

TIGHAR artifact 2-2-V-1
A report as to the purported fit to Lockheed Electra NR16020

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Introduction and credits -

This report provides the author's own observations and findings which are offered by way of continuation of the work done in Dayton Ohio and that work done in the months following as they relate to the possible provenance of artifact 2-2-V-1 to Amelia Earhart's Lockheed Electra, NR16020.

The author is grateful to TIGHAR and Ric Gillespie for a well-ordered expedition to Dayton Ohio during which much was learned by the author of historic aircraft that served in the theatre near and around Gardner island during WWII. It is appreciated that the artifact was closely studied by all TIGHAR members present, aka 'the commission' whereby supportive details were discovered and shared.

Other TIGHAR efforts are appreciated as formative to this quest. Gillespie, Jeff Glickman and Aris Scarla are appreciated for their work in Wichita to demonstrate the putative fit of artifact 2-2-V-1 to an Electra airframe. The visual measuring tape applied during the photography was instrumental in clearing up real measurements and permitted the author a direct means by which to work beyond the visual perceptions caused by artifact deformities, stand-off from the airplane, etc. While measurements were obtained by the author by scaling photographs, those are not applied except in clearly stated instances; the direct measurements did serve to validate much that the author had gleaned from scaling photographs, however. As all things pursued at length with TIGHAR, much was learned.

TIGHAR is also thanked for providing an excellent library of hard-won material that is freely shared among visitors to the web site. Without that and the inspiration that resource provides, the author would not be engaged here and could not offer his opinions. The author would also be the poorer for lacking an excellent and growing lifetime supply of study material as to the Earhart topic generally.

The author has carefully reviewed the fit issue of 2-2-V-1 as the potential window covering ('patch') and will demonstrate why, in his opinion, a fit concern does exist. In offering his opinion, the author also humbly realizes that working with old photos and trying to discern what was done 77 years ago can be an inexact science, and that exacting results are not always the case. That said, the author believes enough firm evidence exists to support a confident position. That position is his own; the reader must judge for himself.

The Wichita exterior photo including visible metrics ('measuring tape' applied to fuselage) was finally found to be the most reliable and distinct means of determining the actual envelope for a cover fit to the example airplane. The artifact's dimensions are taken from TIGHAR's own data as to those details and were in turn validated by the tape applied in the Wichita photo.

Other concerns such as photo evidence of certain 'patch' characteristics, the printed material on the artifact, etc. are not addressed except under general commentary in closing. The author has confined his technical effort to a clinical analysis of physical footprint and how the artifact would fasten and relate to the installation we see on Earhart's airplane.

Respectfully submitted,

Jeffrey Neville

Lockheed Electra NR16020 navigation window – background –

Among the modifications made to Amelia Earhart's airplane was a large, apparently dedicated navigation window which was cut into the right hand skins and roughly centered between fuselage stations 293 5/8 and 320. Reference: Figures 1 & 2.



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Figure 1

Electra NR16020 with large navigation window in lavatory right-hand skin.

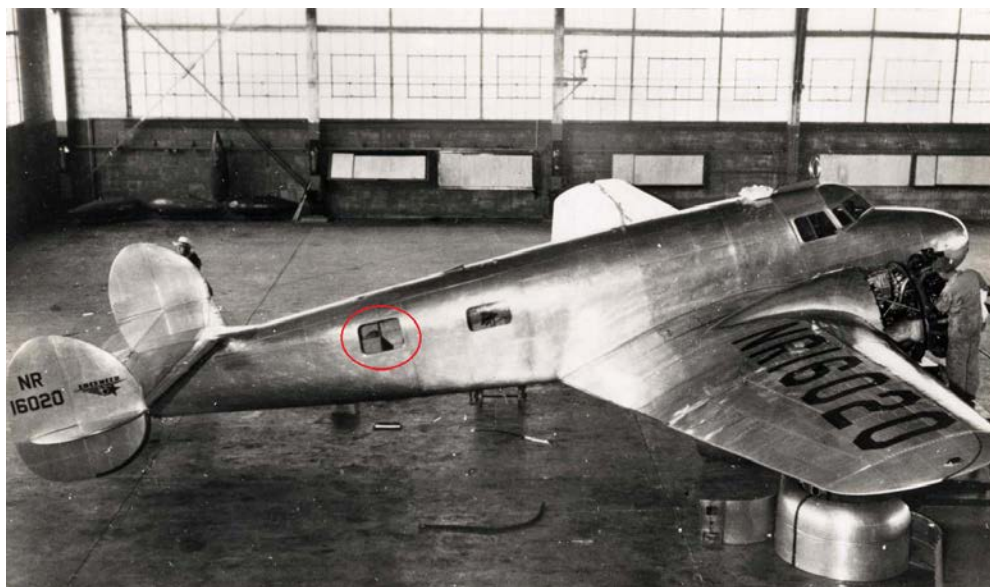


Figure 2

Large Navigation window

Structural arrangement -

The visible structural arrangement for this window includes a prominent outer 'coaming' which finished the cut edge in the skins and may have provided a partial means of transparency retention. The author conjectures that, although narrow in cross section, the coaming itself may have also contributed some degree of reinforcement to the area by way of stiffening and strength in place of the material lost in the window cut-out. This fits with normal sheet metal construction practices as a skin 'doubler'. It is conceded that the thickness and type of material of the coaming is not known. The underlying, pre-existing stock skin was .025" thick alclad.

Structurally, the area of the removed material included two stiffener features:

- The upper - a skin lap with a double row of number 3 rivets (a standard skin lap joint feature) and associated stiffener channel, and
- An intermediate row of fasteners (mid waterline between the upper and lower skin laps in this area) with an associated section of stiffener channel.

Underlying support structure that may have been added to support the window installation is presently unknown. However, two additional rivets may be seen continuing above the coaming at the upper forward edge of same (reference Figure 3). These rivets do not appear on a stock Electra. It therefore appears that some form of internal bracing was added to stabilize the forward skin contour and reinforce the installation. Whether a similar feature was applied at the aft end of the coaming installation arrangement is not known; so far no photograph has proved adequate to show this detail in the author's view.

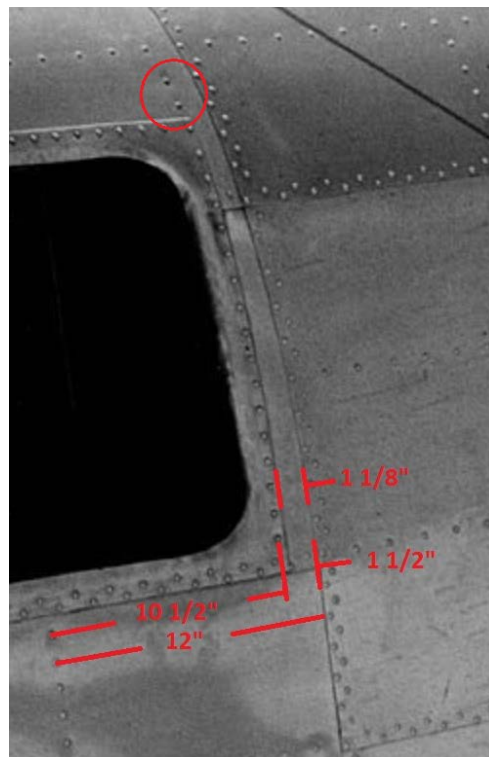


Figure 3

Cropped from Nilla Putnam / Earhart at Miami photo.

Navigation window covering –

After Earhart's failed first attempt to fly around the world, the aircraft was repaired from the Luke Field mishap and eventually flown to Miami, Florida for an early leg of her second attempt. While in Miami and prior to departure to continue that effort, the large navigation window was covered over with metal (reference Figures 4 (Miami take-off) and 5 (in Darwin hangar during world flight)).

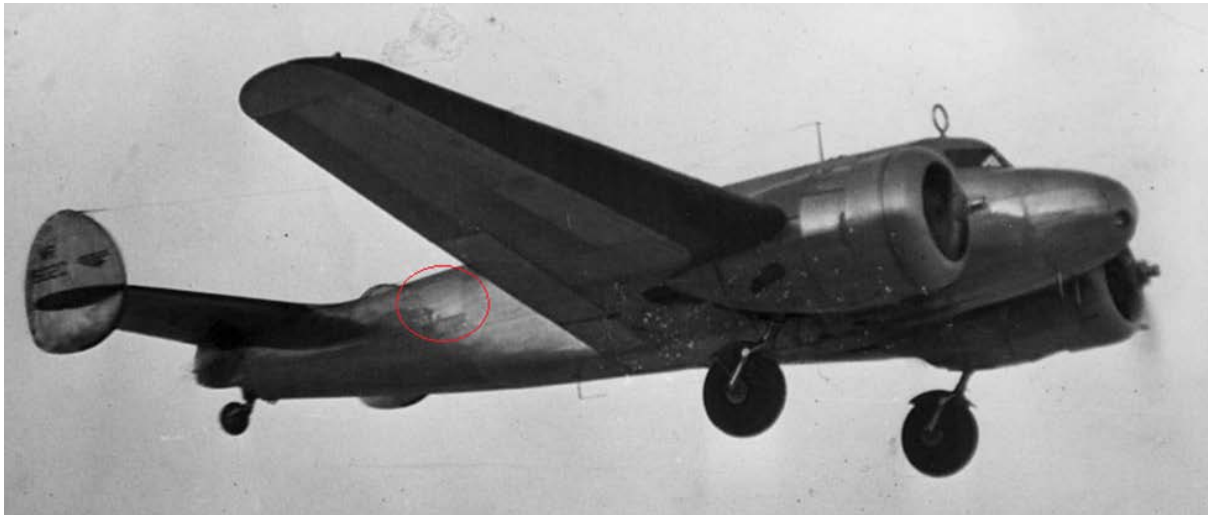


Figure 4
NR16020 on take-off in Miami – Miami Herald / TIGHAR

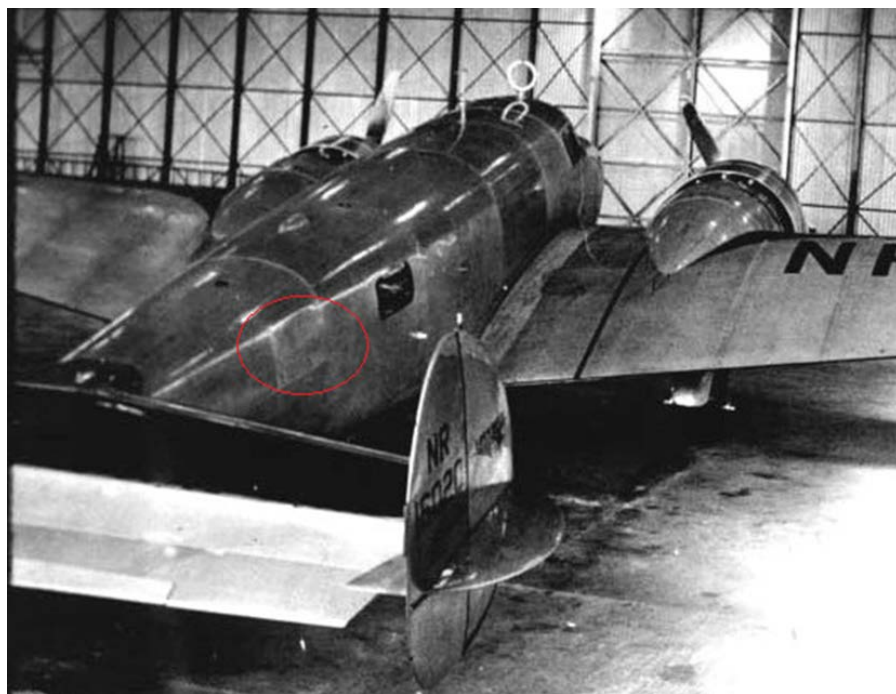


Figure 5
In hangar in Darwin – courtesy Elgen Long (this is not the highest resolution version).

The cover was in the fashion of a 'scab patch' by all the photo evidence seen to-date. It clearly was not a more elaborately fitted 'plug' type hatch or cover, such as may be seen on the Finch Electra in the Museum of Flight in Seattle, WA. Precisely why the window was covered is not known. Speculation has included many thoughts from security and environmental concerns to some structural problem or concern.

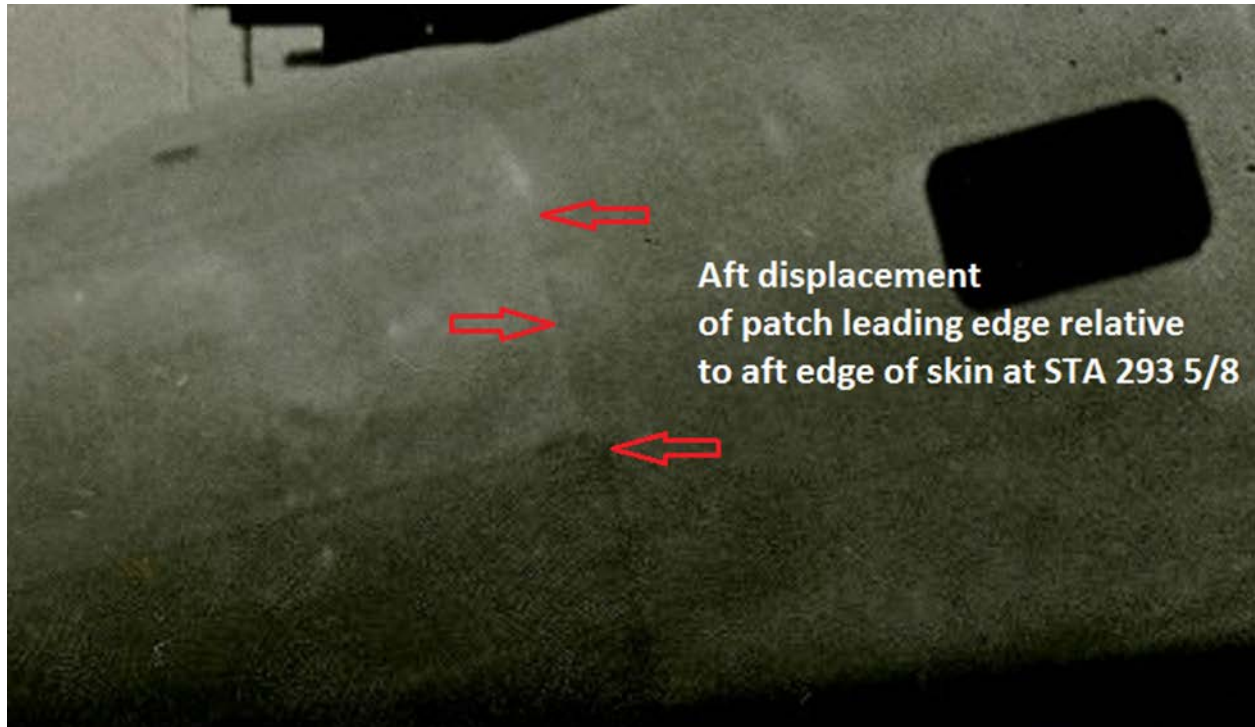


Figure 6

Darwin Ramp - window covering.

Relationship of forward edge to STA 293 5/8 skin edge with offset visibly similar to coaming as in Figure 3.

Investigative work with TIGHAR –

Artifact 2-2-V-1 is a roughly 24 5/8" wide by 18 1/2" high .032" thick sheet of weathered and mechanically distorted aircraft Alclad (reference Figure 7). It bears four rows of neatly spaced number 3 sized rivet holes (pitch equaling 1" apart – verified by Aris Scarla in Dayton, Ohio). These straight rows are themselves somewhat more irregularly spaced from each other with some convergence and divergence apparent in the aggregate arrangement, and spacing varies by some fractions of an inch around +/- 4" apart. The artifact bears evidence of fire or heat exposure and is considerably deformed.



Figure 7
Artifact laid flat, compliments TIGHAR.

How much deformation may have been caused by an event involving the host airplane or from events following the artifact's separation is not clear. The edges bear evidence of various failure modes including fatigue and possibly mechanical intervention (cutting by hand).

An interesting and compelling artifact –

2-2-V-1 has been in TIGHAR's inventory of articles recovered from Nikumaroro since found by Pat Thrasher in 1992. It has now been studied for a potential fit to the Earhart Electra in possibly all conceivable areas of the airframe.

Nothing excites the typical Earhart researcher more than a piece of metal that holds even a remote promise of attachment to aviation's most famous lost airplane. Despite years of effort, no positive fit has been established to-date in 'stock' (as factory built) areas. A potential fit to other airframes common to the islands around Niku has also been investigated in an attempt to determine if the pattern of fasteners, etc. would point to another source. No match has been found to-date despite this effort, which included a well-organized detailed tour of subject airplanes in Dayton Ohio.

Virtually all types known to have been present in the Gardner island area during WWII have been studied to the degree possible in publications or in a museum environment. The author was privileged to be present and was allowed access to exhibits on the museum floor and the back shops at the National Museum of the United States Air Force. It is acknowledged that we were not able to access all interior areas or upper surfaces beyond our reach from the floor. It is also acknowledged that this review is not likely to ever be completely exhaustive of all possibilities.

The author first had the opportunity to study 2-2-V-1 in person in Washington D.C. at the TIGHAR Earhart Symposium in June, 2012. There the author also first learned of the window covering that had been installed in Miami. Realizing other areas were not promising, the Miami mod became a point of intrigue for the author. Ric Gillespie took up the challenge of a navigation window covering as a possible fit in early 2014. The author, Ric and others offered a great deal of thought as to what suggested a potential fit (a matter of record in the TIGHAR forum) –

- The layout of fasteners, while in neat rows, is suggestive of 'field effort' – to the author because of the irregular spacing between rows;
- The general size suggested what one would expect for the covering;
- The thickness is 'right' - .032" is 'one size up' from the .025" stock skins of the Electra in that area, a standard practice for a repair such as this.

Considerations –

Metrics –

In the author's opinion, the metrics (measurements) challenge has come to raise serious questions about how 2-2-V-1 could fit the Electra were it indeed the artifact. This was first undertaken as a study in response to web-based criticism of the part with a notion of rebuttal.

Several methods were applied before arriving at a final analysis. Photo scaling is helpful but limited as it has limited efficacy due to distortion and quality of surviving images in some cases. Eventually, direct measurements were extracted from the Wichita photos and applied in all but the case of scaling that was used on the 'Nilla-Earhart' photo made in Miami to determine rivet row offset in the coaming. Direct measurement of 'landmarks' on the Wichita photo was used to validate similar distances on the Miami coaming photo (Figure 3).

Interpretation of lesser quality photos such as the 'Darwin ramp' photo were not applied except where clearly discernable validating features could be effectively applied – such as demonstrating the window cover's forward edge placement as similar to that of the window coaming edge (Figure 6).

Technical investigation -

Three dimensional concerns will be addressed:

- Whether the 'STA 307 vertical brace' feature is valid to a fit on the Lockheed Electra, and
- Whether the artifact 2-2-V-1 is of an appropriate size (width, considering fracture failures) to be the remnant of the window cover installed on Earhart's Electra in Miami, and
- Whether the artifact bears evidence of edge fastener installations ("rivet holes") along fractures or within the extreme boundaries that should remain if the remnant is of a sufficient size to overlap the attaching rivet lines on the airframe

'Remnant' applies because of the character of the surviving edges of the artifact:

The artifact was clearly separated from a larger piece of metal, evident because of the fracture damage to all four edges, plus an absence of near-edge rivet holes along three edges. The surviving near / at edge rivet holes are along what is typically oriented as the 'lower' edge of the 'patch', and may relate to a double staggered row, such as can be seen along the lower edge of Earhart's navigator's window at the skin lap at that location. The author recognizes challenges as to matching these #5 rivet holes in the artifact to what would normally be a neat double-staggered row of #3 rivets at this skin lap but does not address that in technical detail here.

Validating measurements:

The author used direct measurements obtained from TIGHAR's application of metric tape to the fuselage and artifact in Wichita. This eliminates potential error from less direct photo-scaling efforts done by way of grainy historic photos and the like.

The 'Nilla-Amelia' picture taken in Miami (Figure 3) does contain visible and reasonably scalable detail as to the placement of the window coaming forward edge and rivet line.

The Darwin ramp photo (Figure 6) is valuable for visually validating the offset of the cover from STA 293 5/8 as similar to that of the coaming forward edge offset. This was done and applied for the study. The assumption is that the forward edge of the cover in Figure 6 is coincident to the placement of the forward edge of the coaming in Figure 3.

It was also assumed, for liberal interpretation, that the aft edge of the cover was attached by use of the rivet holes in STA 320. The author does not believe this was the actual case as he believes the 'Darwin ramp photo' provides enough definition to establish clear boundaries for the covering, and some separation from the rivet line at STA 320. This is because that rivet line can be discerned and reasonably validated by measurement. It is seen to be clear of the covering, in the author's opinion. However, that observation is not asserted as a basis here because of interpretative challenges that are understandably raised as to expertise in photogrammetry and the limits of grainy photos. The more liberal (favorable) case of utilizing the STA 320 rivet line is therefore adopted for the purposes of this study.

STA 307 feature / coincident vertical stiffener examination:

During a study of the artifact, TIGHAR had noted a tell-tale 'vertical brace' footprint at what appeared to relate to 'STA 307' on the artifact. This was discovered by Ric Gillespie and Jeff Glickman (reference Figure 9) during hyperspectral imagery efforts conducted at TIGHAR headquarters.



Figure 8

Evidence of a 'crossing member', i.e. a vertical member 'footprint' as outlined between red arrows; TIGHAR suggested this may coincide with the formerly removed member at STA 307, perhaps partly restored during the window covering effort. Red arrows by TIGHAR. Photo: TIGHAR.

The Wichita photo and match of the STA 307 feature (Figure 9) was impressive when published as the odds of finding a 'matching' STA 307 vertical frame footprint seemed remarkably small. This is considered because it was demonstrated as supportive fit in the Wichita effort: if valid, it would lend weight to the possibility of artifact provenance to Earhart's airplane.

During the Wichita effort, Gillespie held the artifact as near to the fuselage of the Wichita Electra as possible (limited by contours) such that a 'tear' at the 'STA 307 line' was aligned with that station's rivet line on the airplane (reference Figure 9, upper center area of artifact as marked). This provided an excellent visual check for fit of that recently realized feature. It might have also supportive as to fit on the host ship by providing an additional datum point by which to validate alignment.

For the alignment of the STA 307 feature to support a fit of the artifact, the forward edge and related forward vertical fastener row on the covering (same as on coaming is assumed) should also be considered. Recall that the rivet line at the forward edge of the coaming (see Figure 3) – and therefore covering (see Figure 6), lay aft of the skin edge near STA 293 5/8 by an approximate 1 ½” offset, as scaled at the bottom of the covering (reference Figure 3).

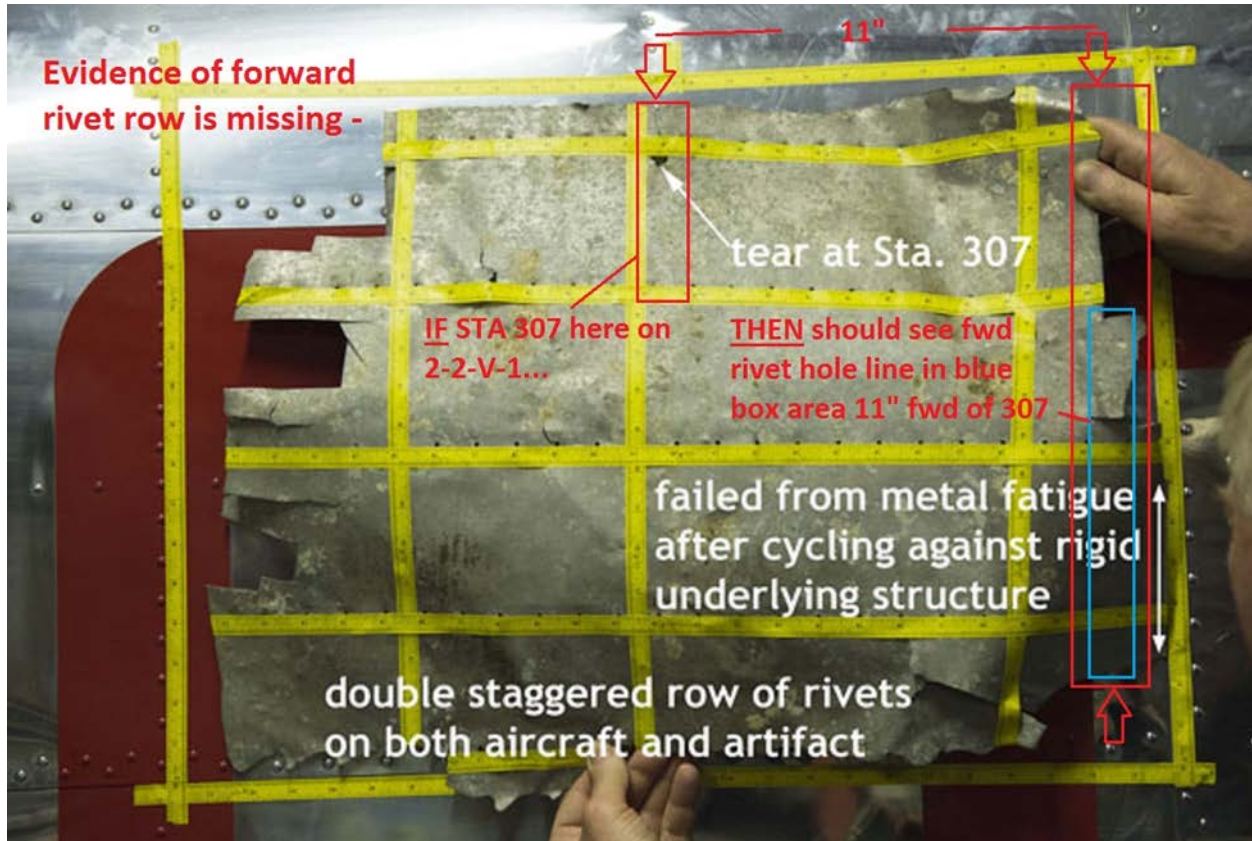


Figure 9

TIGHAR photo – Wichita Electra metrics study

White writing by TIGHAR, red writing and markings, and blue markings by J. Neville;
Scaling taken directly from TIGHAR’s applied measurements (yellow tapes).

The placement of the forward edge of the artifact therefore would have to approximate that of a ‘remnant edge’ at a location that is consistent with having been broken away short of the attachment point. What we see instead is that the artifact’s failed forward edge is at or near the skin edge at STA 293 5/8 (see Figure 10).

The artifact overruns the expected attach point by approximately 1 ½”. Further considered, with the STA 307 features aligned at that station on the airplane and reconsidering the overrun, we can see no evidence of the rivet holes that would be expected in that forward attachment zone (within blue box, Figure 10). This means the alignment of the failure edge station and that of the STA 307 feature are not in agreement with a fit on the airplane. Also, as can be derived from Figures 3 and 6, we can see that the cover did not extend so far forward as to impinge on the skin edge at STA 293 5/8.

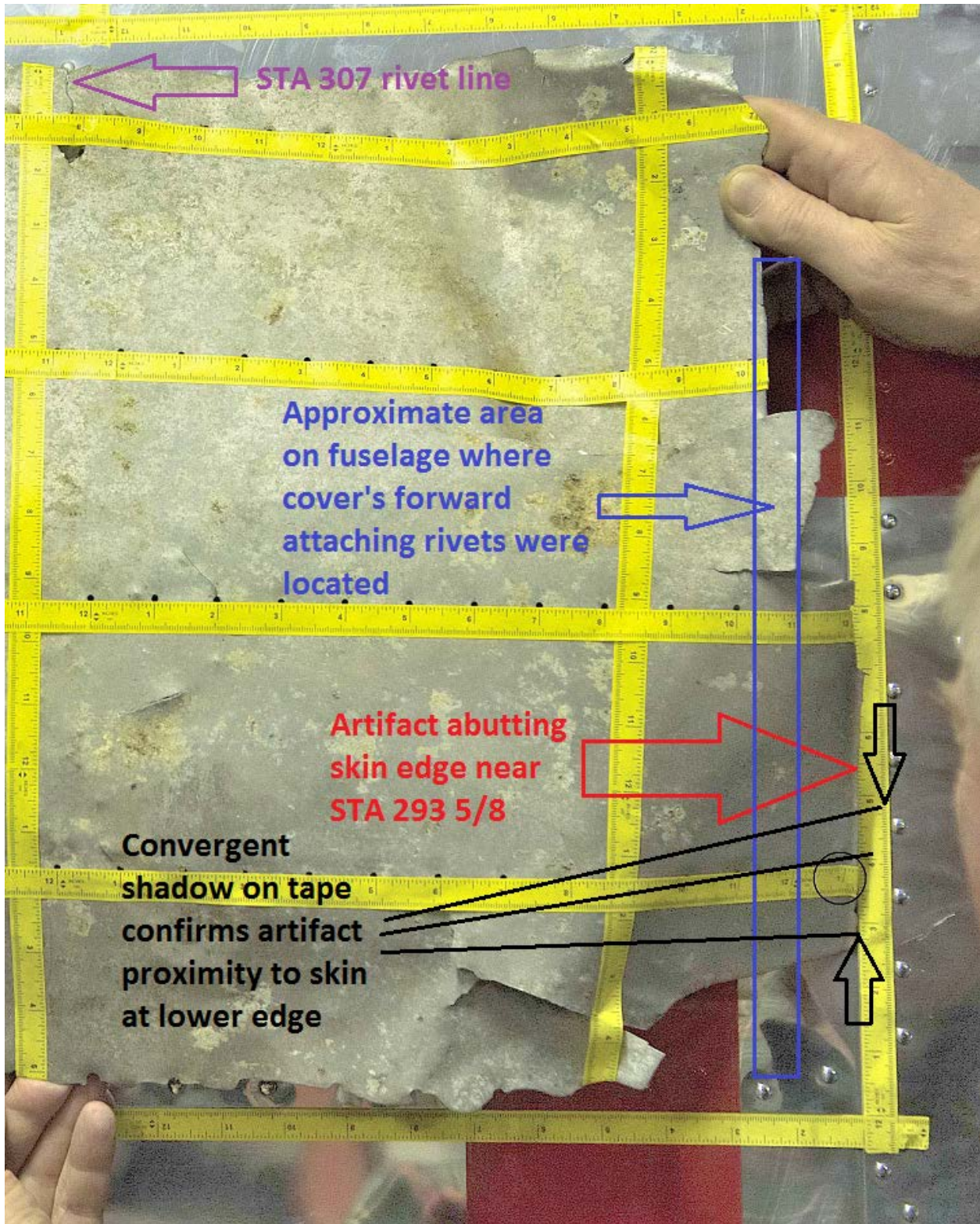


Figure 10
2-2-V-1 extreme forward edge abutting skin edge near STA 293 5/8

Conclusion as to the STA 307 'vertical brace' feature:

The STA 307 brace feature cannot align with that corresponding station on the airplane unless the forward edge of the artifact is placed approximately 1 ½" too far forward. This is a disqualifying fit issue for the STA 307 'vertical brace' feature on 2-2-V-1. The STA 307 vertical member trace is irrelevant to the STA 307 vertical bracing on the Lockheed Electra.

Artifact size (width):

The artifact –

The overall forward and aft fit possibilities were next explored, ignoring the disqualified STA 307 feature.

The artifact itself was considered as to width. According to direct measurement by use of TIGHAR's Wichita exterior photo, the artifact is approximately 24 5/8" wide at its extreme width (see breakout of TIGHAR's Wichita photo with contour-adhering measuring tape in Figure 11).

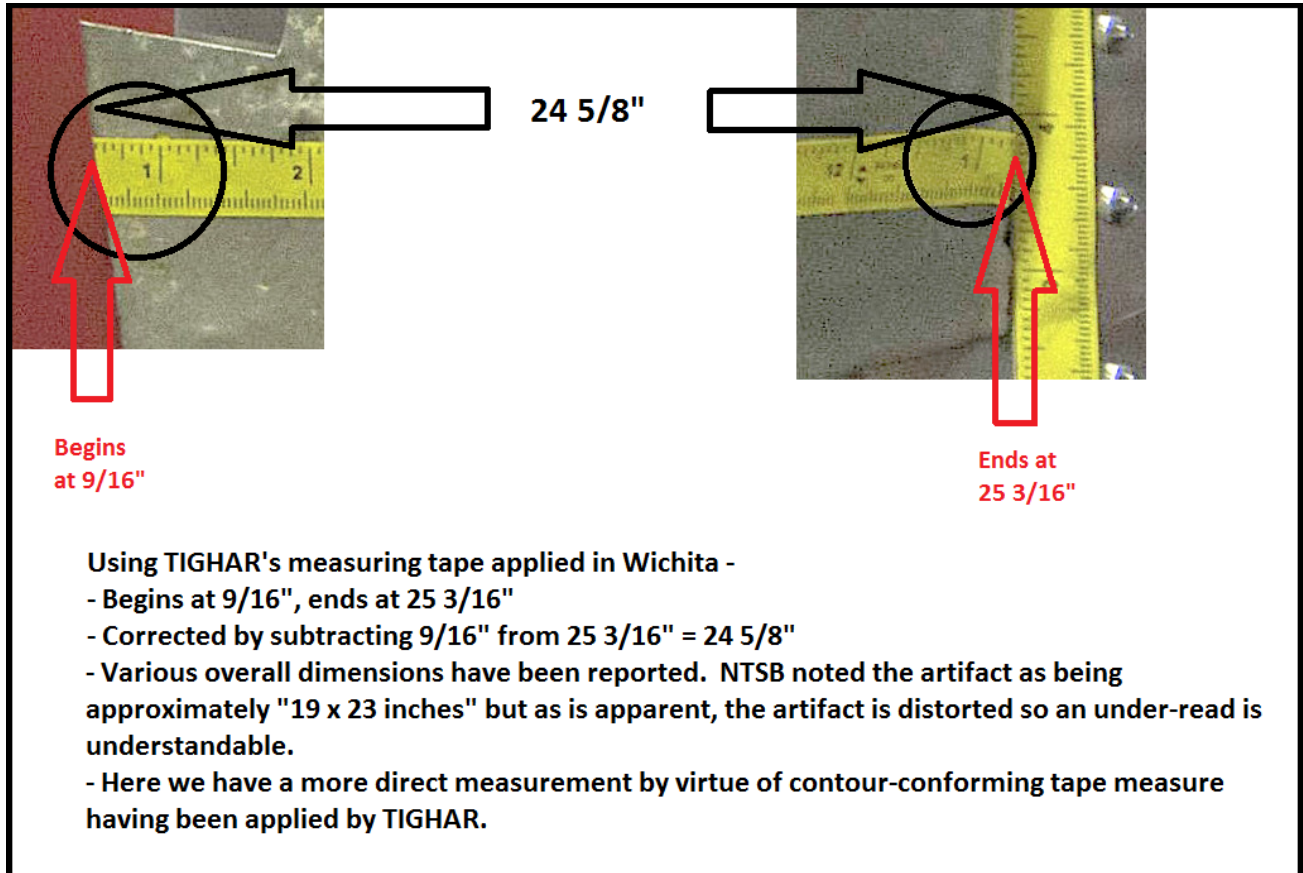


Figure 11

Extreme edges of 2-2-V-1 as measured by applied tape in Wichita. Photo: TIGHAR

Consider that to qualify at the Earhart relic, the artifact would have to fit an 'envelope' defined as a zone lying between the vertical fastener rows along the forward and aft edges of the covering. These rivet lines must be spaced apart, fore and aft, at a greater width than that of the artifact. This is because the fracture failure edges should have left an attachment zone behind when the part was removed from the host airplane. This is because the artifact must be considered as a 'remnant' since it lacks attachment evidence on three sides.

The aft (LH) edge has a tapered edge and therefore not so much surviving margin. Conversely, the forward (RH) edge has a reasonable surviving margin of several inches, vertically. It is a well-defined

fracture which TIGHAR has noted as having failed from repeated bending (cyclic fatigue), possible against a hard edge.

The envelope –

To determine if the artifact could fit and not have surviving rivet holes in the left and right margins, the ‘envelope’ was next determined: the actual distance between the STA 320 rivet row and the zone 1 ½” aft of the skin edge at 293 5/8 where the forward attachment rivet row lay. This is a critical attribute in terms of whether the artifact could rationally fit the Electra (See Figure 12).

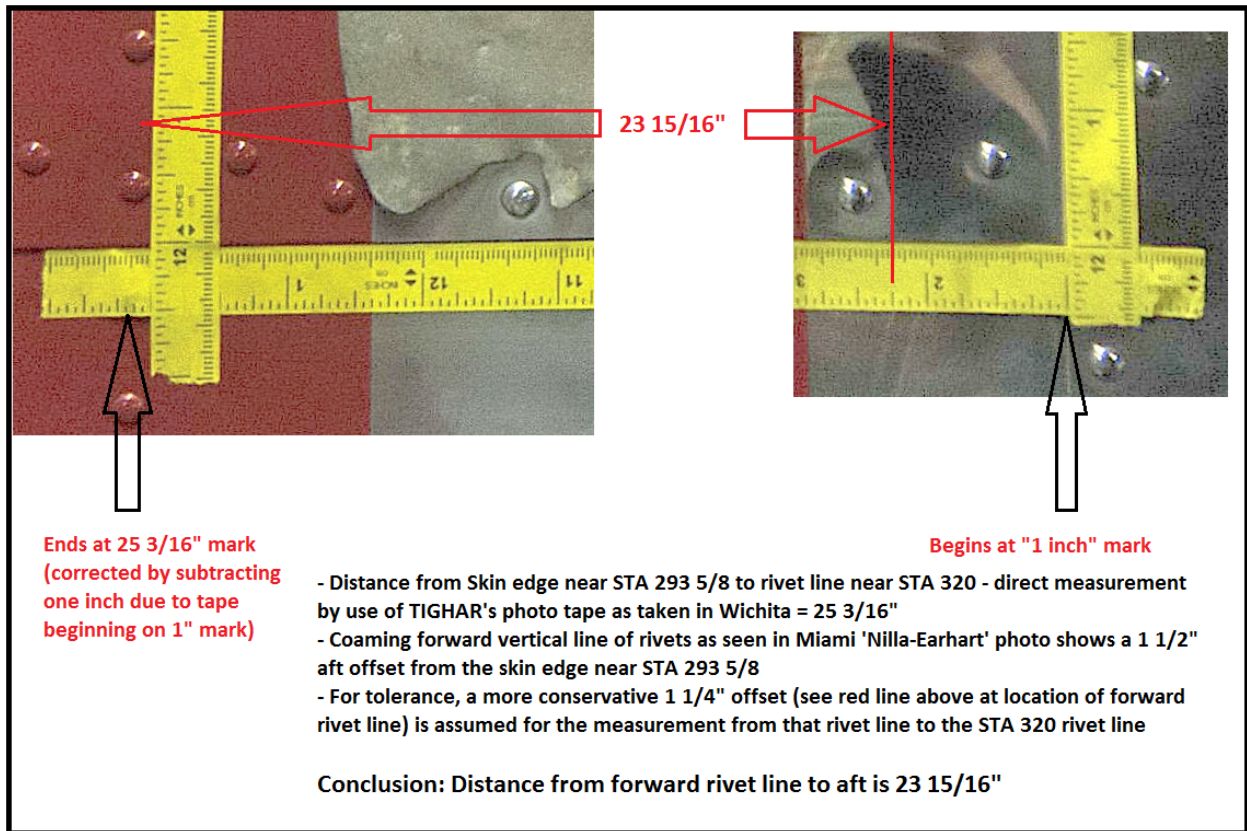


Figure 12

Distance from STA 320 rivet row to forward window cover attachment row as measured by TIGHAR photo with measuring tape applied in Wichita. Images excerpted from TIGHAR photo.

Note:

The author believes the cover did not reach the rivet line at STA 320 as is thought to be observable in the Darwin ramp photo (reference Figure 13). However, for purposes of this review, that belief is ignored in favor of the more liberal assumption of the covering having picked-up the existing row of rivets at STA 320. This creates a wider envelope by which the artifact might be accepted and negates concerns over photo interpretation.

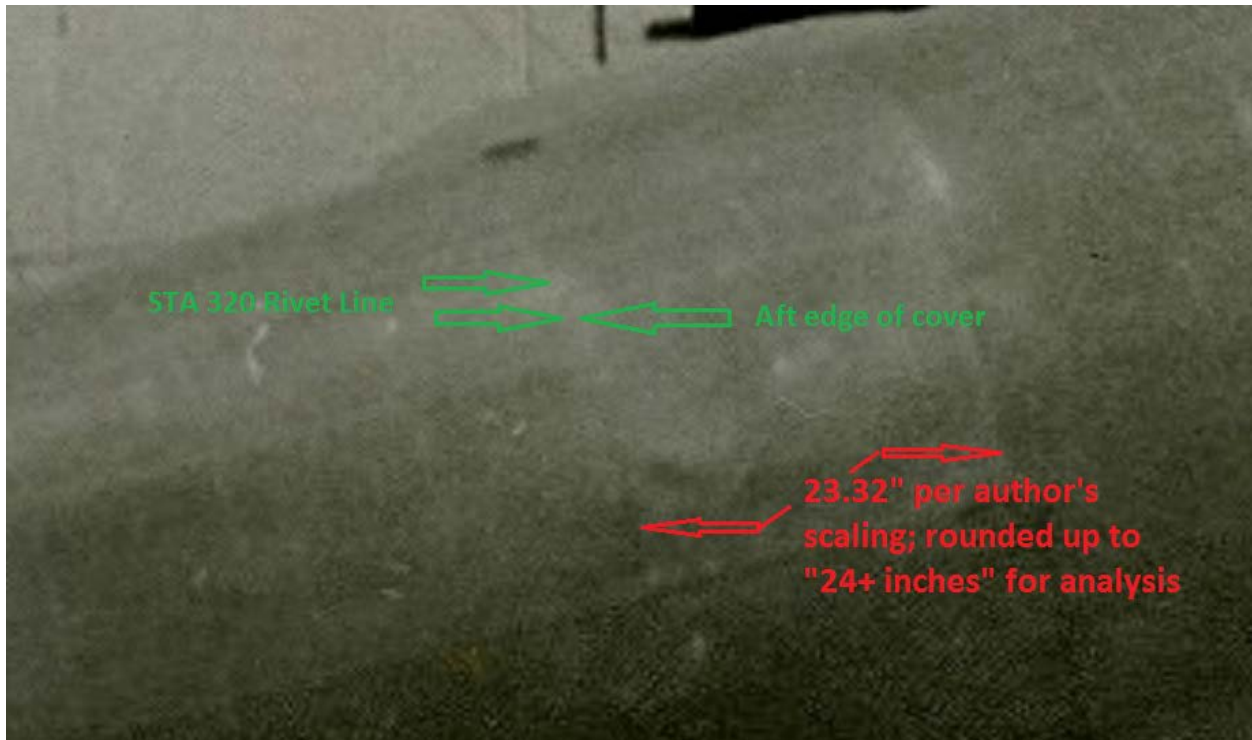


Figure 13
 STA 320 offset from aft edge of Window Cover

The distance between the STA 320 rivet row and the skin aft edge near STA 293 5/8 is slightly less near the top of the artifact (as measured by TIGHAR's applied tape on fuselage). Therefore the wider measurement at the bottom was used to provide a more liberal envelope to allow an artifact fit.

As can be seen in Figure 12, the distance from the aft edge of skin at STA 293 5/8 to the rivet row at STA 320 is 25 3/16". As observed in Figure 3, the forward vertical rivet row in the coaming was offset from the skin edge near 293 5/8 by approximately 1 1/2", and the covering forward row is assumed to have the same offset since there is indication of that in the Darwin ramp photo (Figure 6) and no contrary indication. To provide some liberal tolerance, 1 1/4" was applied in this case (see again Figure 12) – also allowing a wider tolerance for fit of 2-2-V-1.

This method yields a measured distance between vertical rivet rows on the window covering of 23 15/16". See Figure 14 for a comparison. In doing so, please note that scale is not reliable - artifact distortion renders visual comparisons moot; the artifact appears shorter than the true measurement due to significant bending. The dimension was derived from a study of the contour-adhering tape measure per Figure 11.

Given the envelope size of 23 15/16" and the artifact's width of 24 5/8" as established, an artifact overhang margin of some 11/16" of an inch can be seen to exist.

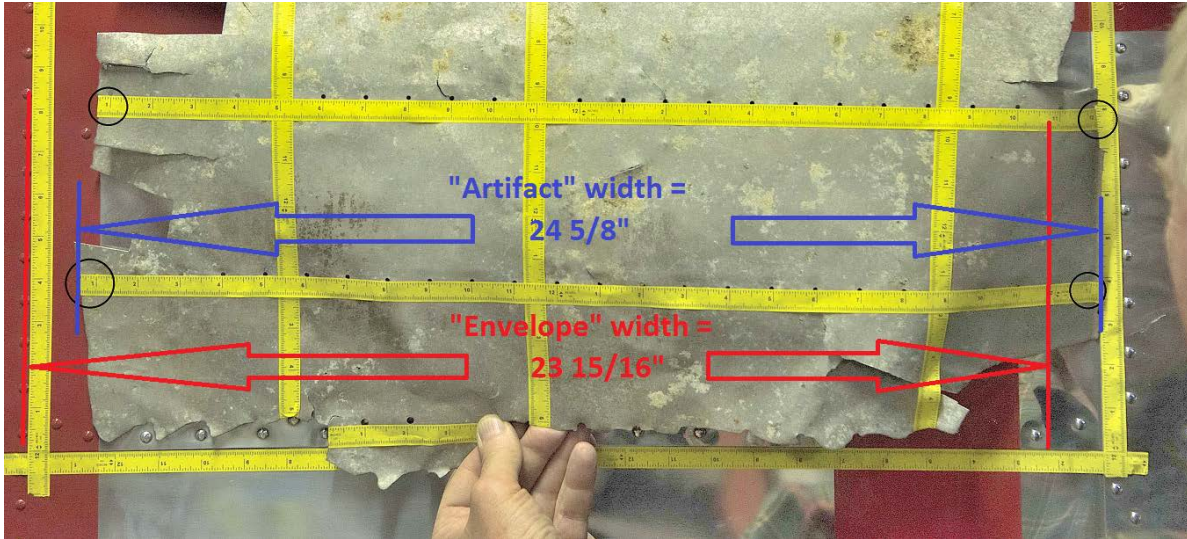


Figure 14

Artifact width vs. Envelope width: 2-2-V-1 is wider than the distance between the two vertical rivet rows where the window covering attached. Note that the artifact visually appears narrower than its actual width due to bending.

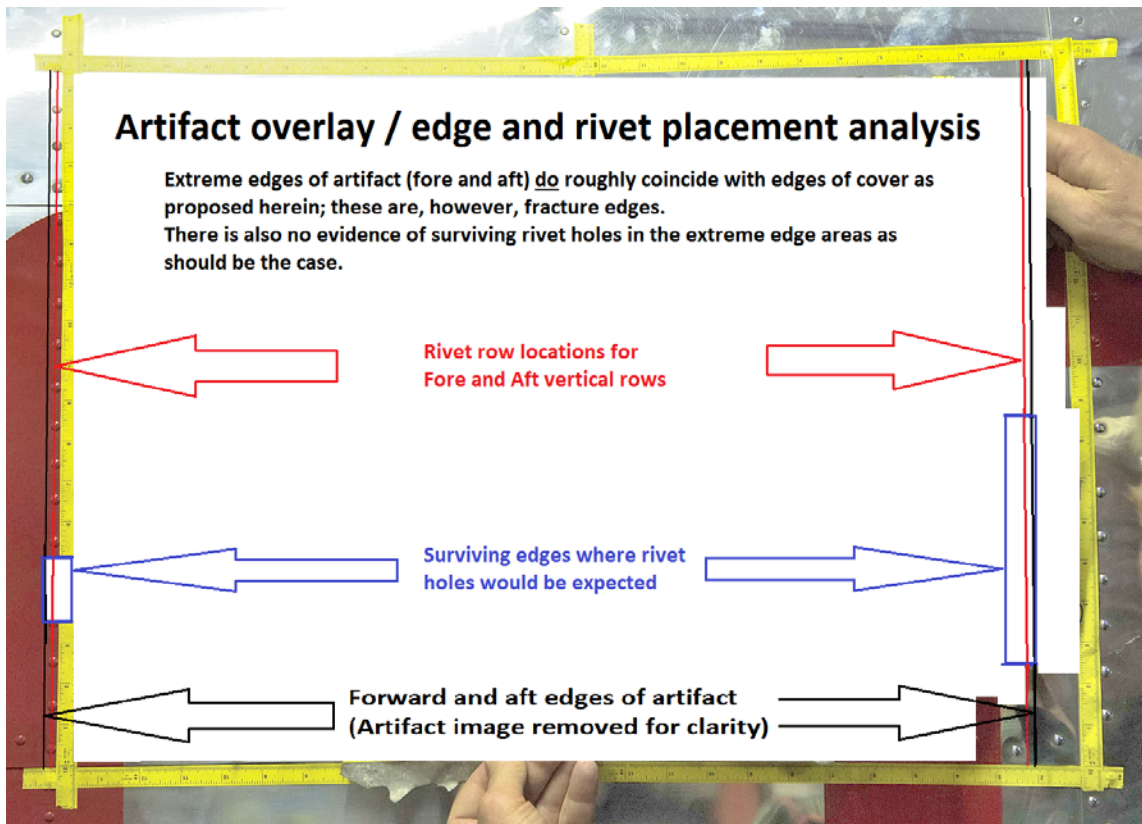


Figure 15

Artifact overlay

Artifact image removed for clarity; black lines represent extreme edges of artifact as measured.

Recap - critical assumptions and attributes:

- Fuselage measurements along the lower edge of the window location were applied since they are slightly wider than those between the rivet line at STA 320 and skin edge near STA 293 5/8 at the upper window area; this provided a more liberal margin for the artifact's footprint
- A more liberal assumption as to aft rivet row placement in the window covering was adopted – that of using the STA 320 rivet line; this provided a more ample envelope to accommodate the width of 2-2-V-1 in this effort
- A 1 ½" forward rivet line aft-offset can be seen in Figure 3; a more liberal interpretation was applied by reducing the offset to 1 ¼" inches to allow for tolerances and provide a more liberal footprint for 2-2-V-1
- Because 2-2-V-1 is misshapen, the contour-adhering measuring tape was used as a direct means of observing the width of the artifact; this negates optical illusions created by the misshapen part and offset from the surface of the airplane
- The efficacy of the surface-applied tape measure was validated by observing correlating distances between the many evenly-spaced #3 rivet holes in the artifact; this hole spacing was reliably established to be one inch apart in Dayton by Aris Scarla and provided an excellent means of ensuring that the tape was reliable

These assumptions were adopted to provide the most liberal tolerance reasonably possible. The author is intimately familiar with aircraft construction by long professional experience and believes these allowances would easily account for any variances between the Earhart Electra and the host airplane in Wichita. Further, they err to negate any concern with 'photo analysis': the two lone examples depended on here being –

- The 'Nilla-Earhart' photo for scaling the coaming forward rivet row offset (Figure 3), and
- The Darwin ramp photo (Figure 6) to validate the window cover's forward edge as visibly coincident to the forward edge of the coaming (again, Figure 3).

The artifact is 24 5/8" wide as measured with some 6" of vertical surviving margin at the RH extreme (see Figure 15, blue box at RH side). The envelope (distance between fore and aft vertical rivet lines for covering attachment) is 23 15/16" wide as measured (red lines in Figure 15), considering the more liberal 1 ¼" aft offset from the skin edge near STA 293 5/8 than is observed in Figure 3.

Were 2-2-V-1 the window covering remnant at 24 5/8" wide, and given a vertical rivet row spacing of 23 15/16" apart (fore and aft), the artifact overshadows the envelope by 11/32" in the fore and aft directions (see red and black lines in Figure 15). The artifact therefore exhibits ample material for a rivet edge distance at the forward and aft rows (11/32" divided equally) of 11/64" per side (as represented by the separation of the red and black lines, Figure 15).

Considering that we see #3 (3/32") rivets in the coaming forward vertical row (Figure 3), we may consider a normal edge distance of 2 ½ diameters to apply (observable in Figure 3 herein and true by the airworthiness guidance of Earhart's day and still so, reference AC 43.13). That would equal 2.5 x .094" = .235", or approximately 5/16" (again, as represented by the red and black lines, Figure 15).

Conclusion as to width and fit of the artifact:

At its extreme width, the artifact could fit as the covering with a reasonable degree of excessive edge distance as to the left and right vertical rivet rows. However, this must be discounted because there is a lack of finished edges which should be evident at this full-width article at least at the forward (RH) edge (see RH blue box, Figure 15). Instead we see a fracture zone.

This is disqualifying in the author's opinion: given the fracture boundaries and considering its full width – which might otherwise coincide handily with the actual covering width, the artifact is physically too wide to be Earhart's Navigation Window Covering. Any edges surviving at the extremes should be finished edges.

Consideration of no surviving forward / aft edge rivet holes –

As considered so far - and excepting for the fracture boundaries, the artifact 2-2-V-1 is remarkably close to the width that would be expected for a fit to the liberally-interpreted (on the side of permissiveness) vertical rivet rows at STA 320 and forward edge of the cover. Considered next then - ignoring the fracture boundary issue, is evidence (or absence of same) of the attaching rivets that should appear at the forward or aft edge of the artifact as established in Figures 3, 6, 15 and 16.

Given that the aft edge has less margin area – being trimmed to more of a point, the odds of finding rivet hole evidence in that area are notably slimmer. However, the forward extreme edge bears a straight fracture edge that is approximately 6” high. Discounting the more pointed aft (LH) edge, ignoring the fracture edge at the forward (RH) end and considering that at 24 5/8” wide the artifact would be ‘full width’, i.e. ‘undamaged width’, there should be observable evidence of rivet holes well within the forward edge area (reference Figure 15). None is observed.

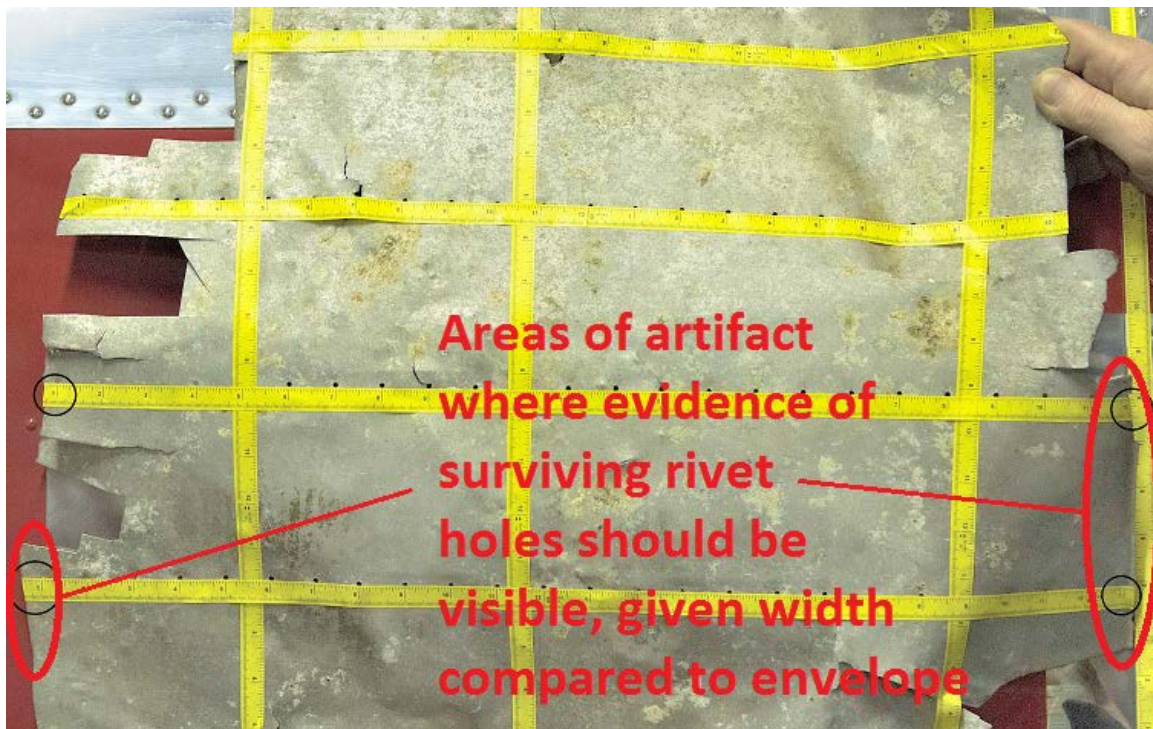


Figure 16

Most probable areas for surviving rivet holes as remnants from forward and aft edge attachment were 2-2-V-1 the navigator’s window covering.

Conclusion as to absence of forward or aft rivet holes in the artifact:

As established, ample margins exist such that surviving rivet holes should be visible in or near the extreme lateral margins of the artifact, were it a remnant of the navigation window covering for NR16020. Given the liberal tolerances applied in the analysis and resulting adequacy of margins for surviving rivet holes and the absence of same, the artifact does not bear evidence of attachment to the Earhart Electra in the Navigation Window area. The author considers this disqualifying.

Other challenges –

Not formally addressed here, the author provides some thoughts after much perusal of these issues.

The ‘tab’ at the lower edge of 2-2-V-1 –

This remains a puzzle to the author and is literally a stick-out that is not yet accounted for in the effort to fit this article to the Electra. It distinctly interrupts the neat double-staggered skin lap row we can observe at the lower edge of Earhart’s window – and know to be from all we can see on a stock Electra today.

It also lends troublesome height to the artifact. None of the photo evidence provides an answering clue to this anomaly in the author’s amateur opinion; the author has confidence, however, that sufficient resolution is present in a number of photos that such a ‘stick-out’ should likely be noticeable in some form, even to the novice viewer. This may be especially true with any over-sized rivets present - as would be the case per the presence of #5 rivet holes as are seen on 2-2-V-1.

It has been supposed that this ‘tab’ feature might relate to some mishap during the window covering that required over-drilling the #3 holes and picking up some added member. However, as a construct to support the window covering idea without more evidence, that is a stretch in the author’s opinion.

While the match in rivet pitch is striking, the oversized “#5 rivet” holes along the bottom row are also out of place: the originals were mere #3 rivets – what could cause so many to have been upsized by two gauges? This is not an advisable practice and installing so many larger rivets in such light structure could actually induce skin fatigue issues, in the author’s view. Perhaps a beefier member was installed to back the structure? Possible – but the author does not sense the purpose; it is not clear that this cover was installed out of a fear of weakened structure per se. While supportive constructs have been offered, the author believes these may be over-extended given all that can now be observed as to 2-2-V-1’s fit.

While it is easily suggested, it is also not entirely clear that the adjoining row in the ‘double staggered arrangement’ was fully present on the artifact, so the author believes it is difficult to establish a good fit.

The printed material – as to fonts –

The more modern appearing character fonts on 2-2-V-1 remain an unknown, but the evidence seen to-date suggests they are of an era later than Earhart’s, however unproven that may remain. By perusal, one must admit no single example of this font has been found in photographic evidence from Earhart’s time, although many examples of similar slant sans serif characters do appear in the years following her disappearance. It is a doubt.

The author concedes that many features on 2-2-V-1 may remain in the ‘perusal’ category for some time unless some intrepid researcher finds more concrete answers. The author is pessimistic as to the need, however, in terms of demonstrating provenance to Earhart, given the thorough vetting that 2-2-V-1 has by now received: virtually the entire Electra airframe has been considered; the lavatory navigation window appears to be the remaining possibility, and the author concedes by this report that no optimism remains on his part.

Features for perusal include considering in aggregate that the tab, so many oversized rivets, the oversized nature of the artifact as demonstrated above, the odd placement (relative to the host structure) of whatever might have gone behind all those mid-field rivet rows are all structural stickouts for the Electra

that are not easily answered. I make no conclusions as to these things; I merely acknowledge them as perusable issues that are not particularly supportive. The forum already contains excellent material with regard to most.

Summary conclusion:

The STA 307 reinforcement feature is not compatible with artifact alignment on the Electra.

The artifact is too wide to be the true navigation window covering on the Electra given fracture failure evidence in the extreme widths where a finished edge would have to appear to support provenance. There is no evidence that the covering was larger than has been liberally supposed here among the assumptions and liberal tolerances applied.

Further, that no evidence of forward or aft edge attaching rivet holes survives in the extreme LH and RH margins is disqualifying given the full width of the article. There is a substantial area of probability for these holes to appear in the zone that is approximately 6" in height at the forward or RH extreme but none appear.

It is recognized that by casual study, the dimensions applied here may appear to enjoy unnecessary fine limits and thereby perhaps be too tight to be useful in this analysis. The author therefore invites the reader to pay close attention to the liberal allowances that were applied throughout this effort to provide the greatest opportunity for a successful fit in terms of adopting the STA 320 rivet line as a boundary and an additional ¼" allowance for the forward vertical rivet line, etc. Further, note that dependence on scaling of photographs was kept to a minimum, and then only applied where clear photos could be validated by direct measurement comparisons to the Wichita picture – which has integral surface measurements applied.

Construction tolerances in this type of structure are also tight enough for confidence – despite the temptation to ascribe errors in build as possibly large. The norm for error between a given set of factory-built 'landmarks' on Earhart's Electra and what we see on the Wichita Electra would be closer to +/- .030" for this type of sheet metal work. This is necessary so as to assure repeatability and conformity to design and was as true in Earhart's day as it remains today. Toward this consideration, recall the extremely consistent 1" spacing that was witnessed as Aris Scarla so carefully inspected 2-2-V-1 with scaled dividers in the Dayton shop: precision is the norm in sheet metal, not the exception.

Other considerations, such as the more modern font appearing as metal identifiers that do not match the known examples of such print from Earhart's time (non-slant, serif), but similar to later examples (slant, sans-serif), and vertical fit questions including the 'tab' (not substantiated here) lend negatives.

The 'tab' feature at the lower edge is a negative by way of perusal of the artifact generally – we see no suggestion of such feature in any of the photos although it clearly adds 'height' – or should protrude downward below the lower normal edge. In any case, the oversized fasteners there (ostensibly x2 rows at #5 sized rivets) could be expected to add some visual prominence that might be detected.

The author has participated in brain-storming many possible explanations to be explored as to these things. Now it appears that the positive constructs that must be developed to support why these things are now drifts beyond the known – and perhaps knowable. For instance, evidence of metal markings in

Earhart's time (fonts) and as to the norm for the Electra's structure (tab, oversized rivets) simply have no found historic basis, to date. They remain stubbornly unsubstantiated.

The volume and magnitude of the constructive explanations that have emerged therefore lack substantial basis, in the author's estimation. In any case, those arguments now appear to be outweighed by careful analysis of direct measurements derived from TIGHAR's own data.

The author's background –

36 years as an FAA Airframe & Powerplant mechanic, with Inspection Authorization ("IA", now inactive) and 20 years in engineering with a major U.S. airframer. The author is a past certified American Society for Quality certified mechanical inspector (including precision measurement) and auditor (no longer an active member). A&P training was attained at South Georgia Technical college in Americus, Georgia, 1978. Bachelor of Professional Aeronautics was attained at Embry-Riddle Aeronautical University in 1988.

Mechanical / structural experience includes 25+ years of hands-on structural work on small and large transport airplanes and helicopters entailing many large scale and complex repairs, modifications and field recoveries as a mechanic and inspector. This was accomplished as an employee of a local FBO and at a major airframer, and as an independent entrepreneur.

Engineering experience includes continued operational safety (COS) oversight and certification of large transport airplanes. Much of the COS history included intense focus on structural issues which was a natural outgrowth of earlier mechanical and inspection experience. The certification focus involves liaison with all technical disciplines for the development of certification positions and presentations on complex new product and existing fleet modifications with a focus on gaining approvals and validations from domestic and foreign airworthiness authorities. The author is not a design engineer but works as a generalist among all disciplines.