

TIGHAR TRACKS

THE JOURNAL OF THE INTERNATIONAL GROUP FOR HISTORIC AIRCRAFT RECOVERY





*... that they might escape the teeth of time and
the hands of mistaken zeal.*

— JOHN AUBREY
STONEHENGE MANUSCRIPTS
1660

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ABOUT TIGHAR

TIGHAR (pronounced “tiger”) is the acronym for The International Group for Historic Aircraft Recovery, a non-profit foundation dedicated to promoting responsible aviation archeology and historic preservation. TIGHAR’s activities include:

- Compiling and verifying reports of rare and historic aircraft surviving in remote areas.
- Conducting investigations and recovery expeditions in co-operation with museums and collections worldwide.
- Serving as a voice for integrity, responsibility, and professionalism in the field of aviation historic preservation.

TIGHAR maintains no collection of its own, nor does it engage in the restoration or buying and selling of artifacts. The foundation devotes its resources to the saving of endangered historic aircraft wherever they may be found, and to the education of the international public in the need to preserve the relics of the history of flight.

TIGHAR Tracks is the official publication of The International Group for Historic Aircraft Recovery. A subscription to *TIGHAR Tracks* is included as part of membership in the foundation (minimum donation \$55.00 per year).

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ON THE COVER

*Bill Carter heading down the lagoon at
Nikumaroro, 2007. See TIGHAR Profiles,
page 22.*

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The Riddle of Artifact 2-2-V-1

Since its discovery on Nikumaroro in 1991, TIGHAR Artifact 2-2-V-1 has been the subject of intense scrutiny and strident controversy. Is this battered sheet of aluminum a piece of the surf-shattered carcass of Amelia Earhart's Lockheed Electra or is it a relic of some other Pacific aviation tragedy? To

get closer to an answer, TIGHAR solicited the interest and assistance of the Restoration Division of the National Museum of the United States Air Force at Wright-Patterson AFB, Ohio. On March 28, 2014, a ten-person TIGHAR investigative commission met with the Restoration Division staff at the NMUSAF and examined a wide variety aircraft in the collection. This is what they learned.



REPORT OF TIGHAR'S ARTIFACT 2-2-V-1 COMMISSION

ON

RESEARCH CONDUCTED AT THE NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE FRIDAY, MARCH 28, 2014

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On March 28, 2014 TIGHAR's Artifact 2-2-V-1 Commission conducted research at the National Museum of the United States Air Force at Wright-Patterson AFB, Ohio. The Commission's access to the museum's restoration hangars, which are located on the active air base, was hosted by Commission member Lt. Col. William Mangus USAF (ret).



Members of the Artifact 2-2-V-1 Commission L to R: Jeff Neville, Ric Gillespie, young photo-bombing museum visitor, Jeff Lange, Karen Hoy, Lee Paynter, Bill Mangus, Aris Scarla, Michelle Martin, Mark Appel. Not shown: Monty Fowler, Greg Hassler. Aircraft is a Lockheed C-60A Lodestar. Photo courtesy J. Neville.

ACKNOWLEDGEMENTS & CAVEATS

During our visit, TIGHAR enjoyed almost unlimited access to the museum's aircraft, materials, and expertise. We want to thank NMUSAF Restoration Division Chief Roger Deere and Restoration Supervisor Greg Hassler for their hospitality and enthusiastic participation in our research. We also extend our sincere appreciation to Restoration Volunteer Garry Guthrie, who devoted his own time to research prior to our visit and accompanied us throughout our entire day at the restoration hangars and in the museum.

The Commission is comprised of 10 volunteers, most, but not all, of whom are TIGHAR researchers. Three members of the Commission are aviation professionals with extensive knowledge and experience in aircraft construction, maintenance, and repair practices. Aris Scarla is the manager of the FAA Flight Standards District Office in Grand Rapids, Michigan, but his work on the Artifact 2-2-V-1 Commission is as a private individual and his opinions should not be construed as official findings by the FAA. Similarly, Greg Hassler is the Restorations Supervisor for the NMUSAF but his opinions should not be construed as official findings of the National Museum of the United States Air Force. Jeffrey Neville is an executive with Gulfstream Aerospace Corporation but, as with the others, his service to the Commission is as an individual volunteer, not as a representative of his employer.



L to R: Lee Paynter, NMUSAF Restoration Supervisor Greg Hassler, Mark Appel, NMUSAF Restoration Division Chief Roger Deere, Ric Gillespie. Photo courtesy W. Mangus.



L to R: Ric Gillespie, NMUSAF Restoration Volunteer Garry Guthrie. Photo courtesy W. Mangus.

STATED PURPOSE

The purpose of the Commission's visit to NMUSAF was to collect data and solicit expert opinion that will help TIGHAR test the hypothesis that Artifact 2-2-V-1 came from Amelia Earhart's Lockheed Electra aircraft.



Lockheed 10E Special NR16020 and owner.

BACKGROUND

In 1991, TIGHAR's second expedition to Nikumaroro discovered a damaged piece of aluminum sheet lying among the vegetation and flotsam from a severe storm that had hit the island since our initial visit two years earlier. Cataloged as TIGHAR Artifact 2-2-V-1, the object has been the subject of intense scrutiny and analysis ever since. In the process of investigating 2-2-V-1 some parts of it have been sacrificed to destructive testing. Specifically, the National Transportation Safety Board Laboratory cut off a small piece for microscopic examination, and the ALCOA company cut out three rather large rectangular "coupons" in order to assess the composition and condition of the metal. As a consequence, the artifact today looks somewhat different than it did when it was first discovered.



Artifact 2-2-V-1 as found on October 18, 1991. TIGHAR photo by P. Thrasher.



Artifact 2-2-V-1 now. TIGHAR photo by P. Thrasher.

ESTABLISHED FACTS

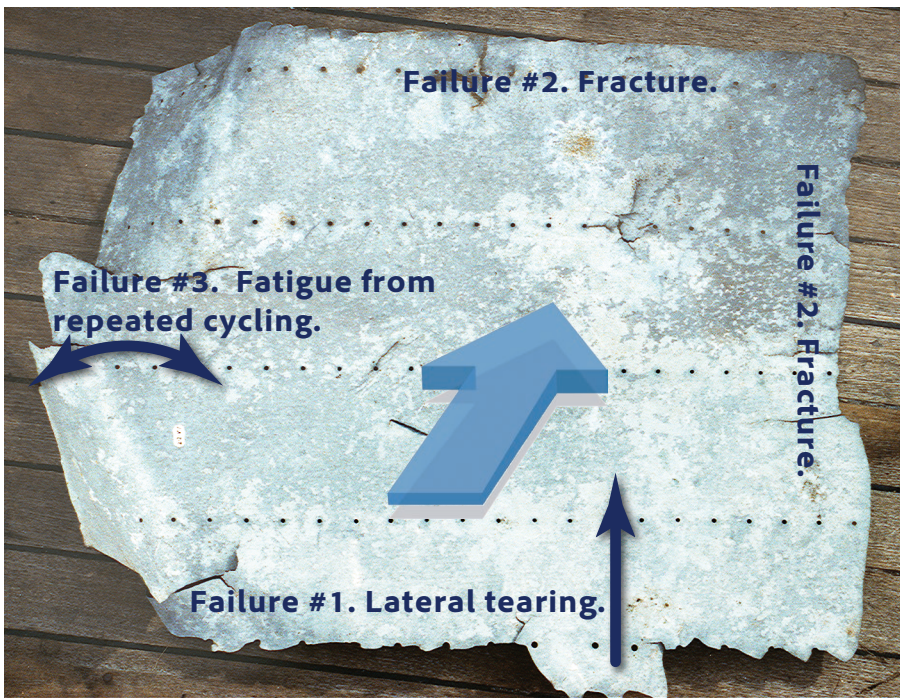
The sheet measures roughly 19 inches wide by 23 inches long. None of the four sides is an original manufactured edge. Artifact 2-2-V-1 is a piece forcibly separated from a larger panel of aluminum aircraft skin.

The edges of the sheet exhibit three types of failures. One long edge failed from lateral tearing; the other long edge and one short edge fractured due to the impact of a powerful fluid force on the interior surface of the sheet; the remaining short edge failed from fatigue after repeated cycling. The failures did not occur simultaneously in a single event. The artifact appears to be a piece of debris from an aircraft that was destroyed in a series of high-energy events over some period of time – perhaps minutes, perhaps hours, perhaps days.



The sheet is perforated with four rows of rivet holes 3/32" in diameter with a precise pitch (interval between holes) of 1". There is no crossing line of rivet holes.

One edge of the sheet failed along a staggered double row of rivet holes 5/32" in diameter with irregular pitch.



The metal failed sequentially from three distinct types of stress – lateral tearing along the line of 5/32" rivets; then fracturing from a force perpendicular to the sheet surface; and finally fatigue from cycling back and forth against a crossing underlying structure.

The sheet is made of a product introduced by Alcoa Aluminum in 1933 known as "24ST Alclad." Earhart's Lockheed 10E Special was skinned with 24ST Alclad. Nearly all American all-metal aircraft manufactured in the 1930s, during WWII, and afterward were skinned with this material.

The sheet is .032" in thickness. Skins of that thickness were common on Earhart's Lockheed and on many other aircraft.



The single surviving rivet is an AN455-AD "brazier head" rivet with a shaft diameter of 3/32" (colloquially a "#3" size rivet). The "brazier head" has a low profile and was used on external surfaces to reduce aerodynamic drag.

The rivet has a shaft length of 3/16" indicating that the underlying structure to which it was once attached was approximately .06" in thickness.

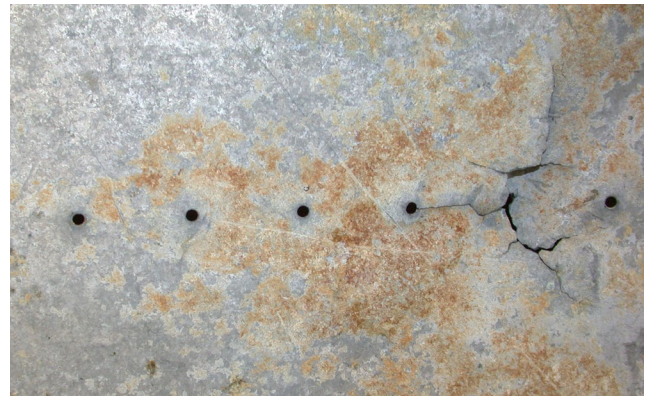


This fragment of stringer from the wreck of Electra c/n 1024 in Idaho is .06" inch in thickness and has #3 size rivet holes with a 1" pitch.

Below: On the exterior surface of the sheet the letters "AD" are clearly visible and are presumed to be remnants of the original Alcoa labeling.



Portions of the sheet have suffered a loss in ductility through exposure to heat – more heat than can be explained by simple exposure to intense sunlight, but not enough heat to melt the metal. Aluminum melts at 1,221°F. The loss of ductility in portions of the sheet is consistent with exposure to heat in the realm of 800°F such as might result from brief exposure to flame. A former resident of Nikumaroro has described cooking fish on a sheet of metal with many small holes.



Although found on land, the sheet exhibits several areas of carbonate (coral) encrustation suggesting that it spent months and perhaps years submerged in relatively shallow water.



The artifact was discovered in 1991 just inland from the head of the landing channel that was blasted through the reef when the island was abandoned in 1963.

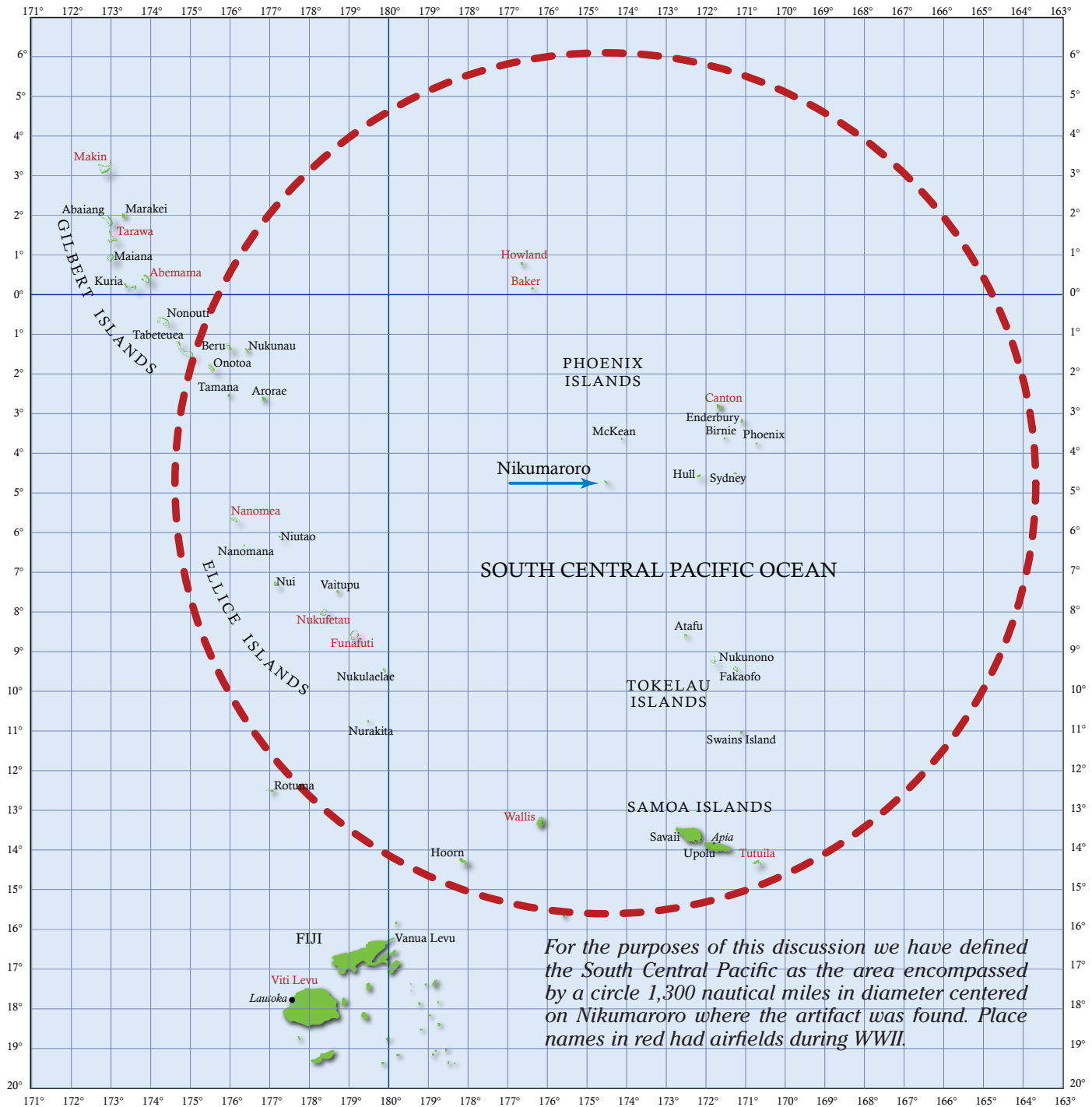


The "1940 Gardner Co-Op Store" was located near the head of the landing channel. This is how it appeared during TIGHAR's first expedition to Nikumaroro in 1989.

When TIGHAR returned to the island in 1991, the beach exhibited severe storm damage. Artifact 2-2-V-1 was discovered among the washed-up beachfront vegetation near the collapsed seaward-facing wall of the store.



PRELIMINARY CRITERIA FOR AN AIRCRAFT-OF-ORIGIN



Artifact 2-2-V-1 is a section of the external “skin” from an aluminum airplane of American manufacture that was destroyed in a catastrophic event somewhere in the Central South Pacific.

There are twenty-eight known occurrences in which aircraft were damaged, lost or destroyed in the Central South Pacific. The aircraft types are:

- Bell P-39 (1 loss, 1942)
- Boeing B-17 (2 losses, 1942)
- Consolidated PBY (1 loss, 1940; 1 loss, 1942; 5 losses, 1943; 1 loss, 1944)
- Consolidated B-24/Navy PB4Y-1 (1 loss, 1943; 1 loss, 1944; 1 loss, 1945)
- Consolidated C-87, cargo version of B-24 (1 loss, 1943)
- Douglas C-47 (1 loss, 1943)

- Lockheed 10E Special (1 loss, 1937)
 - Lockheed PV-1/Army C-60 (1 loss, 1944)
 - Lockheed L-749A Constellation (1 loss, 1962)
 - Martin PBM (1 loss 1942, 2 losses, 1944)
 - North American B-25/ Navy PBJ (2 losses, 1944)
 - Sikorsky S-42B (1 loss, 1938)
- It is, of course, possible that other aircraft types were lost or destroyed but not reported.

QUESTIONS ADDRESSED BY THE COMMISSION

1. Would a detailed examination by experienced aircraft maintenance professionals reveal further clues about the artifact's origin?
2. Would a careful inspection of aircraft and materials in the NMUSAF collection provide further data on aluminum labeling practices?
3. Would an inspection of aircraft in the NMUSAF collection representative of types that served in the South Pacific theater of war reveal structural patterns identical or closely similar to Artifact 2-2-V-1?

FINDINGS

1. Would a detailed examination by experienced aircraft maintenance professionals reveal further clues about the artifact's origin?



Aris Scarla (left) and Greg Hassler (right) debate the significance of features on Artifact 2-2-V-1. Photo courtesy W. Mangus.

A detailed examination by Aris Scarla and Greg Hassler concluded that:

- a. The pitch (interval between rivets) of the #3 rivets is precisely and consistently 1 inch. This level of precision suggests factory-quality work. By contrast, the pitch of the staggered double row of #5 rivets is irregular and was probably dictated by features in the underlying structure that had to be avoided.

Monty Fowler:

"To me, the most relevant new fact that developed as a result of this field trip was the unanimous conclusion that 2-2-V-1 is NOT a USAAF field-applied or field-depot level

repair. It was created under controlled conditions in a factory. That narrows down the point of origin possibilities considerably."

The issue of rivet pitch is an important one. There is an area on the belly of Earhart's Electra where the artifact would fit well assuming that the pitch of the #3 rivets was tightened from 1.5" to 1". However, Aris Scarla and Greg Hassler agreed that such a change would not have been made. Wherever 2-2-V-1 fits on whatever aircraft, the pitch of the #3 rivets must be 1".

- b. Careful measurement of the space between lines of rivets holes revealed that the lines do not taper or converge as previously believed – including by the National Transportation Safety Board (NTSB) Lab. There are, however, slight irregularities in the spacing between lines suggesting that the underlying structures, presumably stringers, were not precisely aligned. These irregularities suggest that 2-2-V-1 may be part of a repair.



Aris Scarla uses dividers to check span between lines of rivet holes on Artifact 2-2-V-1. Photo courtesy W. Mangus.

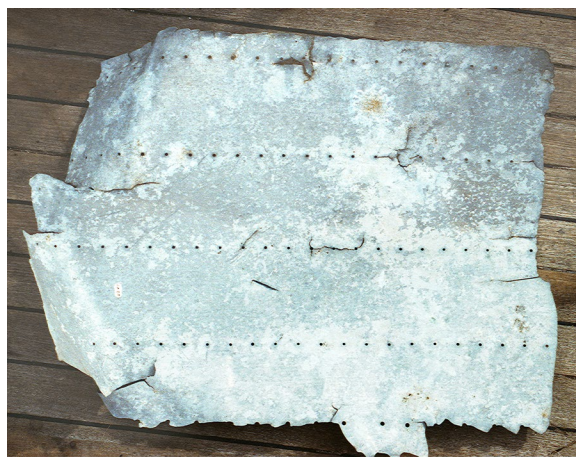
- c. The missing rivets in 2-2-V-1 were not drilled out. The rivet holes exhibit none of the distortion that inevitably results from drilling. This again suggests that the holes were made either during original construction or during factory repair, not wartime field repair.
- d. Most of the rivets failed in tension when a fluid force struck the sheet on the interior surface with sufficient energy to blow the heads off the rivets. Some pieces of the underlying structures (i.e. stringers) appear to have remained attached by a few rivets until being subsequently pried off by human action using a strong knife or similar implement.
- e. The interior surface of the artifact exhibits no sign of the yellow/green zinc chromate paint that was used on the interior surfaces of nearly all WWII aircraft to inhibit corrosion, especially on aircraft serving in the salty South Pacific theater. Some parts of some aircraft, notably the interior surface of bomb bay doors, were painted with a silver-colored corrosion inhibitor. Bombers serving in



Zinc chromate corrosion inhibitor on the interior surfaces of the NMUSAF B-24 Liberator.

the European theater had such short life-expectancies that corrosion inhibitors were considered unnecessary.

Zinc chromate did not come into common use in aircraft until the late 1930s. Earhart's Electra, constructor's number (c/n) 1055, the 55th Model 10, was built in the spring of 1936. Lockheed sales literature for the Model 10 Electra dated March 2, 1936, specifies that "Although its aluminum coating renders Alclad highly resistant to corrosion, every part of the interior of the airplane is painted for further protection." A section of wreckage recovered by TIGHAR in 2004 from the crash site of Lockheed 10A constructor's number (c/n) 1024, which flew into an Idaho mountain in December 1936, has aluminum-colored paint on the interior surface. A close examination of the interior surface of 2-2-V-1 reveals what may be surviving traces of aluminum-colored paint.



Are there remnants of aluminum-colored paint on the interior surface of Artifact 2-2-V-1? TIGHAR photo by P. Thrasher.

Aris Scarla:

"The possibility of the protective coating of paint on 2-2-V-1 is a good find.... My recommendation: first see what can be done to verify the possible paint theory on 2-2-V-1."

Lee Paynter:

"[We should] obtain paint comparisons between the Idaho Electra wreckage and the subject Niku wreckage."

Monty Fowler:

“TIGHAR has documentation that using aluminum/silver paint as an interior anti-corrosion treatment was a standard Lockheed practice in the 1930’s. TIGHAR also has, for reference, parts from the 1936 Idaho Lockheed Electra crash site. A comparison testing of the Idaho Lockheed interior paint and the putative painted side on 2-V-1-1 needs to be done at the earliest opportunity.”



The section of known Electra wreckage in the foreground has aluminum-colored paint on the interior surfaces. Photo courtesy W. Mangus.

2. Would a careful inspection of aircraft and materials in the NMUSAF collection provide further data on aluminum labeling practices?

The existence of remnants of the original Alcoa labeling is remarkable and fortunate. Interpreting its significance is difficult and controversial. TIGHAR is no stranger to either of those adjectives. In 1993 we sought to learn what the letters “AD” on the artifact might signify. Matching the lettering style to labeling found on three aircraft – two Lockheed Electras and a C-47 – we concluded that the letters were probably part of a sequence that originally read “ALCOA R. T. .032” ALCLAD 24S-T3 AN-A-13.” In 1996, while at ALCOA Aluminum’s laboratory near Pittsburgh, Pennsylvania, for metallurgical testing of the artifact, we asked ALCOA engineers if they could help us with the meaning of the presumed sequence. They explained that the 24S alloy was first developed by ALCOA in 1933. The “T3” stands for a heat-treated tempering process that was introduced in 1937. “AN” stands for “Army Navy” – the standard prefix for all aircraft materials specifications in the U.S. regardless of whether they were used in military or civilian applications. The “A” stands for “Alcoa.” The “13,” they said, signifies that it is “reserve stock” sheet that has been certified for uses other than original construction. No documentation was offered to support their explanation.



This example of AN-A-13 labeling was on the inside of a flap actuator cover in the passenger cabin of Electra c/n 1052 at the New England Air Museum in Windsor Locks, Connecticut. Whether it is original to the aircraft or a later replacement is unknown. TIGHAR photo by P. Thrasher.

Recent research by members of the on-line TIGHAR Forum suggests that the Alcoa engineers may have been mistaken in some respects. The AN-A-13 specification appears to have been introduced some time between 1941 and 1943 and has to do with the physical properties of the sheet rather than “reserve stock.” The actual specification has not been found, nor do we know whether AN-A-13 was ever on the artifact or when Alcoa started using the lettering style seen on 2-2-V-1. The lettering on aluminum seen in photos of several pre-war aircraft, including Earhart’s, is not like the

“AD” on the artifact. So far, no example of the letters or lettering style seen on the artifact has been found on aluminum known to date from 1937.

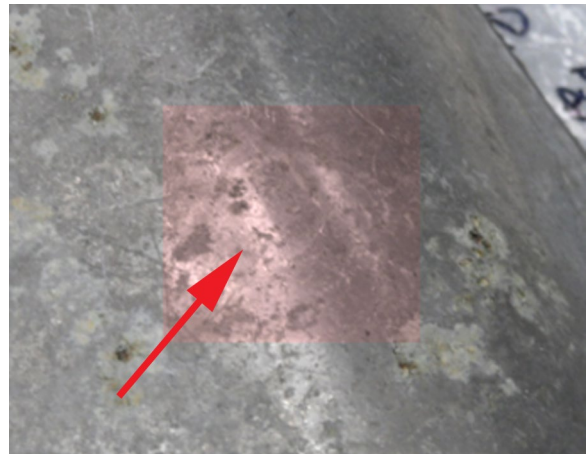


Alcoa labeling on this Electra under construction is simply the repeated designation ALC24ST.

During the Commission’s visit, the NMUSAF staff pointed out examples of original labeling on aluminum from aircraft under restoration. Labeling on original aluminum from B-17F “Memphis Belle” included the word ALCLAD, but in smaller size and a somewhat different style than the AD on 2-2-V-1. No example of AN-A-13 labeling was found.

3. Would an inspection of aircraft in the NMUSAF collection representative of types that served in the South Pacific theater of war reveal structural patterns identical or closely similar to Artifact 2-2-V-1?

If our Preliminary Conclusion is correct – that Artifact 2-2-V-1 is a section of the external “skin” from an aluminum airplane of American manufacture that was destroyed in a catastrophic event somewhere in the Central South Pacific – then there must be someplace on some American aircraft that matches, or could be legally and reasonably repaired in such a way as to match, the materials, measurements, and rivet patterns of Artifact 2-2-V-1. Because the artifact was found on Nikumaroro, it follows that the aircraft-of-origin was a type that was present at some time in that part of the world. Due to the remoteness of the Central South Pacific, those aircraft types are a limited and known population.



Commission member Mark Appel’s fiancée Michelle Martin found another “D” on 2-2-V-1. It is hard to see and somewhat distorted by a bend in the metal, but it’s definitely there. Photo courtesy J. Neville.

Aris Scarla:

“Michelle’s finding of the additional “D” font shows again the secrets that 2-2-V-1 holds.”

Mark Appel:

“The aluminum manufacturing label font style and spacing is ambiguous and varies significantly from fonts observed on period US military aircraft in both research and at the museum—despite matching the same general categorization.”

During the Commission’s visit to NMUSAF, the members inspected 15 aircraft types known or suspected to have been present in the Central South Pacific before, during and after WWII. Each aircraft was examined by the entire team. We had to stay together because NMUSAF restoration shop volunteer Garry Guthrie had to be with us to reassure museum security personnel that the TIGHAR Commission members had official clearance to go beyond the barriers to examine the aircraft in detail. Individual rivets were measured with calipers. Rivet pitch and stringer spacing were measured with rulers. The only portions of the aircraft the commission members could not inspect were the top surfaces of wings and fuselages that would have required scaffolding to see.



*Ric Gillespie and Jeff Lange discuss the rivet pitch on B-17D "The Swoose."
Photo courtesy W. Mangus.*

The aircraft types examined were:

- ❖ Bell P-39 Airacobra
- ❖ Boeing B-17 Flying Fortress. Three examples were inspected:
 - ❖ B-17D "The Swoose" (under restoration)
 - ❖ B-17F "Memphis Belle" (under restoration)
 - ❖ B-17G "Shoo, Shoo, Shoo Baby"
- ❖ Consolidated Model 28, amphibious version, known to the US Navy as the PB5A Catalina and to the Army Air Forces as the OA-10.
- ❖ Consolidated Model 32, known to the Army Air Forces as the B-24D Liberator and to the U.S. Navy as the PB4Y-1.
- ❖ Curtiss P-40 Warhawk
- ❖ Curtiss C-46 Commando
- ❖ Douglas A-20G Havoc
- ❖ Douglas A-24, known to the U.S. Navy as the SBD Dauntless
- ❖ Douglas B-18 Bolo
- ❖ Douglas C-47
- ❖ Lockheed P-38 Lightning
- ❖ Lockheed Model 18, known to the Army Air Forces as the C-60 Lodestar and to the U.S. Navy as the PV-1 Ventura
- ❖ Martin B-26 Marauder
- ❖ North American B-25 Mitchell
- ❖ Northrop P-61 Black Widow

RESULTS OF THE INSPECTION

1. Several of the aircraft were entirely flush riveted and could be quickly eliminated. These included:
 - ❖ Bell P-39 Airacobra
 - ❖ Curtiss P-40 Warhawk
 - ❖ Curtiss C-46 Commando
 - ❖ Douglas A-20G Havoc
 - ❖ Lockheed P-38 Lightning
 - ❖ Lockheed Model 18 PV-1/C-60
 - ❖ Martin B-26 Marauder
 - ❖ Northrop P-61 Black Widow
2. #3 size rivets and brazier head rivets were not uncommon on the B-17, B-24, C-47 and B-18.
3. Parallel rows of rivets were also not uncommon, but parallel rows of #3 brazier head rivets with 1" pitch and spacing between rows similar to those on 2-2-V-1 were not found on any of the aircraft inspected.
4. The closest matches were on the B-24, but not close enough to be considered possibilities for the origin of 2-2-V-1.



The rivet pattern on the underside of the B-24 horizontal stabilizer was somewhat similar to the pattern on 2-2-V-1. Photo courtesy J. Neville.

5. Beyond the quantifiable characteristics of the aircraft inspected, all of the Commission members, having spent an entire day paying close attention to the way various aircraft are constructed, felt that the “scale” of the combination of materials in Artifact 2-2-V-1 was wrong for the WWII aircraft they inspected.

Aris Scarla:

“2-2-V-1 is a unique piece; it has its own distinct forensic signature. I think of it as a puzzle piece – it has to fit somewhere. [T]here was no overall match, not even one that was close enough to consider. From the military types and models looked at it was clear the engineering design was not the same.”

Jeff Neville:

“Overall, I did not find any clear match for 2-2-V-1 among the military types examined. ... At first glance, many panels of aluminum beckoned as to pattern, etc. It did not take long, however, to find that

in the vast majority of cases the weight of structure, rivet size or type, spacing of stiffeners, etc. was not even close. In fact, all the military types – even those ‘lightly built heavy bombers’ like the B-24 – were more substantially skinned and/or internally braced than 2-2-V-1 would indicate. ... In my opinion, 2-2-V-1 is clearly a relic from a lightly-built airplane, in comparison to any of the military types I saw.”

Jeff Lange

“[W]hile we were unable to view the entire top surfaces of the wings and fuselage of the museum aircraft, the group was definitely able to scour the sides and bottoms and see parts of the other surfaces well enough to note that we have a unique piece of debris. The overall size of the piece and the number of rows of rivet holes, their spacing from each other, and the pitch of the rivets kept eliminating example after example we thought matched.”

Bill Mangus

“Very quickly during our Museum walk-around, I found myself thinking, “There’s no way 2-2-V-1 could have come from any of these aircraft.” They were built to different standards, for different, more stressful use than a Lockheed 10E. The spacing and size of the rivets everywhere we looked was just too different. Close inspection of even gear doors, bomb bay doors and like areas which may be subject to lesser stresses failed to find anything that was even close to what is in evidence on 2-2-V-1.”

Mark Appel

“The exercise produced a number of surprises and precipitated many questions for further research. It’s fair to say we were frankly a bit surprised at failure to find a closer match to 2-2-V-1 on the subject aircraft examined. Our intuition suggested that the statistical odds of finding at least a partial match were favorable given the following:

- *the range and number of relevant aircraft available at the USAF Museum*

- *the expert guidance, review, and “scouting” of museum personnel*
- *the number of TIGHAR personnel examining each aircraft (each was examined thoroughly to the limits of our access, i.e. “tops of aircraft” were not physically in reach)*

To us, it seemed finding a match considered “close and reasonable” (even if there were discrepancies) would be more likely rather than not. But despite the myriad combinations of panel size, rivet size and type, represented factory construction and repair patches, as well as the sheer number of aircraft examined, very few examples appeared to offer any possibility of a match.

Given the plethora of relevant aircraft to examine, the lack of any close match was impressive. The subjective look and feel of 2-2-V-1 suggests association with a smaller, more lightly constructed aircraft than the period military examples.”

Aris Scarla

“In my estimation we did a complete evaluation and mitigated the possibility of 2-2-V-1 having come from one of those aircraft types or models.”

CONCLUSIONS

With no firm answers to either confirm or disprove the hypothesis that Artifact 2-2-V-1 is wreckage from the Earhart Electra, any conclusions must be limited to quantifiable data that narrow the field of possible aircraft-of-origin and move the likelihood needle one way or the other.

- ❖ Learning that rivet pitch does not change in a repair means that the artifact is probably not from the area on the belly of Earhart’s aircraft where we had thought it might fit. We need to find a better candidate area on the Electra (if there is one).
- ❖ On the other hand, the new information that the lines of rivet holes on the artifact do not converge or taper as previously thought and that the artifact is not necessarily from a repaired area present more possibilities for a match on the Electra.

- ❖ The discovery of a second D on the artifact gives us more information but until better data about aircraft aluminum labeling practices surfaces, the variety of labeling styles and content seen on museum aircraft precludes any definitive conclusions based on the letters visible on the artifact.
- ❖ The factory-grade precision of the workmanship in the rivet installation reduces the likelihood that the artifact was part of a field repair.
- ❖ The absence of any sign of zinc chromate corrosion inhibitor on the interior surface of the artifact and the absence of paint on the exterior surface argue strongly against 2-2-V-1 being part of any WWII aircraft serving or transiting through the Central South Pacific.

- ❖ The inability of the museum personnel and the Commission members to find a matching pattern on any of the aircraft inspected and their unanimous opinion that the general scale of the artifact suggests a smaller, more lightly built aircraft than any of the wartime types further lower the probability that 2-2-V-1 is from a WWII aircraft.

REFINED CRITERIA FOR AN AIRCRAFT-OF-ORIGIN

Based on the research conducted at the NMUSAF on March 28, 2014, it is possible to refine the criteria for Artifact 2-2-V-1's aircraft-of-origin. The available evidence now suggests that the artifact is probably not from a WWII combat or heavy transport aircraft and is probably from an airplane smaller and lighter than any of the military types that served in or transited through the Central South Pacific. If the artifact is from a repaired area, the repairs were probably done at the factory. The artifact is, without question, from an aircraft that suffered catastrophic damage somewhere in the Central South Pacific region. At present, of the known losses in the Central South Pacific, only Earhart's Electra fits all of the requirements. Further research may yield additional information that will either support or refute the criteria.

WHAT'S NEXT?

Laboratory testing is presently underway to determine whether there is paint on the interior surface of the artifact. If paint is found it will be compared to the paint on the interior surface of known Lockheed Electra wreckage dating from 1936.

Lockheed engineering drawings are currently being searched for areas on the Model 10 that may be reasonable matches to the artifact. In coming weeks Commission members will also inspect Lockheed 10A c/n 1052 and other aircraft at the New England Air Museum in Windsor Locks, CT for possible matches to 2-2-V-1

Several practical experiments are being designed to test whether the hydrodynamic forces present at Gardner Island (Nikumaroro) in early July 1937 were sufficient to cause the kind of damage evident on artifact 2-2-V-1.

LAST WORD

The net result of the Commission's work is that the population of candidates for an aircraft-of-origin for Artifact 2-2-V-1 has been narrowed, and new avenues of investigation have been opened. Questions about labeling and the artifact's possible location on the Earhart Electra remain, and the answers may ultimately disprove the hypothesis, but the process of scientific investigation continues.

I would like to personally thank all of the members of the Commission for the generous devotion of their time, energy, and intellect in the pursuit of an answer to the riddle of Artifact 2-2-V-1.




Ric Gillespie
Commissioner, Artifact 2-2-V-1 Commission
Executive Director
TIGHAR

THE TEAM FOR NIKU VIII

Team member selection for Niku VIII was based on a number of criteria. As always, we're looking for bright, knowledgeable team players who can handle the rigors of an expedition and get along with their shipmates for a month at sea. Hands-on familiarity with Lockheed Electra wreckage increases the chance that they'll be able to recognize components



that may be obscured by coral growth, as is experience with the underwater environment. For this expedition there is also a physiological/psychological requirement.

Team members must be able to fit through the narrow hatch of the Pisces subs and endure eight-hour missions in the cramped, cold Command Sphere.





Ric Gillespie

Lee Paynter

Andrew Sanger

Dr. Kelly Gleason

Gary Quigg

Jim Linder

Terry Kerby

At a press conference in Washington, DC on March 12, Executive Director Ric Gillespie introduced the TIGHAR team for Niku VIII. They are:



Kelly Gleason, Ph.D.
Underwater Archaeologist
Honolulu, Hawai'i

TIGHAR member Kelly Gleason will be the underwater archaeologist on Niku VIII. As the NOAA Maritime Heritage Coordinator and Maritime Archaeologist for the Papahānaumokuākea Marine National Monument, Kelly has first-hand experience with 70+-year-old aircraft debris in the coral reef environment around Midway Atoll. Her participation in Niku VIII is as an individual TIGHAR volunteer, not as a NOAA representative.



Jim Linder
Business Executive
Siler City, North Carolina

Jim is an experienced diver and a former U.S. Navy pilot with a strong background in missing aircraft investigations. He completed the Aviation Archaeology Field School in 2013 and has first-hand experience with Lockheed Electra wreckage.

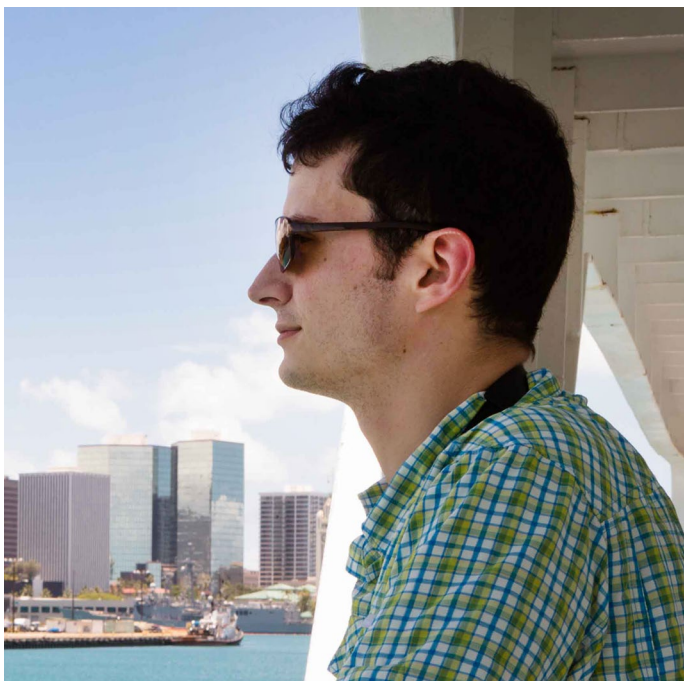
Lee Paynter
Business Executive
Atglen, Pennsylvania

Lee is an experienced diver and has a strong aviation background, including long-distance ocean flying in light twin-engine aircraft. He completed the Aviation Archaeology Field School in 2013 and has first-hand experience with Lockheed Electra wreckage.



Gary Quigg
Archaeologist
Crawfordsville, Indiana

Gary has been a member of TIGHAR since 1990. He runs TIGHAR's Contract Services division and is an instructor for our Aviation Archaeology Field Schools. His TIGHAR expedition travels have taken him to Maine, Newfoundland, Alaska, Idaho, Yap, Fiji, the Solomon Islands, and five times to Nikumaroro. He has first-hand experience with Lockheed Electra wrecks in Alaska and Idaho.



Mark Smith
Cameraman
Jersey City, New Jersey

Mark is an award-winning cinematographer who has been documenting TIGHAR expeditions and research trips since 2001. He has been to Nikumaroro four times, and his work has been featured in two Discovery Channel specials about TIGHAR expeditions. Mark too has hands-on experience with Electra wreckage. His long association with the Earhart Project makes him a valuable member of the research team as well as a cameraman.

Andrew Sanger
Real Estate Manager
Brooklyn, New York

Andrew completed the Aviation Archaeology Field School in 2011. He was a Sponsor Team Member on the 2012 Niku VII expedition and, as such, has many hours of experience searching the underwater reef slope at Nikumaroro.



Ric Gillespie
TIGHAR Executive Director
Oxford, Pennsylvania

This will be Ric's eleventh trip to Nikumaroro but, as with the other TIGHAR team members, it will be his first experience with manned submersibles and his first foray over the underwater cliffs and into the deep, dark depths that hold the answer to one of the history's greatest mysteries.

The University of Hawai'i oceanographic research vessel *Ka'imikai-O-Kanaloa* (known for obvious reasons as "K-O-K") can legally accommodate a maximum of nineteen passengers in the scientific party. For the Niku VIII expedition, seven of those places will be taken by the Hawai'i Undersea Research Laboratory (HURL) staff led by Chief Sub Pilot Terry Kerby. The ship's complement will include a Republic of Kiribati Customs officer and representative of the Phoenix Islands Protected Area (PIPA). Of the remaining eleven berths, seven will be occupied by the TIGHAR team members profiled.



The final four places on the expedition team are reserved for sponsors, whether individuals or media, who will make a significant contribution toward the expedition's \$2,000,000 budget. For more information about Niku VIII sponsorship opportunities contact Ric Gillespie at ric@tighar.org or phone 610-467-1937.

TIGHAR PROFILES

The first in a series of tributes to TIGHAR's most remarkable members.

Bill Carter

Member 2313RCEB



In 1999 a young attorney in Boise, Idaho was thumbing through a magazine in a waiting room and came upon an article about a nonprofit aviation historical group that was using science and serious field research to find answers to some of aviation's most enduring mysteries. The combination of intellectual rigor and high adventure sounded appealing so Bill Carter joined TIGHAR.

Fifteen years later, his outstanding service to the organization has taken Bill Carter from historic crash sites in the mountains of his native Idaho to nearly impenetrable reaches of the Alaskan wilderness and beyond.



Bill is a veteran of three expeditions to Nikumaroro where his capacity for hard work, perceptive insight, and wry humor have made him a legendary figure in the annals of the Earhart Project.



In 2004, Bill was on the TIGHAR team that inspected the wreck of a Lockheed Electra high in Alaska's Misty Fjords Wilderness Area. L to R: John Clauss, Gary Quigg, Bill Carter.



Field work in challenging environments is only part of TIGHAR's mission. In 2011 Bill Carter did valuable archival research at the National Archives of Kiribati in Tarawa.

As a member of TIGHAR's Board of Directors and the organization's in-house attorney, Bill was the principal author and negotiator of TIGHAR's landmark Antiquities Management Agreement with the Republic of Kiribati. Similarly, the exclusive media rights contracts with the Discovery Channel that helped fund TIGHAR's 2010 and 2012 expeditions to Nikumaroro were Bill's accomplishments.

Most recently, Bill Carter has been defending TIGHAR in the bizarre and groundless lawsuit

brought by Timothy Mellon. His work is being done *pro bono*, saving TIGHAR many thousands of dollars in legal fees. In concert with TIGHAR's Wyoming attorney, Bill's skillful handling of the case has resulted in half of the plaintiff's charges being thrown out by the court and excellent prospects for the dismissal of the remaining counts.

Whether armed with chainsaw or briefcase, Bill Carter is one of TIGHAR's greatest assets.



The 1937 Fund appeal, described in the enclosed flyer, initially went out as a TIGHARNews email and a notice on the TIGHAR website on April 4. So far, 116 TIGHAR members and friends have responded with donations of at least \$19.37. The \$6,100 received so far has made it possible for us to start putting together the mass-marketing campaign for funding the Niku VIII expedition, but your continued support is vital. Whether you've already helped or have not yet contributed, please use the enclosed flyer to make a donation. You can send a check payable to TIGHAR or use a credit card. Note that we're now able to take American Express. If you'd rather call to give us your credit card information you can reach us during normal business hours at 610-467-1937. We're always happy to hear from you. And of course you can always donate via Paypal on the secure TIGHAR website at tighar.org. Thank you.

1937 FUND

TIGHAR membership.....	860
Members & Friends	
responding to date:	116
Total raised to date:	\$6,100

AS we go to press

An anonymous TIGHAR member has offered to match, dollar for dollar, the next \$2,500 in donations to the 1937 Fund. Donate today and double your money!

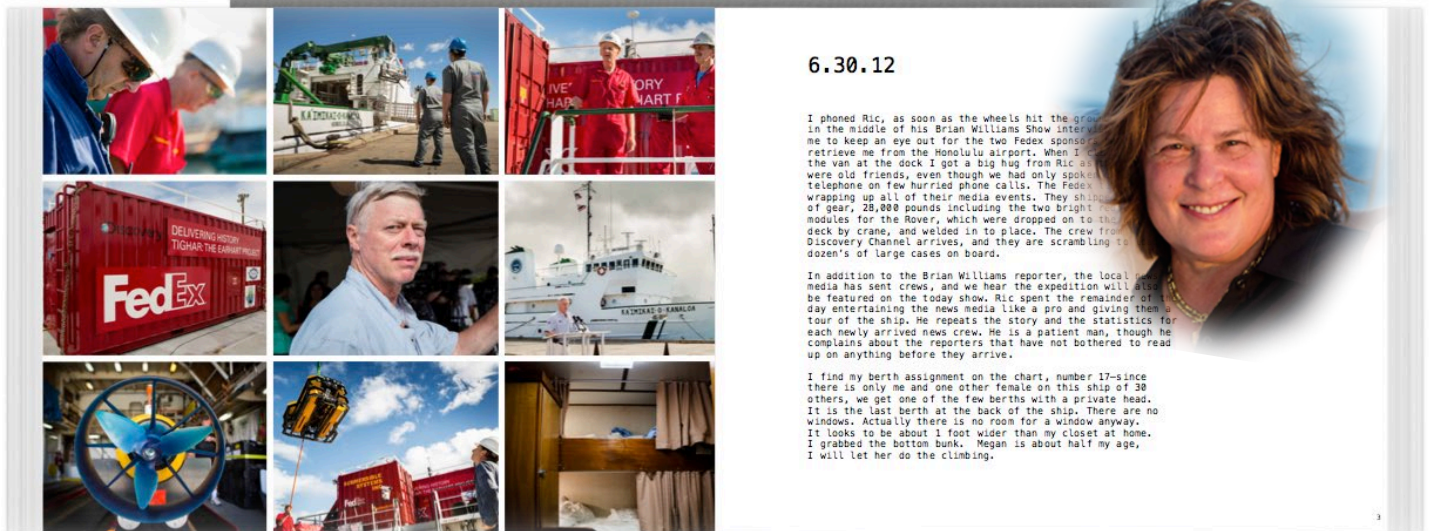
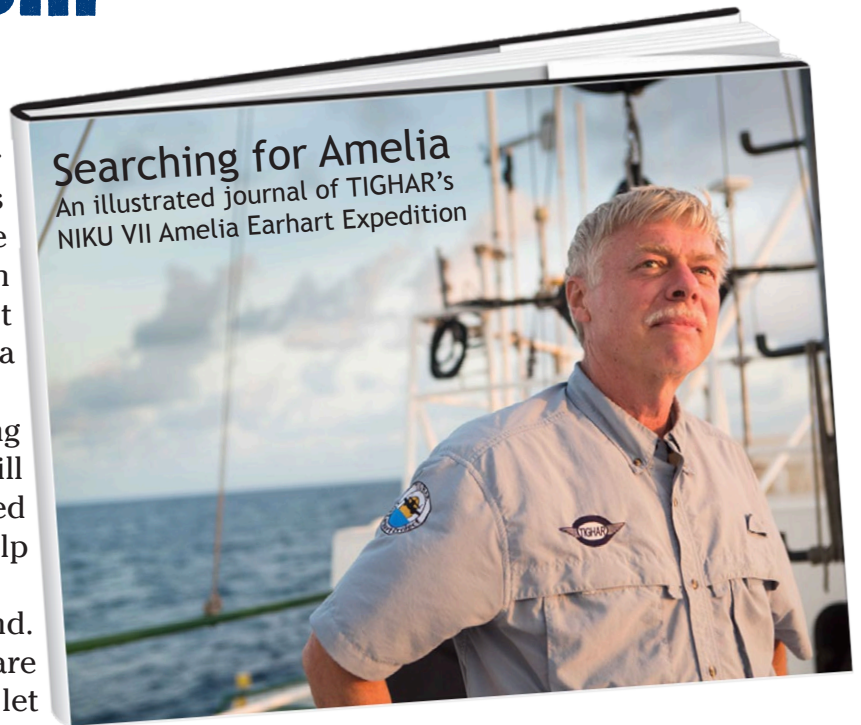


IN THE WORKS...

There's an old TIGHAR saying, "Adventure is what happens when things go wrong." Award-winning photographer Laurie Rubin's personal journal captures the excitement, the drama, and the frustrations of the 2012 Niku VII expedition from the perspective of a Chicago artist suddenly thrown into the adventure of a lifetime.

Published as a coffee table book featuring her fabulous photos, Laurie's journal will take you there. She has generously donated the proceeds from sales of the book to help fund future expeditions.

The book will be published on-demand. As soon as all the details and costs are worked out we'll be taking orders. We'll let you know.



"Of course I can get away. Yes... I am in perfect health. No... I never get seasick."

"Who are you talking to?" asked my husband Bruce, coming through the door with our dinner.

"That guy, the one I have been calling for two months, the one that found the Earhart artifacts."

Ric Gillespie, "that guy," is the executive director of TIGHAR, The International Group for Historic Aircraft Recovery. He had finally agreed to take me as expedition photographer to Nikumaroro in the Western Pacific Ocean in search of the wreckage of Amelia Earhart's airplane.

I had eight days to get ready.

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