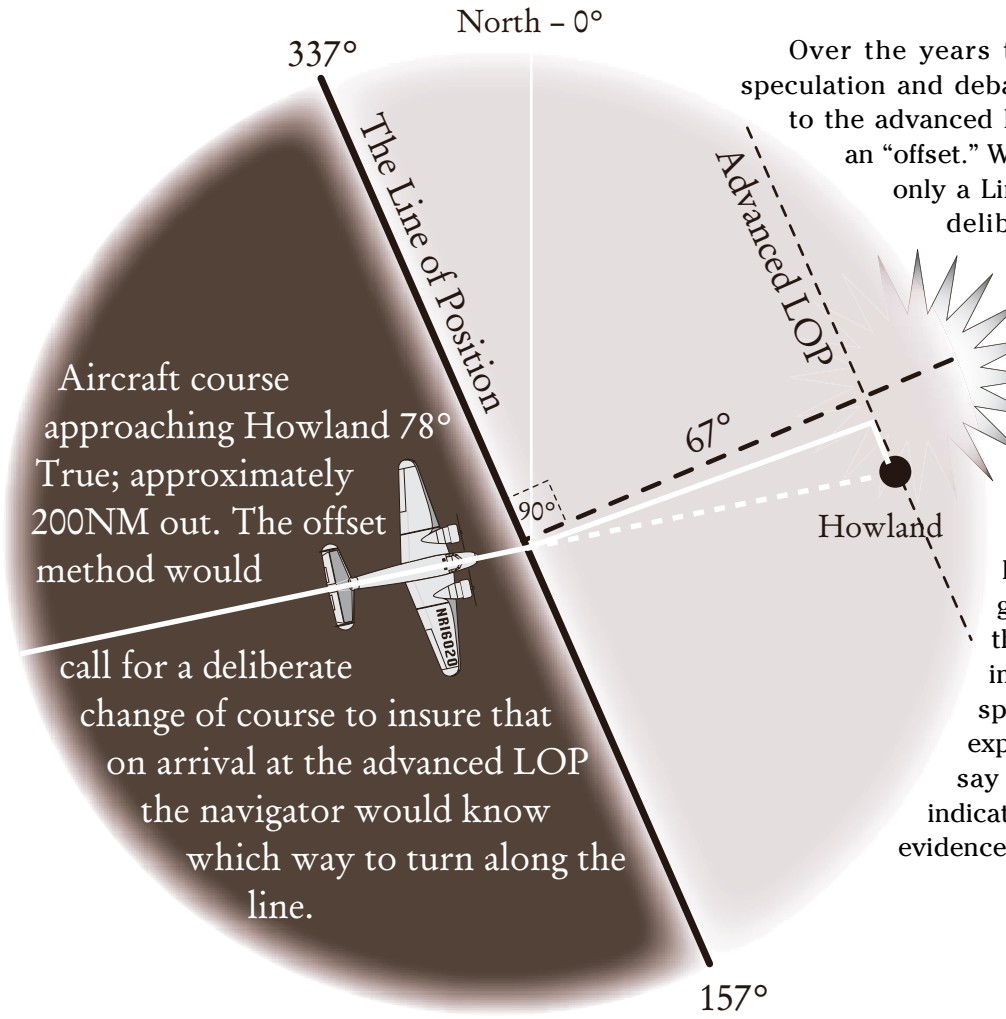
**The* Itasca *log says "We are circling…" but the word "circling" is typed over the partially erased word "drifting." Clearly the operator was not sure what the word was. "Listening" is the word that makes the most sense in the context of the situation.*

to send a distress call. TIGHAR notes, however, that the aircraft should have had several hours of fuel remaining, that the message came at Earhart's regularly scheduled transmission time, and that the known vagaries of radio frequencies may easily explain why no further transmissions were heard.

In the last inflight transmission heard by the *Itasca*, Earhart gave the only position information she had, "We are on the line 157 337" and described the only reasonable course open to them under the circumstances "We are running on line..." Perhaps she said "We are running on line north and south." Or maybe it was "We are running on line north to south." Or maybe it was "We are running on line north then south." The *Itasca* radio operator wasn't sure and we'll never know exactly what she said, but there is no mystery about what line she was talking about and its significance to any investigation of her disappearance.



Offset Navigation



Over the years there has been a great deal of speculation and debate about whether the approach to the advanced LOP employed what is known as an "offset." When trying to find an island using only a Line of Position, it makes sense to deliberately "offset" your approach to one side or the other. This deliberate error removes the doubt about which way you should turn when you get to the line.

However, in Earhart's case, the intention was never to use only the advanced LOP to find the island. Radio Direction Finding was supposed to provide guidance for the final approach and the phrase "We must be on you..." implies a straight-in approach to a specific spot where the island was expected to be. Of course, no one can say for sure, but we see nothing to indicate that an offset was used and some evidence that an offset was not employed.

The Deep Water Handicap

Updates and Corrections

The multi-million dollar deep sea search for The Plane That Isn't There (in our opinion anyway) is off and running – maybe. As you'll recall from our last exciting episode (see *TIGHAR Tracks*, February 2002), there were no fewer than three separate and independent search efforts hoping to scour the same section of the sea floor north and west of Howland Island this spring. One has dropped out, one is rumored to be presently on-site and searching, and the other one has corrected some misconceptions we had but hasn't said what they're doing now.

Scratch

On February 20, 2002 Michael Kammerer's "In Search of Amelia Earhart LLC" website (www.insearchofamelia.com) was replaced with the following short press release:

> *In Search of Amelia Earhart, LLC (ISAE) announced today that the scheduled deep-sea search for Amelia Earhart's lost airplane in the vicinity of Howland Island has been postponed pending the outcome of two competing expeditions that are setting sail early next month.*
>
> *This past weekend ISAE learned with reasonable certainty that Dana Timmer's Howland Island Ltd and Dave Jordan's Nauticos would be searching the same area at the same time.*
>
> *The competition between three search teams is an unattractive scenario when you consider that overall success of any one team as being moderate at best.*
>
> *We wish Howland Landing LTD and Nauticos a safe voyage and the best of luck. Future ISAE plans will depend on the outcome of these two expeditions.*

Spokesmen for ISAE had earlier put their chances for success at 85% or higher. The next day ISAE filed a lawsuit in U.S.District Court in Albuquerque, New Mexico against OceanWorkers Discovery Inc. of San Diego alleging that the technology to be used in the search for the Earhart plane is slower and less efficient than advertised. According to the suit, "In sum, relative to OceanWorkers original representations, In Search of Amelia Earhart would have to pay twice as much for a vehicle that will perform, at best, half as well and twice as expensively." A jury trial, at least a $446,000 refund, and a lien on the ARGUS robot submarine was sought.

Nauticos at Sea?

As we went to press, Nauticos Corporation of Hanover, Maryland (www.nauticos.com) was rumored to be at sea and conducting search operations near Howland Island. No one at Nauticos would confirm or deny that a search is underway but "very interesting" news was promised "soon."

Howland Landing LLC

On March 15, 2002 Dana Timmer, the principle investor in the third search company, Howland Landing LLC, emailed TIGHAR with a number of corrections to our earlier coverage of his involvement in the Earhart search. We, of course, regret any inaccuracies and we asked for his permission to publish his email letter, unedited, on the TIGHAR website and in *TIGHAR Tracks*. He did not choose to grant such permission so we'll try to paraphrase his comments and hope we get it right this time.

Mr. Timmer first wants us to understand that he is not wealthy nor is he a venture capitalist, as we have described him. He did not mention how much he has spent or invested to date but he says that he has put up only a small portion of the money spent in the 1999 search conducted by Williamson & Associates. He says that the 1994 plan to use a Russian vessel as a search platform did not abort because the vessel proved incapable of supporting the search technology but because another investor

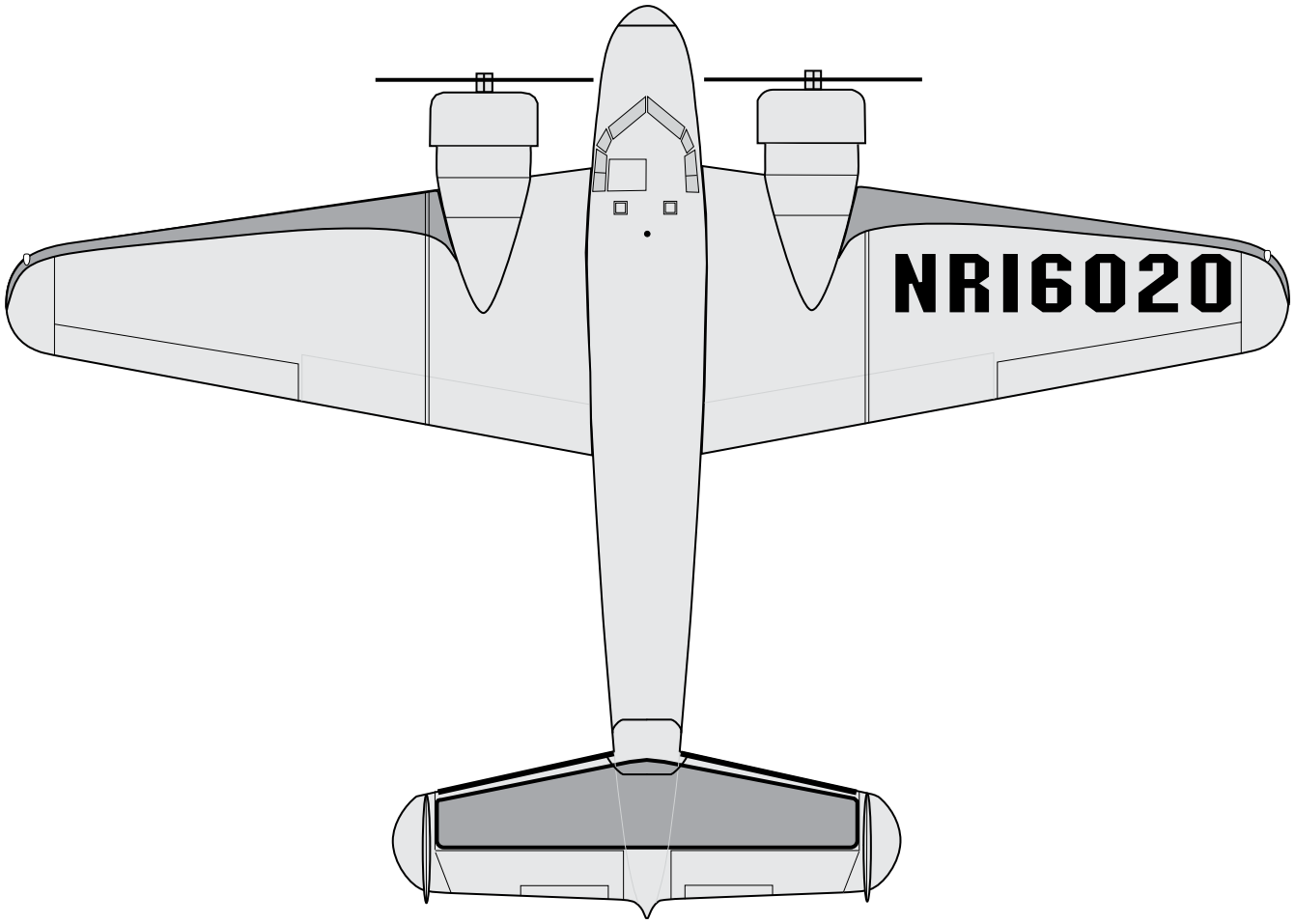
withdrew from the project. He did not provide any further details except to say that, contrary to our impression, there was no acrimony between himself and Elgen Long when their joint effort fell apart.

Mr. Timmer took exception to our characterization of his deal with Earhart's heirs as "the purchase of the Electra." He says that, having determined that the airplane had been owned 100 percent by Amelia and that it was uninsured, he obtained a copy of the will, followed the inheritance claim, contacted the executor, and entered into an agreement should the plane be found. This, he says, was done in 1991. His concern was prompted, he says, by the ongoing litigation concerning the treasure ship *Central America*. He alleges that both Nauticos and ISAE have attempted to secure similar agreements. (TIGHAR, of course, has not. It has never been our intention to own anything we find and, unless proven otherwise, we recognize the claim of the Republic of Kiribati to ownership of anything found on Nikumaroro.)

TIGHAR's description of Nauticos' and Elgen Long's distress upon learning on 1999 that Timmer was about to conduct a search was, according to Mr. Timmer, inaccurate. He says that Long's comment was that "the important thing is that the plane be found." However, we did not make up the bit about Nauticos contemplating a lawsuit and Mr. Timmer has not denied it.

Refuting TIGHAR's claim that Kammerer, Nauticos and Howland landing are all working from the same numbers, Mr. Timmer says that he is using data compiled independently by Roy Nesbitt and Ernest Schofield who are retired RAF pilot/navigators. (Roy Nesbit is a well-respected British aviation historian whose two-part article "What Did Happen to Amelia Earhart?" appeared in the January and February 1989 issues of *Aeroplane Monthly* magazine.) Mr. Timmer says that he also has his own theory, but all put the airplane on the bottom near Howland.

We're grateful to Mr. Timmer for correcting these errors. He did not say anything about another Howland Landing search being imminent but we'll continue to pass along whatever information we can get about these other efforts to find to solve the Earhart mystery.



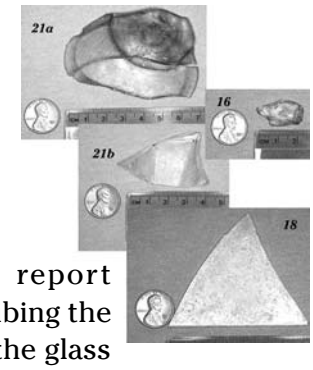
Niku IIII

Post-Expedition Analysis Progress Report

Artifact Identification

For more photos and full descriptions of artifacts see TIGHAR Tracks *November 2001, "Mysteries of the Seven Site" or Earhart Project Bulletin November 20, 2001 on the TIGHAR website at http://www.tighar.org/Projects/Earhart/Bulletins/11_20_01%20Bulletin/mysteriesbull.html.*

Glass Objects



2-6-S-21a
2-6-S-21b
2-6-S-16
2-6-S-18

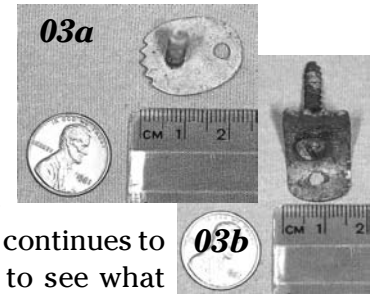
We now have a detailed report from Dr. Rob Jackson describing the physical characteristics of the glass artifacts. We're correlating that information with what we know about the island and the specific site at which the artifacts were found to determine what conclusions can be drawn about the probable origin and use of the artifacts. We'll publish a full report on the TIGHAR website and in an upcoming issue of *TIGHAR Tracks*.

The Knob

2-6-S-45

Scanning Electron Microscopy (SEM) courtesy of the Non-Destructive Testing Laboratory at the United States Naval Academy in Annapolis, Maryland has determined that the metal knob has a high lead (Pb) content. Attempts to further decipher the very worn raised figures on its face have, so far, been unsuccessful but we haven't given up.

The Little Clips



2-6-S-03a
2-6-S-03b

Our suspicion that these were once associated with a sextant box continues to grow. The next step is to see what we can learn about the screws that are part of each artifact. They appear to be wood screws and made of brass. Detailed measurement of their dimensions and comparison to known specifications may tell us where and when they come from.

Faunal Material

Analysis of the various bird, fish, turtle, and shellfish remains collected at the Seven Site continues, with some interesting results. As Dr. Tom King reports:

> *Ten of the seventeen* Tridacna *(clams) from the cluster disassembled and brought back for analysis show evidence of being opened either by forcible prying at the hinge (two specimens) or siphon (two specimens), or by bashing with a rock or other heavy object (six specimens). None of these techniques is consistent with any indigenous* Tridacna *harvesting method of which we have been able to find record thus far. Prying at the hinge is consistent with the way oysters and some clams are typically opened in the United States and Europe. A pointed fragment of ferrous metal found about ten meters from the nearest* Tridacna *feature*

fits neatly into the best preserved pry wound on one of the shells.

The second cluster of clam shells at the site was not collected but appears to be made up of slightly larger clams that do not exhibit this kind of damage. One interpretation might be that the person who harvested clams and brought them to the Seven Site was unfamiliar with how to deal with these tough-to-open Pacific clams and tried unsuccessfully to use a technique that was more appropriate for oysters and ended up just bashing them open, until s/he learned that if the clams are simply left alone for a while they open by themselves.

We're looking forward to detailed reports on the bird and fish bones, but we already know that we have one "mystery bone." We thought it was a turtle bone, but the turtle expert said no. Dr. Kar Burns says it's not a human bone but, so far, three top-notch zoöarchaeologists haven't been able to identify it either. We'll figure it out.

Tom King sketches a clam dump feature at the Seven Site. TIGHAR photo by R. Gillespie.

Niku V

Here We Go Again

We still have a long way to go in finding out everything we can find out from the material and the data we collected during the Niku IIII Expedition, but it is already apparent that further field work at Nikumaroro is more than justified. Therefore, we have set a target date for the Niku V Expedition of summer 2004. In the coming months we'll be convening a special advisory council to outline the general shape of that expedition.

The Niku IIII Expedition

Niku IIII Documentary Progress Report

The forty hours of video shot during the expedition (which turns out to be more like 60 hours) is now in hand and being transferred to digital format from which we'll be producing the documentary. We'll be able to put the final product on either DVD or VHS. This is a huge project but it's one that we really look forward to. Enthusiastic member support through advance purchases at the special $50 price is making it possible for us to purchase the hardware and software to make the documentary the project deserves. Thank you.