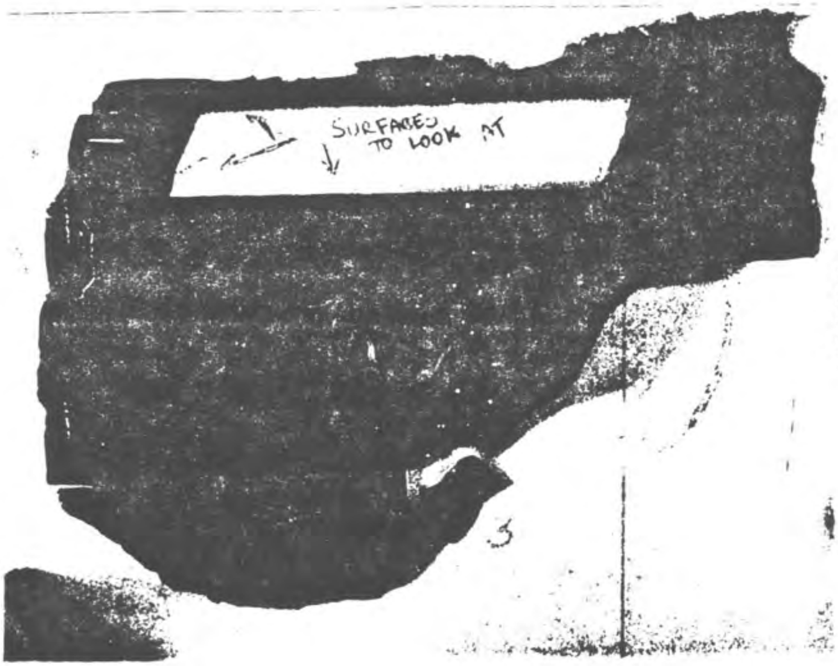


Photo 3
Specified fractured areas identified as #1 - #2 - #3.

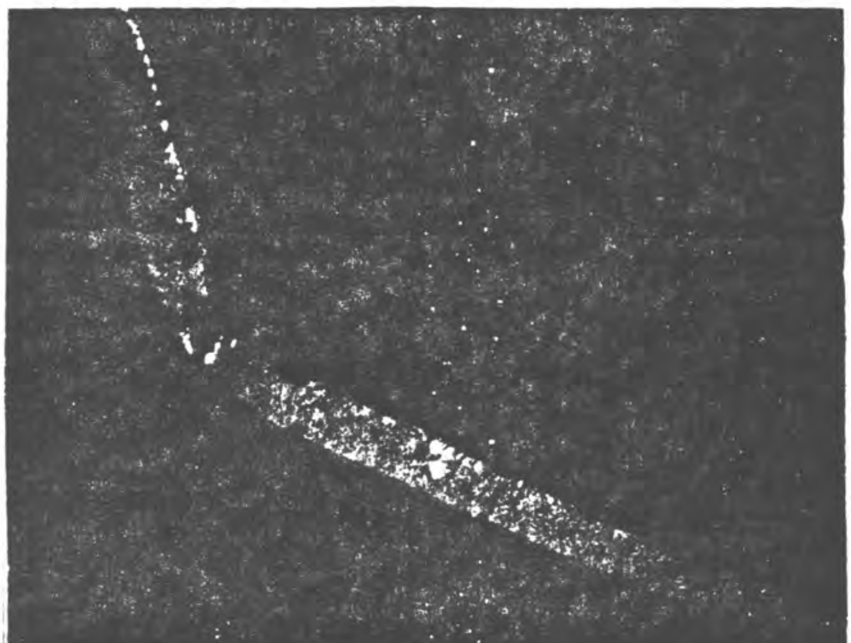


Photo 4
Fractured surface of area #1 tensile shear by overload.

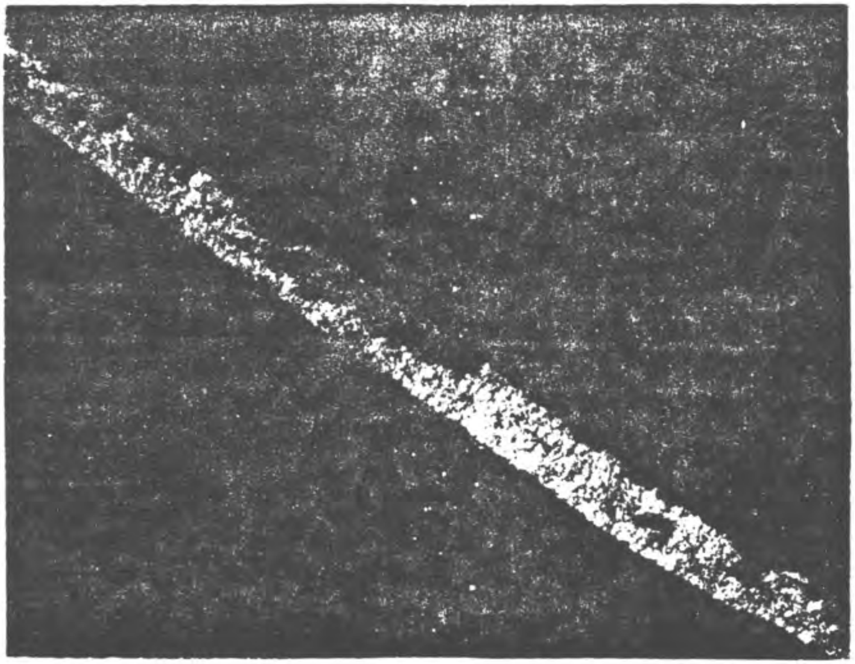


Photo 5
Fractured surface of area #2 tensile shear by overload.

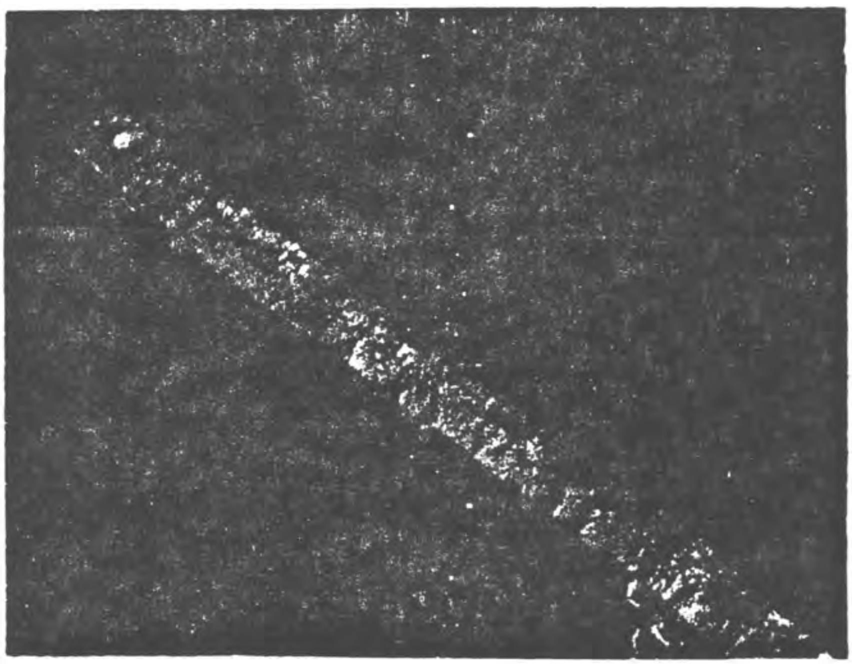


Photo 6
Fractured surface of area #3 tensile shear by overload.

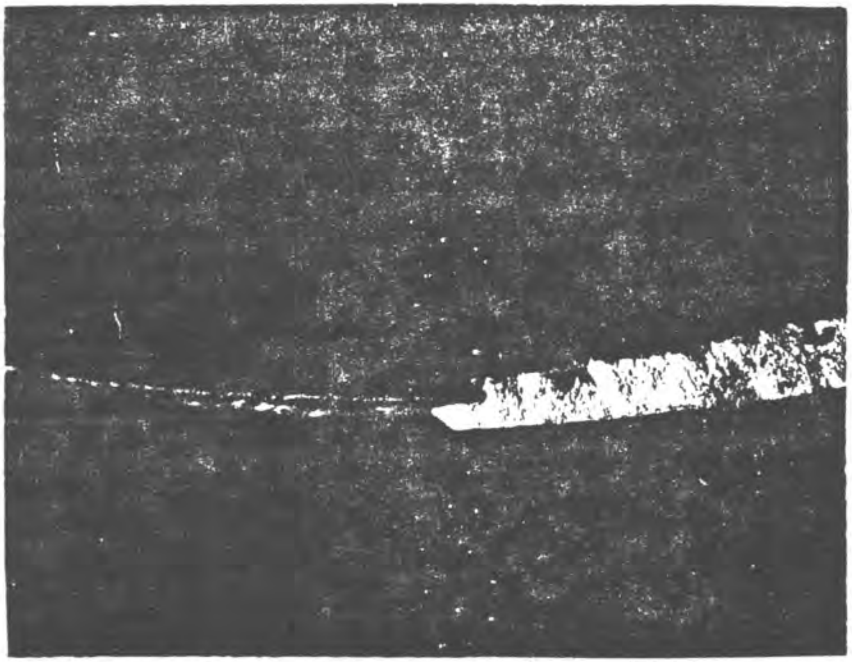


Photo 7
Fractured surface of area #3. Displays the phenomena of the reversal on two planes of the tensile shear.

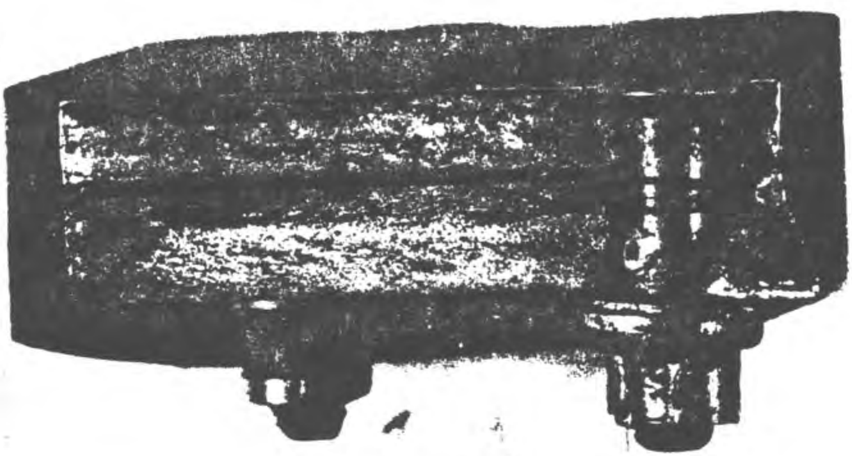


Photo 8
Top fracture - tensile shear.

Bottom fracture typical of a tensile cup.

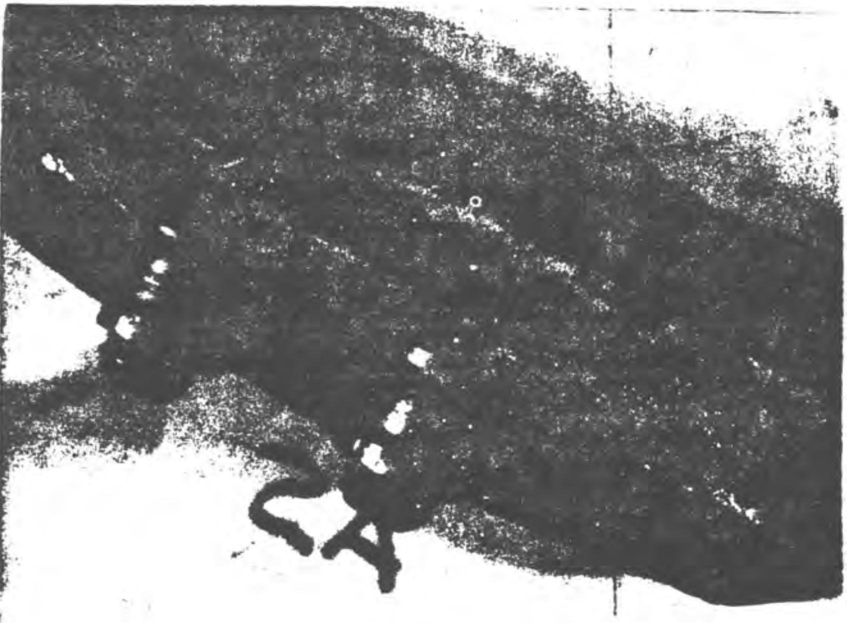


Photo 9
Top fracture - tensile cup in the middle - tensile shear to the left & right of middle.

Failure - Overload.

Bottom fracture - two stage tensile shear.

Failure - Bending overload.

Photo 10
Double action tensile shear.

Failure - Overload.

30 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Right #4 Bellcrank (ASA 7075 T-6 Aluminum Alloy Forging) 23 Apr 75

Task #1128, Attachment #7 #142

Metallurgical Analysis

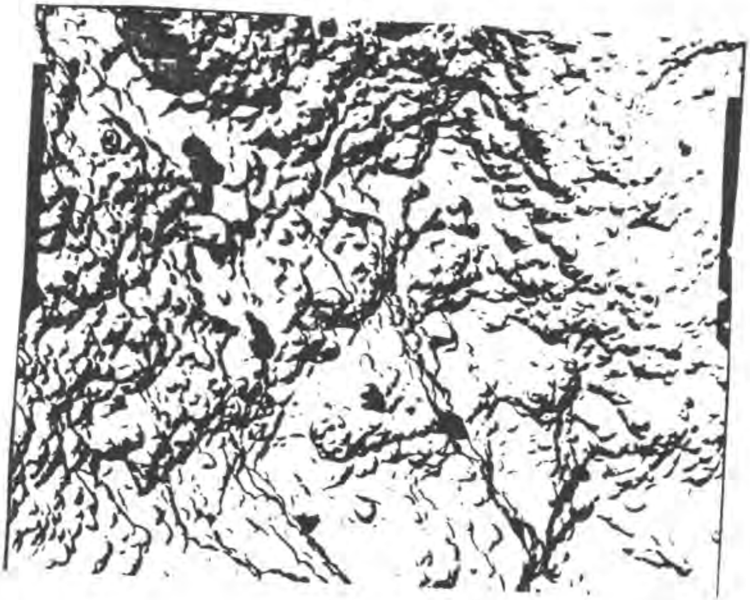
1. One Right #4 Bellcrank was submitted to the Metallurgical Laboratory for analysis in support of MME Task #1128, Attachment #7. This item is shown in Photo 1, as received.

2. A crack was evident at the fillet radius junction between the lobe and flange areas of the fitting, as shown more clearly in Photo 2. Impact damage was also evident on the opposite flange as also shown in Photo 2. Separation of the crack revealed that the crack surface extended completely through the section thickness, and originated at the radius junction between the lobe and flange portions of the fitting, Photo 3. Crack length was measured to be 1-1/4" (length "A", Photo 3).

3. Electron fractographs removed from the crack area shown in Photo 3 verified a stress corrosion growth mode, especially at the area close to the fillet radius, Photos 4 & 5. These fractographs revealed intergranular separation and "mud crack" patterns, indicative of progressive cracking along grain boundaries. Extensive super imposed pitting from extraneous corrosion occluded many surface features, such as shown in Photo 5. Photo 6, which is a fractograph removed from about mid-point of the crack again revealed characteristics indicative of stress corrosion cracking. Although dormant corrosion on the crack surface was evident both on macro & micro levels of examination, stress corrosion features were still dominant enough to be revealed on fractographic examination. The almost complete absence of dimple and cleavage characteristics on this surface, which would normally be present on typical ductile separations for this material, again indicates a progressive mode of growth for the crack. This crack did not induce failure of the item since it was away from the major failure zone and did not self propagate.

4. The clevis pin sleeve was removed and the bore diameter organically stripped for over-all NDI inspection of this area. This inspection did not reveal cracks on the inner bore surface. (NDI Report enclosed). However, an area on one end of the bore, Photos 7 & 8, exhibited a zone of pitting corrosion initiated by galvanic coupling between the steel sleeve and 7075 aluminum alloy. Although this item did not exhibit failure at this location, such a condition is a very likely site for subsequent initiation and growth of stress corrosion cracking.

5. Examination of the inner surface of the small hole (Photo 3) did not reveal any deep score marks, which may have been left by possible rejection of the locking pin-bracket combination on ground impact. This surface did exhibit some corrosion product, the formation of which may have occurred during the total service time of the item. No plastic deformation on the inner surface of the hole or elongation of this hole was evident (See Photo 3) which would normally be expected to occur by "catostrophic" removal of the pin and bracket attachment to this hole. Photo 9, showing this sectioned hole at higher magnification again does not indicate any severe plastic deformation on the inner small pin hole surface.



5600X

Photo 4. Shear dimples typical of a shear overload failure as revealed in fractrographic analysis.

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Right #4 Bellcrank (ASA 7075 T-6 Aluminum Alloy Forging) 23 Apr 75

Task #1128, Attachment #7 #142

Metallurgical Analysis

6. Examination of the hook attachment hole (Arrow B, Photo 3) which accomodates the other end of the locking bracket-pin device again did not reveal any indication of severe plastic deformation attendant with catostrophic separation of the locking attachment, as shown close-up in Photo 10. However, it should be considered that this hole contains a hardened steel insert, which would be considerably more resistant to plastic deformation under severe impact loads than the aluminum alloy of the fitting, and redistribute impact loads more uniformly around the hole.

7. No definite determination could be made on examination of the inner diameter surface of the pressed in clevis insert, (Arrow C, Photo 3), as to whether the clevis pin was or was not installed at the time of impact. Long term contact between pin & sleeve during the total service time of the part would leave an indelible contact pattern, which could not be altered by a single incident where installation of the pin may have been omitted. Photo 11, which shows this sectioned sleeve in color does indicate an excessive amount of corrosion as compared to the sectioned sleeve of #5 Bellcrank, which retained it's pin on impact (Photo 12). Considerable difference in sleeve surface degradation is obvious in this comparison. This may indicate that this surface was originally not covered by the pin (no installation), and on ground impact was subjected to subsequent over-all corrosion; where as the sleeve surface for #5 Bellcrank (Photo 12) was intact with the clevis pin and did not undergo this corrosion. However it is possible that the pin was originally installed and rejected on ground impact, which again would remove protection for the under sleeve. Another possibility to be considered is that #4 Bellcrank pin was originally installed and retained on ground impact, but the assembly eventually landed in a more corrosion exposed area, which resulted in the severe galvanic corrosion that was evident.

SIGNED

PETER J. FRINTZILAS, Metallurgist

2 Atch
1. NDI Report
2. Photos 1 thru 12

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

G-3

LABORATORY ANALYSIS REPORT AND RECORD

DATE: [illegible]

TO: [illegible] [illegible]

[illegible]

SAMPLE [illegible]: Right Bellcrank # 4

28 April 197[illegible]

SAMPLE FROM: MANCE / Task 1128 Attachment 7

LAB CONTROL NR: 75-76

TEST FOR: Cracks

1. One Right Bellcrank, # 4, was received by MANCD for nondestructive inspection of the large clevis pin hole area of the bellcrank.Specimen was identified as the Right Bellcrank, #4, Canted Station 2064, Ramp Station 95.

2. Specimen was inspected as follows:

   a. Specimen was processed by the liquid penetrant method using penetrant inspectior materials, Type I, Method "B", Mil-I-25135, Group VI with the family concept emulsifier and dry fluidized developer.

3. Inspection Results:

   a.Penetrant inspection revealed no discrepancies in the suspected area.

J.N.Garcia
Quality Assurance Specialist

Matias Ramos Jr.

MATIAS RAMOS JR.
Ch, NDT Lab Sec

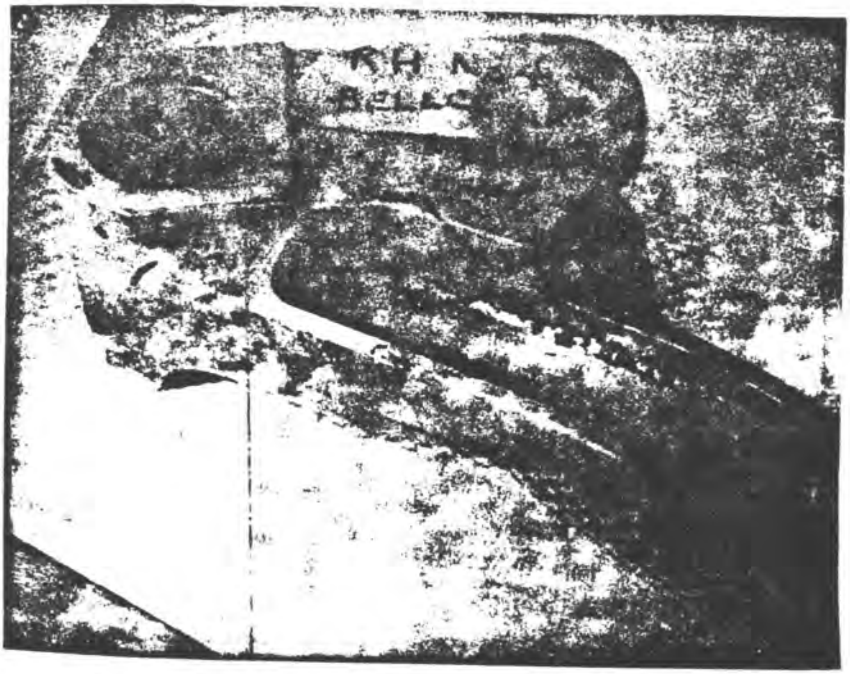


Photo 1 3/4X

#4 Bellcrank submitted for analysis. Item was fractured on impact at right extreme end. Arrow indicates crack indication at lobe-flange fillet area. Material is ASA 7075 T-6 aluminum alloy forging.

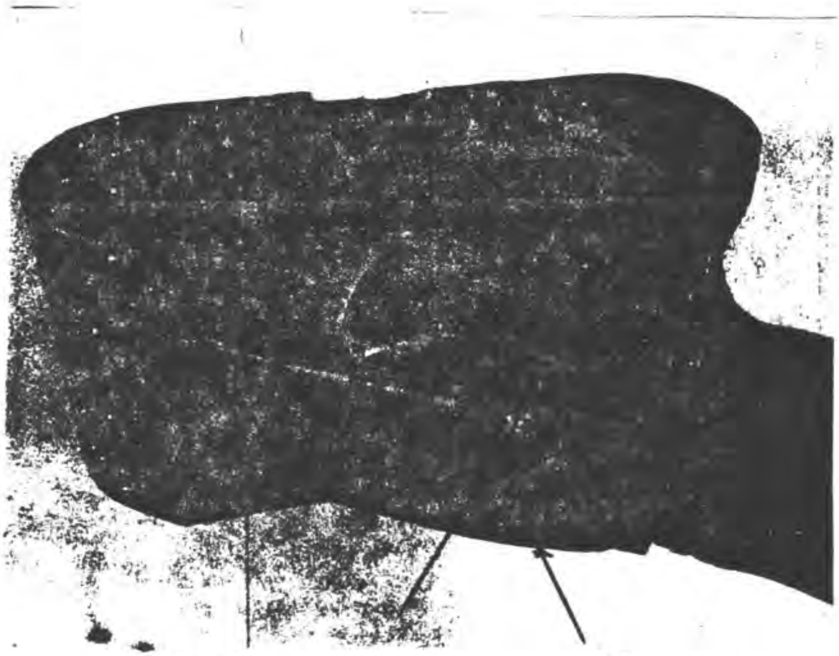


Photo 2 1X

Close-up of crack on lobe-flange junction of Bellcrank. Thin arrows indicate impact damage. Origin of crack at lobe-flange fillet radius is clearly shown.

Photo 3 4/5X

Separated crack (Area A) on flange of Bellcrank. Light fresh fracture "B" is overload zone created on tensile separation of crack. Arrow A indicates small lock pin hole which was examined for prior installation of pin. (See paragraph 2).

Photo 4 Near Fillet Radius 3000X

Photo 5 Near Fillet Radius 3000X

Photos 4 - 6 Electron fractographs removed from separated crack surface shown in Photo 3. Intergranular separation and thick mud crack patterns as indicated by Photo 4 suggest stress corrosion crack growth. Severe pitting, as shown in Photo 5, resulted in occlusion of many of the crack features.

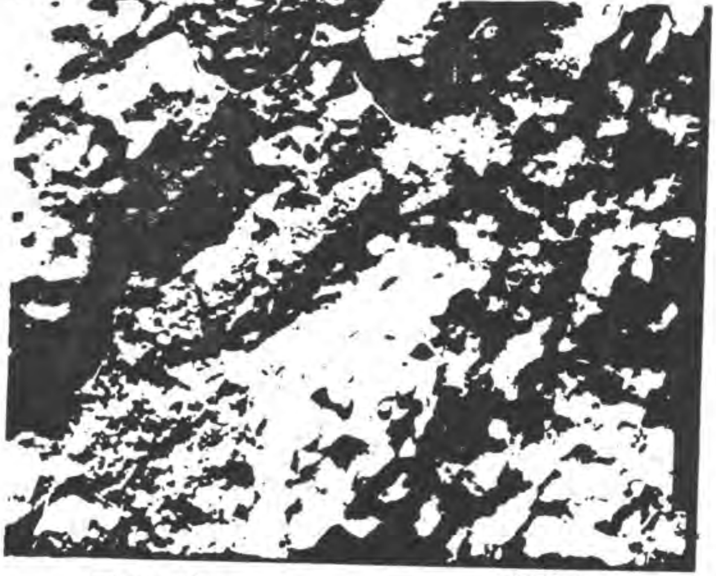


Photo 6 4000X
Near mid section of crack

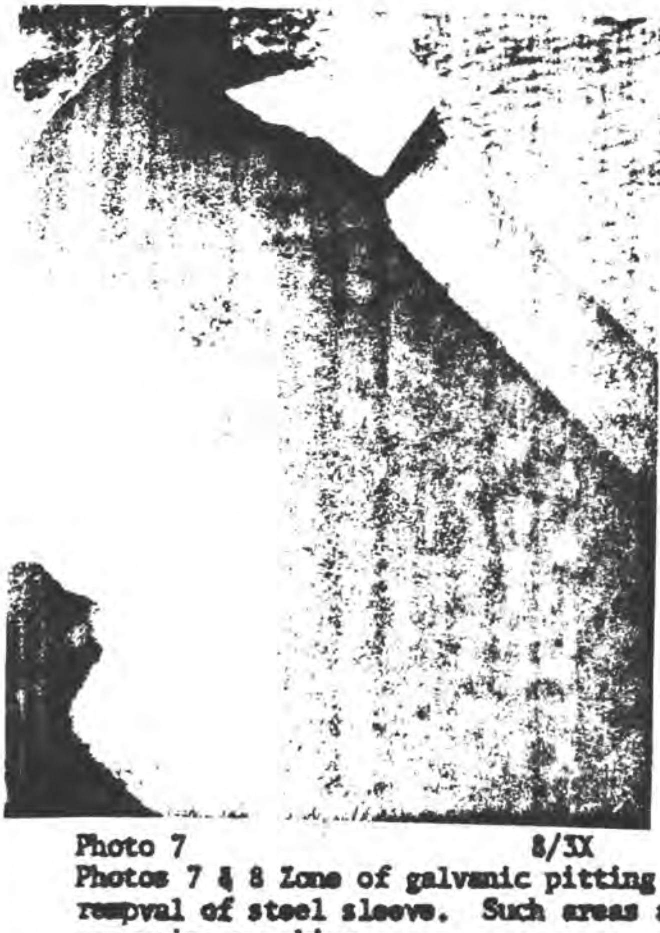


Photo 7 8/3X

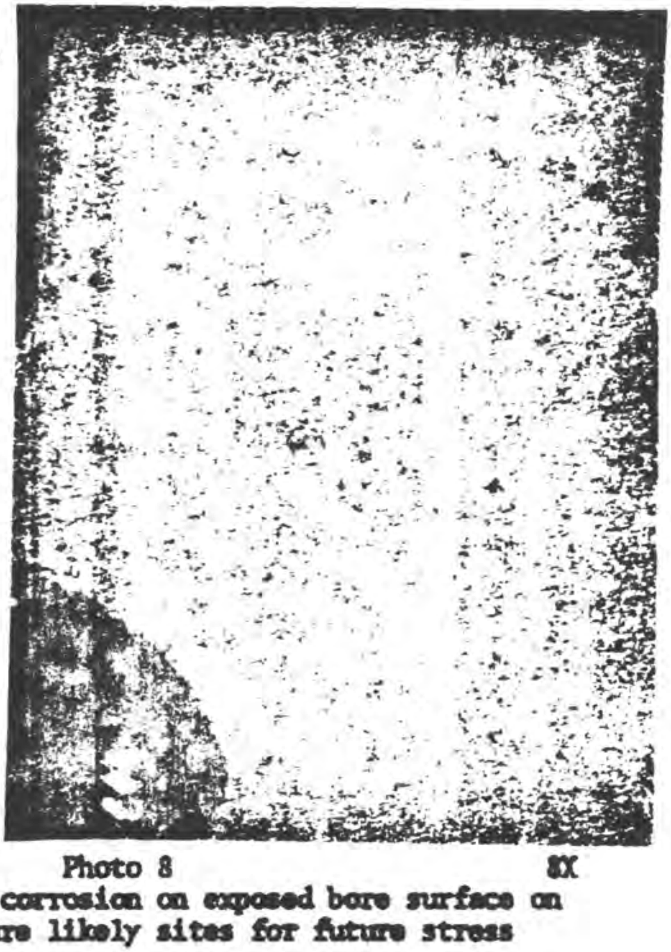


Photo 8 8X

Photos 7 & 8 Zone of galvanic pitting corrosion on exposed bore surface on rempval of steel sleeve. Such areas are likely sites for future stress corrosion cracking.

Photo 9 5X
Segmented portions of small pin shown in Photo 3, revealing absence of deep score marks & plastic deformation.

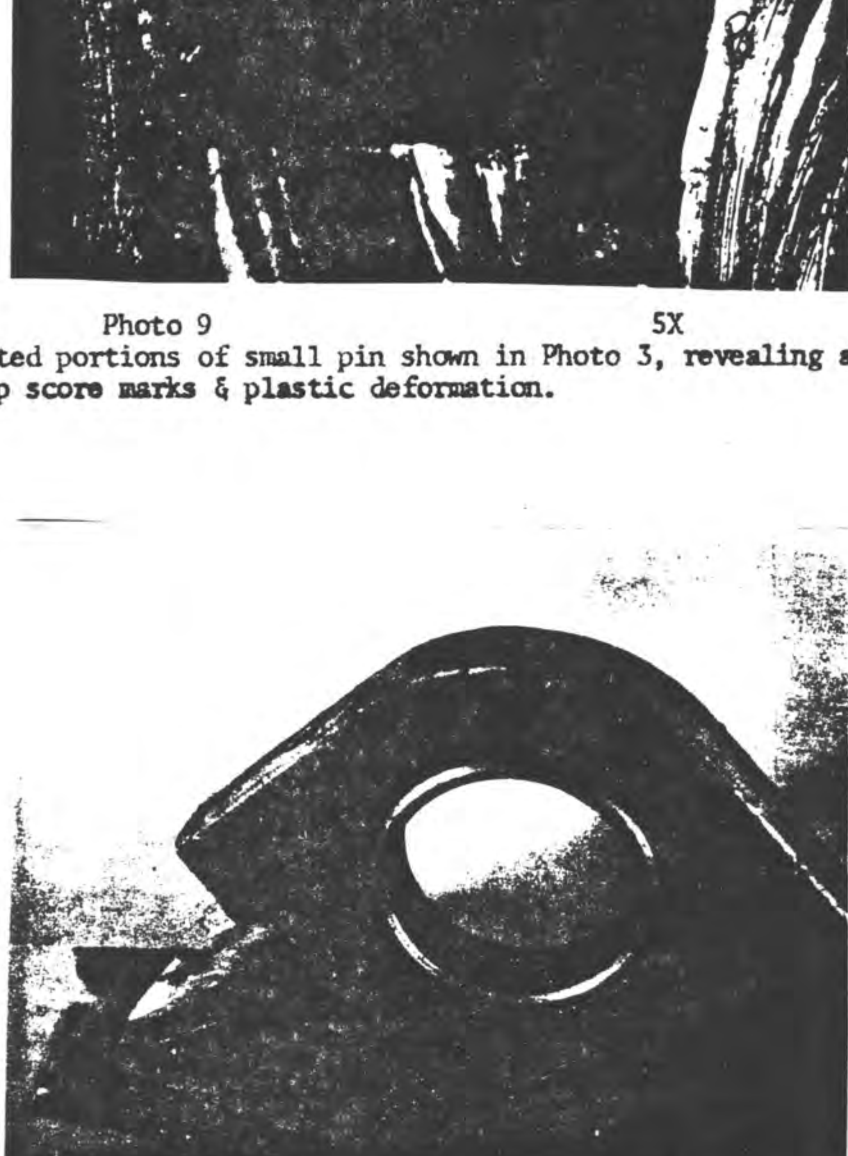


Photo 10 2X
Close-up of hook attachment hole, which accomodated other end of pin-bracket locing device. No severe plastic deformation was evident on steel sleeve.

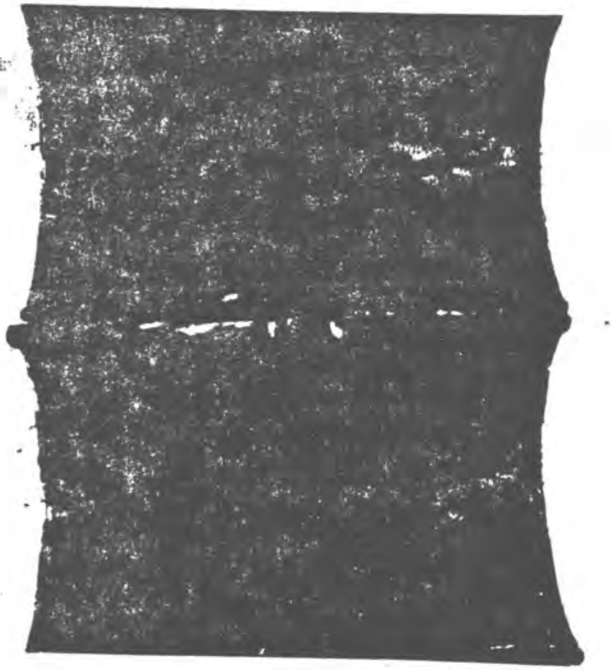


Photo 11 5/3X
Over all and galvanic type corrosion exhibited on inner surfaces of pressed sleeve (Hole C, Photo 3), for Bellcrank #4. No pin was found with this sleeve at impact zone.

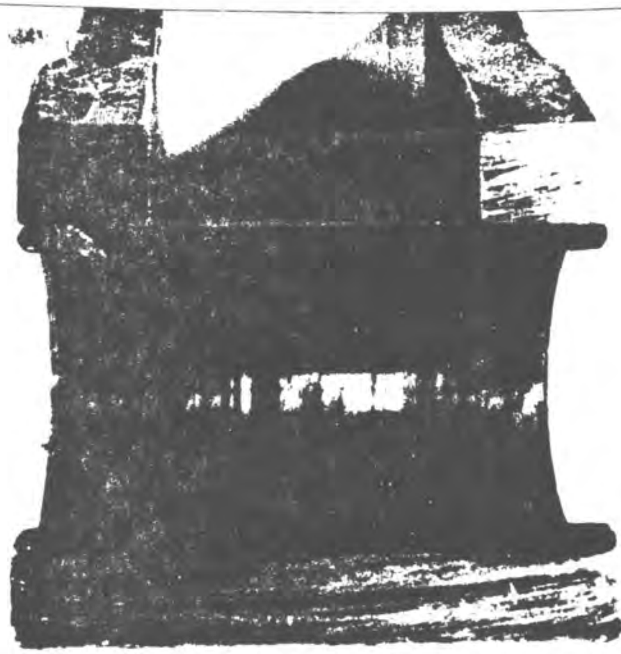


Photo 12 5/3X
Sleeve surface of Bellcrank #5, which retained pin on impact. Surface was considerably smoother and less corroded.

 30 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Right #4 Bellcrank (ASA 7075 T-6 Aluminum Alloy Forging) 23 Apr 75

Task #1128, Attachment #7 #142

Metallurgical Analysis

6. Examination of the hook attachment hole (Arrow B, Photo 3) which accomodates the other end of the locking bracket-pin device again did not reveal any indication of severe plastic deformation attendant with catostrophic separation of the locking attachment, as shown close-up in Photo 10. However, it should be considered that this hole contains a hardened steel insert, which would be considerably more resistant to plastic deformation under severe impact loads than the aluminum alloy of the fitting, and redistribute impact loads more uniformly around the hole.

7. No definite determination could be made on examination of the inner diameter surface of the pressed in clevis insert, (Arrow C, Photo 3), as to whether the clevis pin was or was not installed at the time of impact. Long term contact between pin & sleeve during the total service time of the part would leave an indelible contact pattern, which could not be altered by a single incident where installation of the pin may have been omitted. Photo 11, which shows this sectioned sleeve in color does indicate an excessive amount of corrosion as compared to the sectioned sleeve of #5 Bellcrank, which retained it's pin on impact (Photo 12). Considerable difference in sleeve surface degradation is obvious in this comparison. This may indicate that this surface was originally not covered by the pin (no installation), and on ground impact was subjected to subsequent over-all corrosion; where as the sleeve surface for #5 Bellcrank (Photo 12) was intact with the clevis pin and did not undergo this corrosion. However it is possible that the pin was originally installed and rejected on ground impact, which again would remove protection for the under sleeve. Another possibility to be considered is that #4 Bellcrank pin was originally installed and retained on ground impact, but the assembly eventually landed in a more corrosion exposed area, which resulted in the severe galvanic corrosion that was evident.

SIGNED

PETER J. FRINTZILAS, Metallurgist

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

2 Atch
1. NDI Report
2. Photos 1 thru 12

H-4

9 May 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#4 R.H. Bellcrank 23 Apr 75

Task #1128, Attachment #7 (Amendment) #142

Metallurgical Analysis

1. An additional analysis on the massive failure zone of this Bellcrank, Photos 1 & 2, was requested for the determination of the direction of final separation. Final separation was in the direction of the red arrow, as shown in these photos and explained in the caption. Additional separation of the flange segments C1 & C2 at the laboratory revealed discolored corrosion zones on the fractures, Photo 3. These zones were similar to corrosion zones found previously on the cracks at the other areas of the Bellcrank previously examined in the original analysis.

2. Macro examination of the separated segment C1, showing the portion of the old fracture merging into the fresh lab fracture again reveals a significant difference in texture between these two fractures.

3. Electron fractographs removed from the C1 & C2 flange fractures, at the fresh fracture and old fracture areas revealed a significant difference in characteristics between both zones, as indicated in Photos 5-10. Surface topography varied between ductile tear and cleavage through second phase areas (lab fracture), to a blocky, faceted type configuration (Segment C1) at inward locations of the field fracture, as shown for Segment C1 in Photo 7. Photo 7 reveals what appear to be deep secondary cracks and mud crack configurations. Similar configurations, although not as dominant were observed for Segment C2, Photos 8-10, which indicate extraneous corrosion pitting from the affects of dormant corrosion on these surfaces.

4. Conclusion: Failure direction of this end of Bellcrank #4 RH is indicated and explained in Photos 1 & 2. The presence of "stress corrosion type" separation zones was also observed on longitudinal fracture areas of flange segments C1 & C2, (Photos 1-4), as verified by fractographs analysis. The short transverse direction of the original item material may possibly constitute the thickness direction on these fracture surfaces, and depending on the orientation of the item with respect to the original material would increase the feasability of stress corrosion characteristics there.

PETER J. FRINTZILAS, Metallurgist

1 Atch
Photos 1 thru 10

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

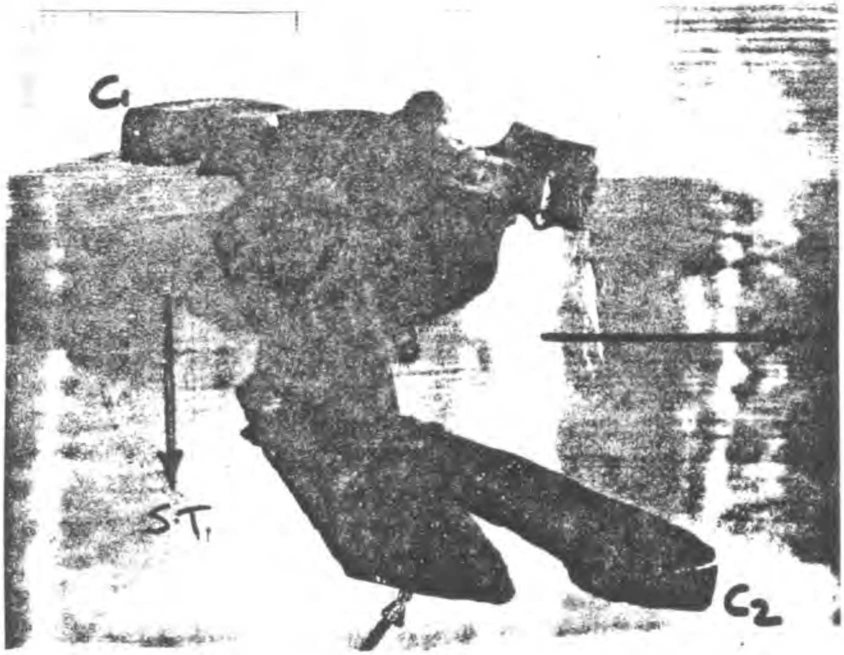
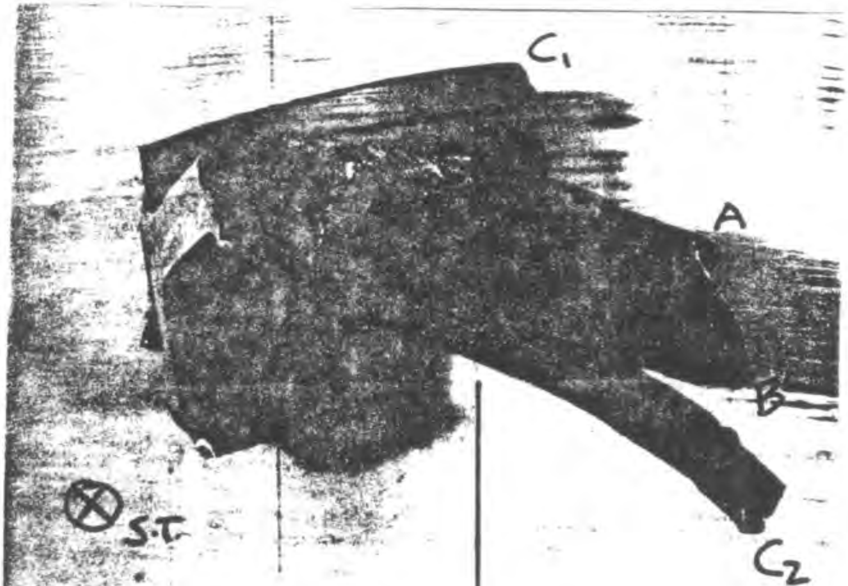


Photo 1 View A 5/2X



Photos 1 & 2 View B 5/2X

Corresponding views of segment exhibiting major failure & separation zone of #4 RH Bellcrank. View B is in direction of green arrow shown in Photo A. All exposed fracture surfaces revealed rapid overload characteristics. Curvature of web portion of Bellcrank, a tensile shearlip at A and compressive mash zone at B (Photo 1), and separation of flange segments C1 & C2 away from web all suggest final separation in direction of red arrow. Heavy blue arrow denotes possible short transverse direction of wrought stock item was machined from.

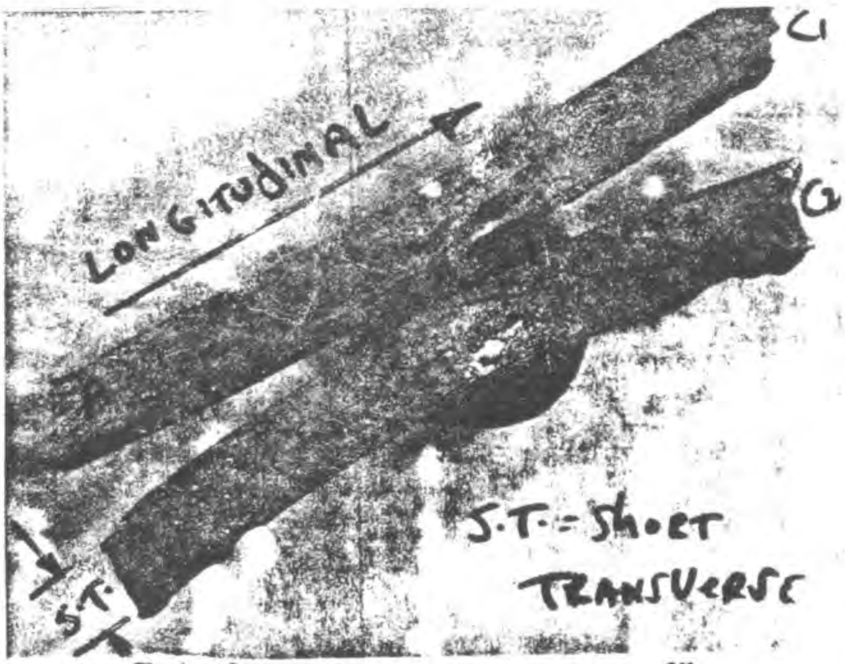


Photo 3 3X

Flange segments C1 & C2 separated at the laboratory. Areas marked "A" are fresh lab fractures. Both segments appeared discolored & exhibited considerable corrosion on old fractures, similar to crack surfaces previously examined in this analysis.

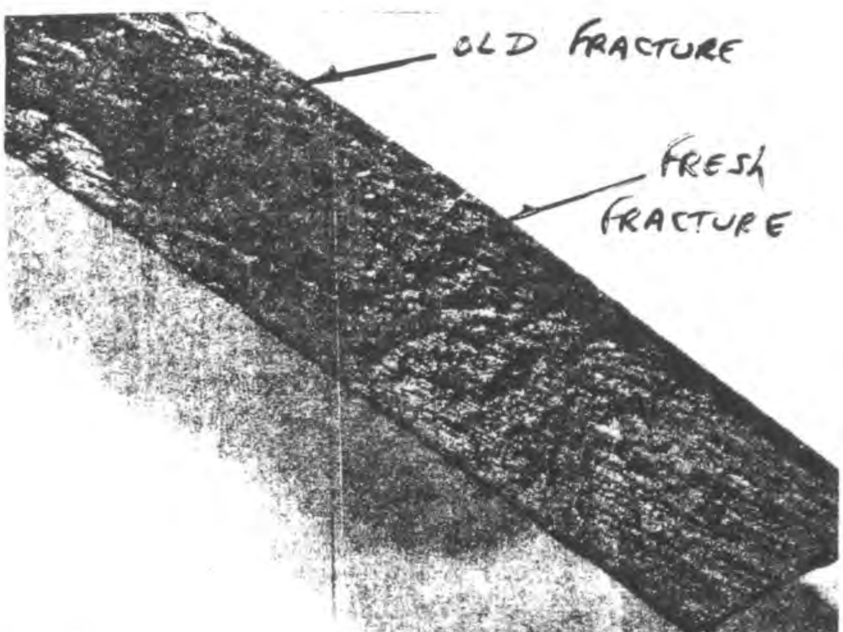


Photo 4 7X

Difference in texture between fresh lab fracture and old fracture on C1 segment. "A", "B", & "C" indicate corresponding areas where fractographs shown in Photos 5-7 were taken.

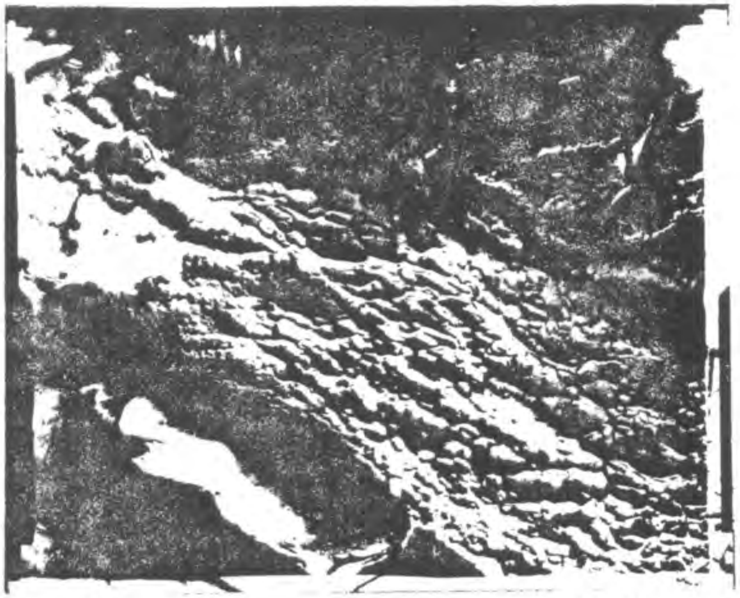


Photo 5 Area A 3000X

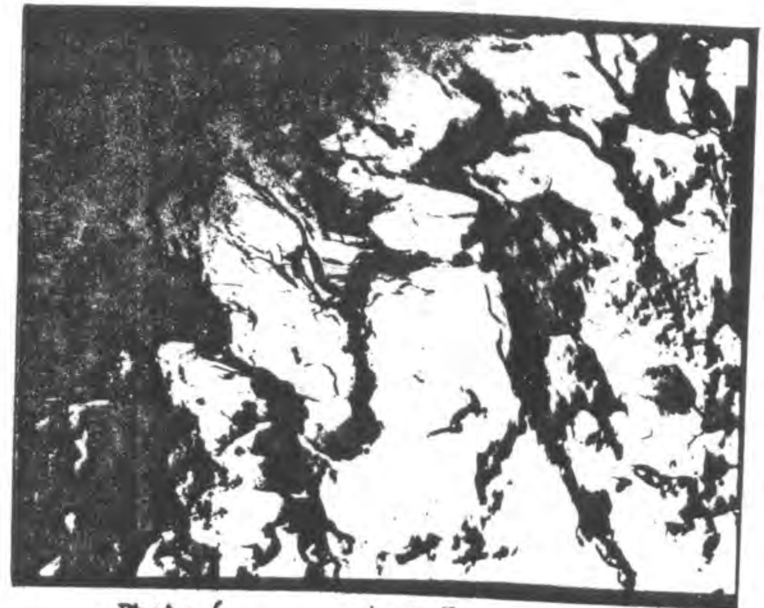


Photo 6 Area B 3000X

Photo 7 Area C 3000X

Photos 5-7 Electron fractographs removed from separated flange segment C1. Topography varies from dimple rupture & second phase cleavage regions on areas A. & B, to intergranular separation at area C (old fracture surface). Comparison between fresh fracture areas (photos 5 & 6) and old fracture area (photo 7) suggests the presence of stress corrosion cracking on the old area. Photo 7 reveals many "mud crack" & "secondary crack" characteristics which are indicative of stress corrosion cracking.

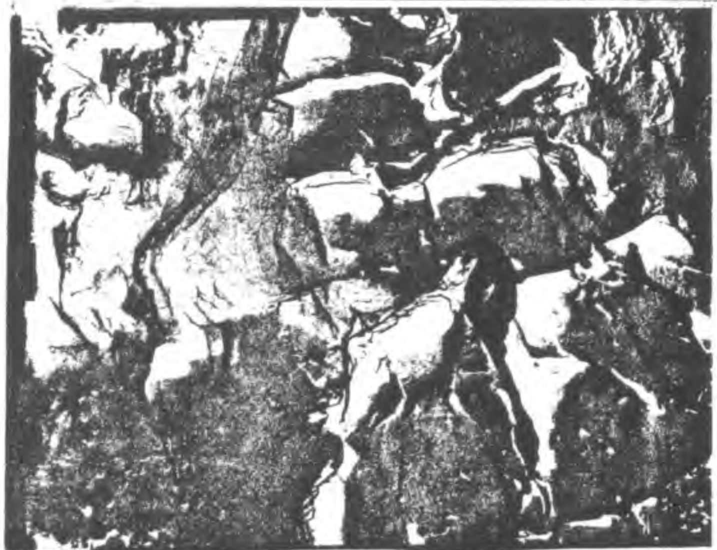


Photo 8 Fresh Lab fracture 3000X

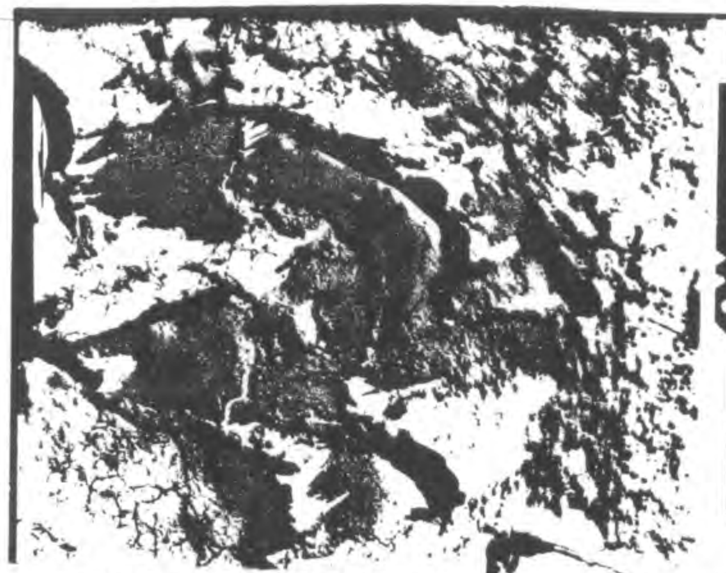


Photo 9 Old field fracture at about mid-point of segment. 3000X

Photo 10 3000x
Old field fracture, at extreme end area of segment.

Photos 8 - 10 Fractographs removed from flange segment C2 at approximately same locations as on segment C1. Replicas from old fracture were removed toward more extreme end (more dormant corrosion), and this is indicated by the more extraneous corrosion shown in Photos 9 & 10.

28 April 1975 I-1

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#5 DOS 3 may 75

Right ~~or left~~ [redacted] Hook, Bellcrank and Pushrod 23 Apr 75

Task 1128, Attachment 8 142

Metallurgical Analysis

1. One right or left #3 hook, bellcrank and pushrod assembly was submitted to the Metallurgical Laboratory for analysis in support of Task 1128.

2. This item assembly, as submitted, is shown in Photos #1 and #2. Failure was exhibited by fracturing of the bellcrank and shearing off of the pushrod end, as shown in the photos. A crack was evident underneath a lobe of the bellcrank (Material ASA 7075-T6), as shown in Photo #2 and close-up in Photo #3. Separation of this crack, Photo #4, revealed discoloration on the crack for a length of about 3 inches (Arrow "A", Photo #4) prior to entry of the crack into the overload zone "B" created by fracturing of the crack segment at the laboratory. An electron fractograph of the zone "B" area (Photo #5) revealed the expected severely dimpled characteristics, normal for rapid tensile overload failure in this material. However, fractographs removed from the discoloration zone of the old crack (Photos #6 to #9) revealed flat and indiscernible features in many areas, with evidence of some pitting on the crack surface and some zones indicating intergranular separation. These features suggest stress corrosion crack growth on this item. It is not believed that dormant corrosion of an opened impact crack would leave such features, especially those of the type shown in Photos #6 and #9, which suggest crack growth along grain boundaries.

3. Examination of the pushrod fracture surface (Photo 10) indicated failure by a combination of rapid bending and torsional shear. Final separation of the mating portion is believed to have occurred in the direction indicated by the arrow. This is suggested by crimping of the rod at the right side and "fluting in" of the appending segment "A".

PETER J. FRINTZILAS, Metallurgist

1 Atch
Photos #1 thru #10

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

28 Apr 75

MANCF/Mr. Orms MANCD/Nondestructive Testing Lab Sec

Right or Left Hook #3 26 Apr 75

MANCE/Task 1128, Attachment 8 75-76

Cracks

1. One each Right or Left Hook #3 was received by MANCD for nondestructive inspection. Specimen was identified as a portion of the Right or Left Hook #3 Assembly, Canted Fus Station 2044, Ramp Station 74.

2. Specimen was inspected as follows:

a. Specimen was processed by the liquid penetrant method, using penetrant inspection materials, Type I, Method "B", MIL-I-25135, Group VI, with the family concept emulsifier and dry fluidized developer.

3. Inspection results:

a. Liquid penetrant inspection revealed no discrepancies.

NOTE: It is not known whether this hook is right or left.

Jose N. Garcia
Qlty Assr Spec

MATIAS RAMOS JR.
Ch, NDT Lab Sec

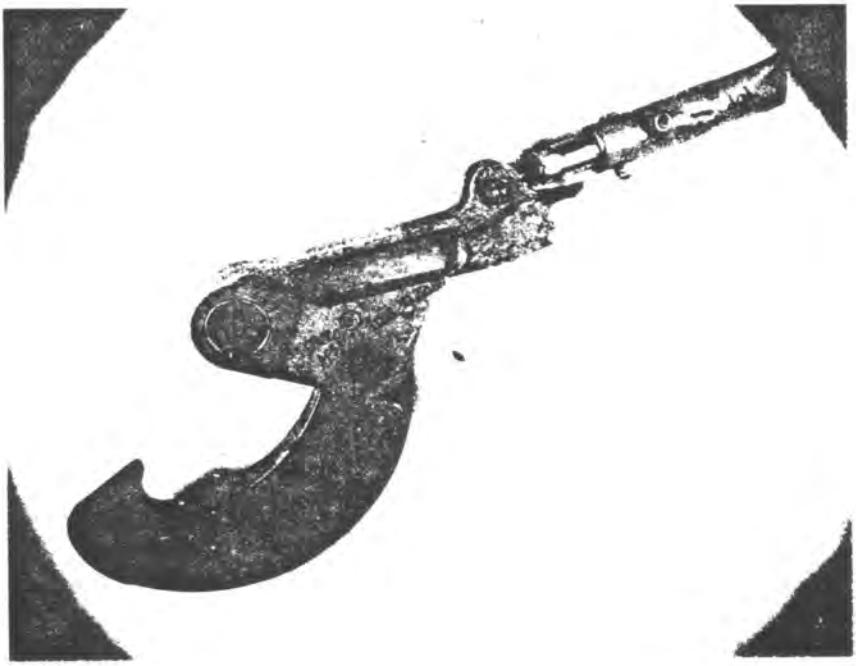


Photo 1 1/3X

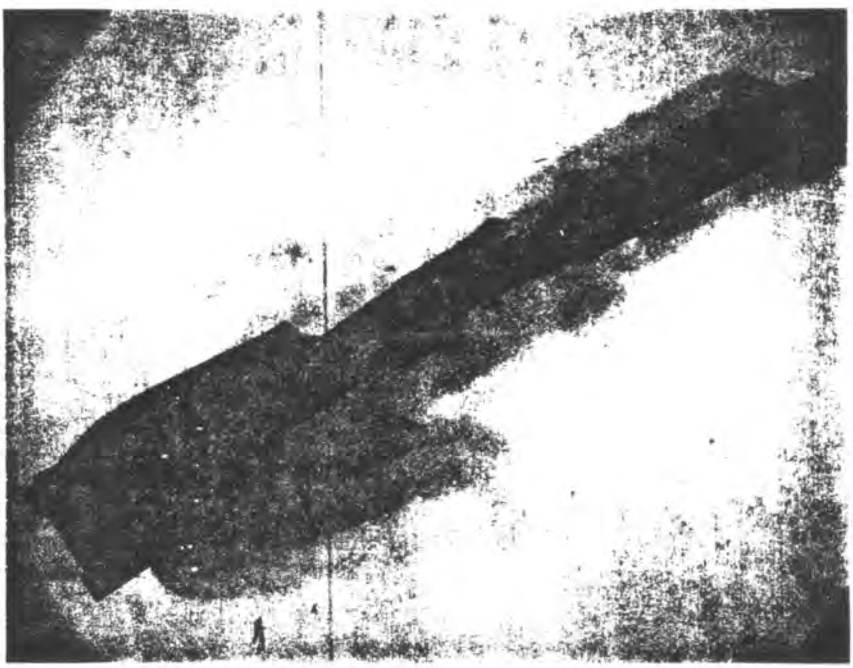


Photo 2 1/3X

Photos 1 & 2. Right or Left #3 Hook, Bellcrank and Pushrod Assy Submitted for Analysis. Crack was Evident at Junction of Crank Lobe and Flange, as Shown in Photo 2. See Photos 3 and 4.

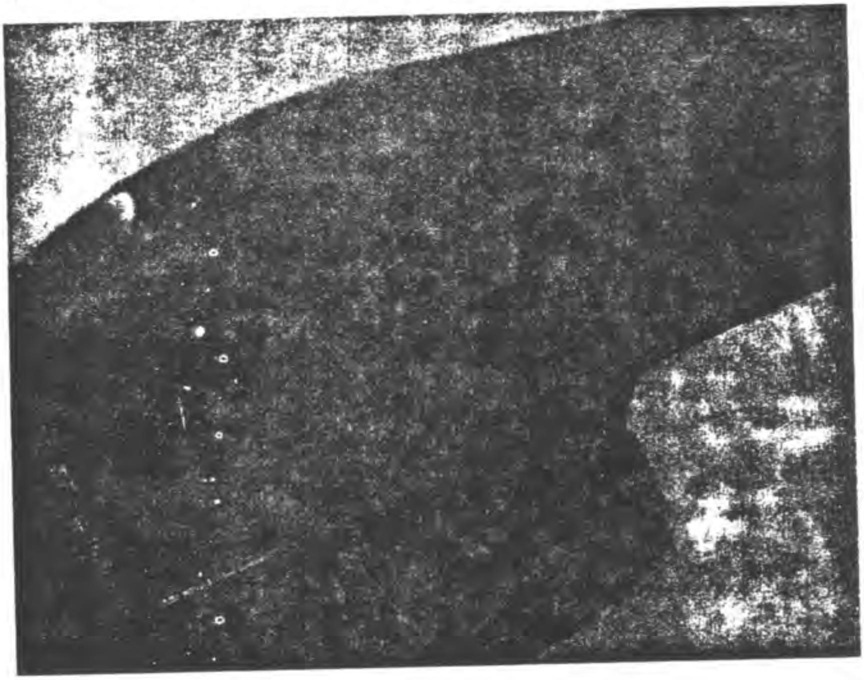


Photo 3. Closeup of Crack on #3 Bellcrank 1 1/2X
Shown in Photo 2. Crack Extended Through Full
Section Thickness of Crank Flange.

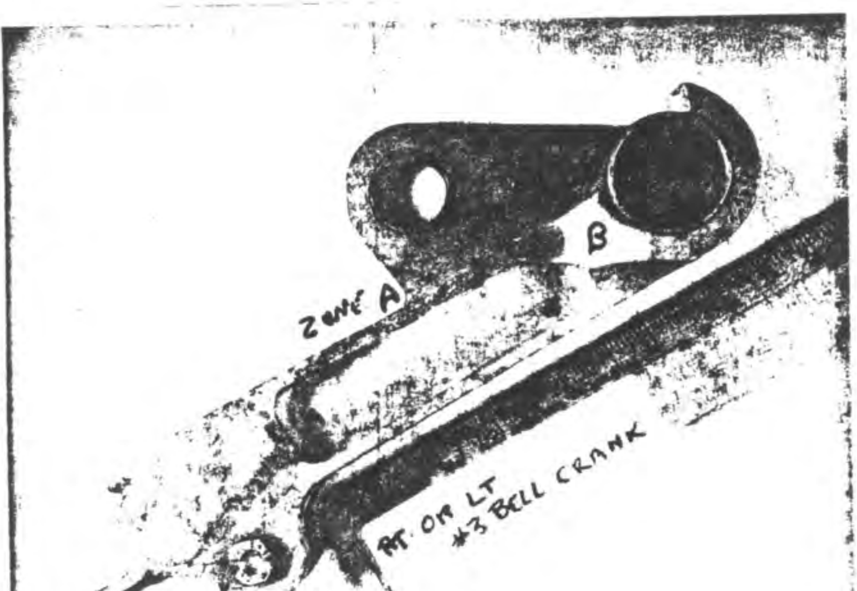


Photo 4. Separated Crack Surface on #3 Bellcrank. 5/8X
On This Examination, Crack Appears Progressive,
Emanating from Edge of Flange, Point "A", and Along
Full Length of Recess to Point "B". Light Area
is Area of Final Separation, Where Crack was Separated
at Laboratory.

Photo 5. Electron Fractograph Removed from Fresh Fracture Zone "B" of Photo 4, Showing Dimpled Structure Indicative of Normal Tensile Overload for this Material. 30000X

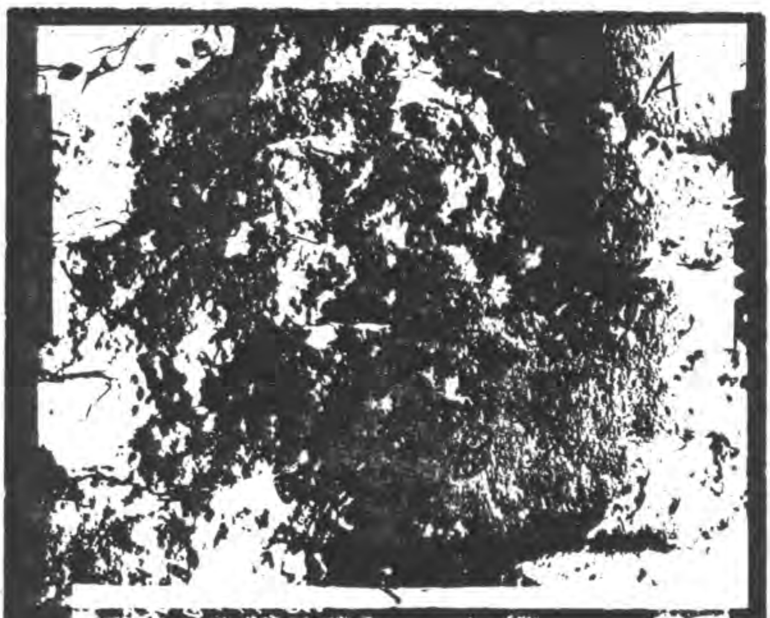


Photo 6. Electron Fractograph Removed from Old Crack Surface "A" of Photo 4. Surface for the Most Part is Featureless, with Some Signs of Intergranular Separation, Zones "A" & "B" and Some Pitting. See Additional Fractographs from this Surface, Photos 7 to 9. 4000X

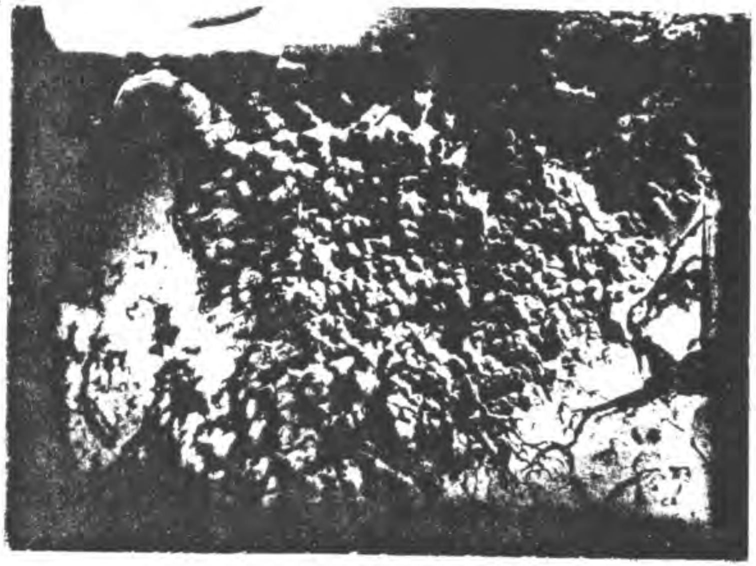


Photo 7 3000X

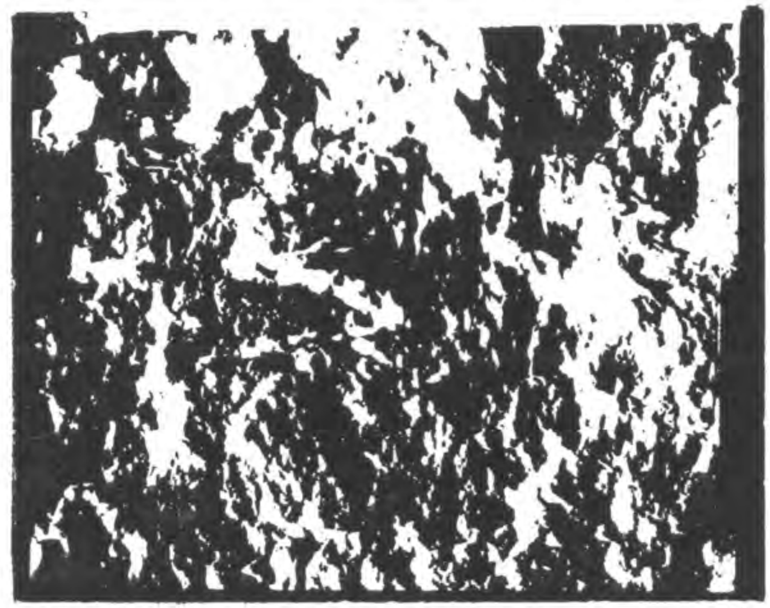


Photo 8 4000X

Photo 9 4000X

Photos 7-9. Additional Electron Fractographs Removed from Discolored Crack Zone of #3 Bellcrank, Near Left-Most Extemity of Crack as Shown in Photo 4. Some Scattered Dimpling Surrounded by Flat Areas (Photo 7), Massive Areas of Corrosion Deterioration (Photo 8) and Some Evidence of Intergranular Separation (Photo 9) were Evident Throughout this Location of the Crack.

28 Apr 75

MANCF/Mr. Orms MANCD/Nondestructive Testing Lab Sec

Right or Left Hook #3 26 Apr 75

MANCE/Task 1128, Attachment 8 75-76

Cracks

1. One each Right or Left Hook #3 was received by MANCD for nondestructive inspection. Specimen was identified as a portion of the Right or Left Hook #3 Assembly, Canted Fus Station 2044, Ramp Station 74.

2. Specimen was inspected as follows:

a. Specimen was processed by the liquid penetrant method, using penetrant inspection materials, Type I, Method "B", MIL-I-25135, Group VI, with the family concept emulsifier and dry fluidized developer.

3. Inspection results:

a. Liquid penetrant inspection revealed no discrepancies.

NOTE: It is not known whether this hook is right or left.

Jose N. Garcia
Qlty Assr Spec

MATIAS RAMOS JR.
Ch, NDT Lab Sec

28 Apr 75

MANCF/Mr. Orms | MANCD/Nondestructive Testing Lab Sec

Right or Left Hook #3 | 26 Apr 75

MANCE/Task 1128, Attachment 8 | 75-76

Cracks

1. One each Right or Left Hook #3 was received by MANCD for nondestructive inspection. Specimen was identified as a portion of the Right or Left Hook #3 Assembly, Canted Fus Station 2044, Ramp Station 74.

2. Specimen was inspected as follows:

a. Specimen was processed by the liquid penetrant method, using penetrant inspection materials, Type I, Method "B", MIL-I-25135, Group VI, with the family concept emulsifier and dry fluidized developer.

3. Inspection results:

a. Liquid penetrant inspection revealed no discrepancies.

NOTE: It is not known whether this hook is right or left.

Jose N. Garcia
Qlty Assr Spec

MATIAS RAMOS JR.
Ch, NDT Lab Sec

Photo 1 1/3X

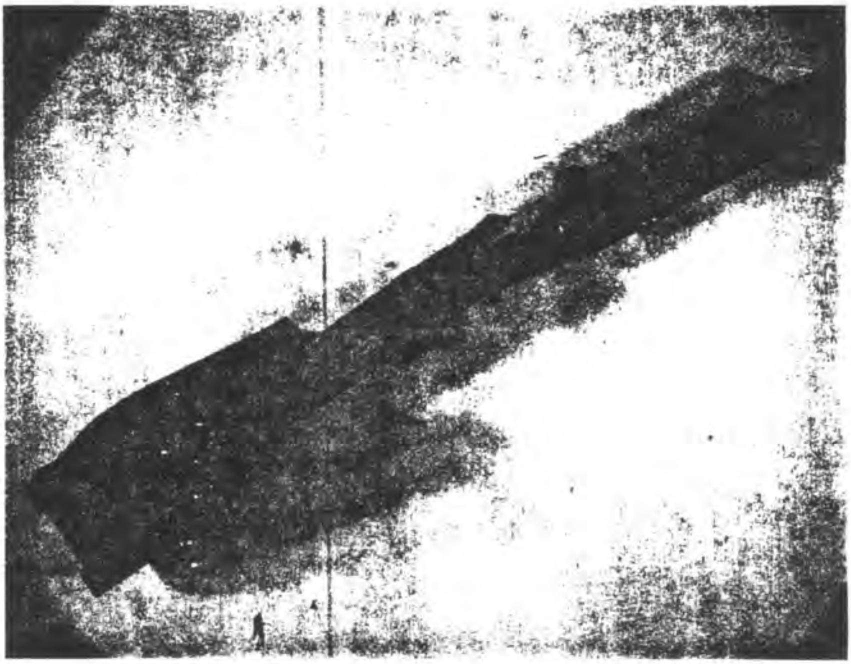


Photo 2 1/3X

Photos 1 & 2. Right or Left #3 Hook, Bellcrank and Pushrod Assy Submitted for Analysis. Crack was Evident at Junction of Crank Lobe and Flange, as Shown in Photo 2. See Photos 3 and 4.

Photo 5. Electron Fractograph Removed from Fresh Fracture Zone "B" of Photo 4, Showing Dimpled Structure Indicative of Normal Tensile Overload for this Material. 30000X

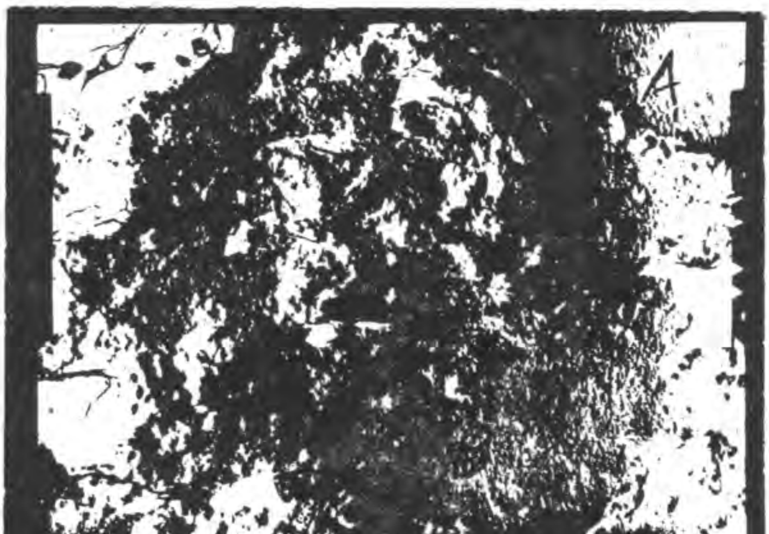


Photo 6. Electron Fractograph Removed from Old Crack Surface "A" of Photo 4. Surface for the Most Part is Featureless, with Some Signs of Intergranular Separation, Zones "A" & "B" and Some Pitting. See Additional Fractographs from this Surface, Photos 7 to 9. 4000X.

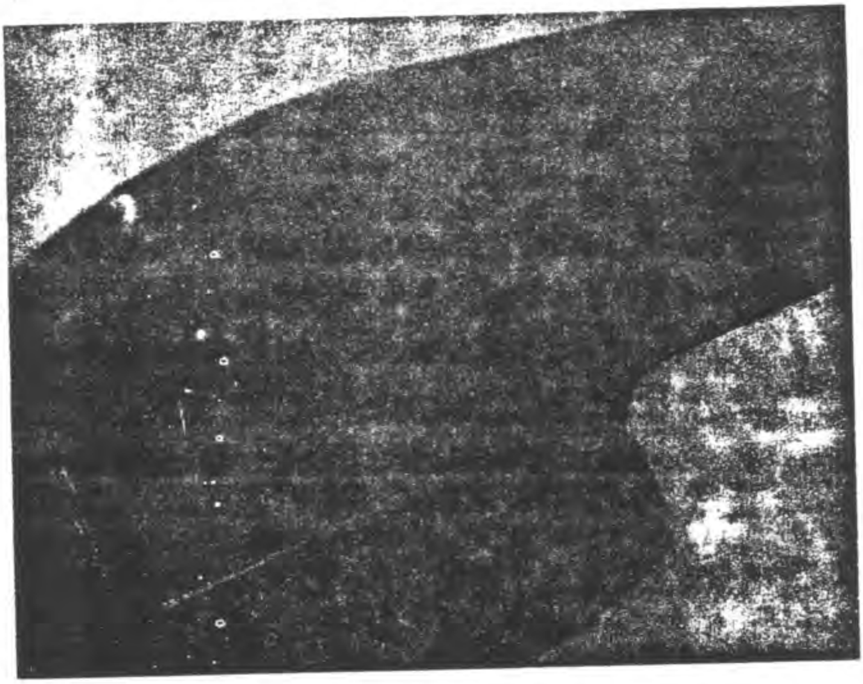


Photo 3. Closeup of Crack on #3 Bellcrank 1 1/2X
Shown in Photo 2. Crack Extended Through Full
Section Thickness of Crank Flange.

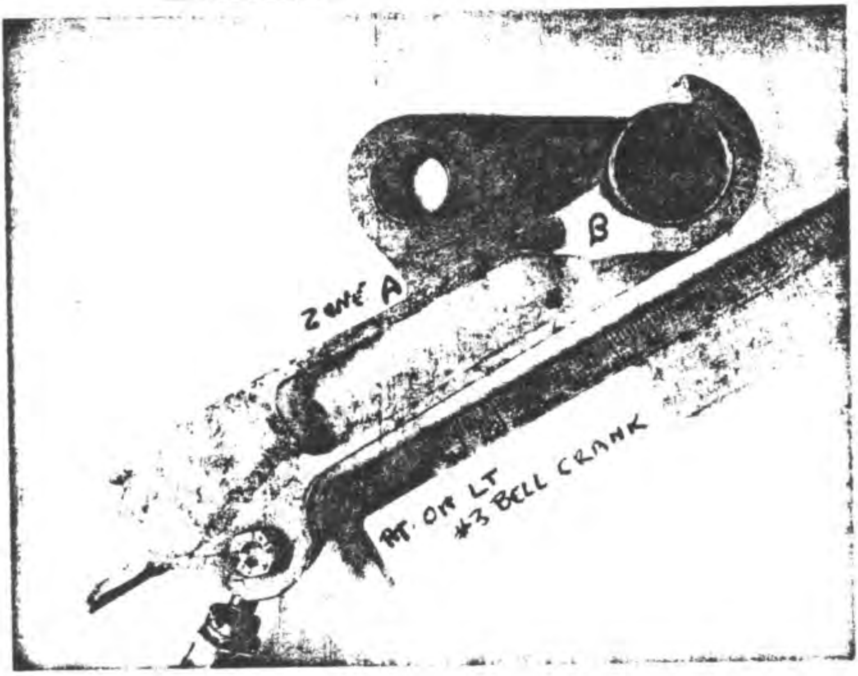


Photo 4. Separated Crack Surface on #3 Bellcrank. 5/8X
On This Examination, Crack Appears Progressive,
Emanating from Edge of Flange, Point "A", and Along
Full Length of Recess to Point "B". Light Area
is Area of Final Separation, Where Crack was Separated
at Laboratory.

Photo 10. Failed Pushrod Tube Attached to #3 2 1/2X
Bellcrank. Arrow Indicated Direction of Separation of Mating Portion of Tube. Fluting of Appending Segment "A" and its Bending in a Downward Direction Suggest Final Separation in this Vicinity.

I-8

12 May 1975

MME-5/Capt Gregory/Capt Scheiding/57845

MANCE (Metallurgical Laboratory)
Hook &

#5 R.H. Bellcrank, originally identified as #3 Right or Left Bellcrank 23 Apr 75

Task #1128, Attachment #8 (Amendment) #142

Metallurgical Analysis

An additional analysis on the massive failure zone on this item was requested to determine the direction of final separation. Macro examination of the fracture areas, Photos 1 & 2, indicating tensile overload characteristics, a massive sliding shear zone (B) and bending of the appending segment (A) in the direction of the red arrow verify final separation in this direction. All fracture faces and adjacent areas exhibited considerable plastic deformation and impact markings, and verify failure by impact overload.

PETER J. FRINTZILAS, Metallurgist

1 Atch
Photos 1 & 2

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

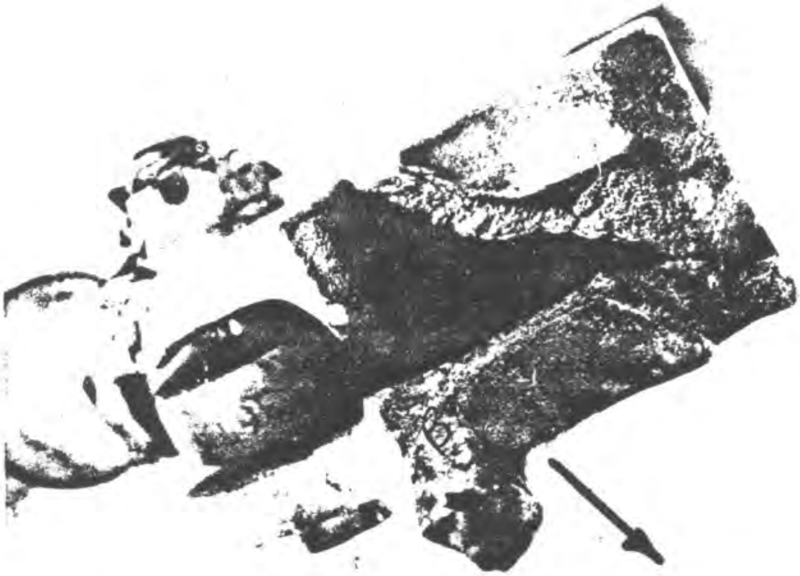


Photo 1 View A 2X

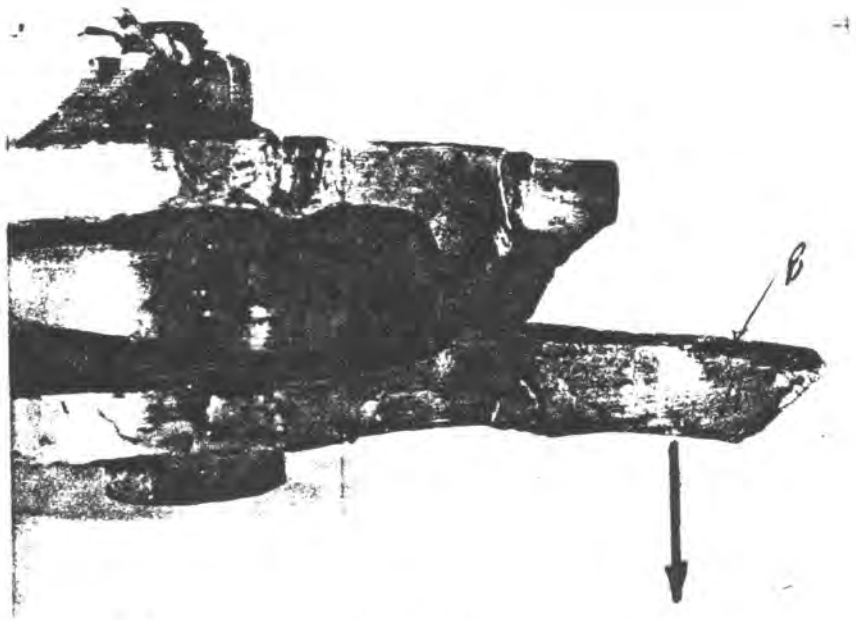


Photo 2 View B 2X

Corresponding views of R.H. Bellcrank #5; view B in direction of green arrow. All fractures exhibited overload characteristics. Red arrow in both views indicates direction of final separation as verified by bending of segment A in same direction and presence of massive sliding shear zone on adjacent lattral surface of segment, area B.

27 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (METALLURGICAL LABORATORY)

No 1/No 3 Bellcrank Pushrod 23 Apr 75

Task #1128 Attachment #9 #142

Metallurgical Analysis

1. A piece of pushrod with the end fitting attached was submitted for analysis as per attachment #9 of basic MME Task #1128.

2. Photographs 1 and 2 are of the pushrod as received. Note that the failed mounting lugs are attached to the end fitting. Photos 3 and 4 are close up shots of the failed areas.

3. Examination of the fractured surface around the circumference of the pushrod was accomplished as follows: Seven areas were marked counter clock-wise starting on the top side of the pushrod. Area 1, approximately 3/8 inch long, exhibited obliterated surface due to impact after fracture. Area 2, approximately 3/4 inch long, exhibited separation by tearing. Area 3, approximately 5/8 inch long, exhibited an outward tensile shear mode of failure. Area 4, approximately 1/2 inch long, failed in a tensile shear mode; however a reversal fracture pattern indicated that a flexing motion occurred during failure, reference photo 6. Area 5, approximately 1/2 inch long, exhibited a tensile shear mode of failure. Area 6, approximately 1/2 inch long, same as area 4. Area 7, approximately 1 inch long, exhibited a failure mode similar to area 5. *(Photograph 5 shows the different failed areas marked on the circumference of the pushrod).

4. Examination of the failed lugs found attached to the end fitting showed a tensile shear mode of failure. Photograph 7 is of the fractured surface on the right side of the end fitting. The left side exhibited a similar fracture mode. Fractographs of the lugs fractured surfaces, (Photos 8 & 9) show a dimpling effect which is characteristic of a tensile shear mode of failure. Lug material was identified as 7075 aluminum alloy.

5. Conclusion: Fractured surfaces examined on both the pushrod and mounting lugs revealed an overload type of failure. There was no material deficiency or defects that could have caused or contributed to the ultimate failure of fractures examined.

MARCOS R. SOLIS, Metallurgist

1 Atch
Photos 1 thru 9

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

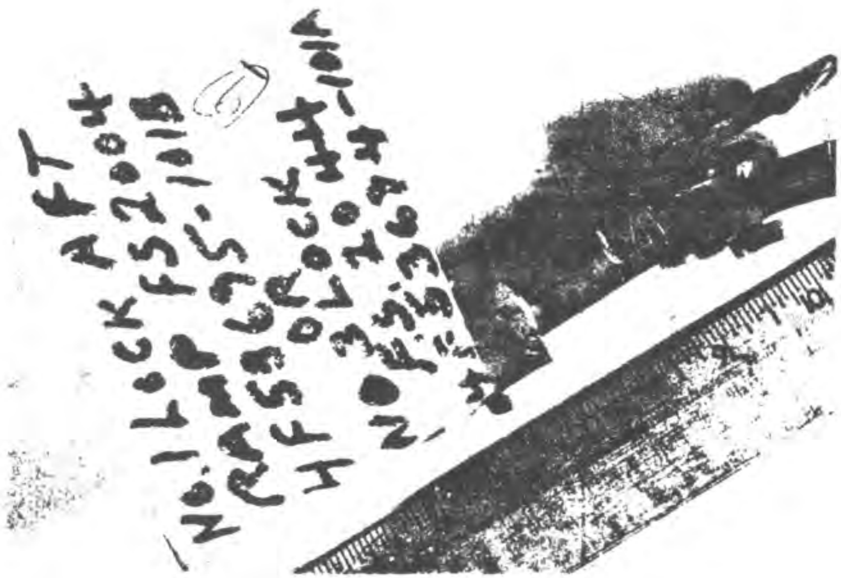


Photo 1
Pushrod as received.

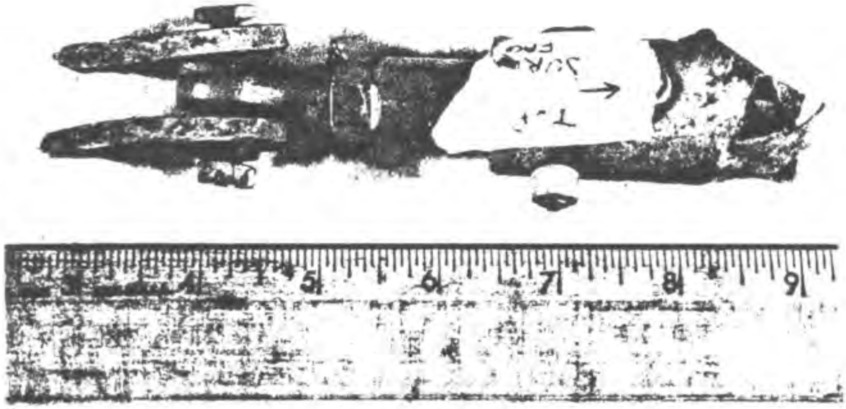


Photo 2
Top side of pushrod showing the two failed areas.

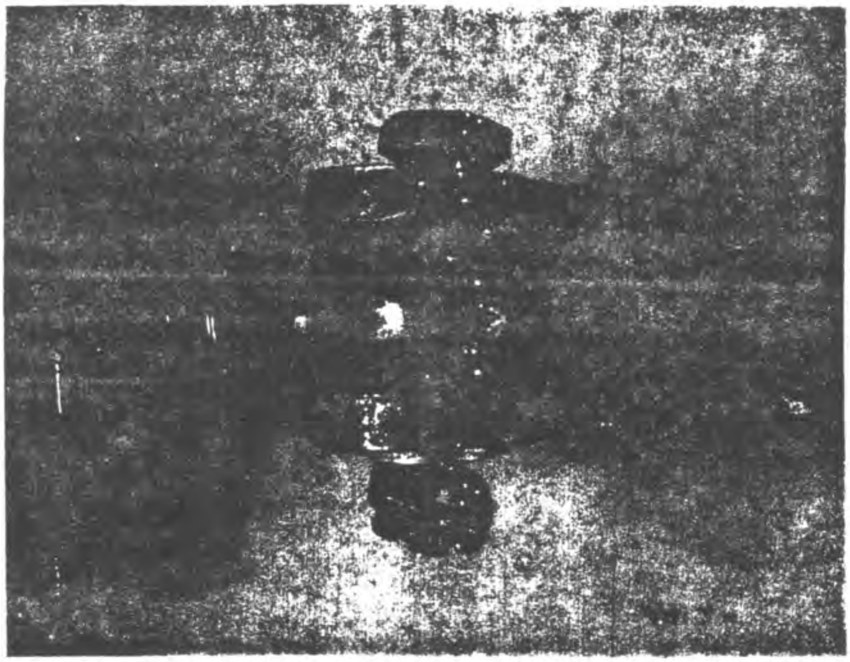


Photo 3
Close up view of end fitting and attached failed mounting lugs.

Photo 4
Close up view of failed pushrod tube.

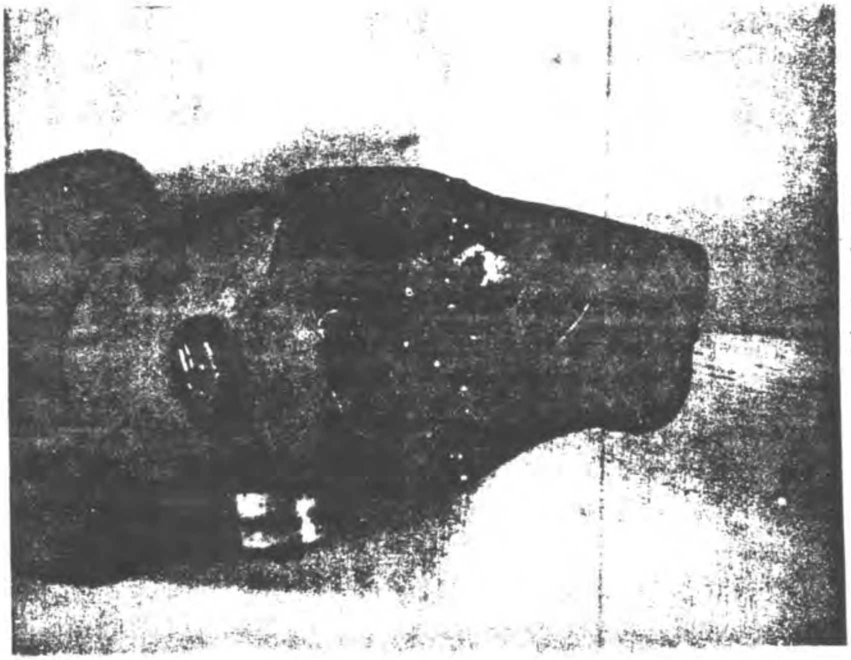


Photo 5
Arrows point to failed areas (around the circumference of the pushrod) as marked for reporting purposes.

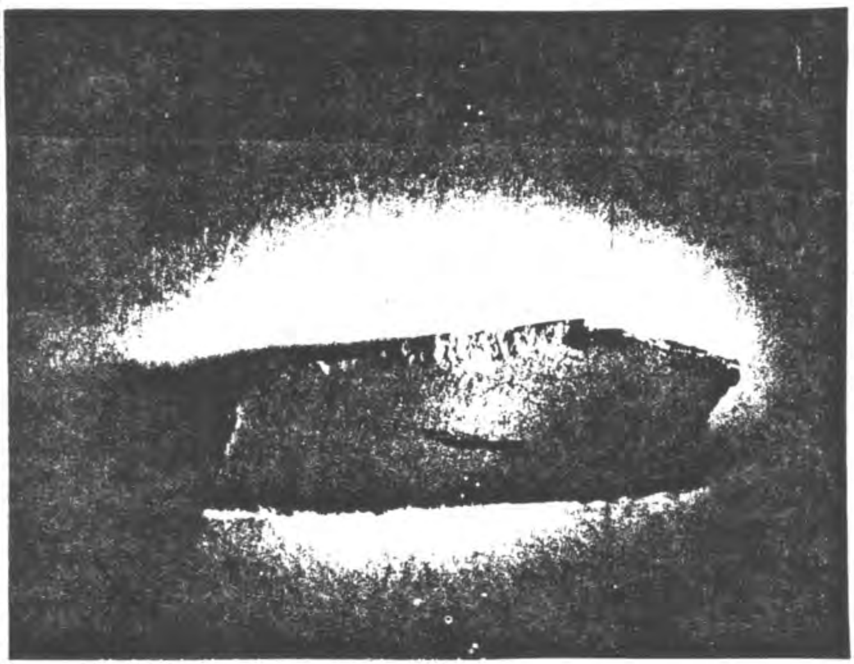
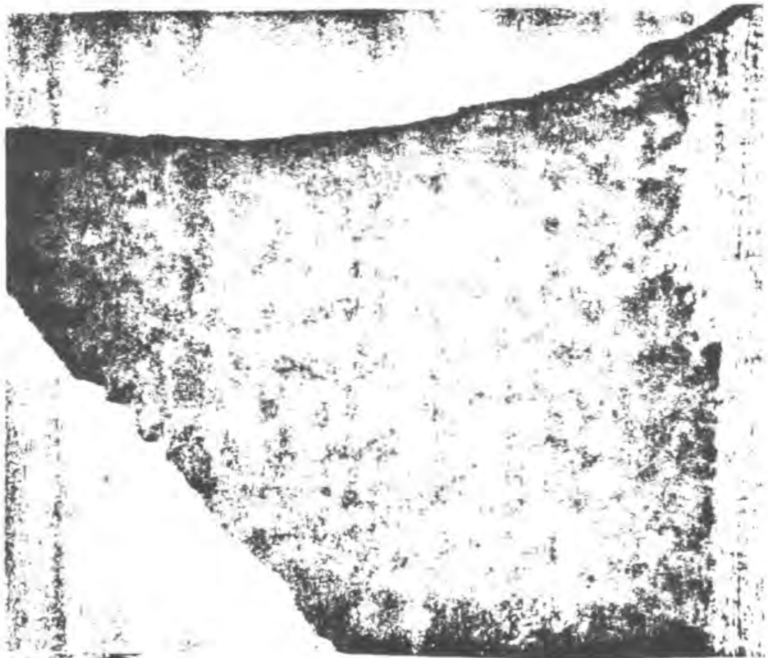


Photo 6
Edge of pushrod tube showing reversal fracture pattern caused by flexing.

Photo 7
Fractured surface on failed lug showing plastic deformation associated with tensile shear failure.



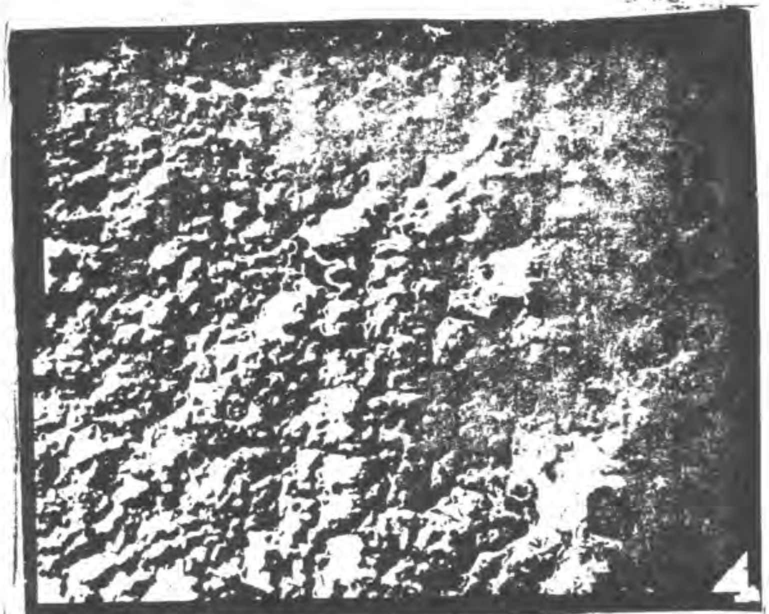


Photo 8
Fractograph of left side failed lug. Dimpling effect verifys a tensile shear overload failure.

Photo 9
Fractograph of right side lug. Fracture pattern is the same as on the left side.

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Left Side #5 Hook Bellcrank Assembly 23 Apr 1975

Task 1128, Attachment 10 142

Metallurgical Analysis

1. One C5A left side #5 hook assembly was submitted to the Metallurgical Laboratory in support of task 1128.

2. Visual and microscopic examination of the "as received" parts are identified in photo #1.

3. Spectrochemical analysis of the cracked bellcrank and bent pushrod were as follows:

a. Bellcrank - 7075 aluminum alloy.

b. Pushrod - 2024 aluminum alloy.

4. Visual and microscopic examination at 45X power revealed the following:

a. Photos #2 and #3, taken from the bellcrank body, revealed one large crack located approximately 1" below the left bushing hole. Also noted were two dents located on the left side of the bellcrank body.

b. Photos #4 and #5, taken of the two fractured surfaces, revealed possible signs of corrosion.

c. Photo #6, taken from the bellcrank body, revealed that the two bushing holes were elongated and occurred on aircraft impact.

d. Photos #7 and #8, taken of the 55K hook, revealed a dent at the left side of the hook. The attached link programming hook was also bent.

e. Photo #9 revealed that the fractured pushrod, which is attached to the main bellcrank body (photo #1), was in a stationary position on impact.

f. Photos #10 and #11, taken from the pushrod fractured faces, revealed a combination of tensile and torsional overloading as the mode of failure. It should be noted in this laboratory report that attachment 12, photos #6 and #7, which are of the same pushrod, also showed that a combination of tensile and torsional overloading was found to be the mode of failure.

5. Further examination of the suspected corrosion as seen in photos #4 and #5, utilizing the TEM (Transmission Electron Microscope), revealed the following:

a. Fractographs (12 and 13) taken along the bellcrank fracture faces conforms the presence of stress corrosion.

6. In conclusion, failure of the bellcrank was initiated by stress corrosion which can be seen in photos #12 and #13. Failure to the pushrod and other assemblies were found to be of the overload (impact) type.

SIGNED

DAVID BARRERA
Metallurgist

SIGNED

1 Atch
Photos #1 thru #13

SIGNED

O. H. [illegible]S, JR
Chief, Metallurgical Laboratory Section
MA

28 Apr 75

MANCE/Mr Orms — MANCD/Nondestructive Testing Lab Sec

Bellcrank and Hook Assembly — 28 Apr 75

MANCE/Task 1128, Attachment 10 — 75-76

Cracks

1. One each Bellcrank and Hook Assembly was received by MANCD for nondestructive inspection. Assembly was identified as Bellcrank and Hook Assembly, Left #5, Canted Fus Station 2084, Ramp Station 116.

2. Assembly was inspected as follows:

a. Specimen was processed by the liquid penetrant method using penetrant inspection materials Type I, Method "B", MIL-I-25135, Group VI with the family concept emulsifier and dry fluidized developer.

3. Inspection results:

a. Liquid penetrant revealed no indications of surface discontinuaties.

SIGNED

Jose N. Garcia
Qlty Assr Spec

SIGNED

MATIAS RAMOS JR.
Ch, NDT Lab Sec

Photo #1. As received #5 hook bellcrank assy

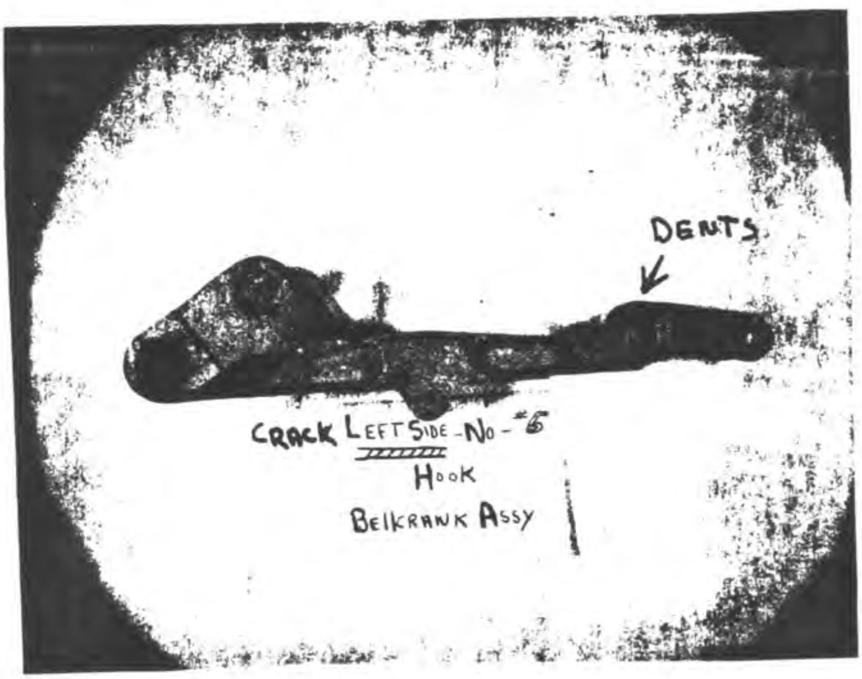
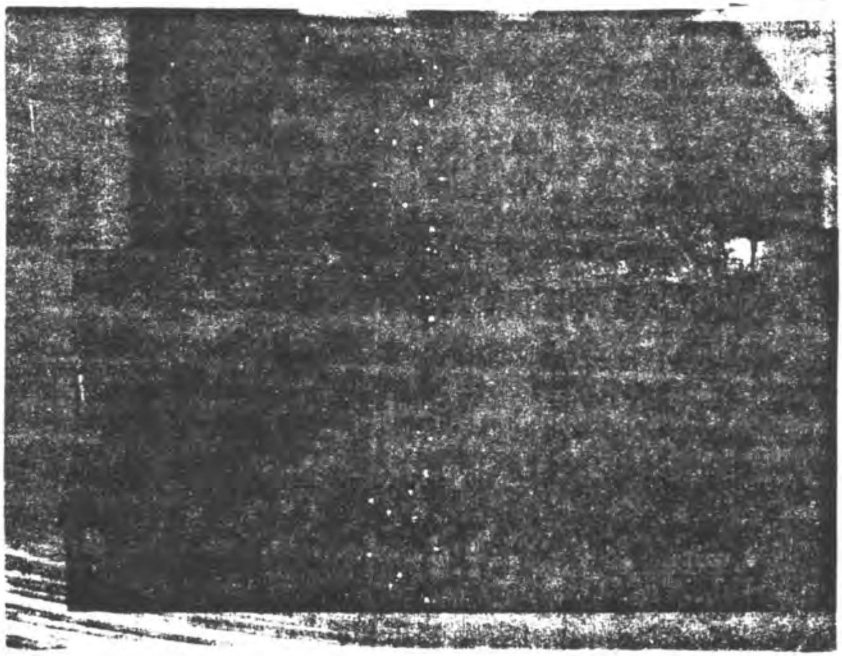
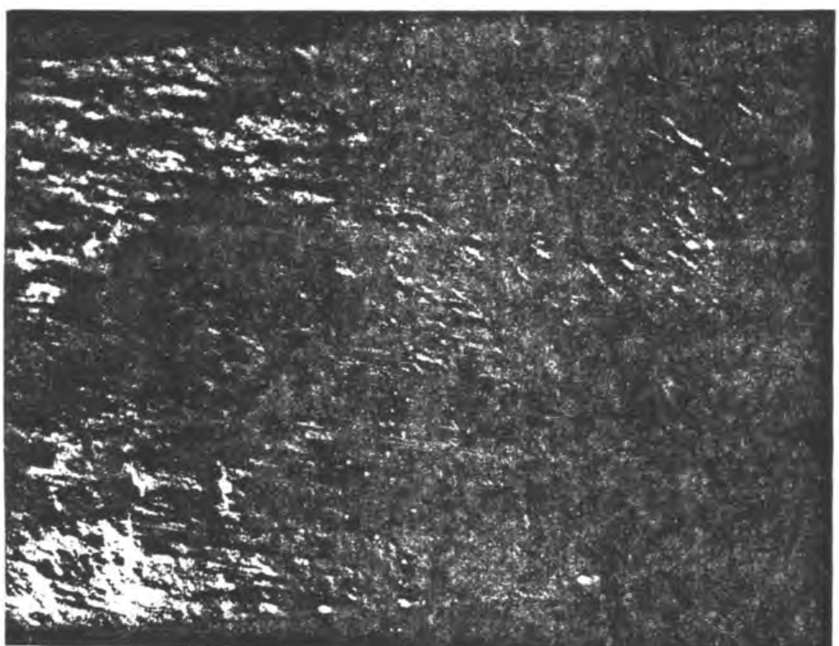


Photo #2 exhibits crack and two dents located on the same side of the bellcrank.

Photo #3 exhibits crack in bellcrank which is also adjacent to elongated bushing holes.



Photos #4 & #5
Taken from the Bellcrank
fracture faces.



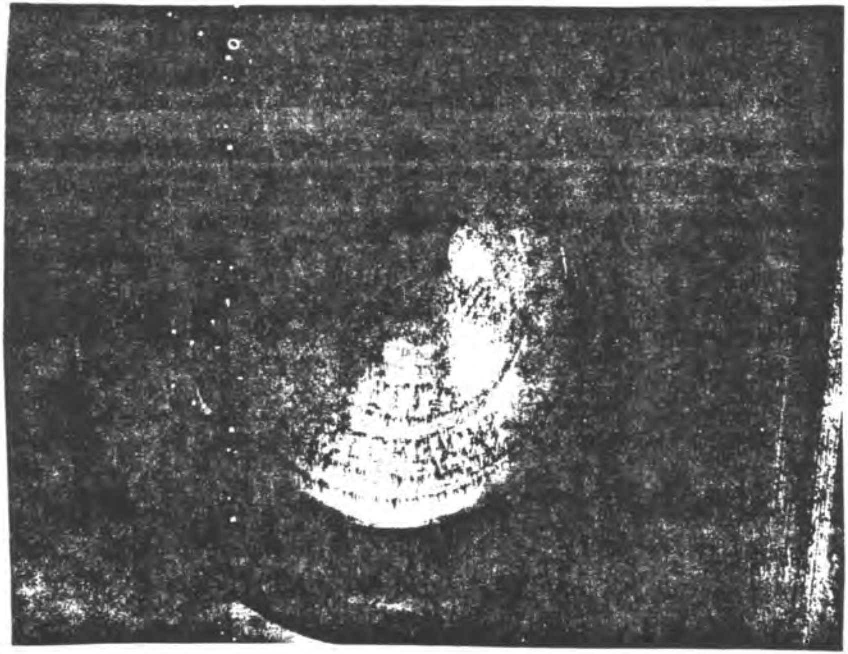


Photo #6. Bellcrank bushing (arrow) exhibits elongation of the bushing holes.

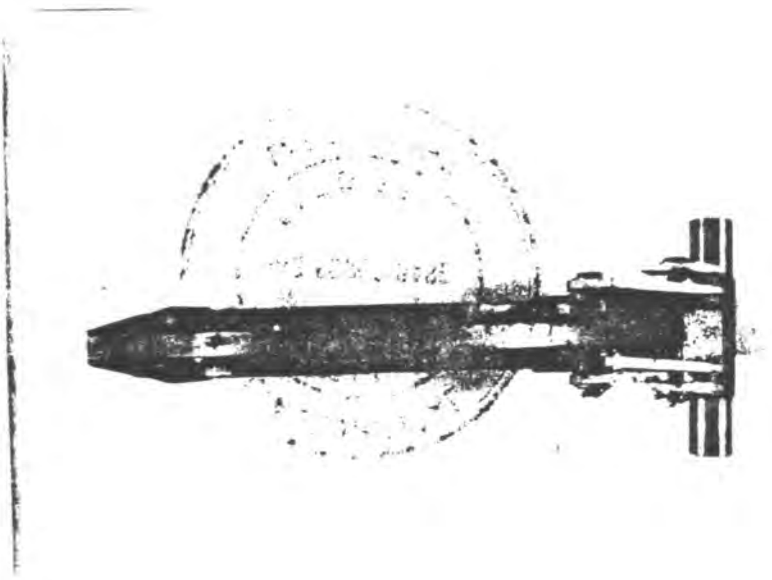


Photo #7. Main hook and benk link programming hook.

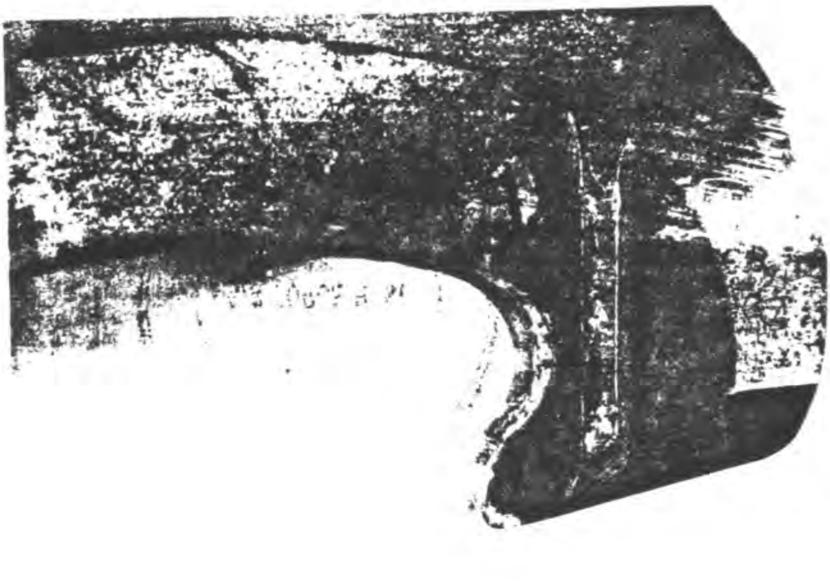


Photo #8. Hook latch reveals impact damage at left side of the hook.

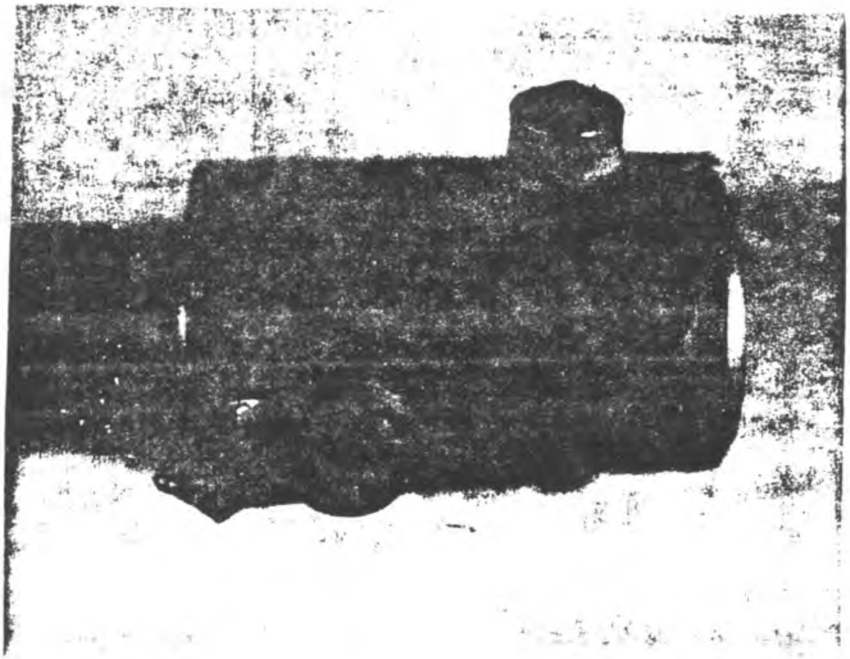


Photo #9. Fractured pushrod.

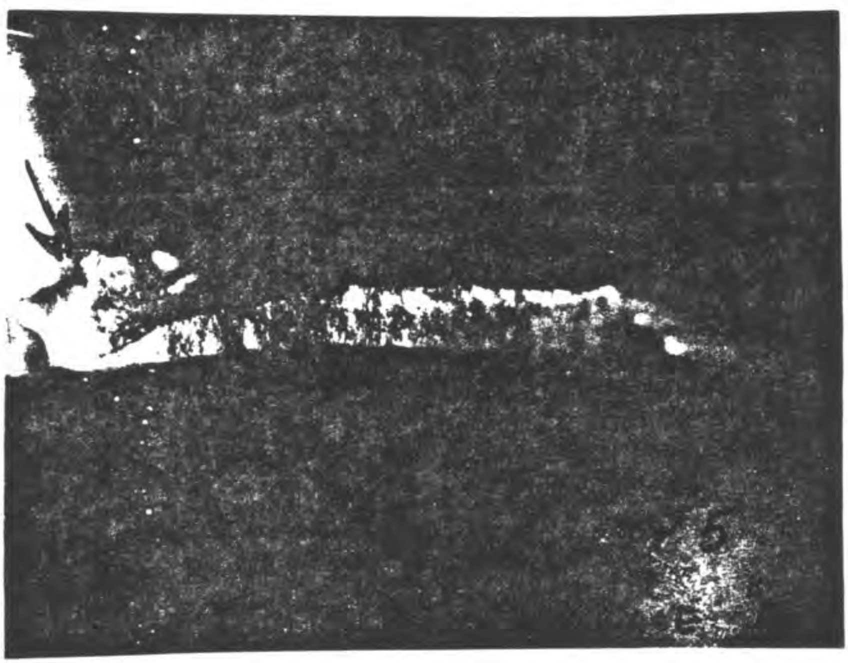


Photo #10. Macro-examination revealed that ultimate failure of the pushrod was the result of a twisting action ; also evidence of elongation.

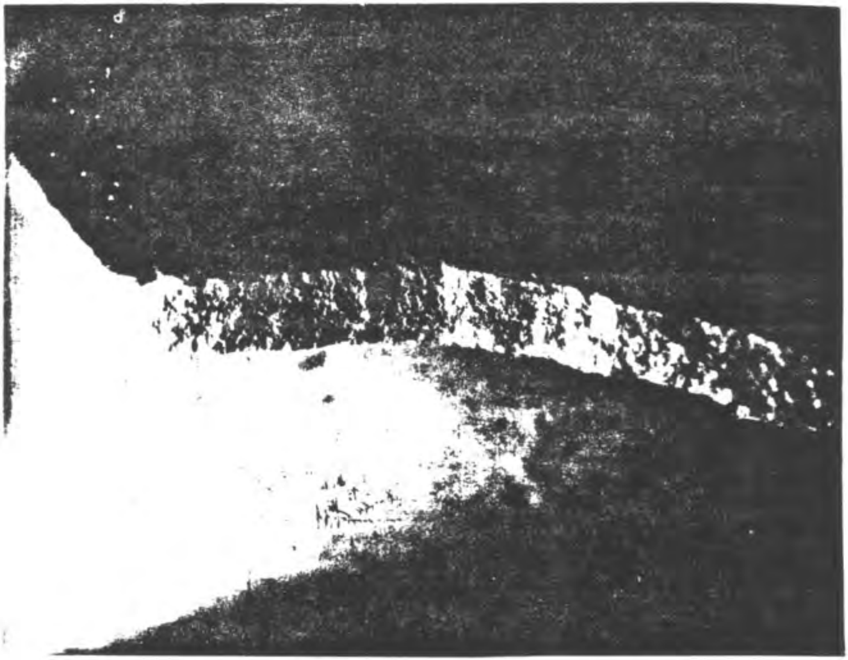
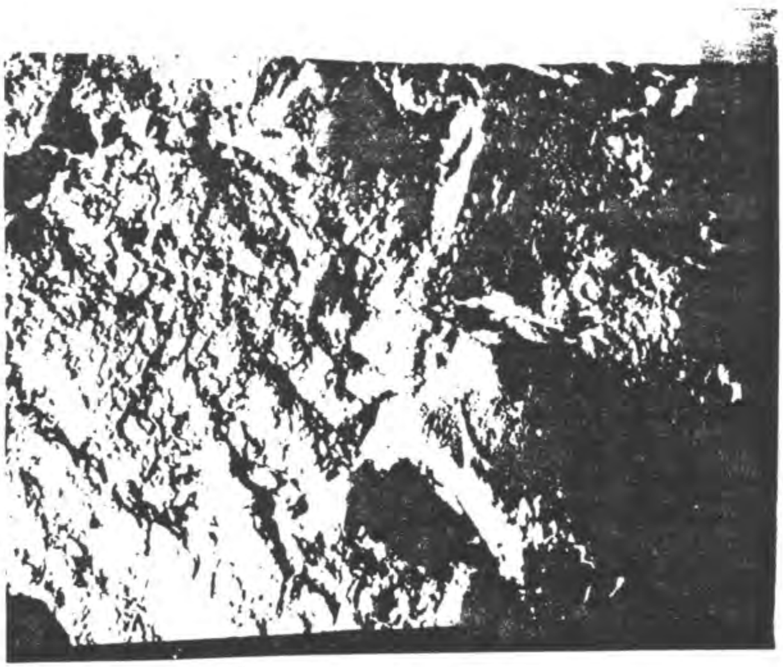


Photo #11. Exhibits fracture face.



3000X

Photos #12 and 13. Fractograph shows stress corrosion (red arrows) taken from the bellcrank fracture surface.

26 Apr 1975

MME-5/Capt Gregory/Capt Scheiding/57845/53503 MANCE/Metallurgical Laboratory Section

Left #5 Saddle Fitting 23 Apr 1975

Task 1128, Attachment 11 142

Metallurgical Analysis

1. One failed saddle fitting identified as #5 left side was submitted to the Metallurgical Laboratory for analysis in support of Task 1128.

2. Photographs of the exhibit as received are identified as Photo #1.

3. Spectrographic analysis identified the material of this exhibit as 7075 aluminum alloy, with a Rockwell hardness of Rc 92. This indicates the material is in the T6 heat treated condition.

4. Visual and microscopic examinations of the fractured surface showed the area was smeared from foreign object damage, or impact. There was a small area that did not show this condition, and this is where we made our examination. There was some light blue paint on the surface near the beginning of the damaged area (see Photo #2). The fracture was not an old failure, but the result of impact.

SIGNED

J. PARKER
Metallurgist
O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

1 Atch
Photos #1 and #2

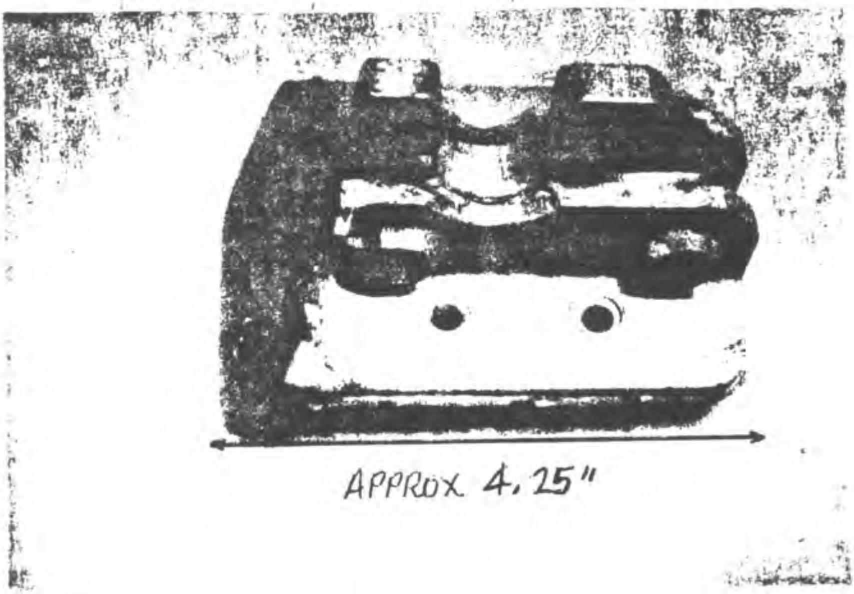


Photo 1. #5 Left Side Saddle Fitting Showing the Exhibit as Received Here in Metallurgical Laboratory.

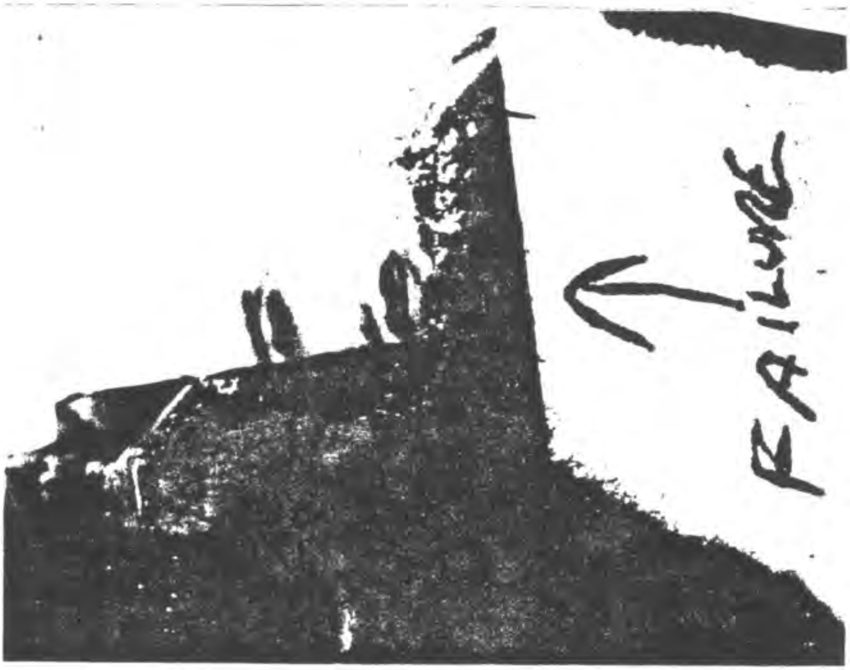


Photo 2. #5 Left Side Saddle Fitting Showing the Area Where the Light Blue Paint was Noted (see arrows) at the Beginning Where Fracture Initiated.

M-1

26 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory

Left 4 to 5 Pushrod 23 Apr 75

Task #1128 Number 12 Attachment #142

Metallurgical Analysis

1. Two failed pieces of tubing identified as Left 4 to 5 Pushrod were submitted for analysis as per attachment 12 of basic MME Task #1128.

2. For the purpose of this report the pieces will be refer to as exhibit "A" (piece with the swivel fitting attached) and exhibit "B" (piece without the fitting). Photographs 1 thru 3 are of the exhibits as received.

3. Visual examination of the exhibits showed three fractured surfaces, one (1) on exhibit "A" and two (2) on exhibit "B". It was also noted that the fracture surface on exhibit "A" matched one of the fractured surfaces on exhibit "B" (reference photographs 4 and 5). These are photos of the matched surfaces as viewed from two angles 180° apart. It was also noted that both exhibits were dented as shown by the arrows on reference photographs. At this time it was determined that one item in attachment 10, marked Left #5 Bellcrank and Hook Assembly was the missing piece of the left 4 - 5 push rod (reference photograph 6). This item was matched to the other two exhibits and photographed (see photo #7).

4. Spectrographic analysis showed that the push rod tube was made of type 2024 aluminum alloy.

5. Microscopic and metallographic examination of the fractured surfaces showed a fracture mode characteristic of overload in a bending and twisting motion. Photograph #7 shows the buckling of the tube due to bending and the twisting load paths. Although the primary load path on exhibit "A" was counter clockwise, some flexing occurred as evident by the reversal in direction of fracture (reference photograph #8). Photograph #9 shows the typical tensile shear mode of fracture observed on all fracture surfaces.

6. Conclusion: It was determined that the fractured surfaces examined exhibited a fracture mechanism characteristic of an overload failure, and that there was no evidence of material deficiency or defects that caused or contributed to the ultimate failure.

SIGNED

MARCOS R. SOLIS, Metallurgist

1 Atch
Photos 1 thru 9

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

OVB

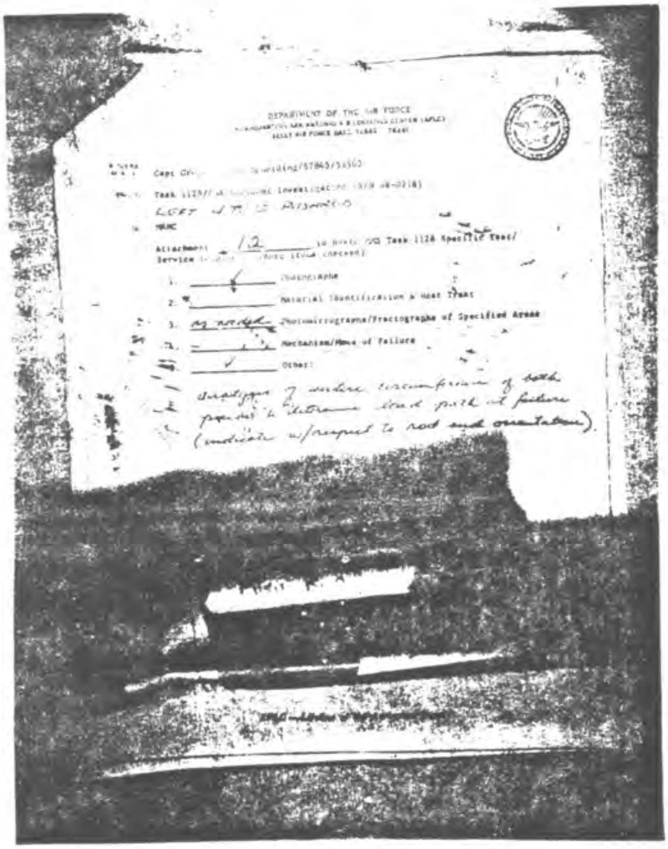


Photo #1
Pieces of tubing and attachment
as received.

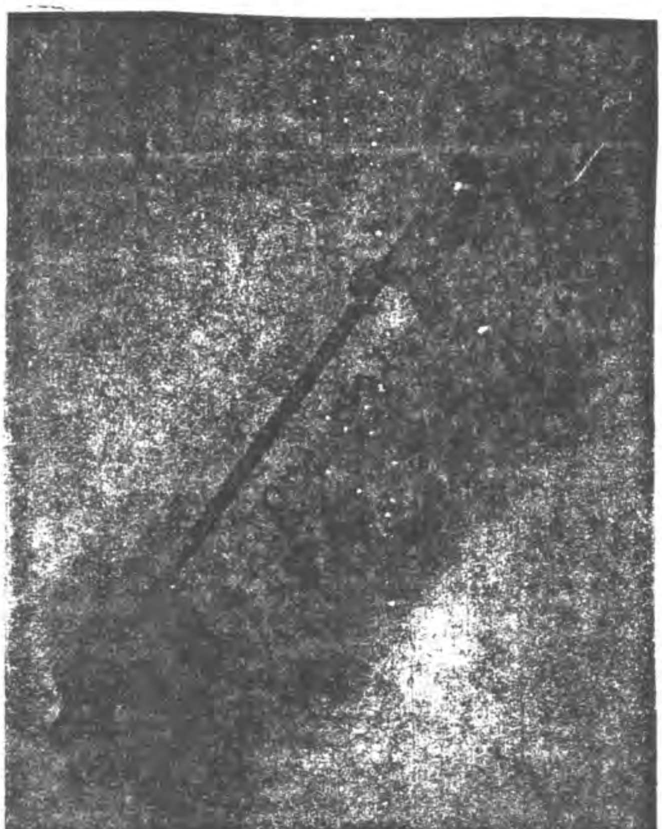


Photo #2
Close up view of exhibit "A"
as received.

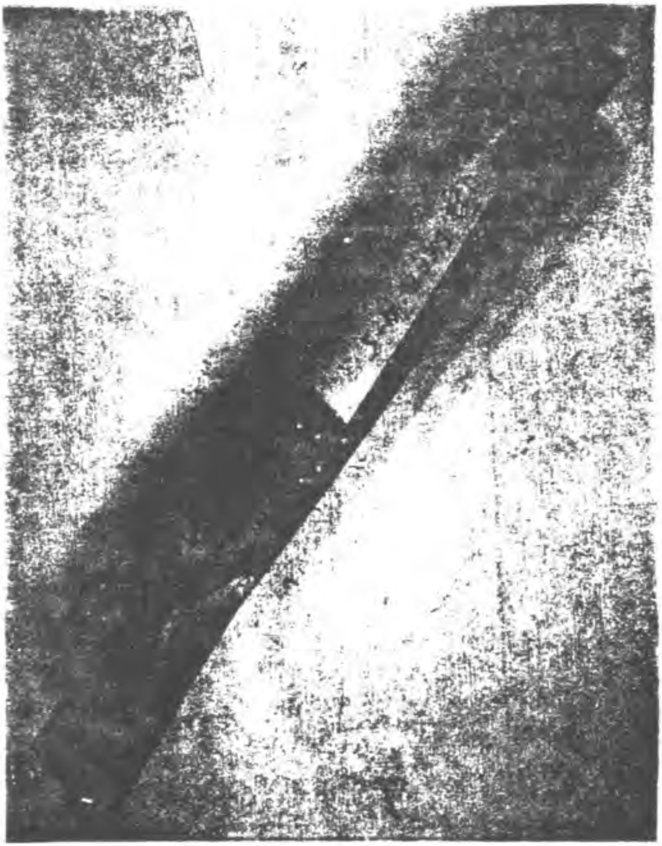


Photo #3
Close up view of exhibit "B"
as received.

Photo #4
Matching fractured surfaces fitted together. Arrows point to the fracture and also to a dent noted exhibit "B".

Photo #5
Same as photo #4 except viewed from a different angle. Note that exhibit "A" was also dented.

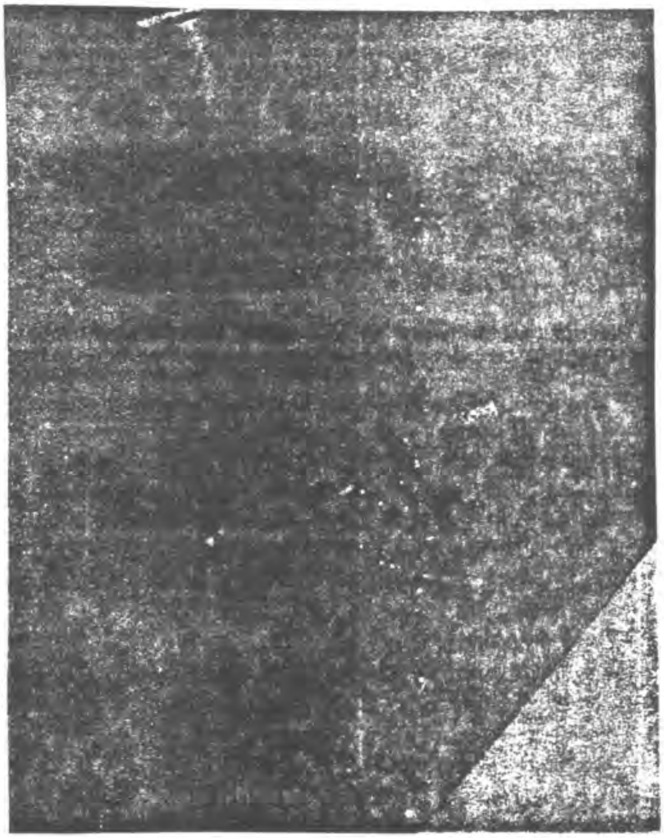


Photo #6
This item was with attachment 10 but was found to be the missing part of subject push rod.

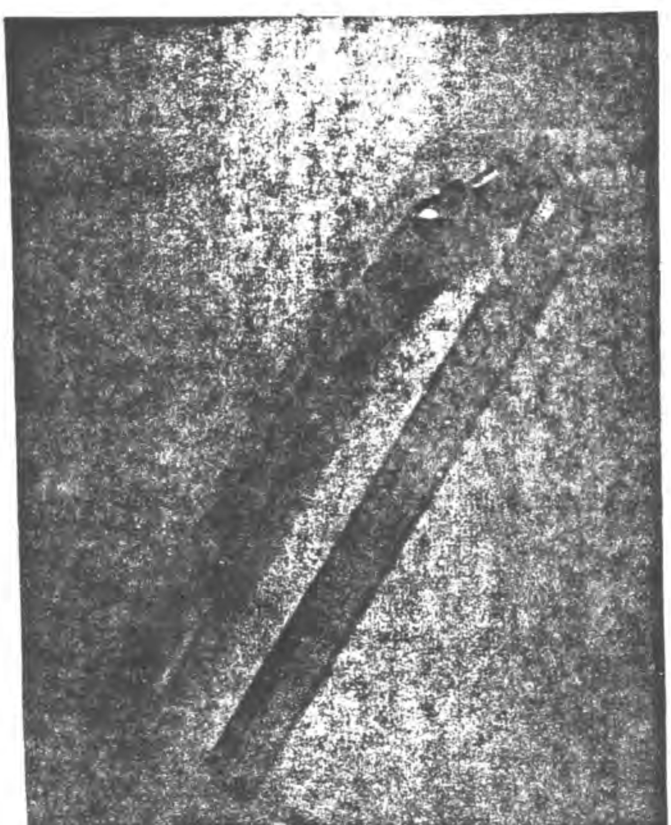


Photo #7
Load paths are indicated by arrows. Fracture at exhibit "A" showed evidence of flexing.

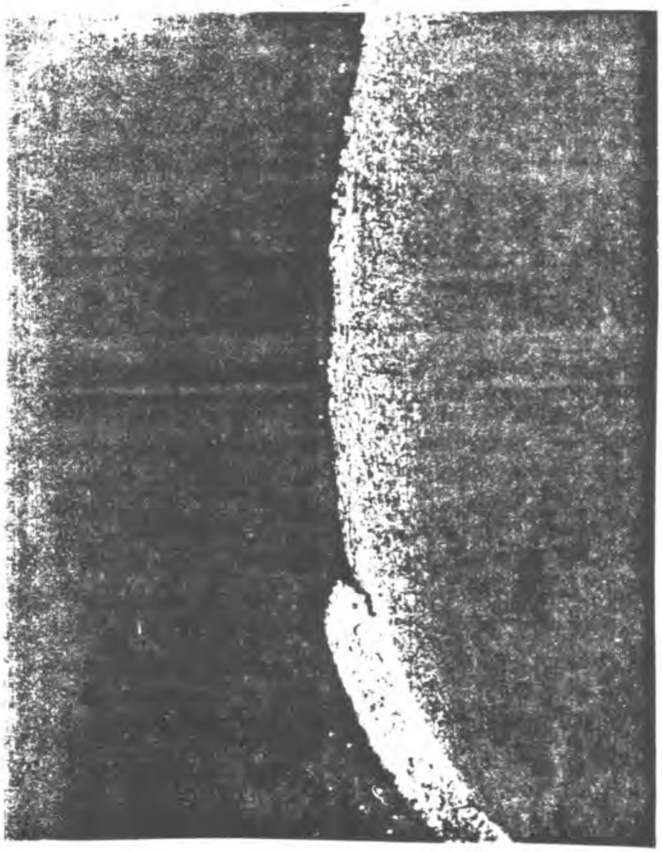


Photo #8
Fractograph of shear reversal pattern caused by flexing.

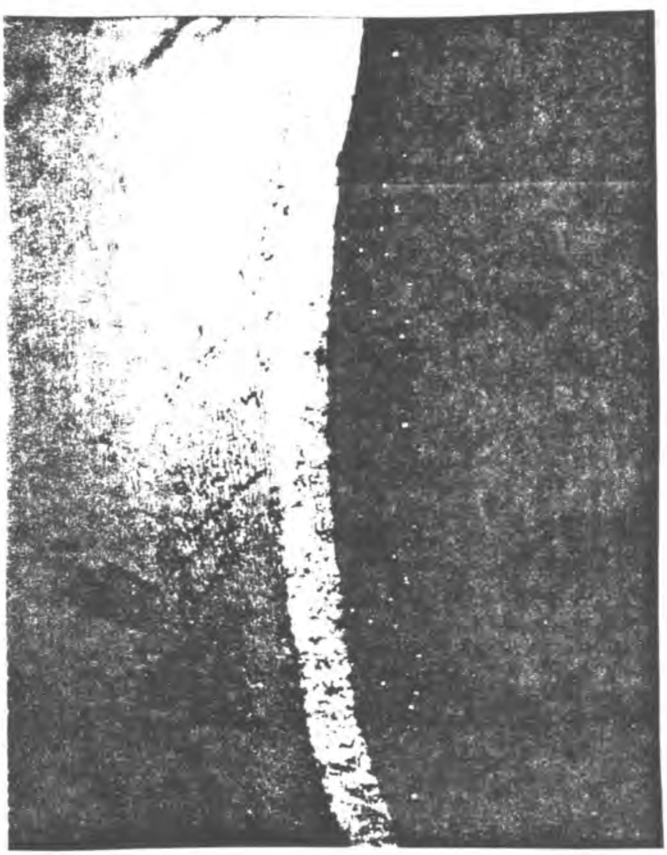


Photo #9
Typical tensile shear pattern observed on all fractured surfaces.

28 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#4 Left Side Hook & Bellcrank Assembly 23 Apr 1975

Task 1128, Attachment 13 #142

Metallurgical Analysis

1. One #4 left side hook and bellcrank assembly was submitted to the Metallurgy Laboratory for analysis in support of Task 1128, Attachment 13. Nondestructive Test Report is attached.

2. Photo #1 identifies the hook and bellcrank assembly. The corrosion pitting of the bellcrank should not be taken into consideration in this investigation. This was the result of the cleaning operation, in the stripping of the part.

3. The crack indication as reported by Nondestructive Test Report, Lab Control #75-76 was investigated under the microscope. The suspected crack was forced open. A replica was made of the fractured surface, for observation under the Electron Microscope. Photo #2. In forcing the crack open, the suspected crack did not propagate under load. The bellcrank cracked in another location adjacent to the initial crack. Then the suspected crack was opened to obtain the initial crack face.

4. The Electron Microscope investigation and analysis showed stress corrosion combined with stresses on the fractured surface. Fractographs were made on the suspected surface. They revealed the start of stress corrosion cracking, which can be attested to the "mud crack" as indicated in the center of Photo #3. Fractography 5600X. Photo #4 is further proof of the stress corrosion. The dimple area on both photographs 3 & 4 is the result of the state of stress.

5. Spectrograph analysis identified the material as 7075 aluminum alloy.

SIGNED

W. H. CROCKER, Metallurgist

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

2 Atch
1. NDT Lab Report
2. Photos 1 thru 4

28 Apr 75

MANCE/Mr Crocker | MANCD/Nondestructive Testing Lab Sec

Side Hook and Bellcrank Assembly | 25 Apr 75

MANCE/Task 1128, Attachment 13 | 75-76

Cracks

1. One each Side Hook and Bellcrank Assembly was received by MANCD for nondestructive testing. Assembly was identified as Side Hook and Bellcrank Assembly, Left Side #7 Canted Fus Sta 2064, Ramp Sta 95.

2. Specimen assembly was processed as follows:

a. All assembly components made from ferro-magnetic materials were processed by the magnetic particle method, using longitudinal and circular fields and the wet continuous method of particle application.

b. All assembly components made of non-magnetic materials were processed by the liquid penetrant method using inspection materials Type I, Method "B", MIL-I-25135, Group VI with the family concept emulsifier and dry fluidized developer.

3. Inspection results:

a. Magnetic Particle Inspection:

(1) No discrepancies were noted on all ferro-magnetic components inspected.

b. Liquid Penetrant Inspection:

(1) Inspection revealed one non-magnetic component to contain extensive corrosion pitting throughout the entire casting. Corrosion pits were deep, heavily concentrated in some areas with some pits following chain-like patterns. One crack indication was also noted in the recessed area of the casting. Indication was approximate .250" in length followed by a series of corrosion pits. See attached sketch. No discrepancies were noted on the other non-magnetic component. Defective component was identified as follows:

(a) Bellcrank Assembly P/N 4F53694-101A, TO 1C-5A-4-1, fig 182-38.

4. All defective areas were marked.

SIGNED
Jose N. Garcia
Qlty Assr Spec

SIGNED

MATIAS RAMOS JR.
Ch, NDT Lab Sec

1 Atch
Sketch

Photo #2
Identifies suspected crack.

Photo 1. Hook and Bellcrank Assy after stripping and cleaning.

Photo #2
Identifies suspected crack.

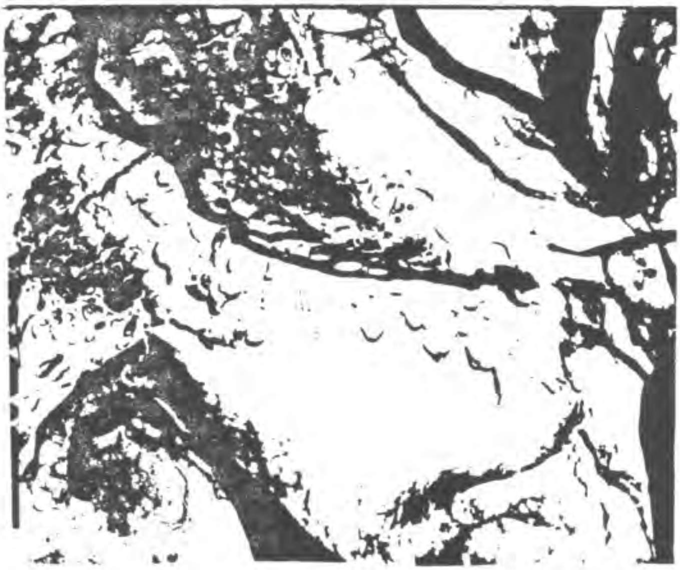


Photo #3 - 5600X MAG
Shows stress corrosion cracking identified by typical "mud cracking" dimples are the result of the state of stress.

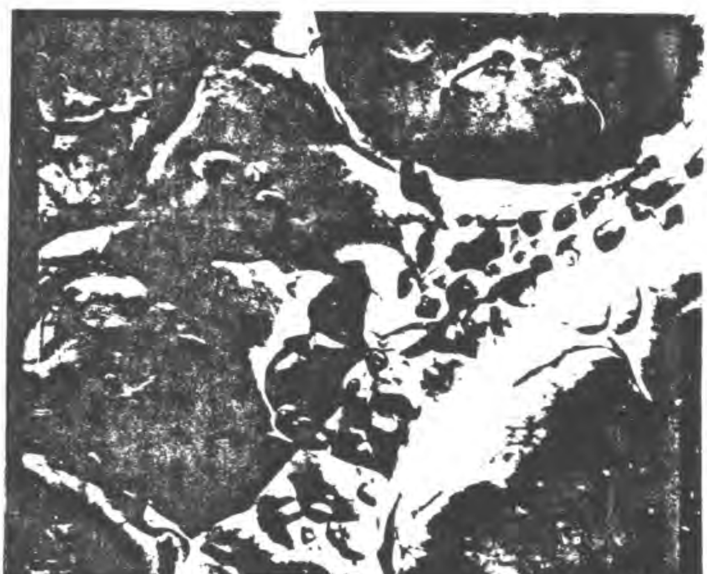


Photo #4 - 5600X MAG
Stress corrosion dark lines crack phenomena - plus dimpling and stresses.

26 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#7 Yoke Guide (Left) Support Backup Structure 23 Apr 75

Task #1128 Attachment #14 #142

Metallurgical Analysis

1. One #7 yoke guide (left) support backup structure was submitted to the Metallurgy Laboratory on attachement #14 to investigate the drilled hole.

2. Photo #1 identifies the yoke guide. Photo #2 shows the elongation of the hole present in the yoke guide.

3. Microscopic investigation revealed no evidence of a recent repair or installation of a new fastener. There is no indication of the hole being redrilled.

W. H. CROCKER, Metallurgist

1 Atch
Photos 1 & 2

O.H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

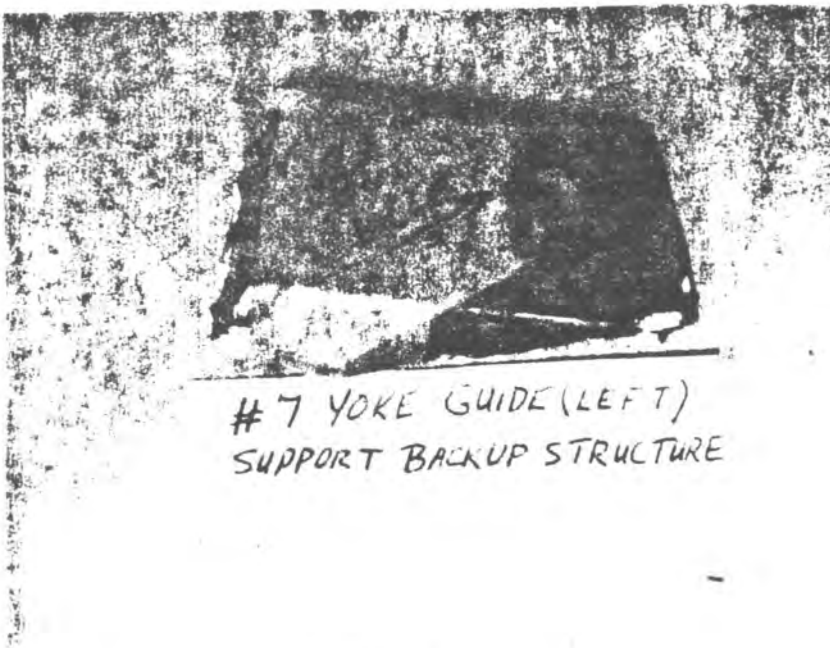


Photo #1

One #7 yoke guide (left) support backup structure as submitted to the Metallurgical Laboratory.

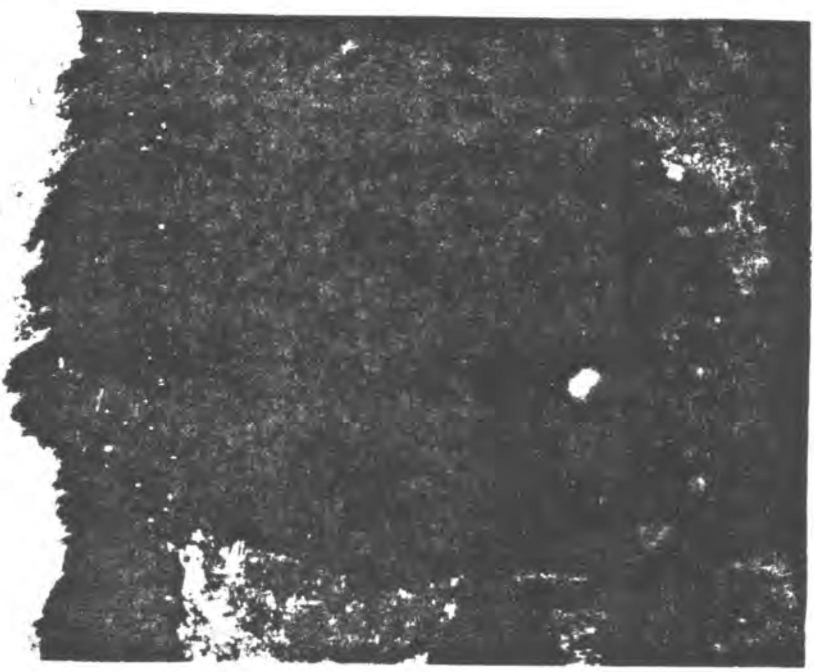


Photo #2

Elongation of the hole as shown by 13X magnification.

26 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845   MANCE (Metallurgical Laboratory)

#7 Yoke Guide (Left) Support Backup Structure   23 Apr 75

Task #1128 Attachment #14   #142

Metallurgical Analysis

1. One #7 yoke guide (left) support backup structure was submitted to the Metallurgy Laboratory on attachement #14 to investigate the drilled hole.

2. Photo #1 identifies the yoke guide. Photo #2 shows the elongation of the hole present in the yoke guide.

3. Microscopic investigation revealed no evidence of a recent repair or installation of a new fastener. There is no indication of the hole being redrilled.

W. H. CROCKER, Metallurgist

1 Atch
Photos 1 & 2

O.H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

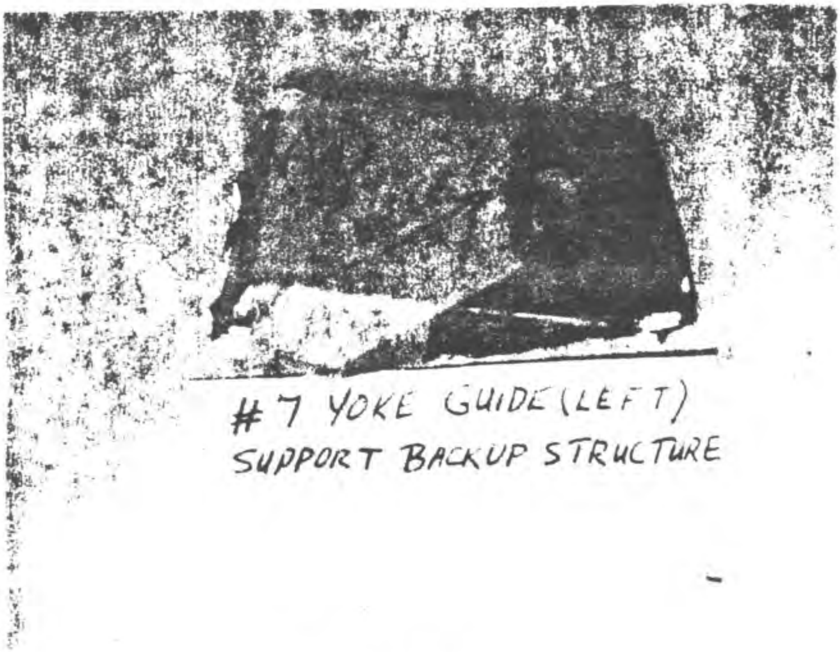


Photo #1

One #7 yoke guide (left) support backup structure as submitted to the Metallurgical Laboratory.

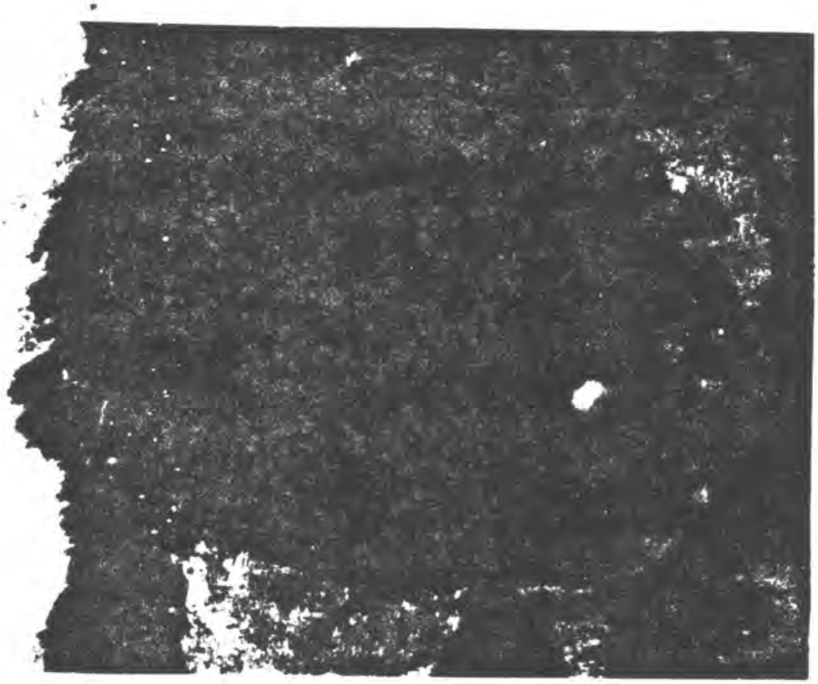


Photo #2

Elongation of the hole as shown by 13X magnification.

29 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#5 Pressure Door Roller Bracket 23 Apr 75

Task #1128, Attachment 15 #142

Metallurgical Analysis

1. One failed piece of pressure door roller bracket identified as #5 Pressure Door Roller Bracket, was submitted for analysis as per Attachment #15 of basic MME Task #1128.

2. Photograph of the exhibit as received are identified as Photo 1, also shows where metallurgical specimen was taken, along with the TEM (Transmission Electron Microscope) fractographs specimens.

3. Spectrographic analysis identified the material of the bracket as 7075 aluminum alloy, with a Rockwell hardness of R_B 90, this indicates the material is in a T6 heat treated condition.

4. Visual and microscopic examination of the fractured surface showed a "woody" and fibrous appearance, this is typical for high strength aluminums. Also this exhibit showed a cupping effect on the fractured surface which is indictive of tensile overload.

5. Metallurgical and TEM analysis revealed the mode of failure was due to stress-corrosion cracking on both sides of the exhibit (see photos 3 & 4 also photos 7 & 8). After stress-corrosion cracking was initiated it propagated in a series of steps which was caused by fluctuating loads, with final failure being a tensile overload on one section of the bracket.

6. Conclusion: The failure of the bracket was initiated by stress-corrosion, of crack initiated from both sides of the part. Other fractures on the bracket were found to be of the overload (impact) type failures.

SIGNED

JOHN PARKER, Metallurgist

1 Atch
Photos 1 thru 8

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

JdB

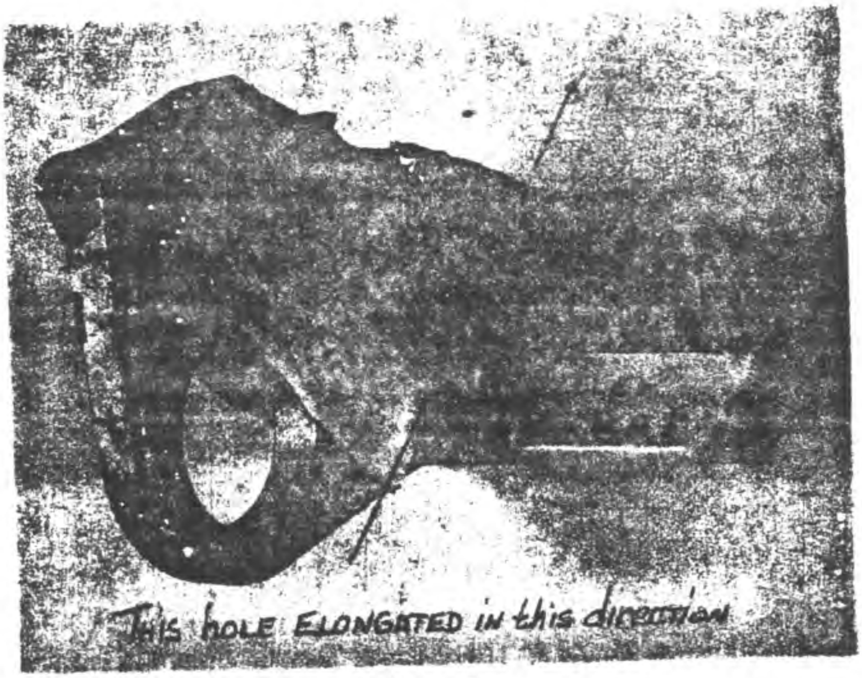


Photo 1
#5 Pressure Door Roller Bracket - Showing the exhibit as received here in the Metallurgical Laboratory, also the direction that bracket fractured in, MET Specimen & TEM (Transmission Electron Microscophy) specimen were taken as indicated on the fractured surface.

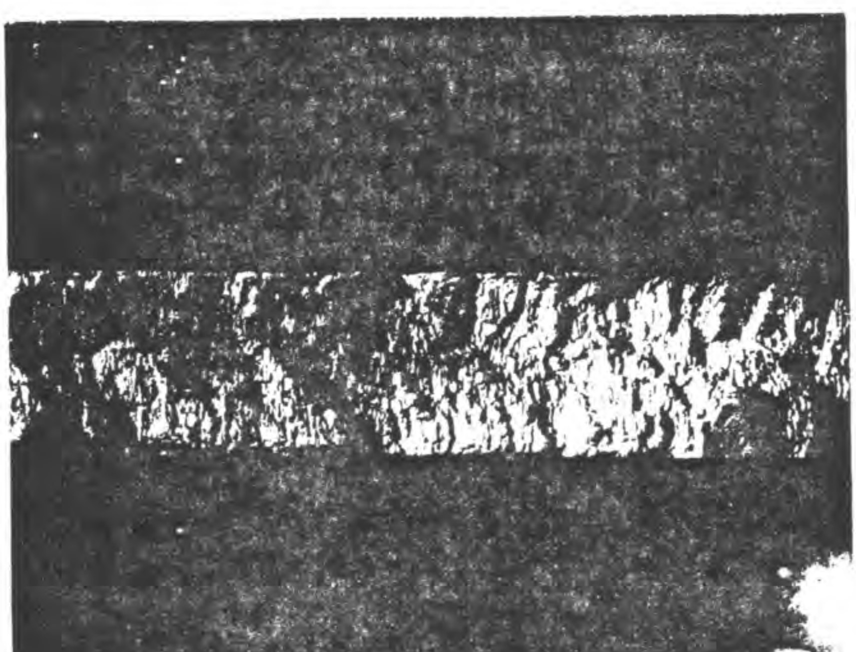


Photo 2 8X
#5 Pressure Door Roller Bracket - Showing the fractured surface where TEM specimen was taken, this area shows stress-corrosion cracking initiating on the top & bottom sides of the bracket (see next photos).

Photo 3 200X

#5 Pressure Door Roller Bracket - Showing the top side of the exhibit, and how the corrosion has attacked the surface along with intergranular corrosion in the grain boundaries.

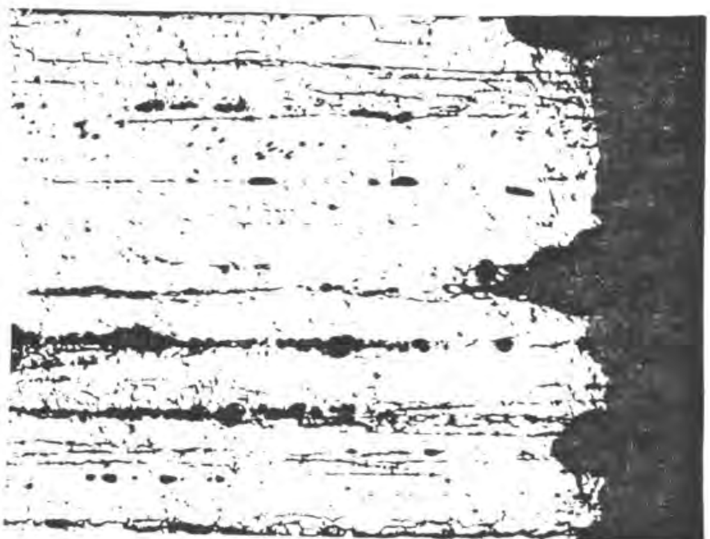


Photo 4 200X

#5 Pressure Door Roller Bracket - Showing the bottom side of the exhibit with the same condition as the above photograph.

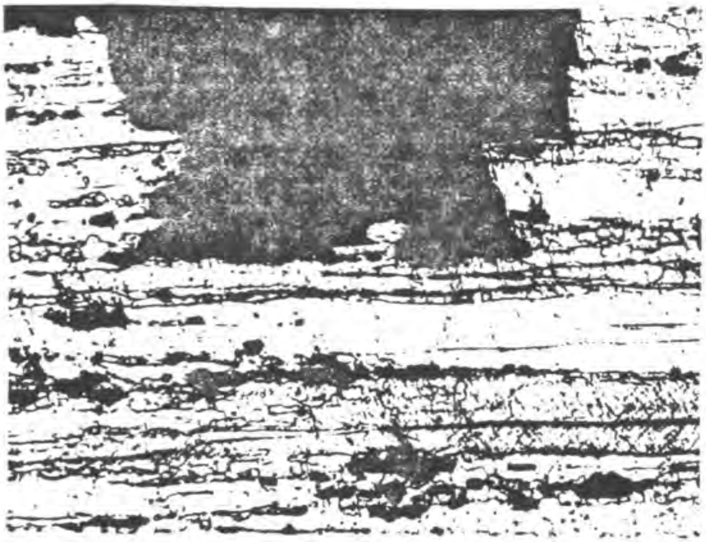


Photo 5 200X

#5 Pressure Door Roller Bracket - Showing the fractured surface of the exhibit, notice how the stress-corrosion has actually separated the grains, along withthe missing piece (center) that was attacked by corrosion also. Stress-corrosion cracking was favored by imposition of tensile stresses and by exposure to atmospheric conditions.

Photo 6 200X

#5 Pressure Door Roller Bracket - Showing the fractured surface at a different location, with the same condition as the above photograph.

28 Apr 75

MANCF/Mr. Orms MANCD/Nondestructive Testing Lab Sec

Right or Left Hook #3 26 Apr 75

MANCE/Task 1128, Attachment 8 75-76

Cracks

1. One each Right or Left Hook #3 was received by MANCD for nondestructive inspection. Specimen was identified as a portion of the Right or Left Hook #3 Assembly, Canted Fus Station 2044, Ramp Station 74.

2. Specimen was inspected as follows:

a. Specimen was processed by the liquid penetrant method, using penetrant inspection materials, Type I, Method "B", MIL-I-25135, Group VI, with the family concept emulsifier and dry fluidized developer.

3. Inspection results:

a. Liquid penetrant inspection revealed no discrepancies.

NOTE: It is not known whether this hook is right or left.

Jose N. Garcia
Qlty Assr Spec

MATIAS RAMOS JR.
Ch, NDT Lab Sec

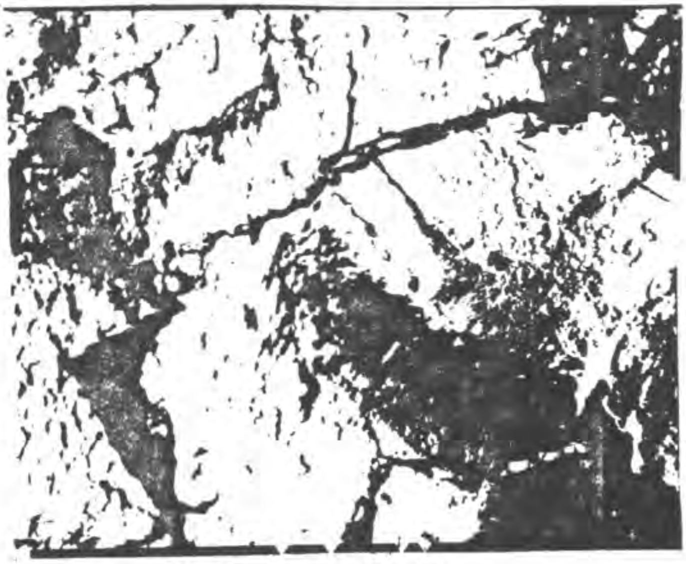


Photo 7 8000X

#5 Pressure Door Roller Bracket - Showing a fractograph of the fractured surface with "mud cracks" and stress-corrosion cracking. The fracture had a dull, woody appearance and secondary cracking was also evident.

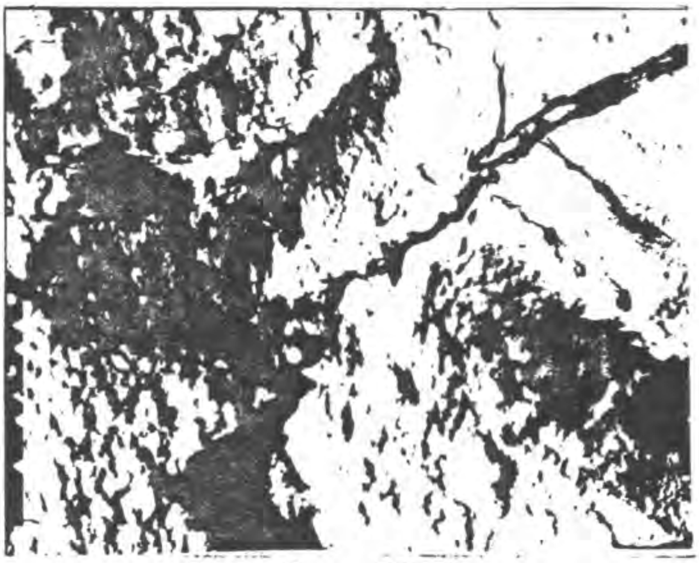


Photo 8 8000X

#5 Pressure Door Roller Bracket - Showing a fractograph with the same condition as reported in the above fractograph.

Q-1

27 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#7 Right Hook & Bellcrank Assembly 23 Apr 75

Task #1128, Attachment #16 #142

Metallurgical Analysis

1. One failed #7 Right Hook & Bellcrank assembly was submitted to the Metallurgy Laboratory in support of Task 1128, Attachment #16.

2. Photographs were taken of the hook and bellcrank assembly. Photo 1. Photo 1 also identifies A & B specimens selected for analysis.

3. Microscopic investigation revealed specimen "A" failed in tension overload. Surface is fibrous, with numerous secondary cracks. Photo 2. Specimen "B" failed in a similar mode except there was extensive rubbing action, which destroyed the fracture surface. Photo 2. This specimen also displayed a bending action and impact.

4. There was no evidence of damage to the hook other than the impact to one side of the root of the hook. Photo 1.

SIGNED

W. H. CROCKER, Metallurgist

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

2 Atch
1. NDI Enclosure
2. Photos 1 & 2

Q-2

26 Apr 75

MANCE/Mr Crocker MANCD/Nondestructive Testing Lab Sec

Right Hook and Bellcrank Assembly #7 25 Apr 75

MANCE/ Task 1128, Attachment 16 75-76

Cracks

1. One each Right Hook and Bellcrank Assembly was received by MANCD for nondestructive inspection. Assembly was identified as Right Hook and Bellcrank Assembly #7, Right Side, Canted Fus Station 2064, Ramp Station 95.

2. Assembly was processed as follows:

a. All assembly components made from ferro-magnetic materials were processed by the magnetic particle method using longitudinal and circular fields and the wet continuous method of particle application.

b. All assembly components made from non-magnetic material were processed by the liquid penetrant method using inspection materials Type I, Method "B", MIL-I-25135, Group VI with the family concept emulsifier and dry fluidized developer.

3. Inspection results:

a. Magnetic Particle Inspection: No discrepancies were noted.

b. Liquid Penetrant Inspection: No discrepancies were noted.

Jose H. Garcia
Qlty Assr Spec

MATIAS RAMOS JR.
Ch, NDT Lab Sec

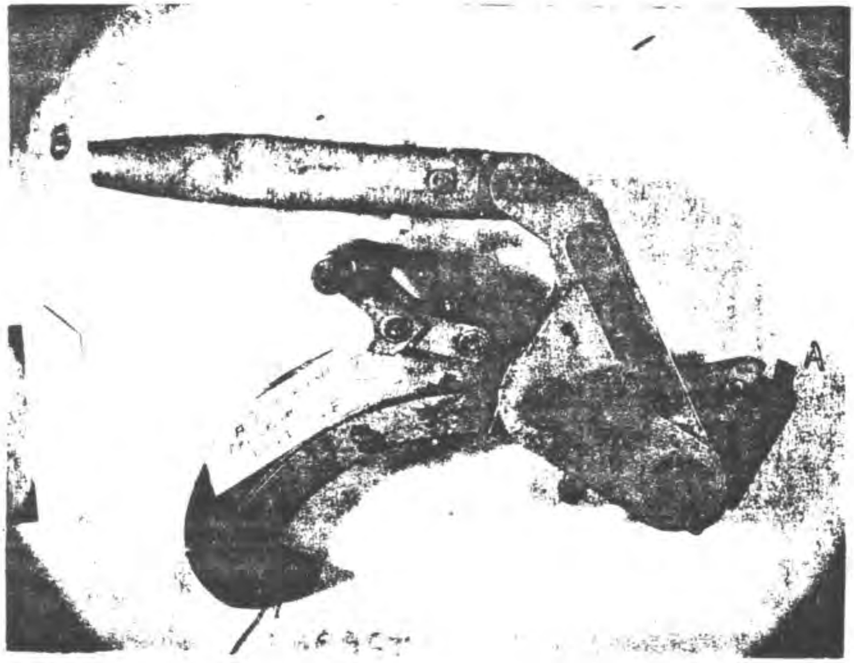


Photo 1
#7 Right Hook & Bellcrank assembly. A & B identifies fractures used as specimens.

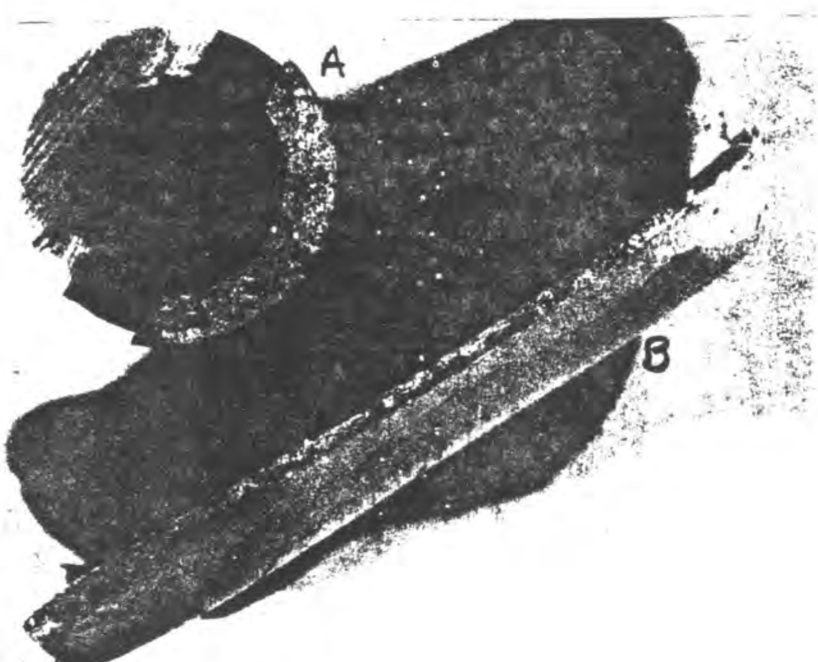


Photo 2
"A" failed in tension overload.

"B" exhibits rubbing & bending action induced by impact.

30 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Ramp (Right Side) Part 4-8 23 Apr 75

Task #1128, Attachment #17 #142

Metallurgical Analysis

1. One failed part of the ramp identified as Right Side Part 4-8, was submitted for analysis as per Attachment #17 of basic MME Task #1128.

2. Photographs of the exhibit as received here in the Metallurgical Laboratory are identified in Photo 1, along with designated areas "A" thru "F" that were sectioned for visual and microscopic examination.

3. Visual and microscopic examinations showed most of the fractured surfaces were smeared from the two surface rubbing together, or from foreign object damage from impact.

4. The mechanism and mode of failure was attributed to excessive shearing and tensile overload, with ramp failing from the right and left directions, to a straight tensile pull on the ramp.

SIGNED

JOHN PARKER, Metallurgist

1 Atch
Photos 1 thru 7

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

JHB

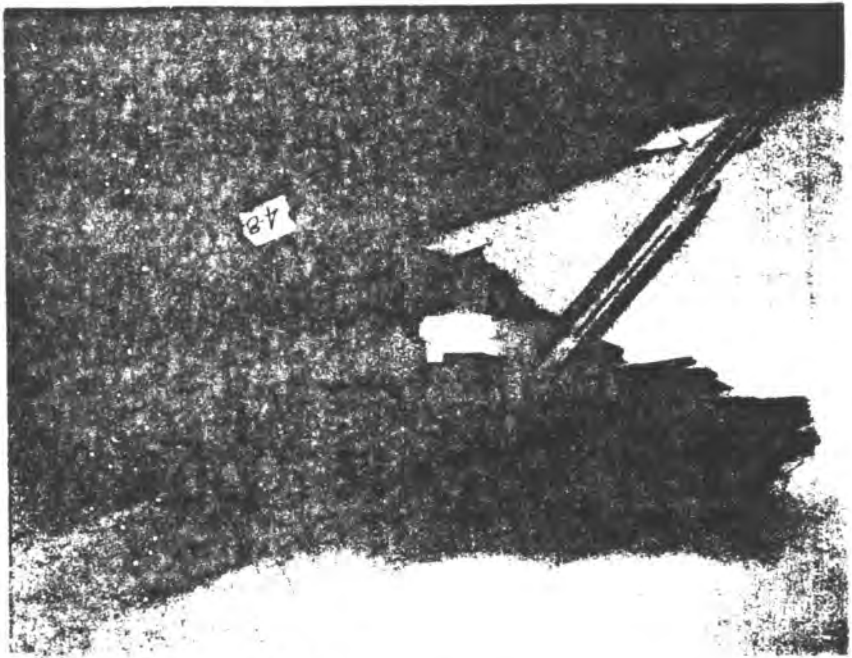


Photo 1
Ramp (Right Side) Part 4-8 - Showing the exhibit as received here in the Metallurgical Laboratory, with areas "A" thru "F" being listed in designated photographs.

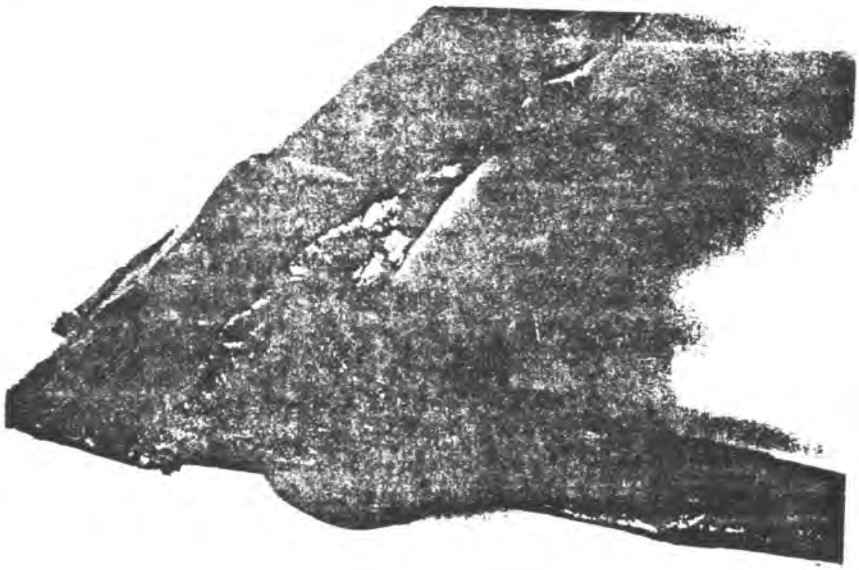


Photo 2
Ramp (Right Side) Part 4-8 -Showing the fractured surface from area "A" in Photo 1, this area shows excessive shearing to the right, also excessive tensile overload in the upward direction.

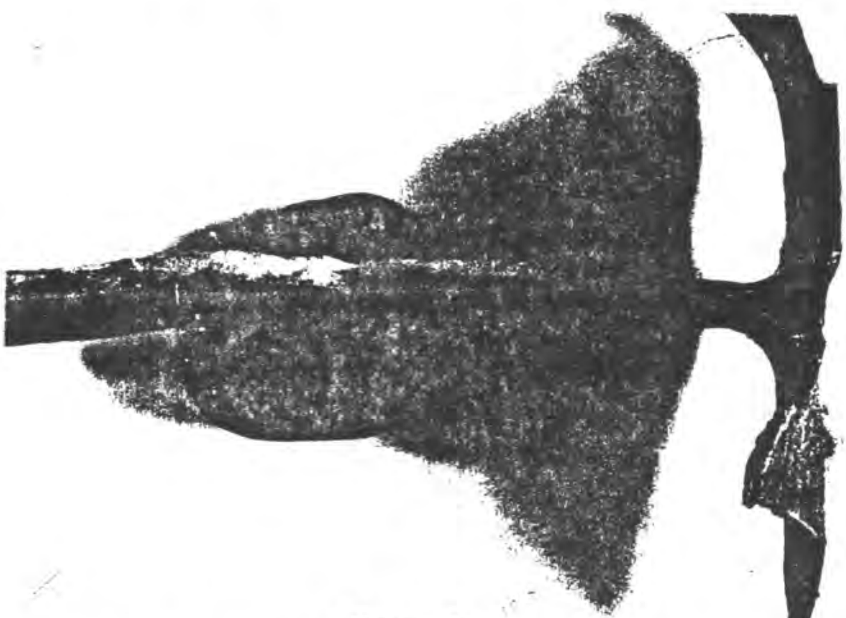


Photo 3
Ramp (Right Side) Part 4-8 - Showing the fractured surface from area "B" in Photo 2, this area shows excessive shearing to the right, with some to the left, also other surfaces showed tensile overload type of fractures.

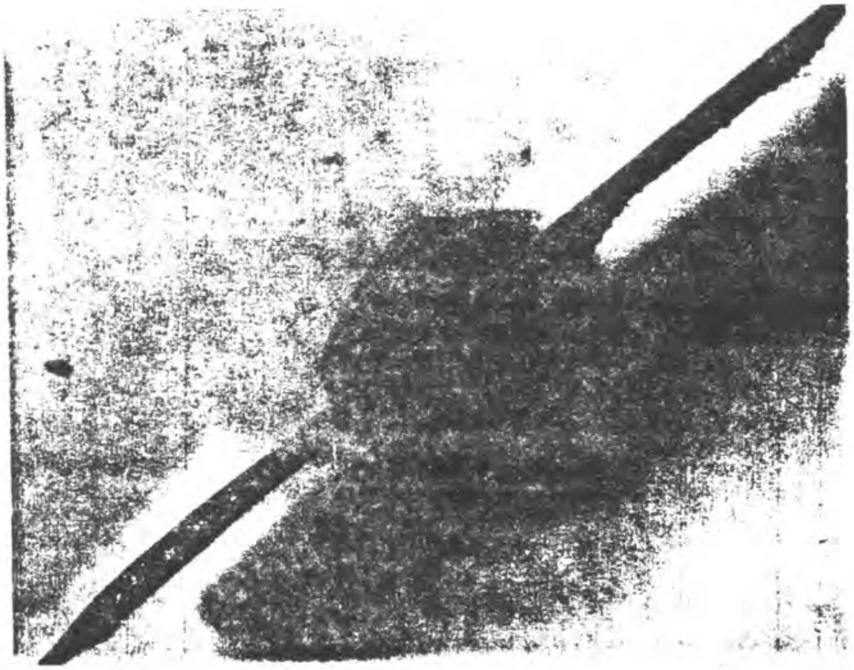


Photo 4
Ramp (Right Side) Part 4-8 - Showing the fractured surface from area "C" in Photo 1, this area show excessive tensile overload in the upward direction.

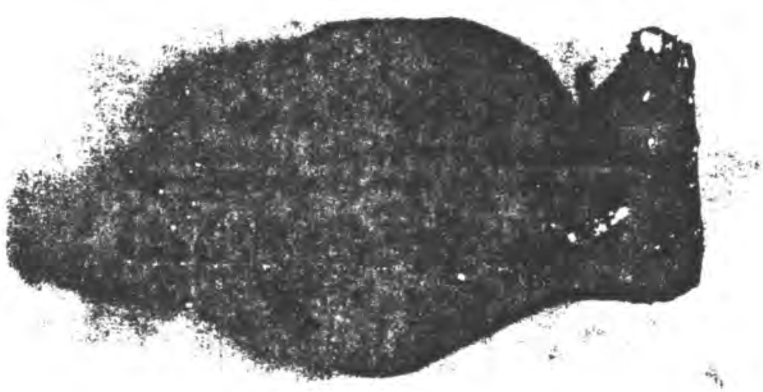


Photo 5
Ramp (Right Side) Part 4-8 - Showing the fractured surface from area "D" in Photo 1, this area shows excessive shearing and tensile overload to the left in the upward direction.

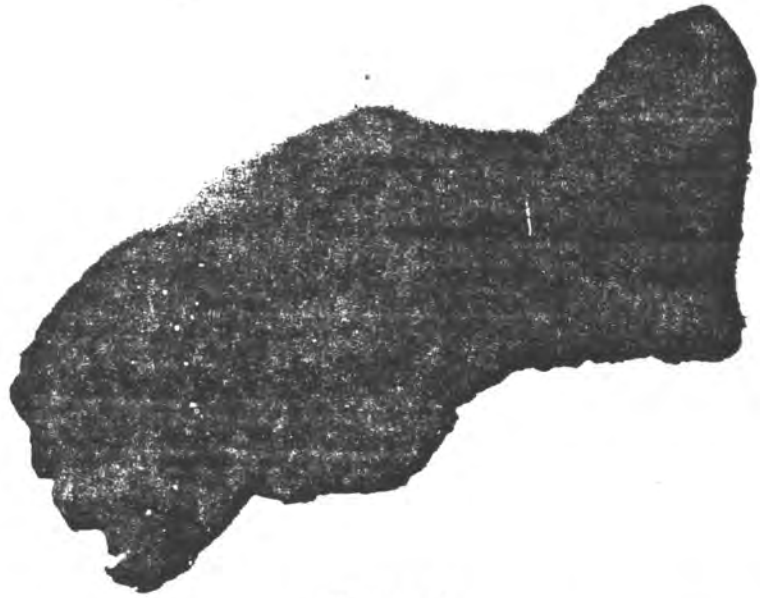


Photo 6
Ramp (Right Side) Part 4-8 - Showing the fractured surface from area "E" in Photo 1, this area shows excessive tensile overload to the left, with some shearing to the left and right directions.

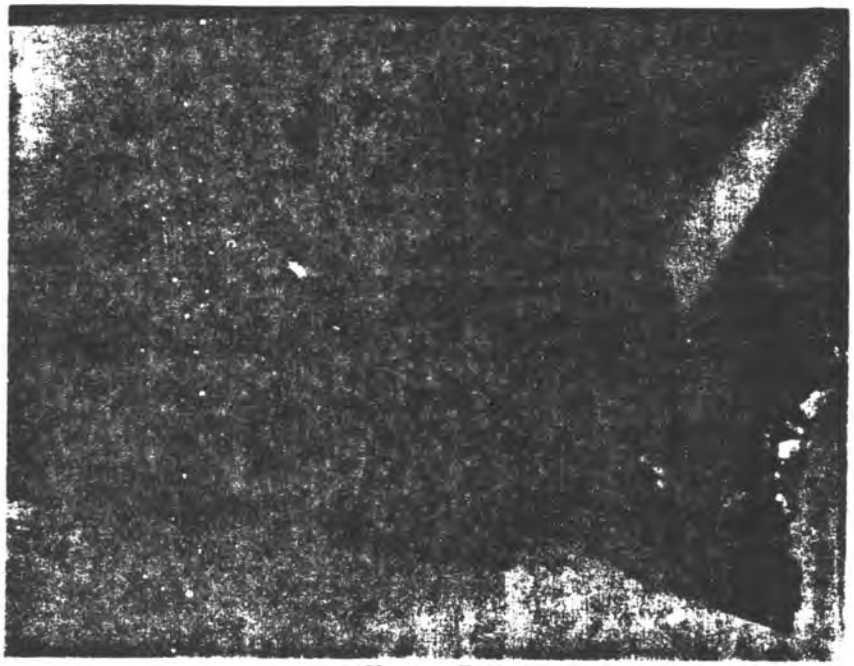


Photo 7
Ramp (Right Side) Part 4-8 - Showing the fractured surface from area "F" in Photo 1, this area shows excessive shearing and tensile overload in the right direction.

28 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Aft Ramp (Part Labeled 4-6 and 4-5) Sections 23 Apr 75

Task 1128, Attachment 18 142

Metallurgical Analysis

1. Two failed aft ramp sections were submitted to the Metallurgical Laboratory for analysis in support of Task 1128.

2. The majority of the fractured surfaces exhibited extensive rubbing of the crack surfaces. This action obliterates most of the identifiable cracking phenomena.

3. Visual and magnified examination indicated the direction of the progression of failure to be from left to right of the aft ramp (Photo 1). Several areas show damage exerted from the top of the ramp.

4. Two fractured sections were selected for microscopic sutdy (Photo 1). They were designated "A" and "B" for these tests.

5. Microscopic study on part "B" revealed a tensile cup indicative of a tensile failure (Photo 2). A study on part "A" disclosed a shear cleavage by overload or impact (Photo 3).

SIGNED

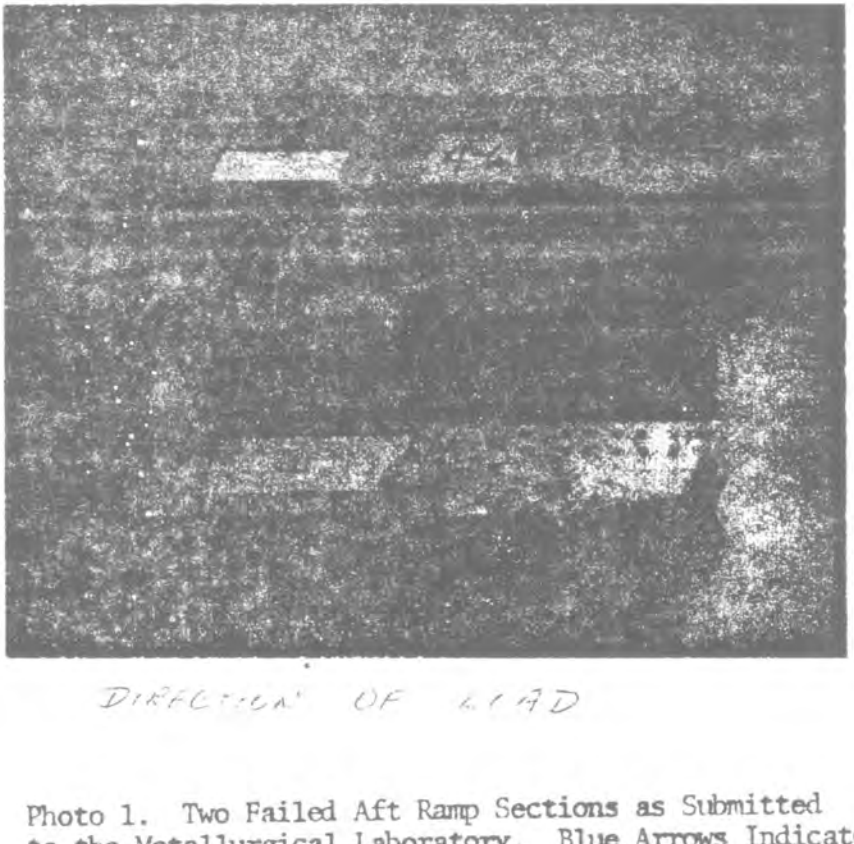
W. H. CROCKER, Metallurgist

1 Atch
Photos 1 thru 3

SIGNED

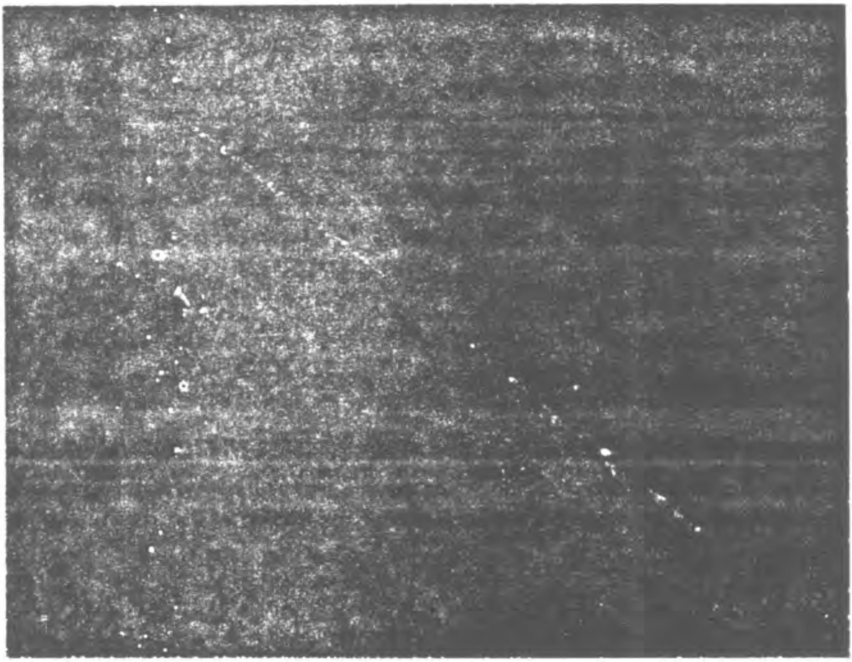
O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

JHB



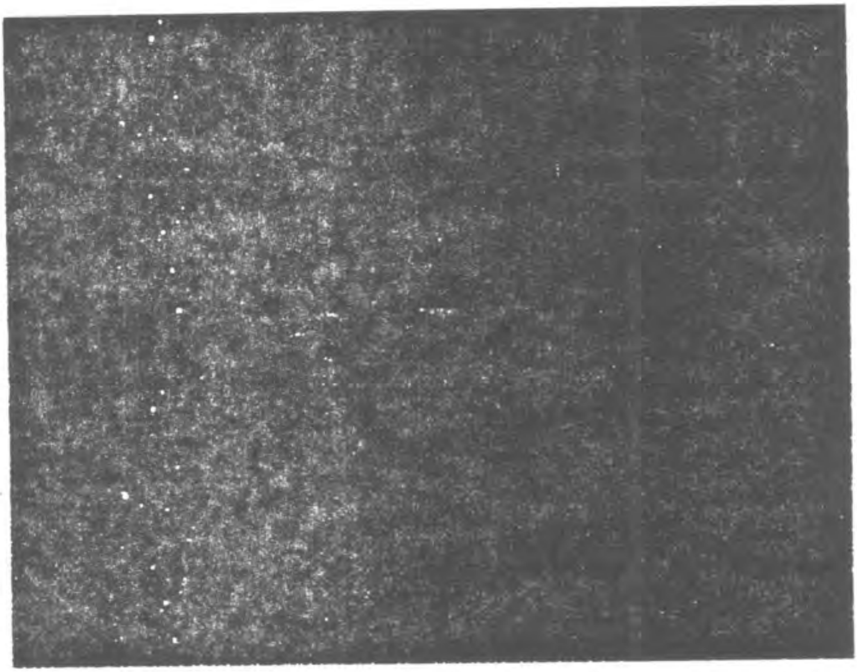
DIRECTION OF LOAD

Photo 1. Two Failed Aft Ramp Sections as Submitted to the Metallurgical Laboratory. Blue Arrows Indicate Direction of Load. Each Section was Labled as "A" and "B" respectively.



A B

Photo 2. Section "B" Showing a Tensile Cup Which is Indicative of a Tensile Failure.



A

Photo 3. Section "A" Disclosing a Shear Cleavage Indicative of Overload or Impact.

T-1

29 April 1975

MME-3/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Aft Ramp Section (4-3) 23 April 1975

Task #1128, Attachment 19 142

Metallurgical Analysis

1. One aft ramp section (4-3) was submitted to the Metallurgical Laboratory for analysis in support of task 1128, attachment 19.

2. Photographs were taken of the aft ramp section. Samples 1, 2 and 3 were taken to identify sections used to determine load direction and also to analyze the mode of failure. Photo 1, samples 4, 5, 6 and 7 were identified on photo 2 for the same reasons.

3. Microscopic examination of sample 1 revealed tensile cup and shear by overload. All the seven samples will indicate tensile cup and/or tensile shear, with the direction of shear shown by the arrows. Elongation of holes and rubbing phenomena will be shown with their direction by arrows. The remaining six samples exhibited a similar mode of fracture. The samples as indicated on the photographs show reversing of the tensile shear with an overload pulling, tearing and bending force.

4. Conclusion: the aft ramp section (4-3) failed in tension or tensile shear and or cup overload, as did the other ramp sections.

SNED

W. H. CROCKER
Metallurgist

1 Atch
Photos 1 thru 9

SNED

DAVID BARRERA
Metallurgist

SNED

O. H. DOUGLASS, JR
Chief, Metallurgical Laboratory Section
MA

DLB

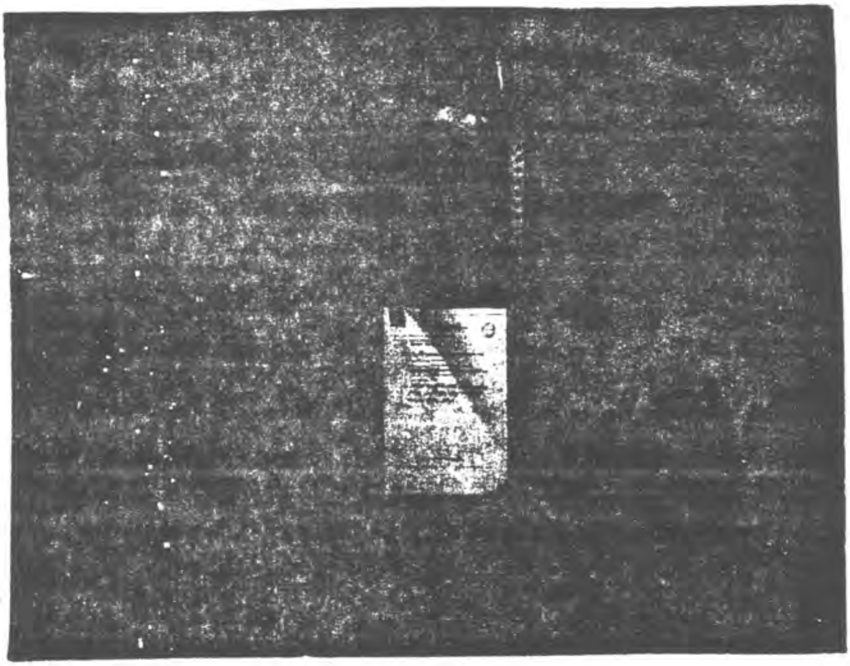


Photo 1. Aft ramp section (4-3) identifies location of samples 1, 2 and 3.

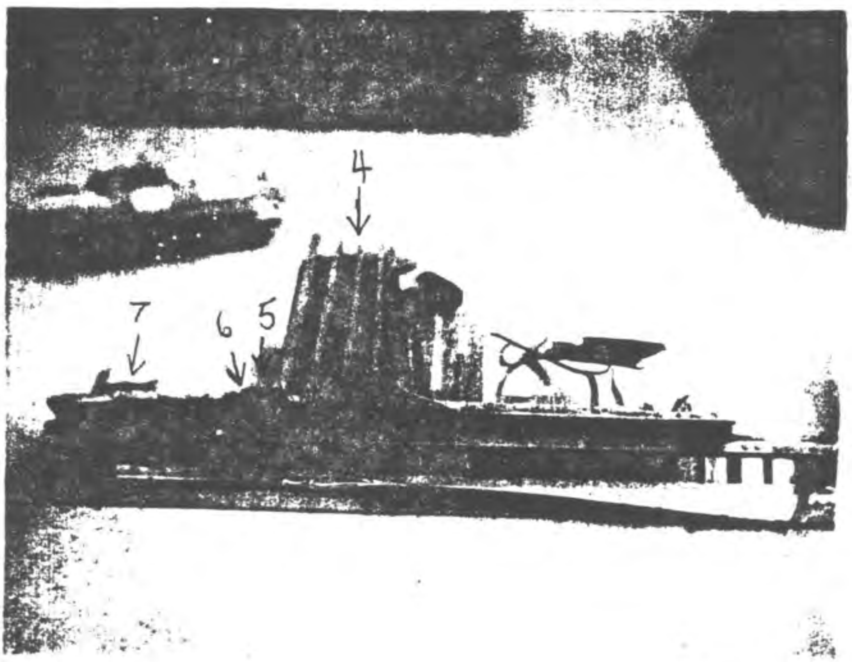


Photo 2. Aft ramp section (4-3) identifies location of samples 4, 5, 6 and 7.

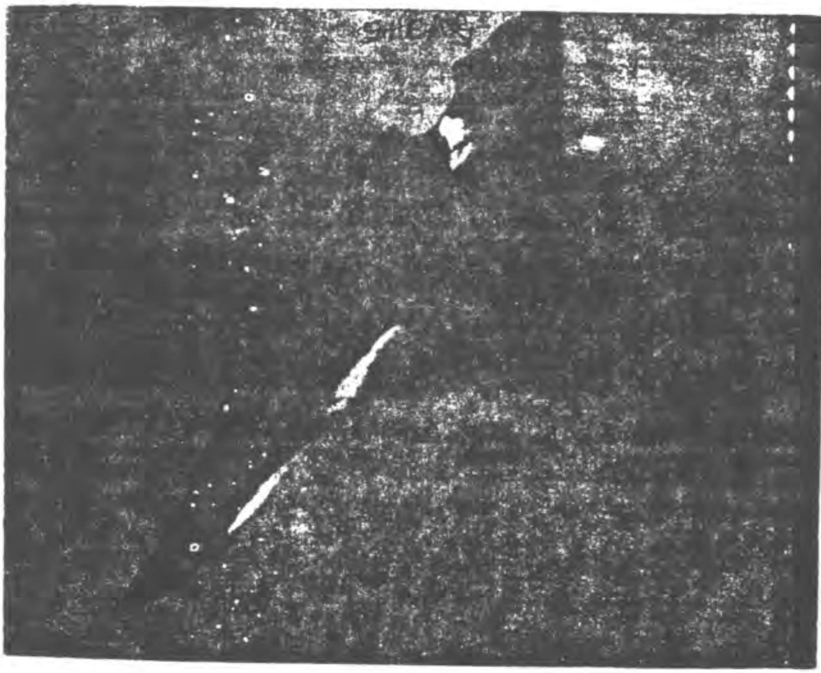


Photo 3. Mode and direction of fracture failure. Fracture - tensile cup and shear by overload.

Photo 4. Mode and direction of fracture failure. Fracture - tensile cup and shear by overload.

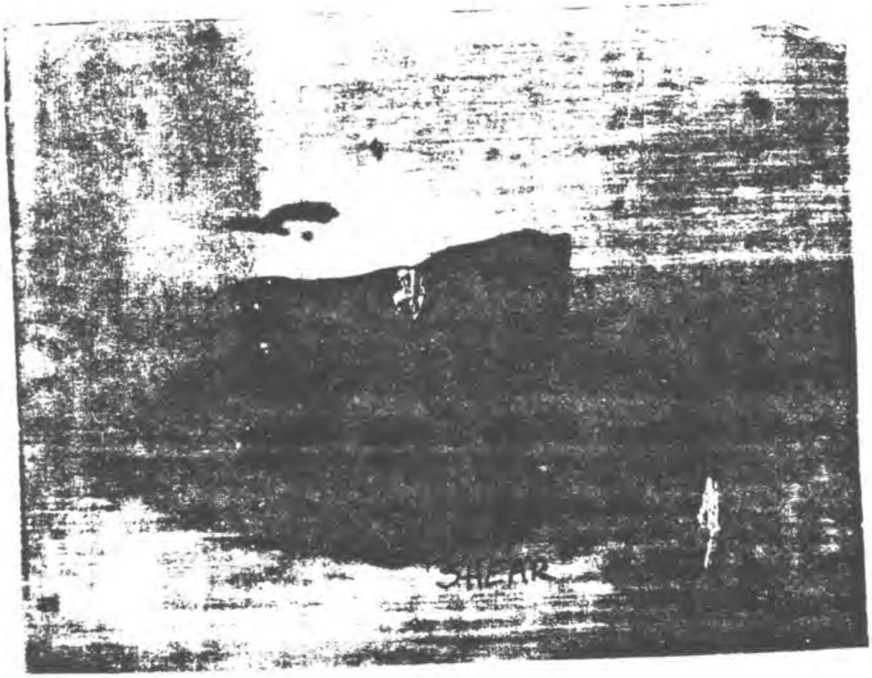


Photo 5. Mode and direction of fracture failure.
Fracture - tensile shear by overload. Rubbed area.

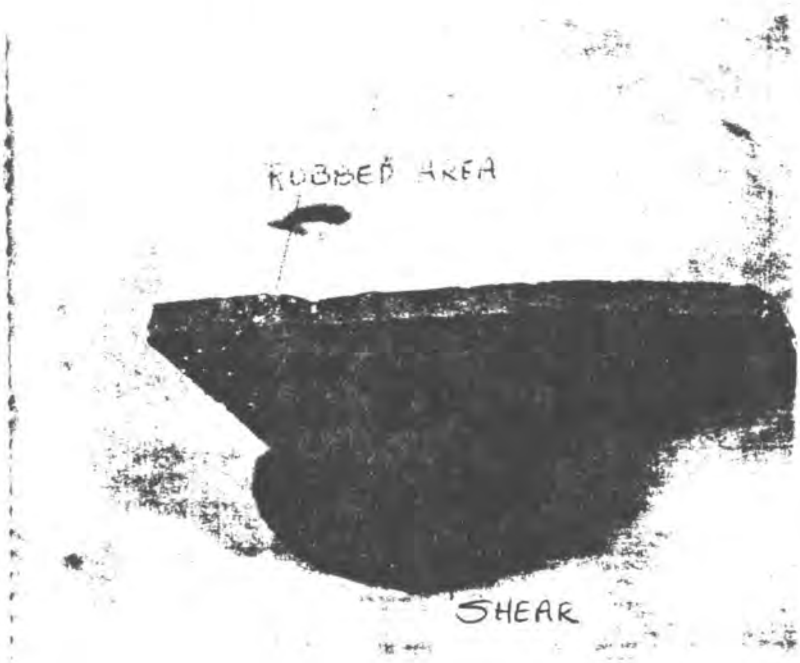


Photo 6. Mode and direction of fracture failure.
Fracture - tensile shear and rubbed area.

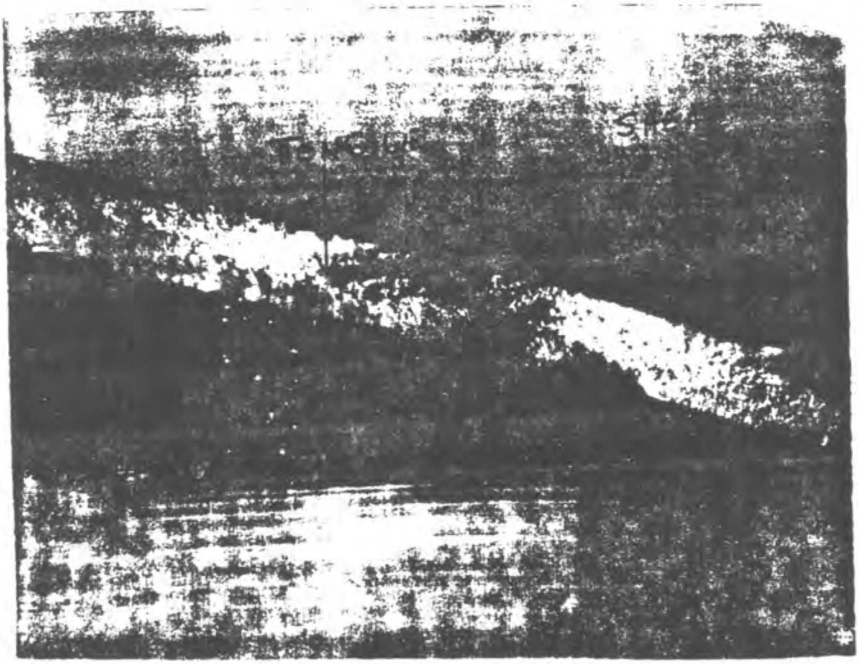


Photo 7. Mode and direction of fracture failure.
Fracture - tensile cup and shear by overload.

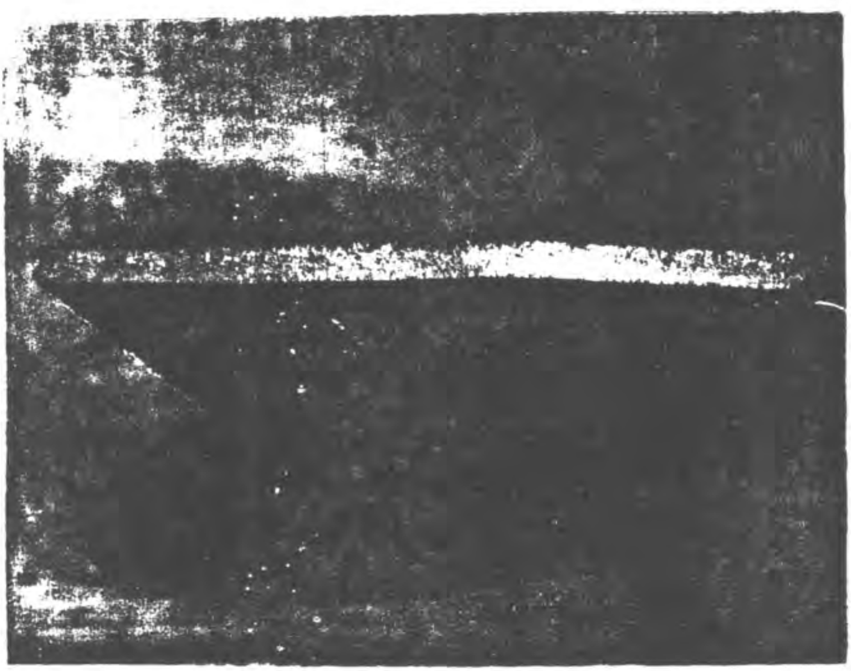


Photo 8. Mode and direction of fracture failure.
Fracture - tensile shear by overload.

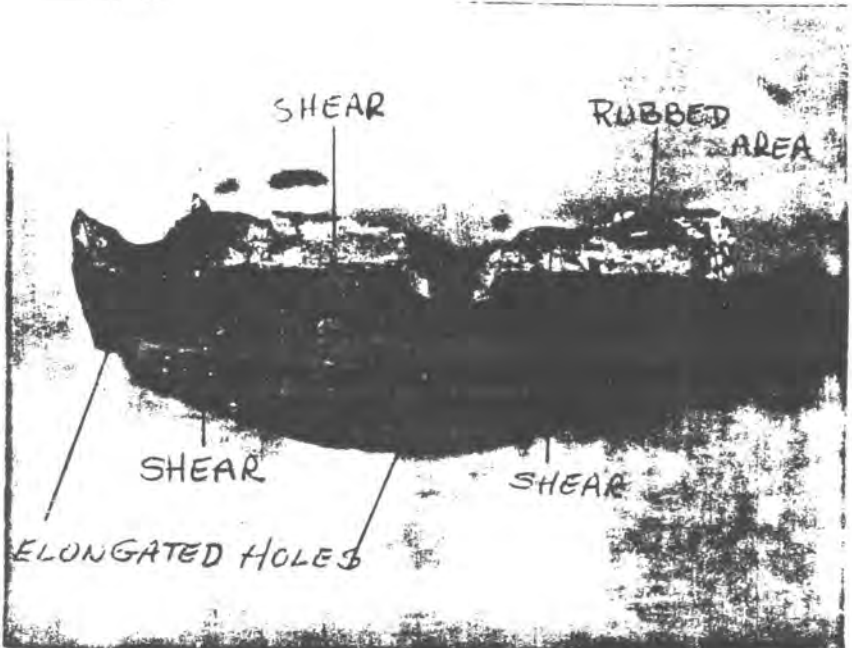


Photo 9. Mode and direction of fracture failure.
Fracture - tensile shear by overload.
Elongated holes and rubbed area.

29 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Aft Ramp Section Labled 4-1 23 Apr 75

Task #1128, Attachment #20 #142

Metallurgical Analysis

1. One failed Aft Ramp Section was submitted to the Metallurgy Laboratory for analysis in support of Task #1128, Attachment #20.

2. Photographs were taken of the Aft Ramp Section. Sample #1, #2 & #6 were identified on Photo #1. Sample #3, #4 & #5 were identified as to location on Photo #2. These samples were taken to show the direction of load applied to propagate the failure.

3. Macro and Microscopic investigation of sample #1 revealed the fracture had failed in tensile shear. The shiny area at the upper edge of fracture showed rubbing action and direction of shear, Photo #3. Arrows indicate tensile shear direction on all samples to show reversing of the shear mode of failure. Sample #2 shows tensile shear by overload, Photo #4. Sample #3 shows the same phenomena of tensile shear reversing the plane of direction, also tensile cup, Photo #5. These failures were by overload. Sample #4 displays tensile shear by overload. Shiny areas identifiy rubbed areas, Photo #6. Sample #5 failed with tensile shear and tensile cup as indicated on Photo 7. Sample #6 displays the start of a tensile shear, a delay in the shearing process, then a continuing of the tensile shear to failure, Photo #8. Microscopic analysis show fibrous and woody fractures, indicative of tensile overload.

4. Conclusion: As indicated in the sampling of the fractures, all the fracture modes show a tension failure due to overload. Manyyof the fractures show cycling, bending, twisting and vibration under tension force.

SIGNED

W. H. CROCKER, Metallurgist

1 Atch
Photos 1 thru 8

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

JHB

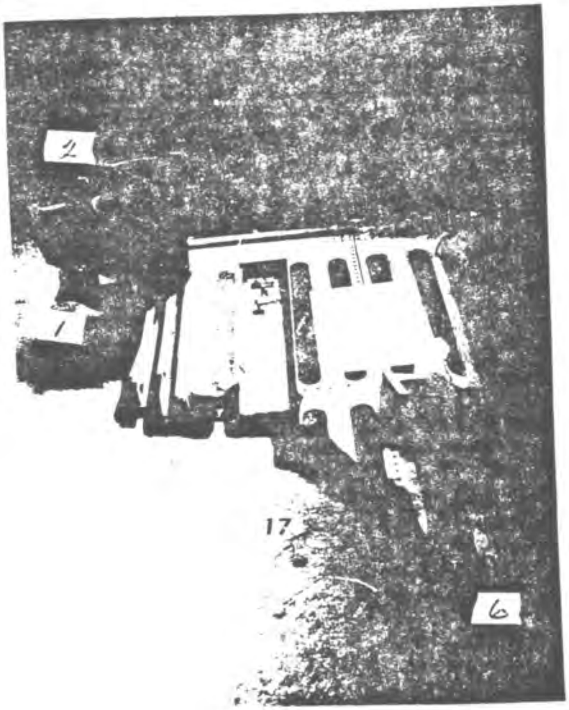


Photo #1
Aft Ramp Section (Labeled 4-1) identifies location of Samples #1, #2 & #3.

Photo #2
Aft Ramp Section identifies location of Samples #3, #4 #5.

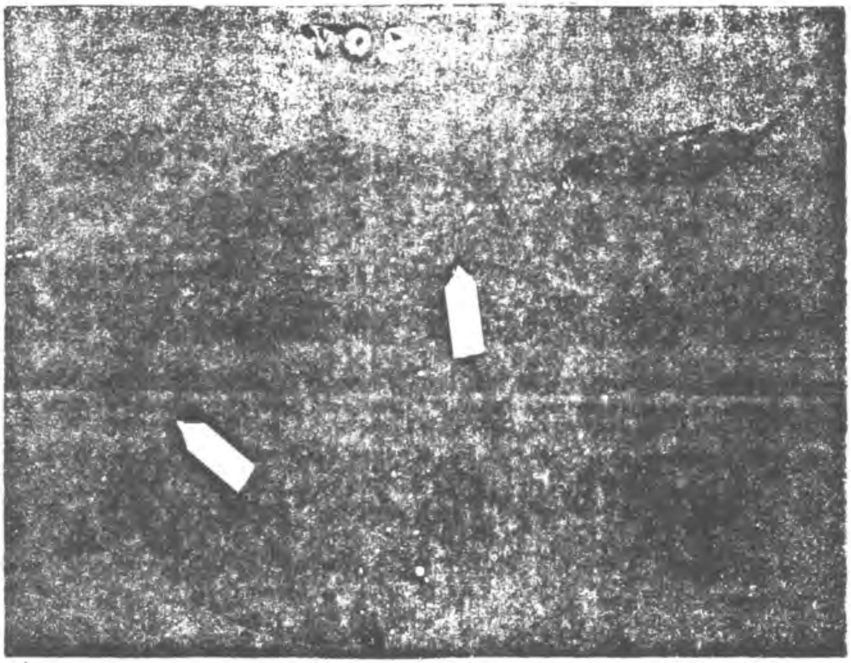


Photo #3
Mode of failure - Tensile Shear

Arrows point direction of shear

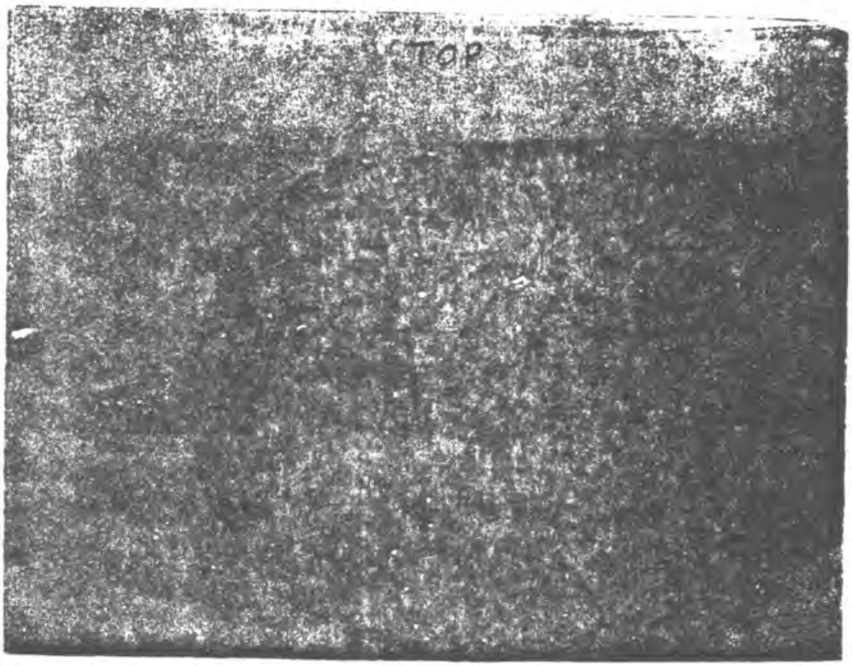


Photo #4
Mode of failure - Tensile Shear

Arrows point direction of shear.

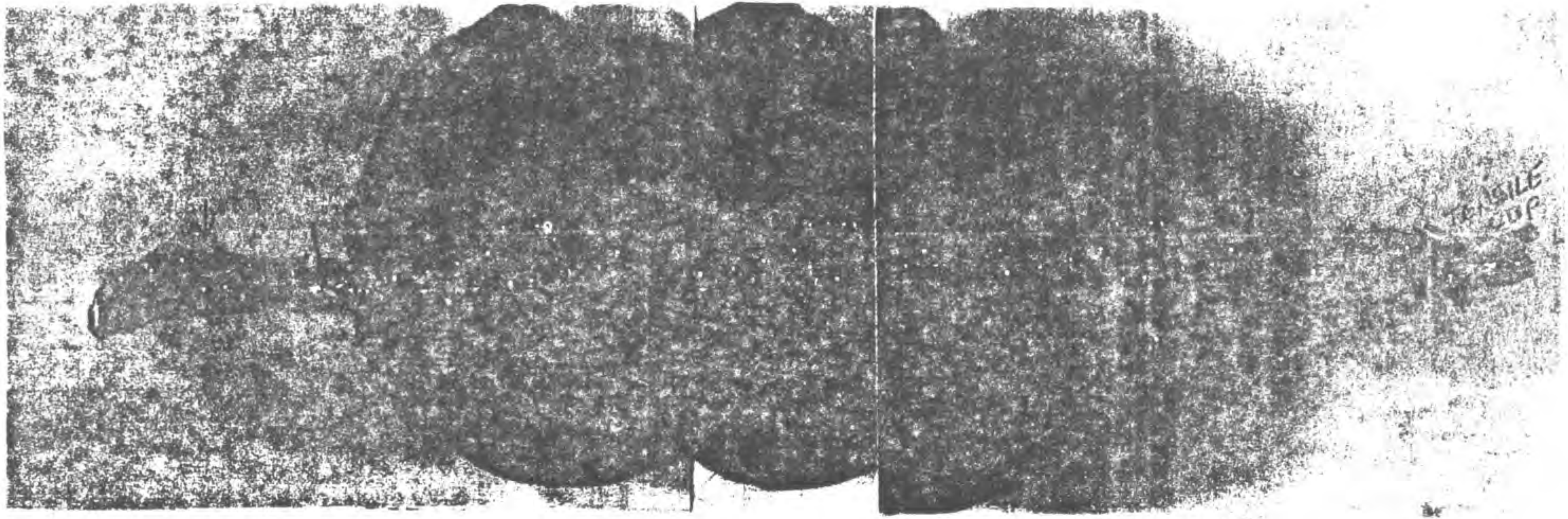


Photo #5
Mode of failure - Tensile cup and shear arrows indicate direction of shear.

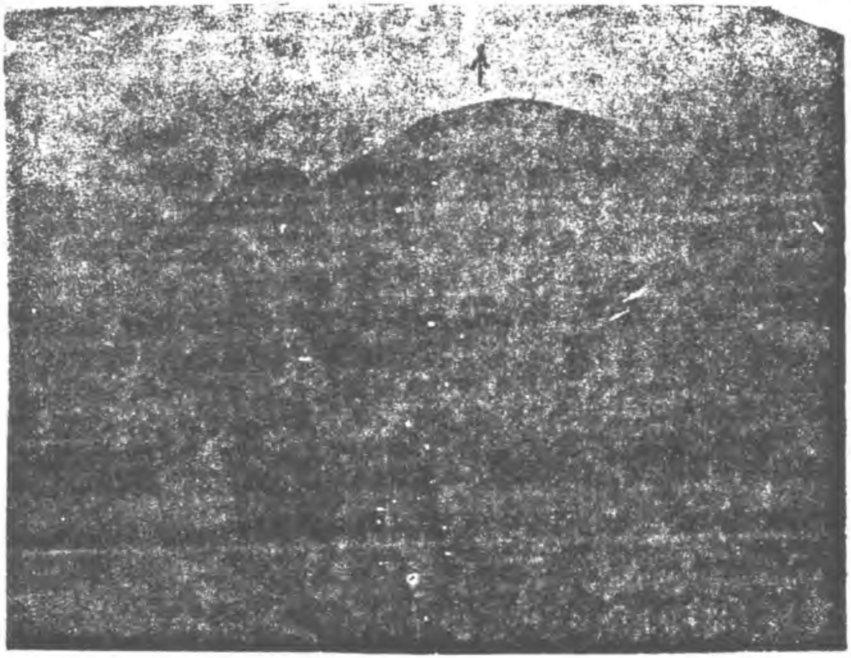


Photo #6
Mode of failure - Tensile shear

Arrow indicates direction of shear.

Photo #7
Mode of failure - Tensile cup & shear

Arrow indicates direction of shear.

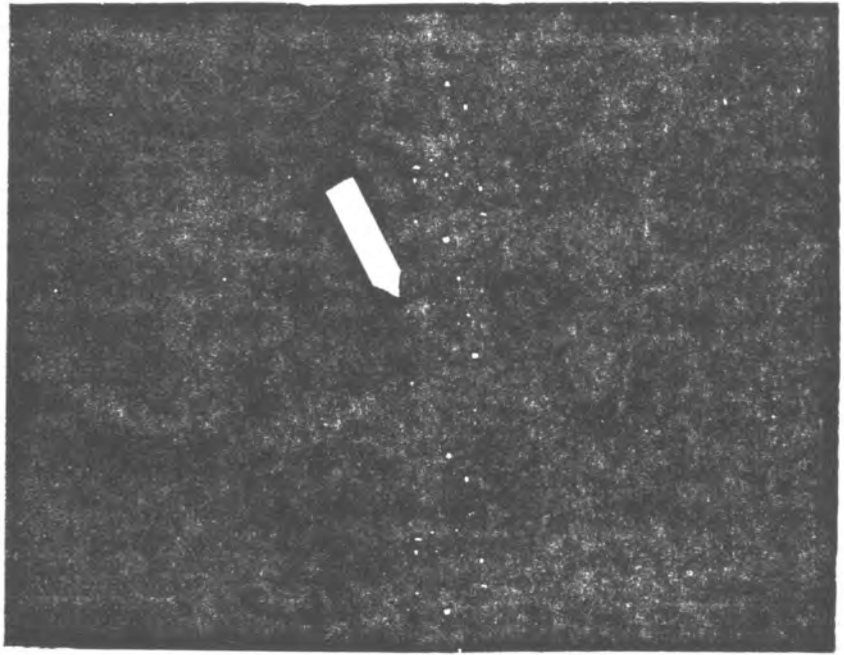


Photo #8

Mode of failure - two planes of tensile shear - fibrous & woody fractures.

Arrow indicates direction of shear.

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Control Cables 23 Apr 75

Task 1128, Attachment 21 142

Metallurgical Analysis

1. Three C5A control cables, marked exhibits 1 - 2 - 3, were submitted to the Metallurgical Laboratory to determine mode of failure (photo #1). This report is in support of MME task 1128.

2. Spectrochemical analysis taken from the three submitted cables and its cover were as follows:

   a. Cables #1, #2 and #3 - AISI 302 stainless steel.

   b. Cover 6061 aluminum alloy.

3. Hardness tests taken on the Knoop Scale and converted to the Rockwell Scale were as follows:

   a. Cables #1, #2 and #3 - Rc 52.

   b. Cover 6061 - Rb 62.5.

4. Hardness readings of Rc 52, which were taken from the failed control cables, place the 302 stainless steel in the full hardened condition. The cable cover, which is 6061 aluminum alloy, had hardness readings averaging Rb 62.5. This places the 6061 in the T-6 condition.

5. Visual and microexamination of the submitted fractured cables and their aluminum covers revealed that failure was due to a combination of tensile and torsional overloading (photo #2 - photo #5).

SIGNED

DAVID BARRERA
Metallurgist

1 Atch
Photos #1 - #5

SIGNED

O. H. DOUGLASS, JR
Chief, Metallurgical Laboratory Section
MA

JHB

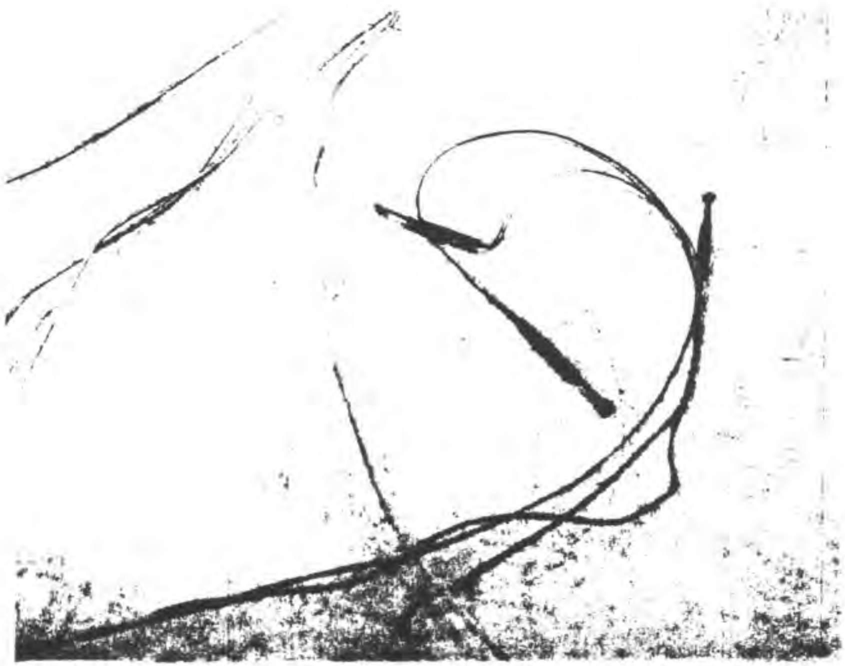
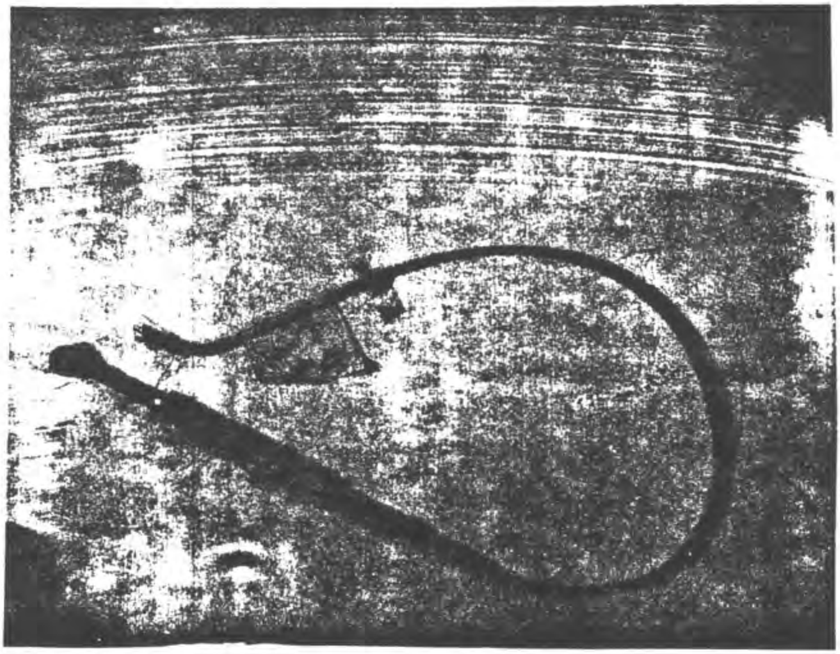
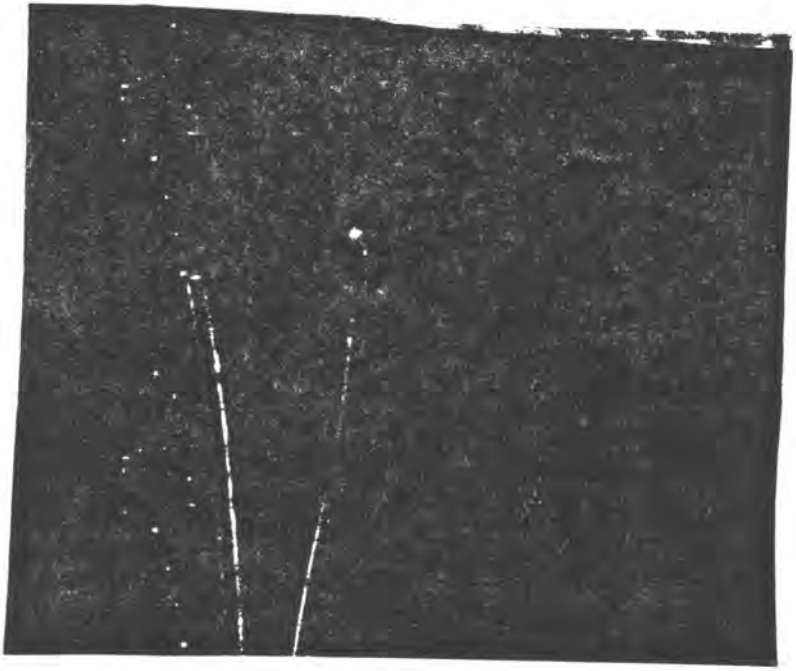
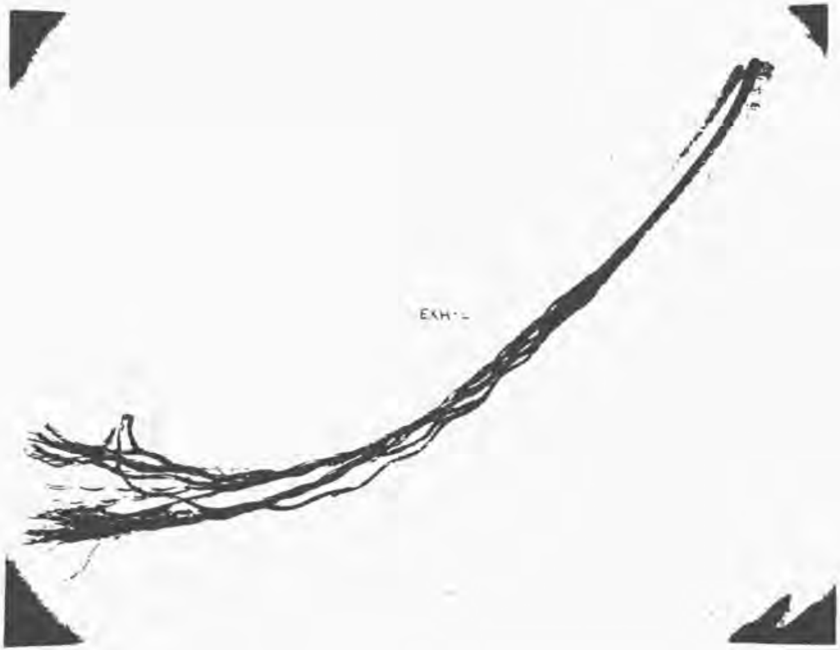


Photo #1. As Received control cables.
Exhibit 1 - short cable
Exhibit 2
Exhibit 3

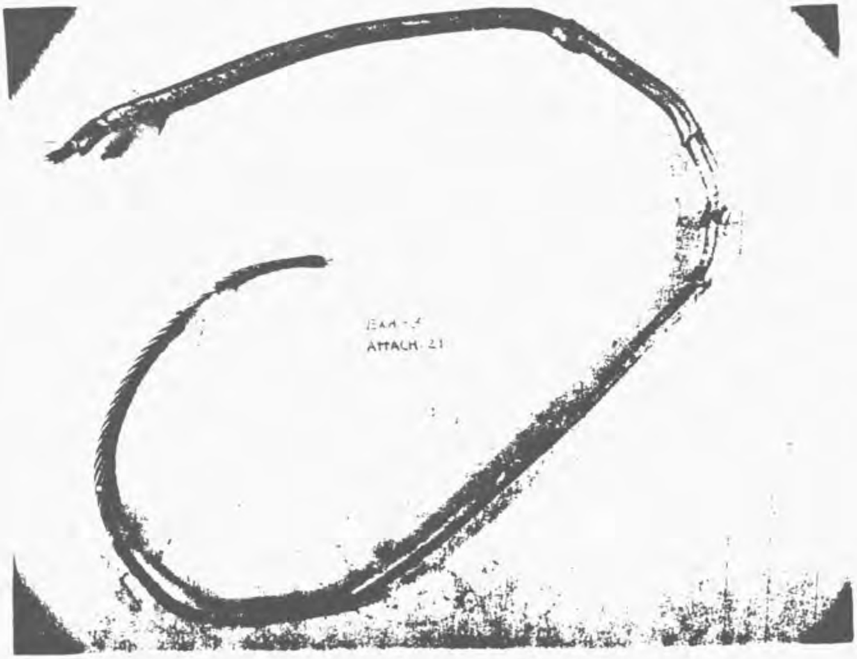


Photos #2 and #2A. Exhibit 1 taken of two magnifications revealed minor necking down of the fractured cables.





Photos #3 and #3A. Exhibit 2 taken at two magnifications revealed necking down of the fractured cables as well as some minor impact damage.



Photos #4 and #4A. Exhibit 3 taken at two magnifications revealed excessive bending and fracturing of the cable outer cover (arrows).
Necking down of the fractured cables can also be seen.

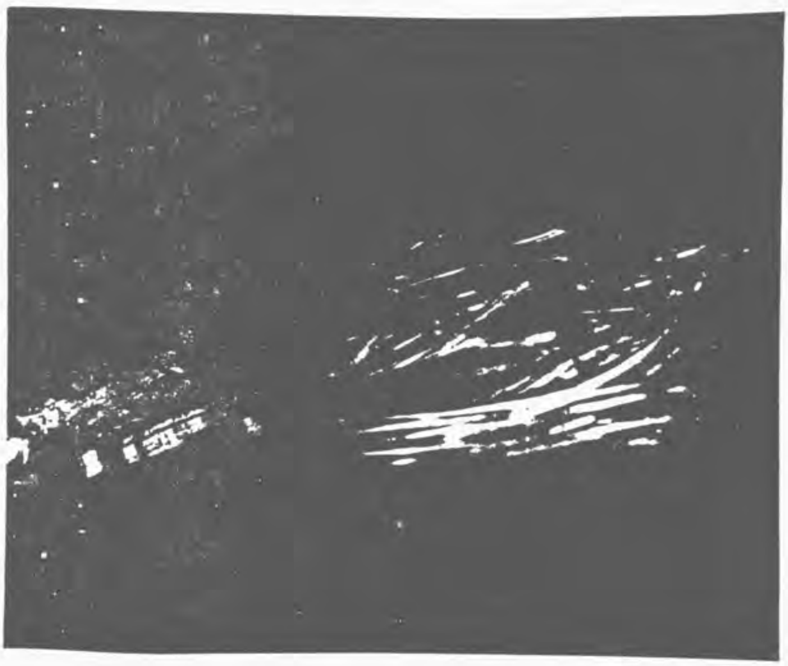


Photo #5. Photomicrograph taken at 200X power illustrates direction of grain flow as well as necking down of a fractured cable.

26 April 1975 W-1

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Hydraulic Lines 23 Apr 75

Task #1128 Attachment #22 #142

Metallurgical Analysis

1. Two failed hydraulic lines were submitted to the Metallurgy Laboratory in support of Task #1128 Attachment #22.

2. Both of these left forward hayloft hydraulic lines have been subjected to denting, tearing, kinking and finally failure of the line. Photo 1.

3. Paint indications were microscopically identified on samples #1 & #2. Photo 2. They were classified as G=green & Y=yellow respectfully. Samples #3 & #4 did not show any signs of paint fragments on the fractured surfaces.

4. Sample #1 of the hydraulic lines had been cut approximately 1/4" of the way through the OD of the tubing. The remainder of the fracture propagated through tension overload. Photo 2.

5. All the other samples failed in a similar manner except where bending had occurred, these failed through shear cleavage.

SIGNED

W. H. CROCKER, Metallurgist

1 Atch
Photos 1 thru 3

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

JWB

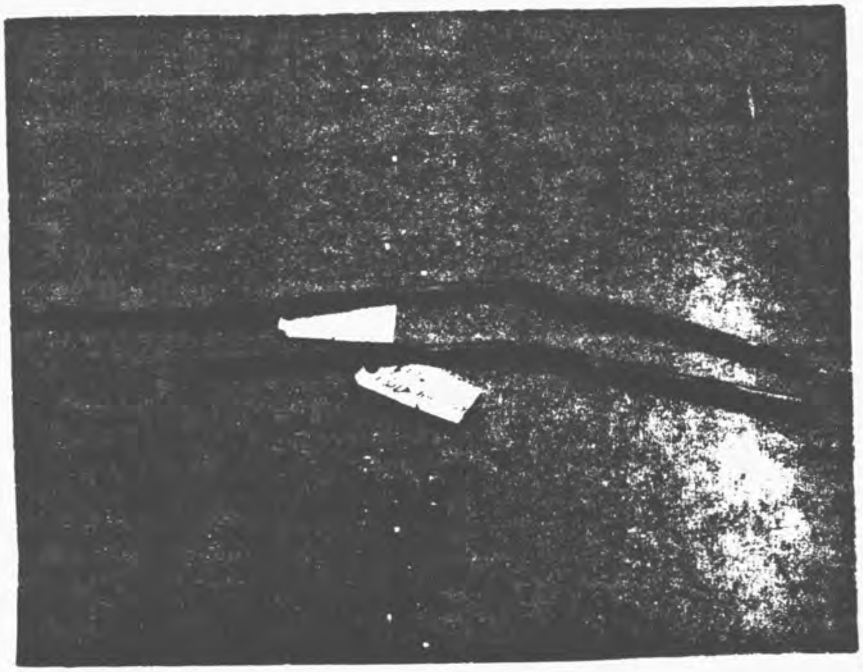


Photo 1
Identifies two left forward hayloft hydraulic lines - also identifies samples taken.

Photo 2
Identifies samples #1 & #2, also paint fragments.

Photo 3

Identifies samples #3 & #4.

X-1

30 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Ramp Bulkhead 23 Apr 75

Task #1128, Attachment #23 #142

Metallurgical Analysis

1.* One Ramp Bulkhead segment (Attachment #23) was submitted to the Metallurgical Laboratory for analysis in support of MME Task #1128.

2. The item as submitted, is shown in Photos 1 & 2. Considerable impact damage was exhibited, as indicated in the photos. A small "bullet like" hole, and adjacent tear were evident at the location shown in Photo 1 and close-up in Photo 3. The closer view indicates a glancing blow by an obstacle, obtrusion, projectile, etc. inflicted on impact. Slivering up of material (Arrow A, Photo 3) and a built up edge around the hole (Arrow B) indicate impact in the direction shown by the heavy arrow. (Also arrow A, Photo 1).

2. A chemical spot test for lead deposit around the hole area proved positive but so did other tests at the skin-honeycomb backing inter face (Arrow B, Photo 1) made on the segment. This specific test for lead traces around the hole is therefore inconclusive because of the primary presence of lead in the bonding medium between skin & honeycomb (Chemical Laboratory Report enclosed). Separation of the skin and removal of honeycomb material around the subject area did not uncover the presence of any protectile which may have inflicted this damage pattern. This verifies that damage on the subject area was inflicted by a glancing blow (projectile or obtrusion), rather than by an impacted projectile.

3. Over-all examination of the Bulkhead segment damage areas did not indicate any such areas which could have resulted from intense heat. All fracture and tear surfaces on this exhibit were the result of severe plastic deformation incurred on ground impact.

SIGNED

PETER J. FRINTZILAS, Metallurgist

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

2 Atch
1. Chemical Report
2. Photos 1 thru 3

*Note: "Not Ramp Bulkhead Segment"
JHB

X-2

30 Apr 75

MANCE/Mr P. Frintzilas MANCA

Ramp Bulkhead Segment 23, Task 1128 29 Apr

MANCE 30

Whether lead was present around "bullet like" hole

1. Using a chemical spot test, we found traces of lead in the area of the hole. However, using the same test on an exposed area between the two skin sheets several inches from the hole, we also obtained a positive test for lead.

2. Our test consisted of removing material from the edge of the hole with a cotton swab moistened with dilute nitric acid, making the acid slightly alkaline with ammonium hydroxide and then adding a drop of diphenylthiocarbazone in carbon tetrachloride. A brick-red color was obtained which is characteristic of lead. The test is sensitive.

R. C. CRIPE
Chemist

R. L. GARCIA
Chemical Laboratory Section
MA

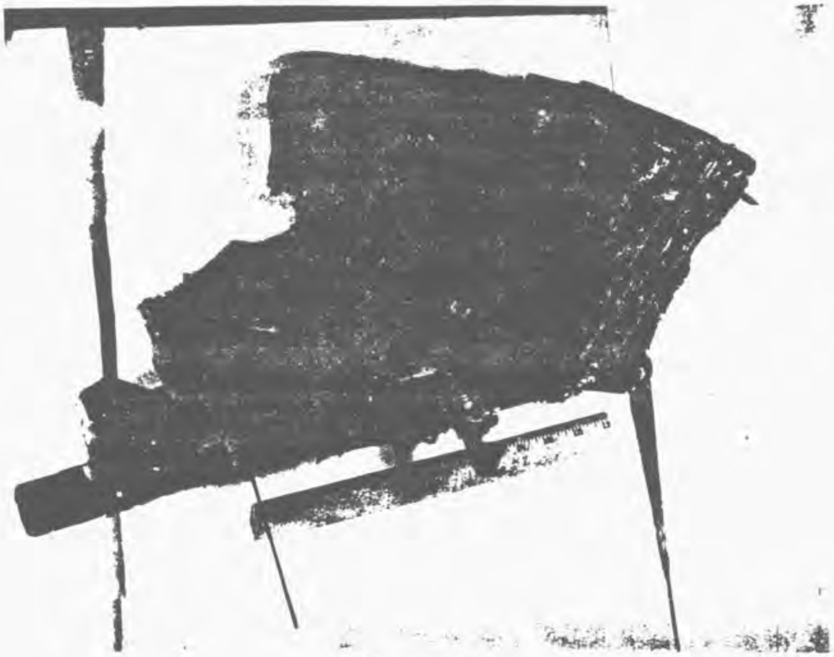


Photo 1

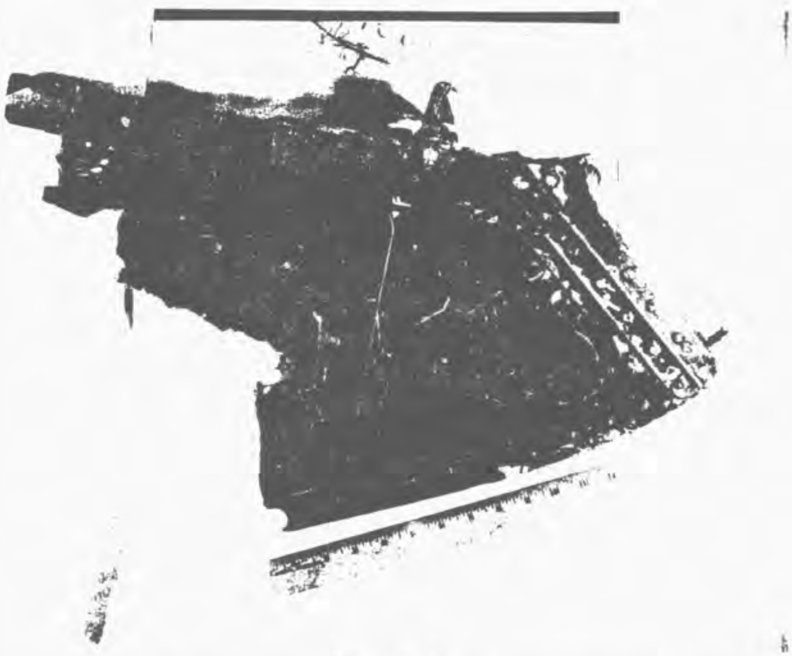


Photo 2

Lateral surface views of Ramp Bulkhead segment. "Bullet like" hole and adjacent tear (Arrow A, Photo 1) were observed on one surface. See close-up, Photo 3. The hole shown in Photo 1 did not penetrate the opposite side. Chemical spot tests for lead deposits made on areas A & B both gave positive indications.

Photo 3 2X

Close-up view of location shown in Photo 1. Metal slivering (Arrow A) and built-up edge of hole (Arrow B) indicate impact blow in direction shown by heavy arrow (Same direction as arrow shown in Photo 1).

29 April 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Bellcrank and Pushrod 23 April 1975

Task #1128, Attachment #24 142

Metallurgical Analysis

1. Three pieces off of a bellcrank and pushrod were submitted for analysis as per attachment 24 of basic MME task 1128. The three pieces were identified for the purpose of this report as exhibits 1, 2 and 3. Exhibits as received are shown on photographs 1 through 3.

2. Examination of the three exhibits showed extensive physical damage. Photographs 4, 5 and 6 are close-up views of exhibit 2 which was the primary object of this analysis. The retainer washer on the first rivet of the end fitting was sheared off and buckling of the tube was also noted (reference photo #4). Examination of the bellcrank showed what appeared as a badly worn area (reference photo 6). However further examination showed that the damage was caused by impact. It was further determined that the pushrod (area "B" of photo 7) was jammed against the bellcrank (area "A" photo 7) and that was what caused the damage to the bellcrank and the buckling of the tube. Examination of the fractured surfaces around the circumference of the pushrod tube (exhibits 1 and 3) showed considerable plastic deformation and shear lips indicating a shear overload mode of fracture (see photos 8 and 9). Examination of the bellcrank fracture showed a bending load path. Consequently, a portion of the failure was longitudinal and the other portion was loaded in a transverse direction (see photo 10). Fractrographic analysis showed dimple rupture on the longitudinal (with grain) fracture. On the transverse fracture (cross grain) there were areas of intergranular fracture with and without dimples. Flat stretch regions were also noted (see photos 11 and 12).

3. It was determined that the fractures examined were caused by an overload condition from bending, twisting, tension and impact. It was further determined that there was no material deficiency or defects that contributed to the failure.

SIGNED

MARCOS R. SOLIS
Metallurgist

1 Atch
Photos 1 thru 12

SIGNED

O. H. DOUGLASS, JR
Chief, Metallurgical Laboratory Section
MA

JHB

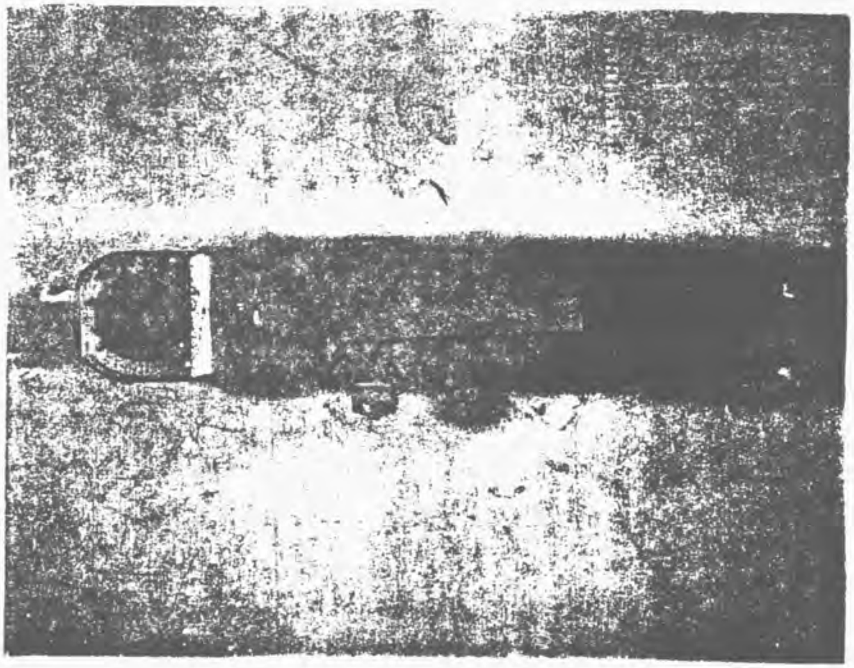


Photo 1. Section of pushrod and end fitting as received.

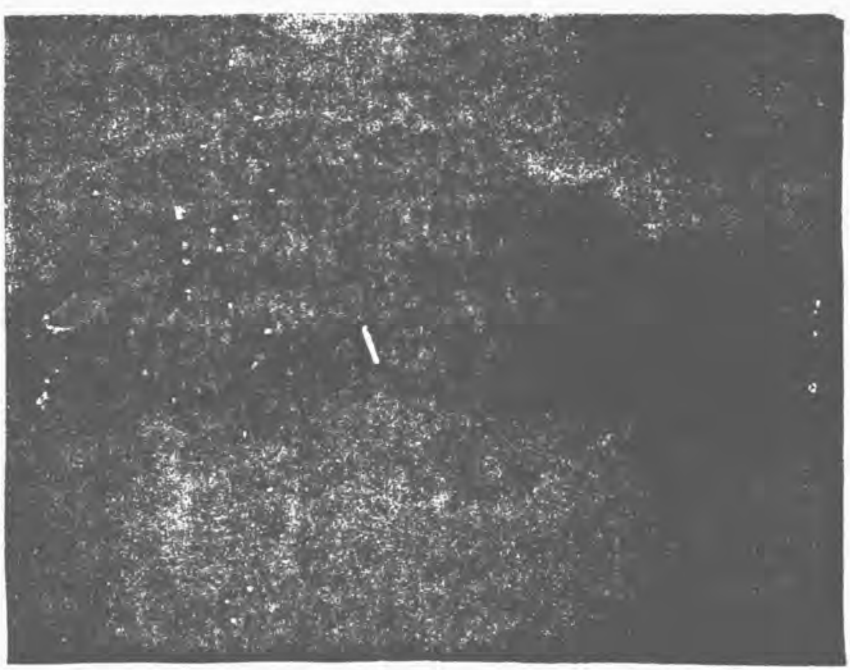


Photo 2. Section of pushrod, end fitting and portion of bellcrank as received.

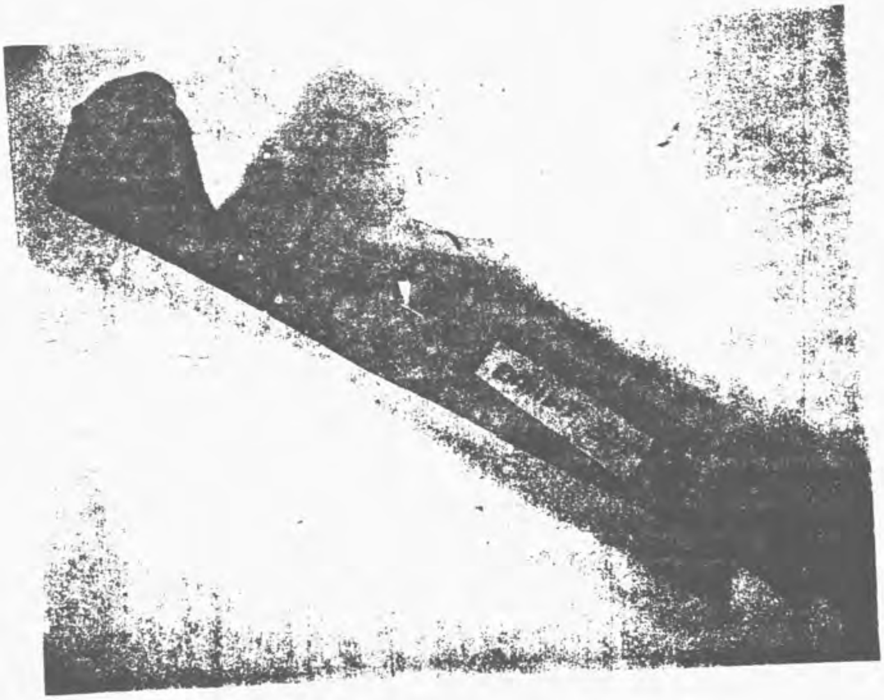


Photo 3. Section of pushrod as received. NOTE: twist on tube.

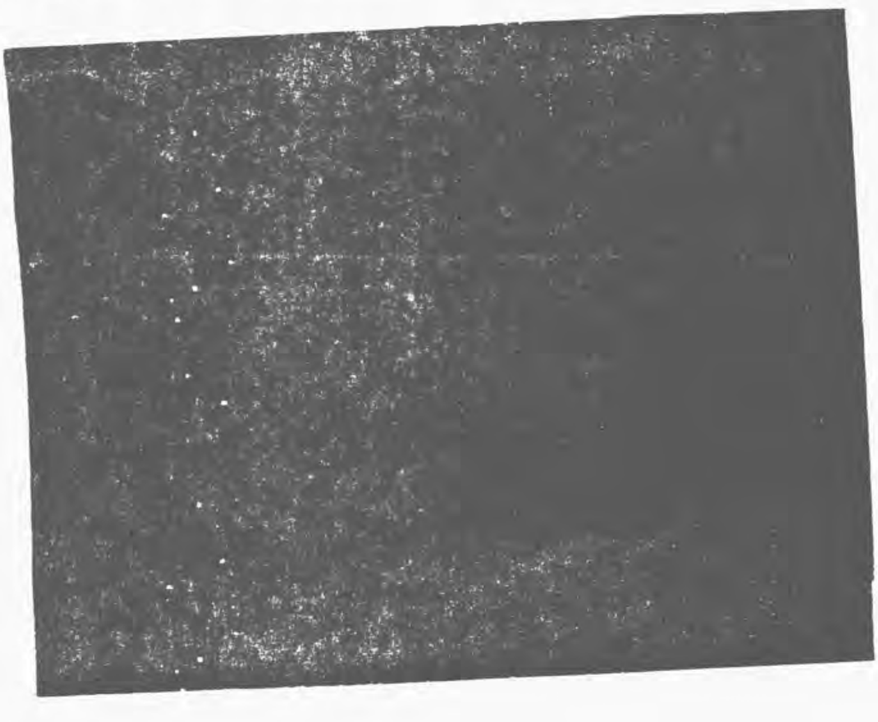


Photo 4. Close-up view of pushrod showing damage to rivet head, tube and end fitting.

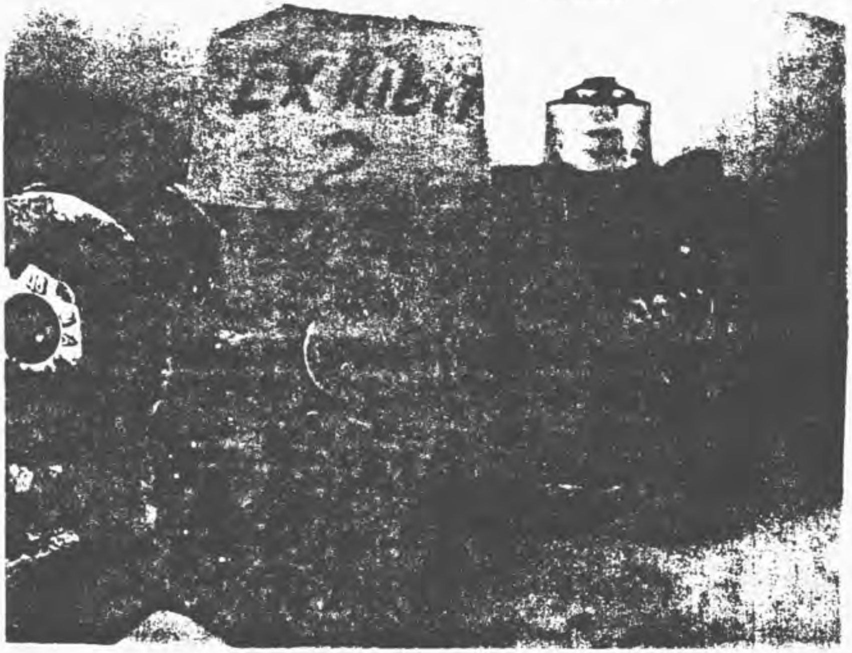


Photo 5. Close-up view of pushrod damage as viewed from a different angle.

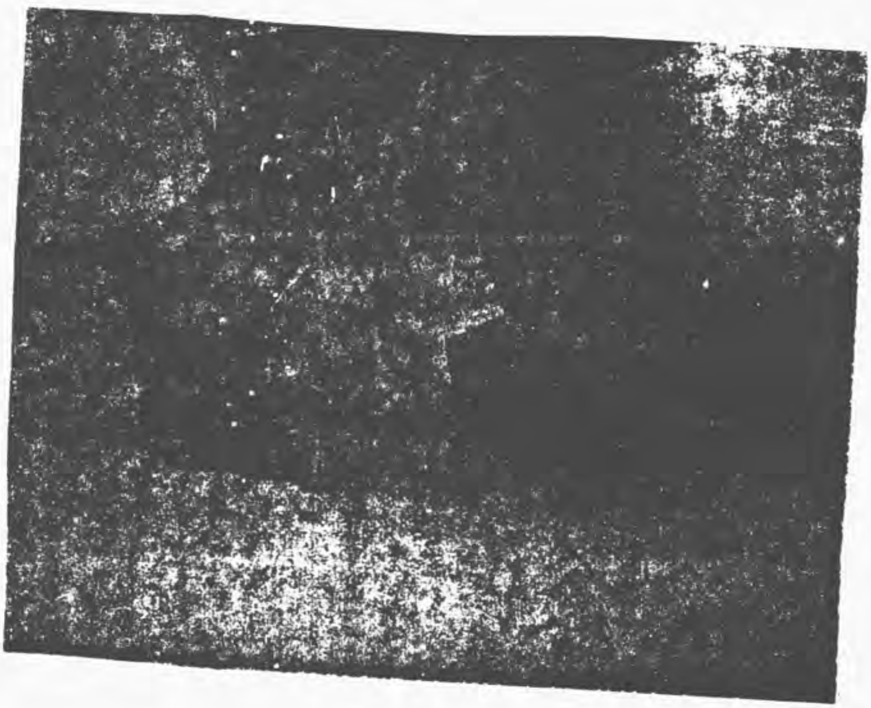


Photo 6. Close-up view of bellcrank section. Arrow points to impact damaged area.

Photo 7. Area "A" showed impact damage resulting from pushrod and end fitting (area "B") being jammed against the bellcrank (area "A").

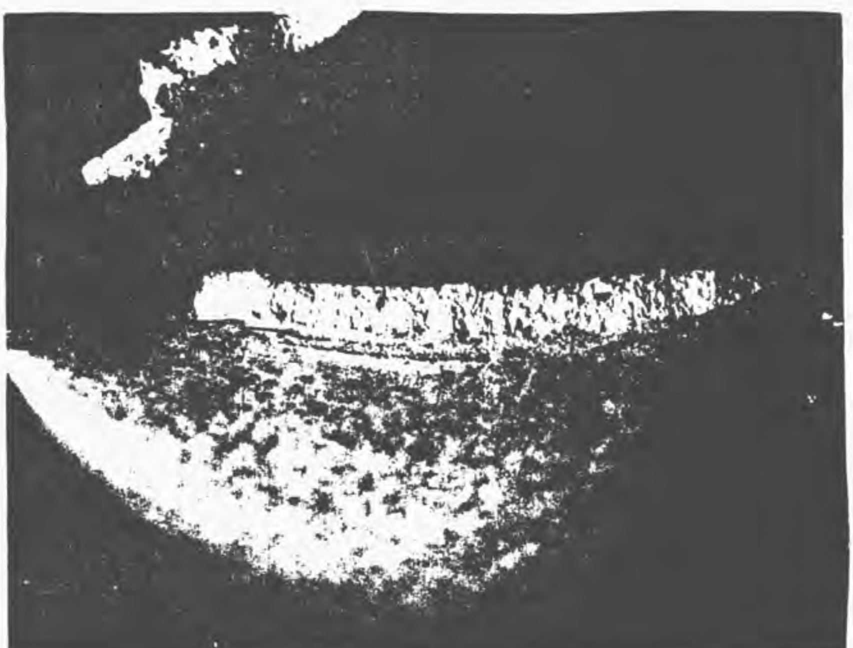


Photo 8. Fractured surface on exhibit 3. Mode of fracture was also shear overload.

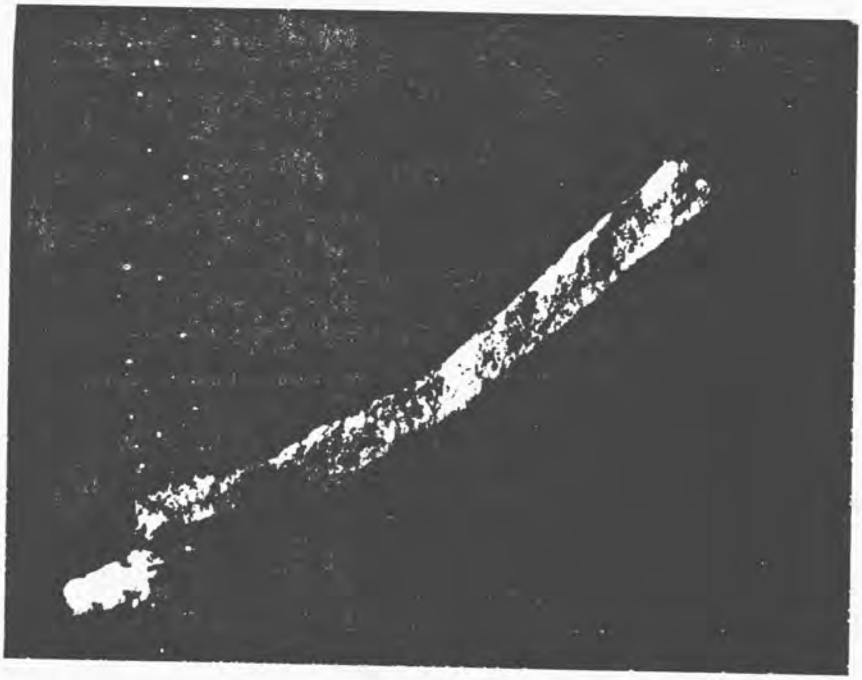


Photo 9. Fractured surface on pushrod tube (exhibit 1) showed plastic deformation and shear lip indicating a shear overload fracture mode.

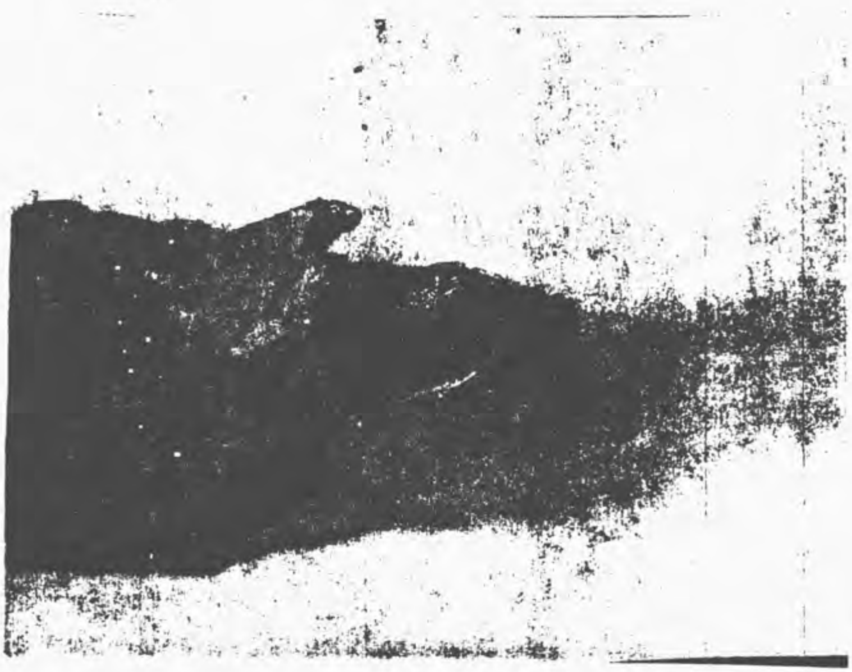


Photo 10. Fracturedesurface on bellcrank was jagged and severely battered. Arrow points to load path as determined by the direction of deformation.

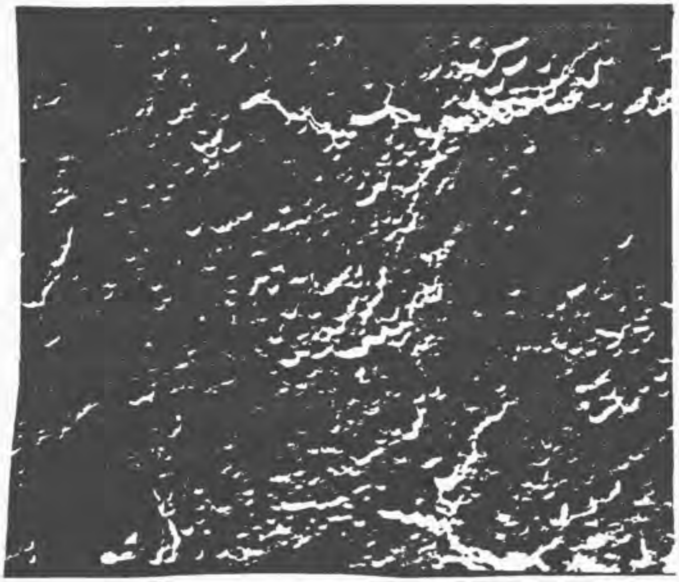


Photo 11. Transverse fracture (cross grain) shows intergranular fracture with and without dimples.

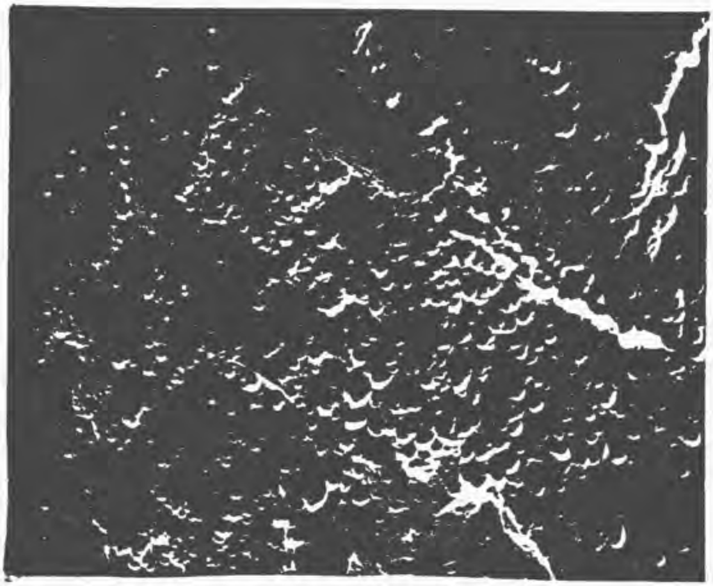


Photo 12. Flat, stretched regions were also noted on the transverse fracture.

7 May 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#2 Right Side Yoke Assembly 2 May 1975

Task #1128, Attachment #25 #142

Metallurgical Analysis

1. One Yoke Assembly identified as No 2 Right Side Yoke Assembly was submitted for analysis as per Attachment #25 of basic MME Task #1128.

2. Photograph of the exhibit as received are identified as Photo 1.

3. Spectrographic analysis identified the material of the alignment pin as AISI 416 Stainless Steel.

4. Visual and microscopic examination of the upper and lower pin shafts are as follows:

a. Upper pin shaft (yoke) showed some scratches on the shank and lug areas also flange area showed damage.

b. Lower pin shaft showed some scratches on the shank, also some wear, but no shear damage. The alignment shaft showed corrosion on the surface, and on the first through fourth threads, no cracks were noted.

5. Visual and microscopic examination of other areas of the assembly are as follows:

a. The four (4) fastener holes were not elongated on the bracket, the four bolts showed some scratches on the shank, one small bolt was slightly bent, all others showed no evidence of bending.

b. The mount ball-bearing revealed no cracks on the outside diameter or inside the hole.

6. Magnetic particle inspection by the NDI Laboratory revealed one small crack on the sleeve where the hook connects to the bracket, no other cracks were found. See attached Lab Report, dated 5 May 1975, Lab No 75-76.

7. Measurements of the yoke holes, and bracket holes are attached to this report.

JOHN PARKER, Metallurgist

3 Atch
1. Drawing
2. Photo 1
3. NDI Lab Report

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

Z-2

5 May 75

MANCE/Mr Parker

Nondestructive Testing Lab Sec/MANCD

Right-Side Yoke Assembly #2

4 May 75

MANCE/ Task 1128 Attachment 25

75-76

Cracks

1. One each Right-Side Yoke Assembly was received by MANCD for nondestructive inspection. Specimen was identified as Right-Side Yoke Assembly #2, Canted Fus Station 2024, Ramp Station 54.

2. Specimen was processed as follows:

a. Specimen was processed by the magnetic particle method using circular and longitudinal magnetic fields and the wet continuous method of particle application.

3. Inspection results:

a. Blacklight inspection revealed two small indications on the alignment pin roller P/N 4F 51724-101A. Indications were located within a surface worn area and were orientated in a longitudinal direction.

b. Whitelight inspection with 10X magnification showed indications to be two small surface cracks.

c. No other discrepancies were noted; all indications were marked.

Jose N. Garcia
Qlty Assr Spec

MATIAS RAMOS JR.
Ch, NDT Lab Sec

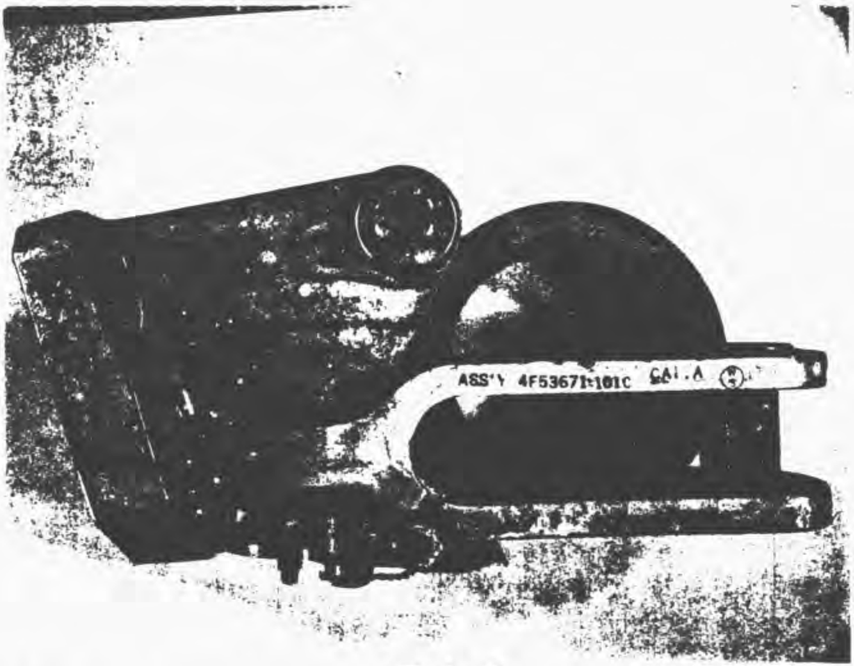
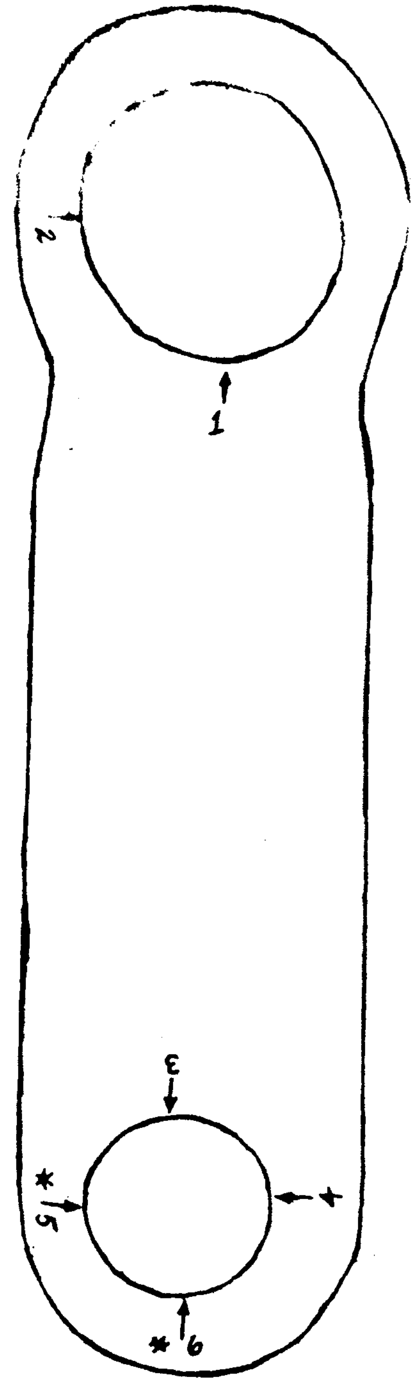


Photo 1

#2 Right Side Yoke Assembly - Showing the exhibit as received here in the Metallurgical Laboratory.

Yoke Hole Diameter Measurements

1. 0.389"	2. 0.370"
3. 0.938"	4. 0.937"
5. 0.998"	6. 1.000"



* Other Side "B"

#2 Right Side Yoke Assembly - Attachment #25

Measurement of Shaft and Bolt Holes

1.	0.643"	Large bolt holes
2.	0.644"	
3.	0.381"	Small bolt holes
4.	0.381"	
5.	0.998"	Bottom eccentric shaft holes
6.	0.998"	
7.	0.776"	Upper eccentric shaft holes
8.	0.776"	

8 May 1975

ME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Ramp Floor Fracture Surface 2 May 1975

Task #1128, Attachment #26 #142

Metallurgical Analysis

1. The Ramp Floor was submitted to the Metallurgy Laboratory for analysis of the fractured surfaces. This was in support of Attachment #26, Task #1128.

2. Samples #1 thru #5 were sectioned from section #1 to determine mode and direction of failure. Photo 1. Sample #6 thru #12 were identified on section #2. Photo 1. Samples #13 thru #17 were identified on section #3. Photo 1. Samples #18 thru #23 were identified on section #4. Photo #1. Samples #23 thru #27 were identified on section #5. Photo 20. Fractographs were taken of sample #15 and #24 to identify mode of failure.

3. Microscopic investigation revealed the majority of the fractures to be either in tensile shear or tensile cup. The mode of failure progressed with bending, shearing, twisting and tearing by overload. Most of the fractures displayed a development of corrosion that partially obliterated the direction of the fracture failure. On all the photographs, the arrows identifying the shear area will also indicate the shear direction, unless otherwise noted. The shear lips identifying the direction of failure on some of the samples was obliterated either by corrosion or were not present due to missing parts.

4. The Ramp Floor fractured surfaces displayed a combination of tensile shear and tensile cup by overload. These modes of failure were accompanied by shearing, tearing and bending action. The trend of the failure initiated on the right side of the ramp floor with an upward bending movement, followed by a tensile downward moment in overload. Many of the fracture surfaces representing shear were either uniaxial, biaxial or triaxial in tension.

SIGNED

W. H. CROCKER, Metallurgist

1 Atch
Photos 1 thru 29

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

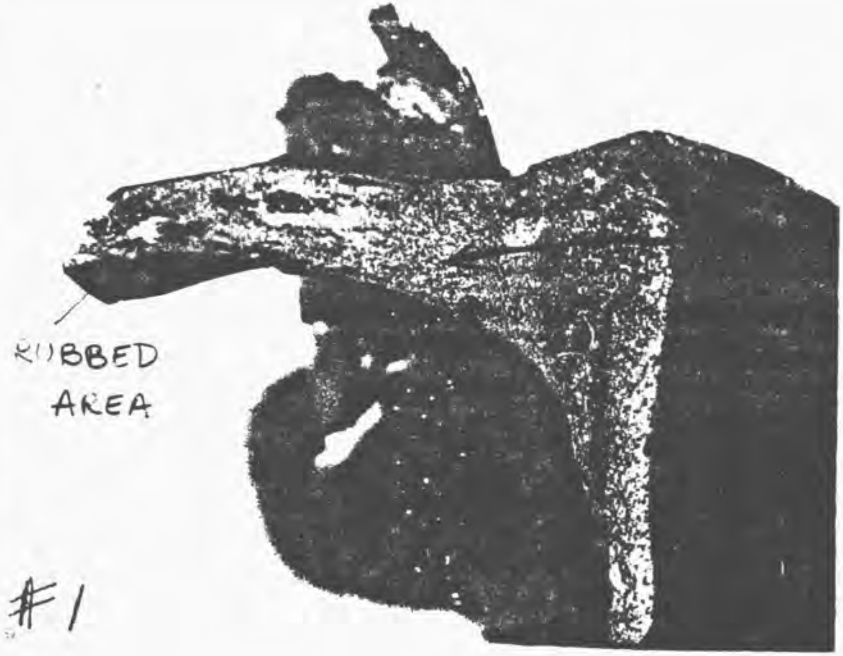


Photo 2

Sample 1

Mode of Failure - Tensile shear by overload

Rubbed area shows vibration - arrows indicate shear direction.

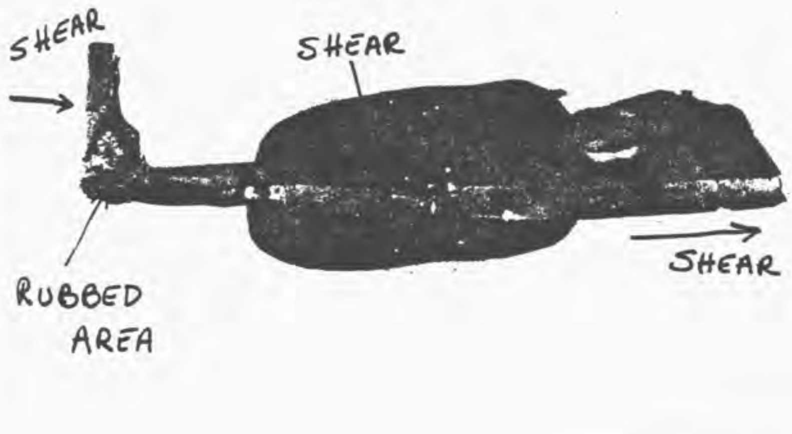


Photo 2

Sample 2

Mode of Failure - Tensile shear by overload

Arrows indicate shear direction which change with a bending action.

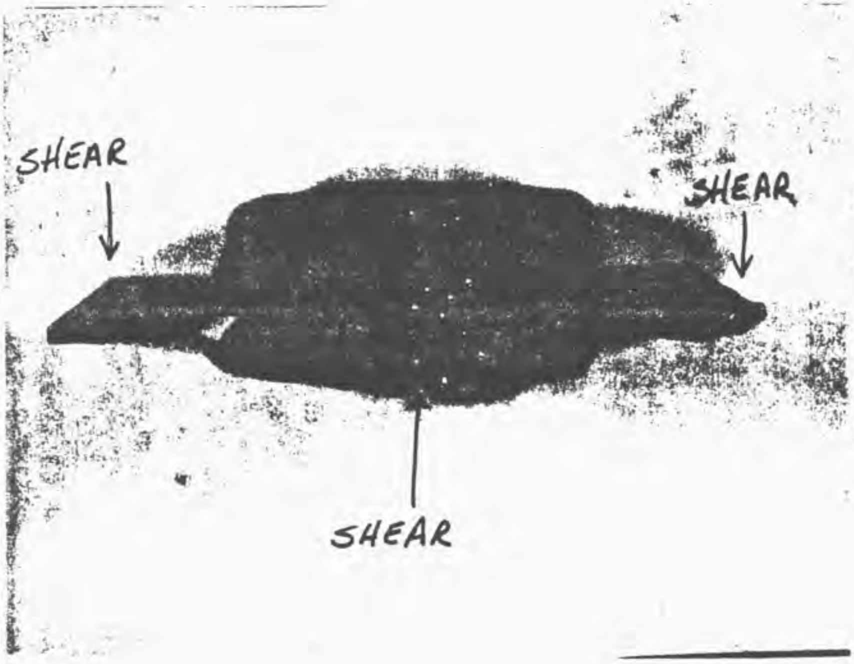


Photo 4

Sample 3

Mode of Failure - Tensile shear by overload.

Arrow indicate direction of bending action.

Photo 5

Sample 4A

Mode of Failure - Tensile shear by overload.

Arrows indicate direction of shear.

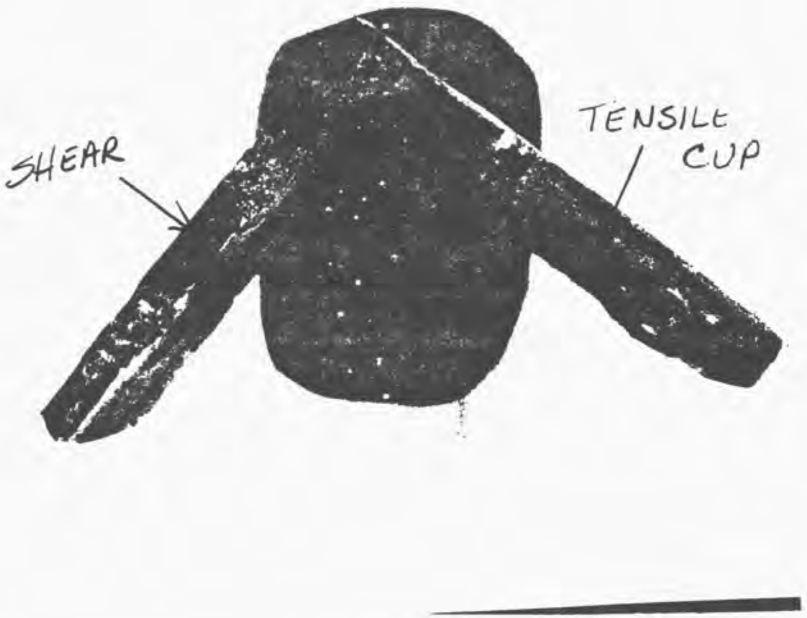


Photo 6

Sample 4

Mode of Failure - Tensile cup & shear by overload.

Arrows indicate direction of shear.

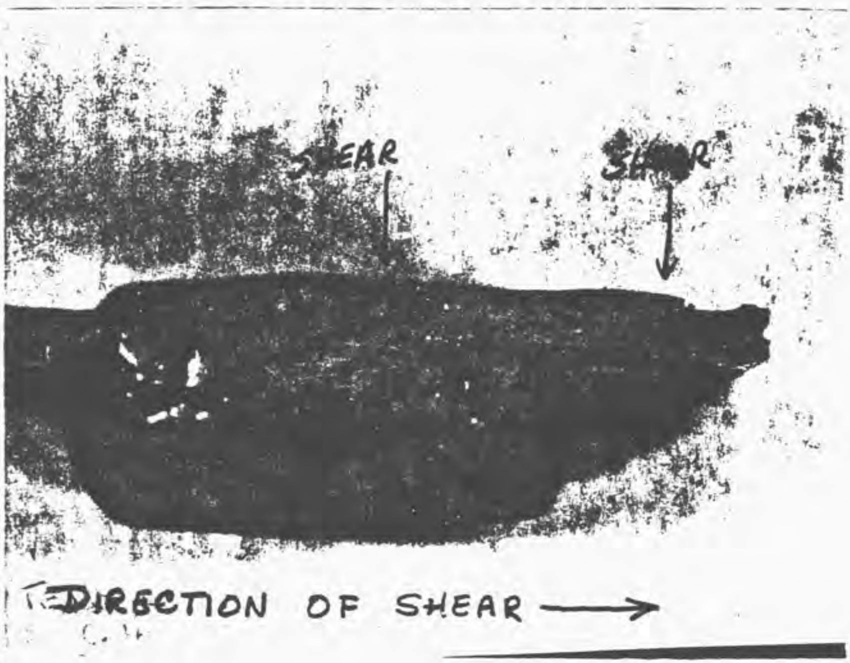


Photo 7

Sample 5

Mode of Failure - Tensile shear by overload.

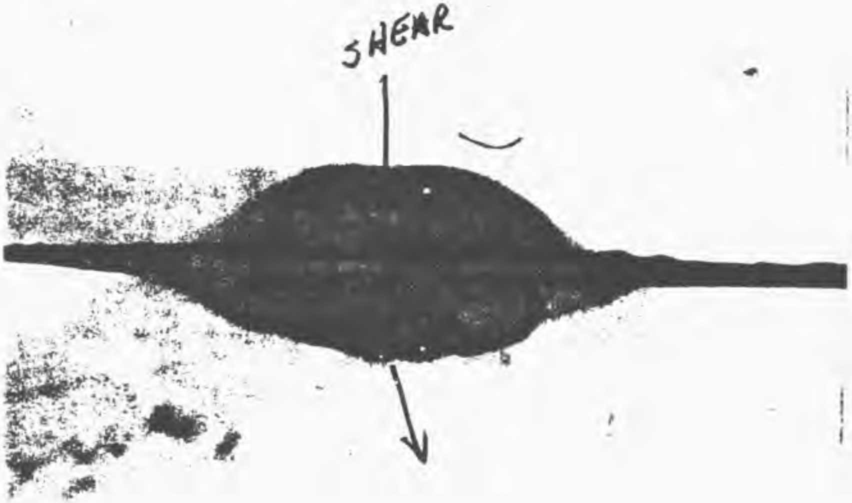


Photo 8

Sample 6

Mode of Failure - Tensile shear with a tearing action by overload.

Arrows indicate direction of shear.

Photo 9

Sample 7

Mode of Failure - Tensile shear by overload.

Arrow indicates direction of shear.

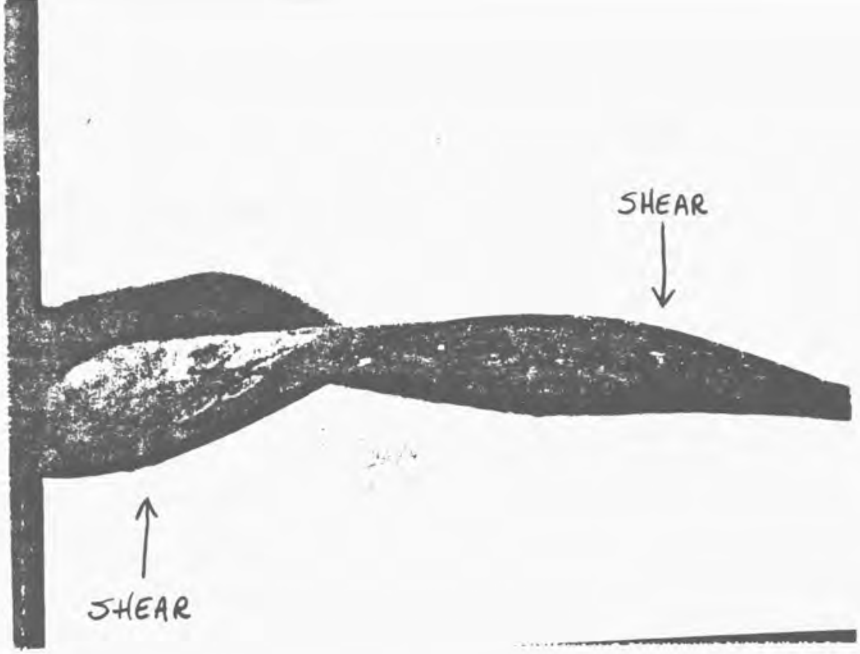


Photo 10

Sample 8

Mode of Failure - Tensile shear or tearing by overload.

Arrows indicate direction of shear.

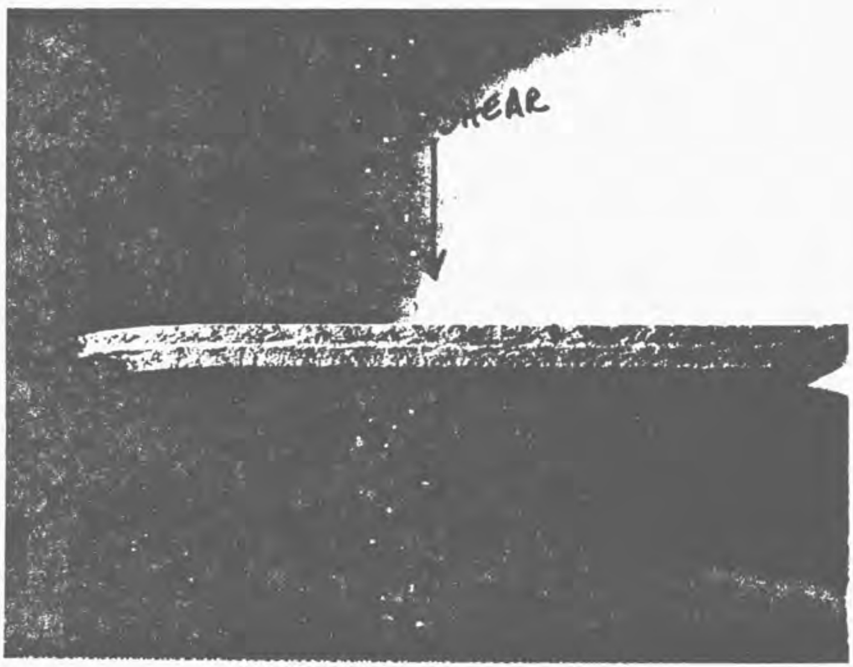


Photo 11

Sample 9

Mode of Failure - Tensile shear - double action by overload.

Arrows indicate direction of shear.

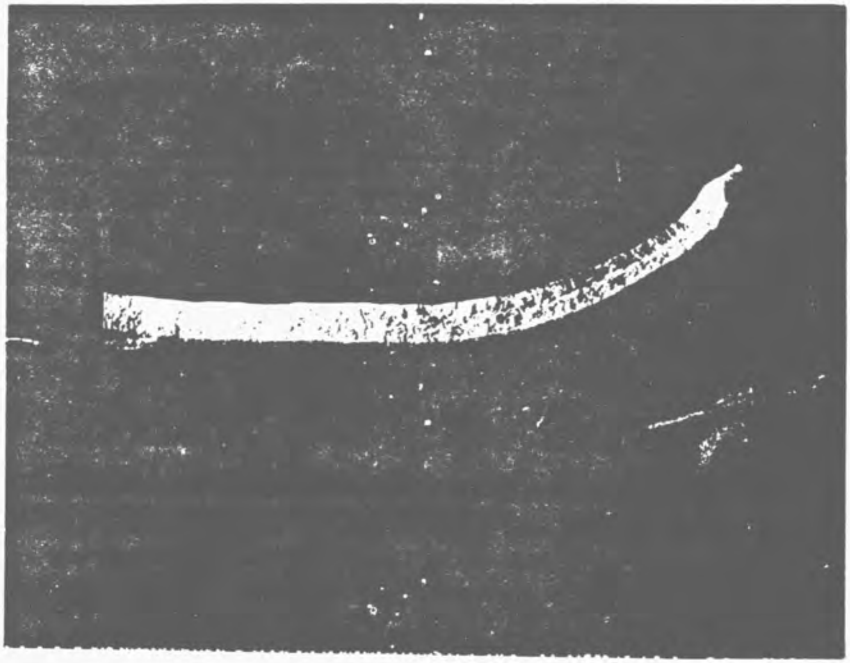


Photo 12

Sample 10

Mode of Failure - Tensile shear by overload.

Arrow indicates shear direction.

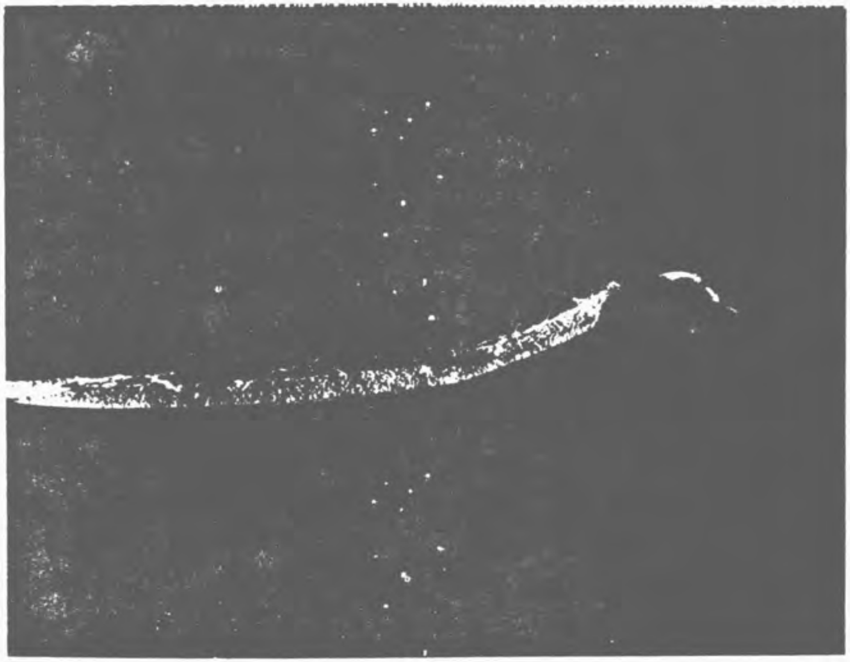


Photo 13

Sample 11

Mode of Failure - Tensile shear by overload.

Arrow indicates shear direction.

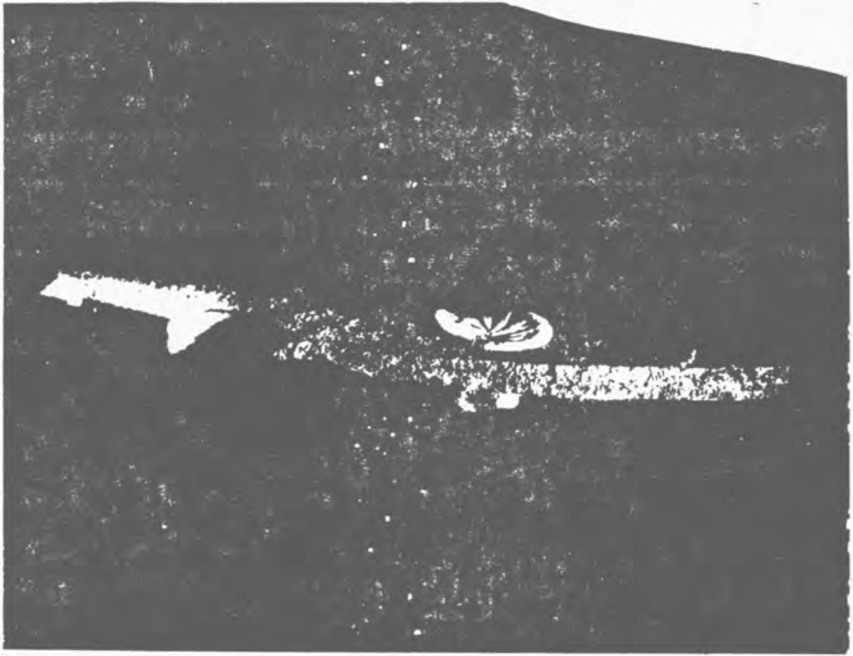


Photo 14

Sample 12

Mode of Failure - Tensile shear by overload.

Arrow indicates shear direction.

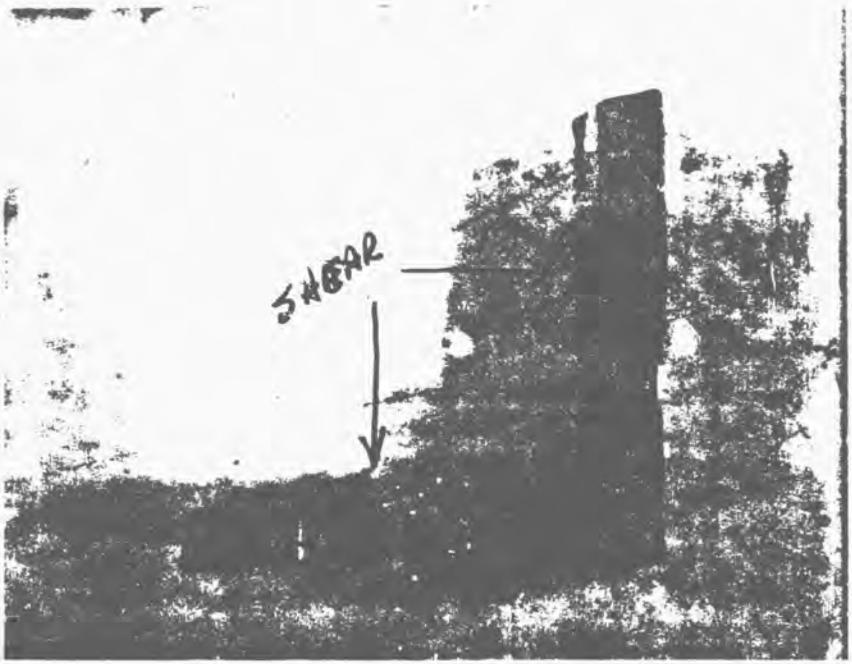


Photo 15

Sample 13

Mode of Failure - Tensile shear by overload.

Arrows indicate shear direction.

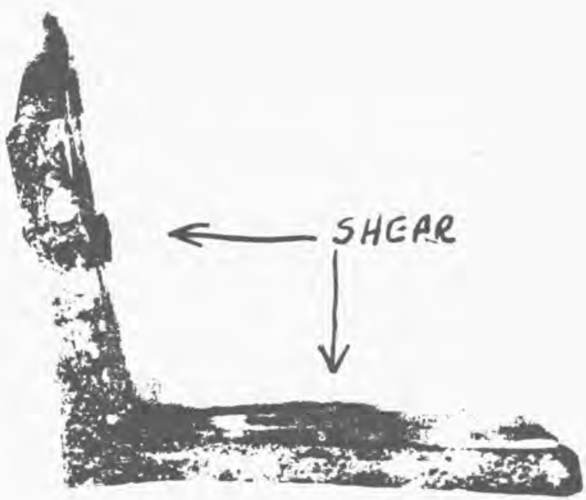


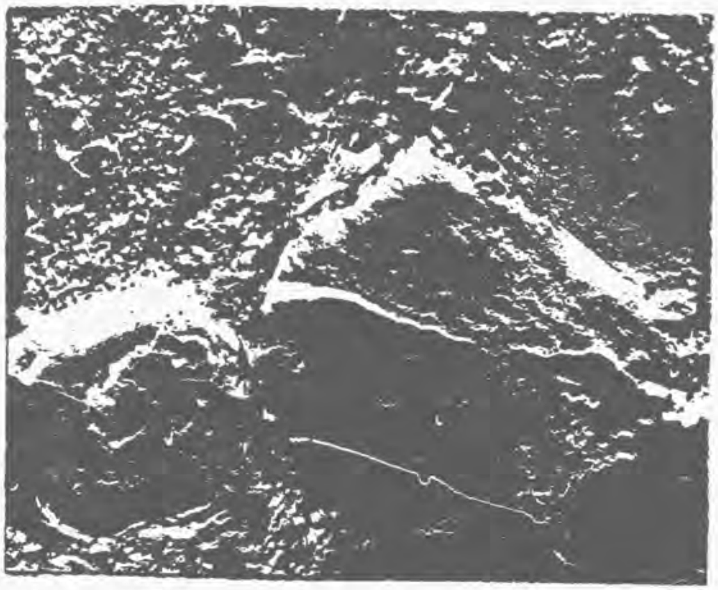
Photo 16

Sample 14

Mode of Failure - Tensile shear by overload.

Arrows indicate shear direction.

Fractograph of sample #15
5600X - Fracture consists primarily of stretched areas & fine - dimples. Failed by tension overload.



Fractograph of Sample #15
5600X

Dimple rupture - all fractograph show tensile tear. The fracture faces exhibit corrosion, which flattened down the fracture faces. This corrosion is not part of the failure mode. Tension - Overload.

Fractograph of Sample #15
5600X

Predominately dimple rupture dimples are elongated as the result of the state of stress during rupture.

Tension Overload.

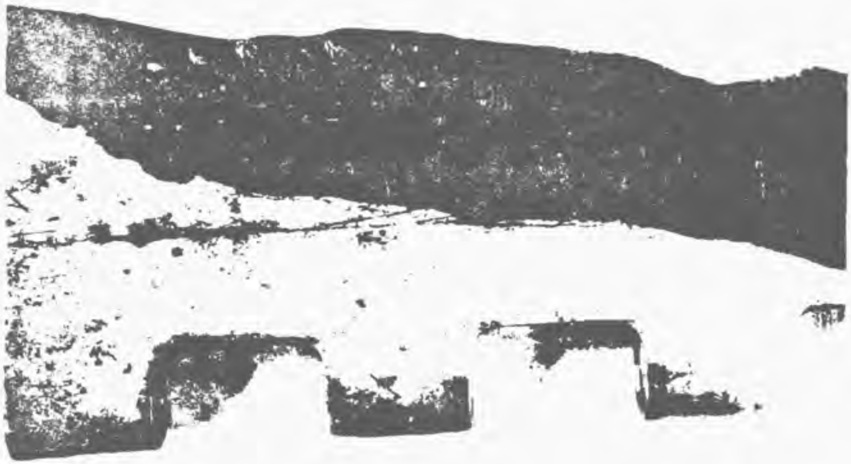


Photo 17

Sample 15

Mode of Failure - Tensile tear or shear by overload.

Spectrographic analysis identified material as 7075 aluminum alloy.

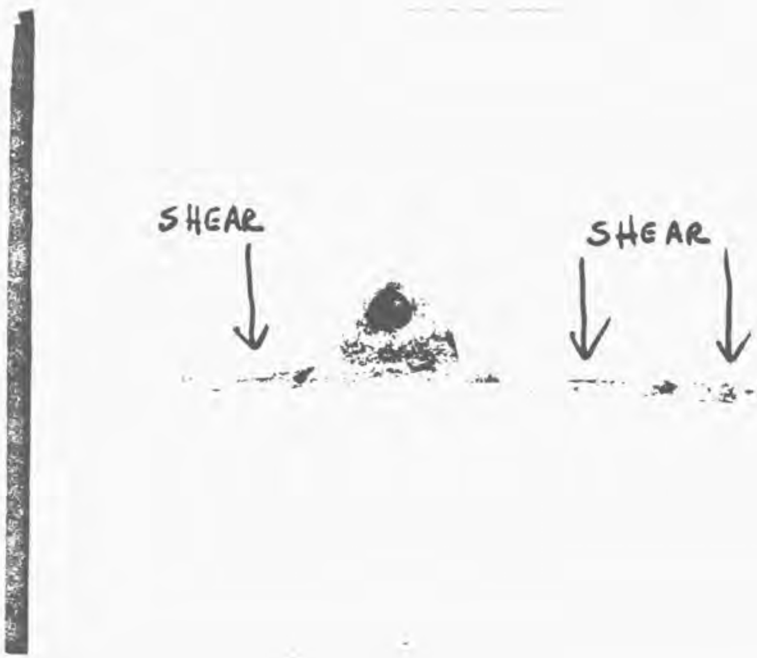


Photo 18

Sample 16

Mode of Failure - Tensile shear by overload.

Arrows indicate shear direction.

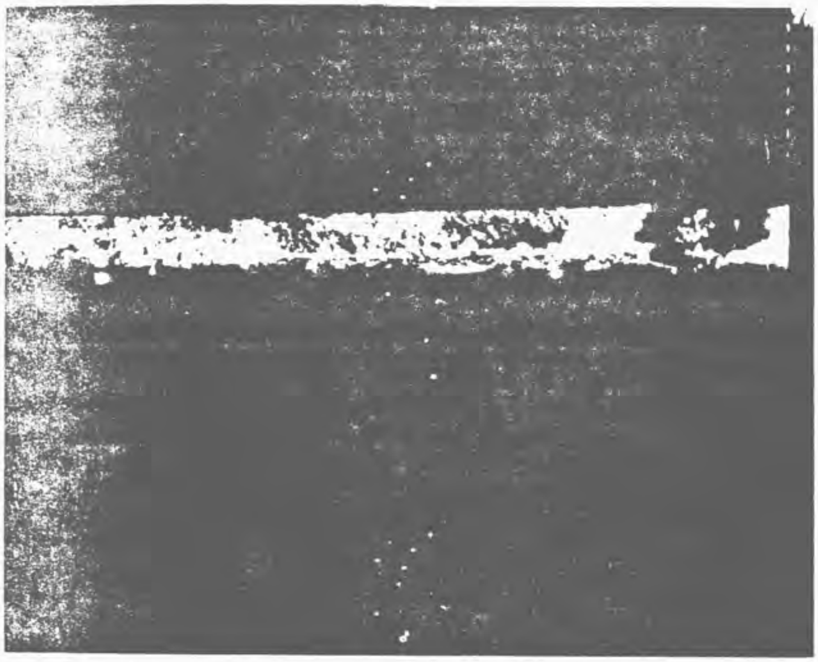


Photo 19

Sample 17

Mode of Failure - Tensile shear through tearing by overload.

Arrows indicate shear direction.

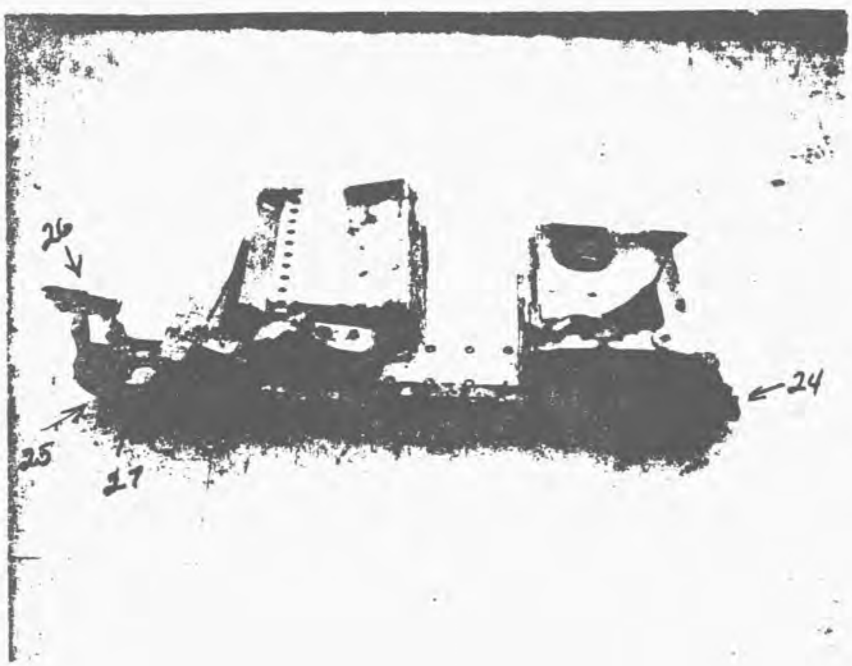


Photo 20

Identifies location of samples in section #5.

Photo 21

Sample 19

Mode of Failure - Tensile shear by overload.

Arrow indicates shear direction.

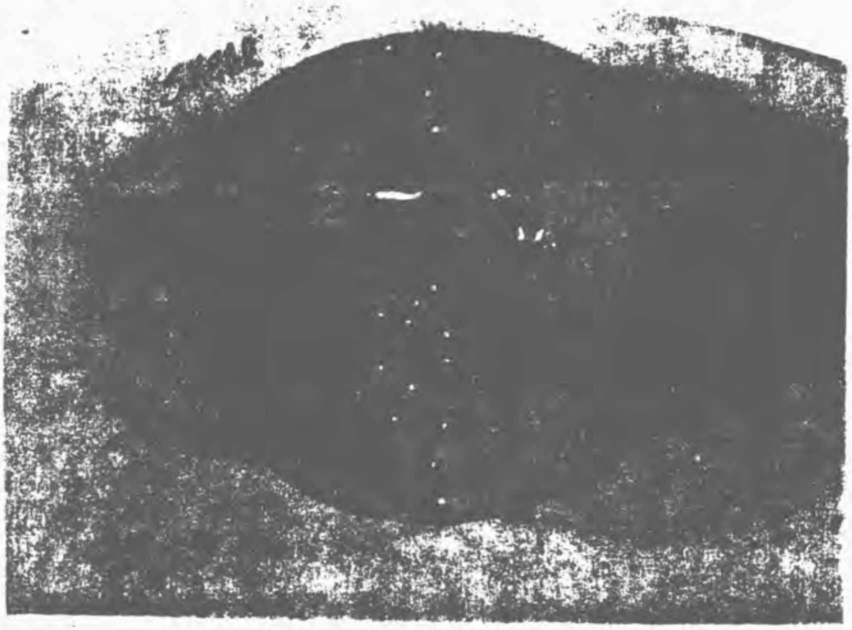


Photo 22

Sample 20

Mode of Failure - Tensile shear with a reversing action by overload.

Arrows indicate shear direction.

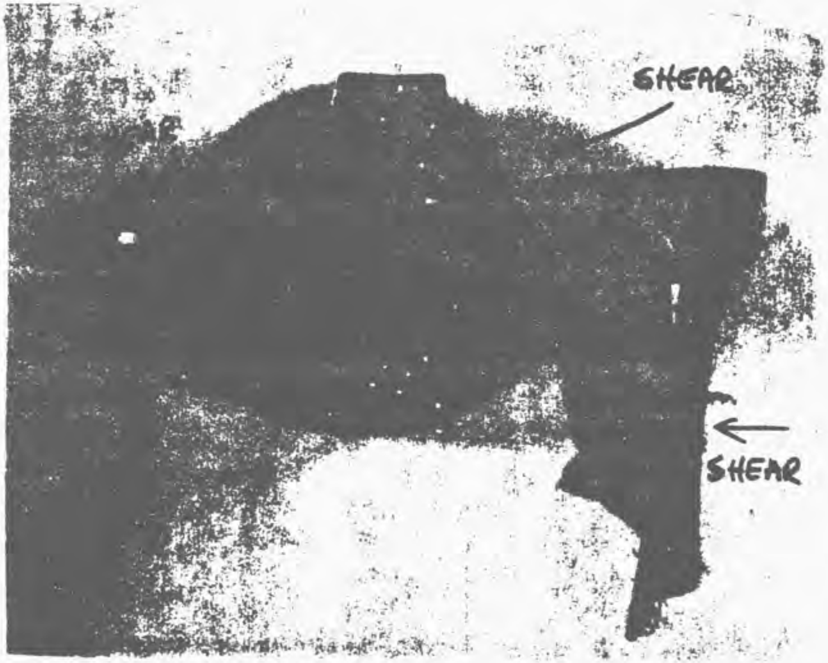


Photo 23

Sample 21

Mode of Failure - Tensile shear with a reversing shear.

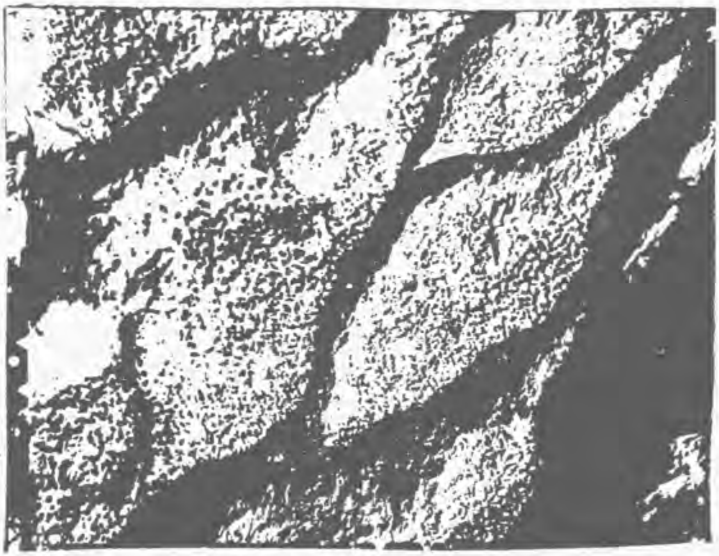
Arrows indicate shear direction.

Photo 24

Sample 22

Mode of Failure - Tensile shear with bending & ripping.

Arrows indicate shear direction.



Fractograph of Sample 24
Fractograph analysis - Rapid failure by dimple rupture. Fracture exhibits "mud cracks typical of stress corrosion cracking." 5600X

Fractograph of Sample 24
Fractograph analysis - mode of failure was intergranular with a rapid failure by dimple rupture. Fracture exhibits "mud cracks" typical of stress corrosion cracking. 5600X

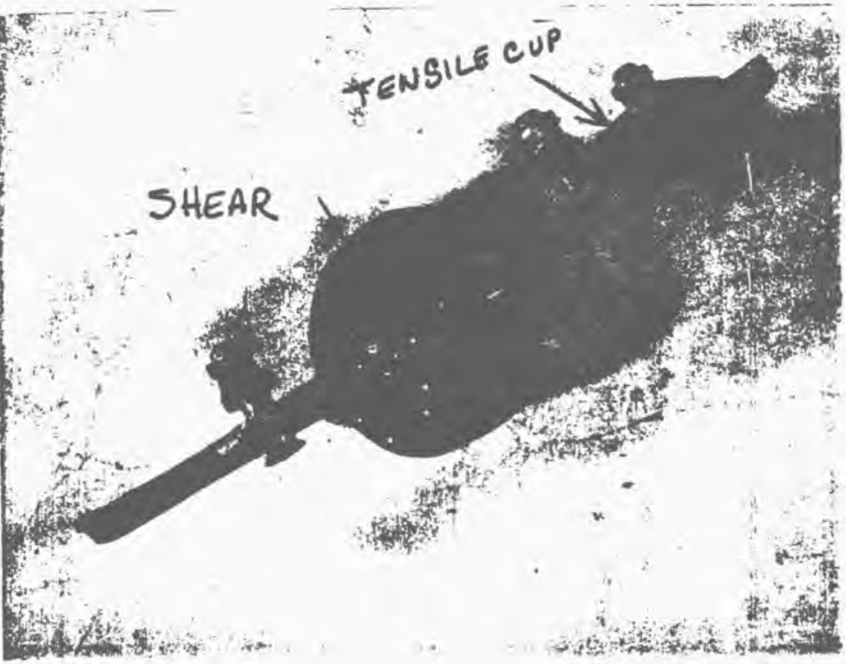


Photo 25

Sample 23

Mode of Failure - Tensile cup & shear - by overload.

Arrow indicates shear direction.

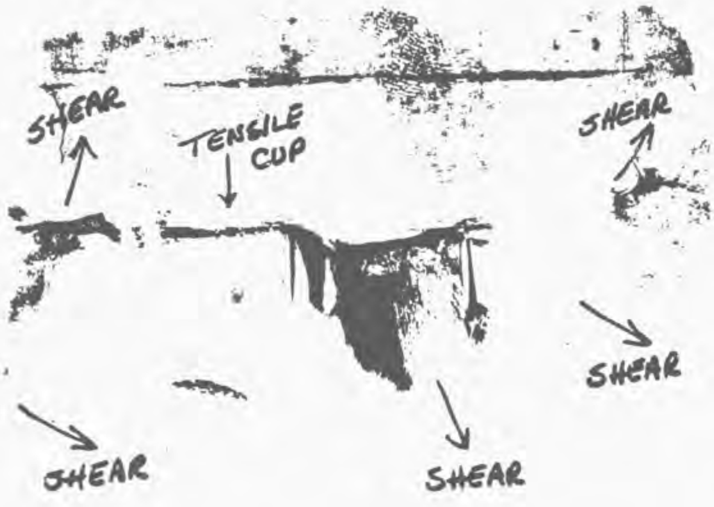


Photo 26

Sample 24

Mode of Failure - Tensile cup & shear, tearing action.

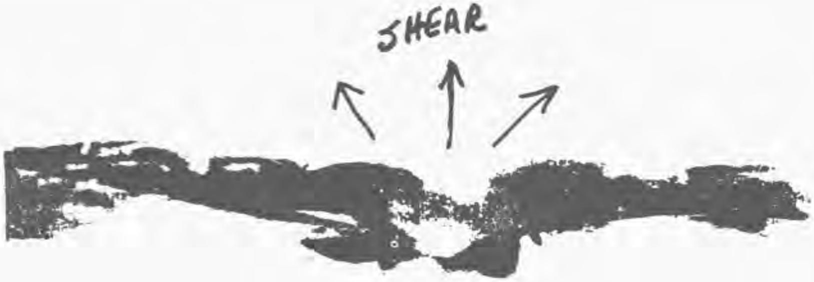


Photo 27

Sample 25

Mode of Failure - Tensile shear tearing by overload.

Arrows indicate shear direction.

Photo 28

Sample 26

Mode of Failure - Tensile shear by overload.

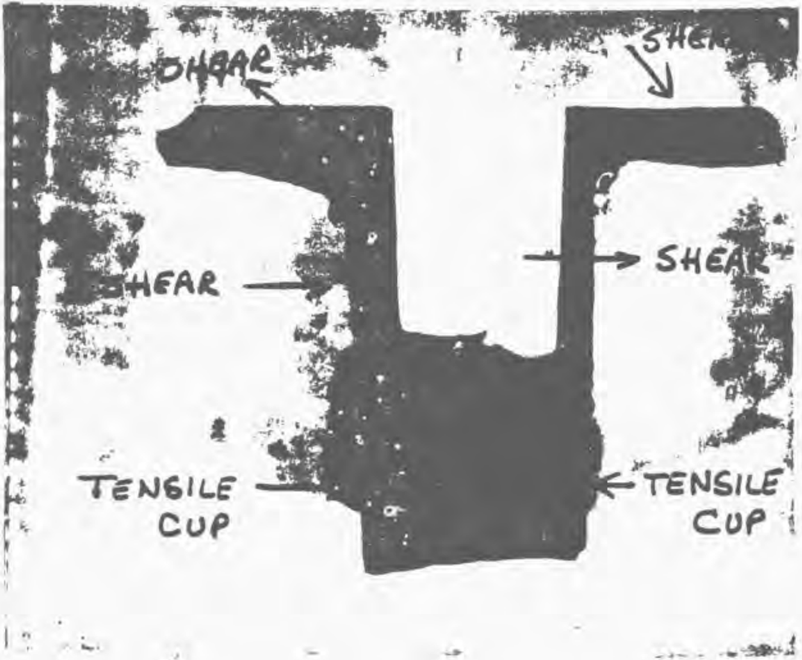


Photo 29

Sample 27

Mode of Failure - Tensile cup & shear - by overload accompanied by cycle tearing.

Arrows indicate shear direction.

7 May 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#3 Right Side Yoke Assembly 2 May 1975

Task #1128, Attachment #27 #142

Metallurgical Analysis

1. One Yoke Assembly identified as No 3 Right Side Yoke Assembly was submitted for analysis as per Attachment #27 of basic MME Task #1128.

2. Photograph of the exhibit as received are identified as Photo 1.

3. Spectrographic analysis identified the material of the alignment pin as AISI 416 stainless steel.

4. Visual and microscopic examination of the upper and lower pin shafts are as follows:

a. Upper pin shaft - (yoke) showed some shearing action on the pin bracket, and also on the yoke on one side.

b. Lower pin shaft - showed some slight shearing action on the surface on one side. The alignment shaft showed some corrosion with pits, no cracks were noted..

5. Visual and microscopic examination of other areas of the assembly are as follows:

a. The four (4) fastener holes were not elongated on the bracket, holes on the yoke were not elongated, the four bolts showed some scratches on the shank, one small bolt was slightly bent, all others showed no evidence of bending.

b. The mount ball-bearing showed no cracks on the outside diameter or inside the hole.

6. Magnetic particle inspection report is attached, dated 4 May 1975, Lab No 75-76.

7. Measurement of the yoke holes, and bracket holes are attached to this report.

JOHN PARKER, Metallurgist

3 Atch
1. Drawing & Measurements
2. Photo 1
3. NDI Report

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

Photo 1

#3 Right Side Yoke Assembly - Showing the exhibit as received here in the Metallurgical Laboratory.

[illegible]

Measurements of Shaft & Holt Holes

1.	0.521"	Large Bolt Holes
2.	0.521"	
3.	0.382"	Small Bolt Holes
4.	0.382"	
5.	0.876"	Upper eccentric shaft holes
6.	0.876"	
7.	0.999"	Lower eccentric shaft holes
8.	0.999"	

LABORATORY ANALYSIS REPORT AND RECORD

4 May 1975

TO: MANCE / Mr Parker	FROM: Nondestructive Testing Laboratory Section
SAMPLE IDENTITY: Right-Side Yoke Assembly #3	DATE RECEIVED: 4 May 1975
SAMPLE FROM: MANCE / Task 1128 Attachment 27	LAB CONTROL NR: 75-76
TEST FOR: Cracks	

1. One Right-Side Yoke Assembly was received by MANCD for nondestructive testing. Specimen was identified as Right-Side Yoke Assembly, #3, Canted Fus Station 2044, Ramp Station 74.

2. Specimen was processed as follows:

a. Specimen was processed by the magnetic particle method using circular and longitudinal magnetic fields with the wet continious method of particle application.

3. Inspection Results:

a. Blacklight inspection revealed one longitudinal indication one half inch long located on a surface worn area of the roller P/N 4F 51724-101A.

b. Whitelight inspection of the indication showed the indication to be a surface crack.

c. No other indications were noted; all indications were marked.

Jose N. Garcia
Qlty Assur Spec

SIGNED

MATIAS RAMOS JR.
Ch, NDT Lab Sec

CC-1

8 May 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#5 Right Side Floor Bracket 2 May 1975

Task #1128, Attachment #28 #142

Metallurgical Analysis

1. One Floor bracket identified as No 5 Right Side Floor Bracket was submitted for analysis as per Attachment #28 of basic MME Task 1128.

2. Photographs of the exhibit as received are identified as Photo 1, the others are of the two damaged eccentric shaft holes.

3. Visual and microscopic examination of the bottom eccentric holes indicated that extensive loading was applied in the straight up direction, notice this effect in the photographs, there was some metal deformation on the hole.

4. The four (4) fastener bolts showed some scratches on the surface, no evidence of bending was noted.

5. Measurements of the bracket holes are attached to this report.

6. Magnetic particle inspection report is attached, dated 4 May 1975, Lab No 75-76.

JOHN PARKER, Metallurgist

3 Atch
1. Photos 1 thru 3
2. Measurements
3. NDI Report

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

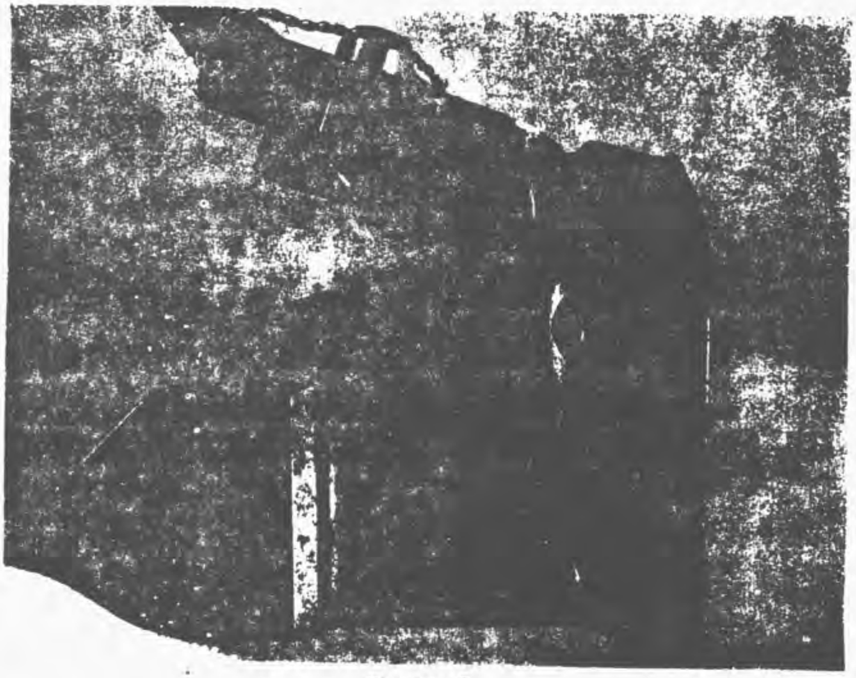


Photo 1
#5 Right Side Floor Bracket - Showing the exhibit as received here in the **Metallurgical Laboratory.**

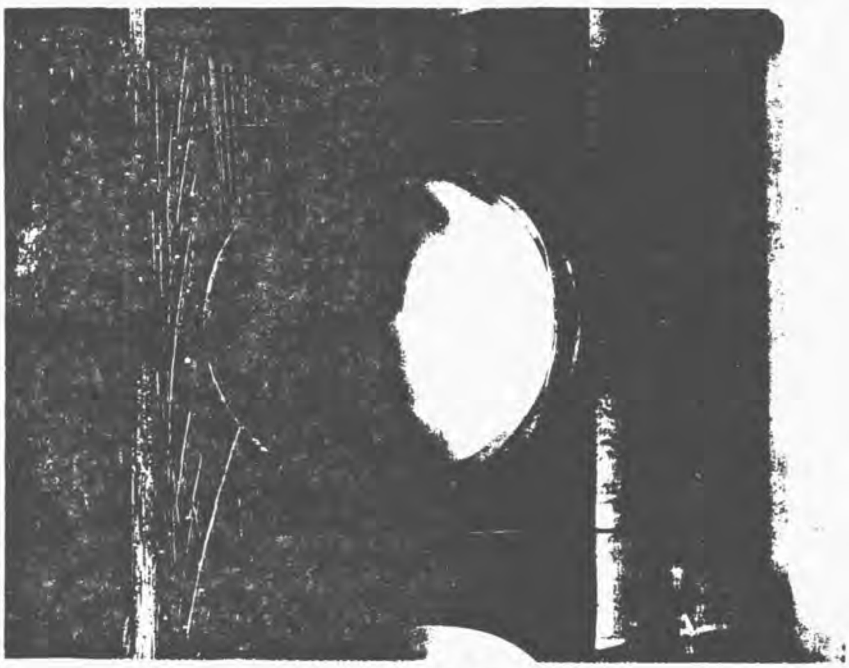


Photo 2
#5 Right Side Floor Bracket - Showing the bottom eccentric hole on the thin section where the two large bolt holes are, notice the deformation of the metal is in the straight up direction.

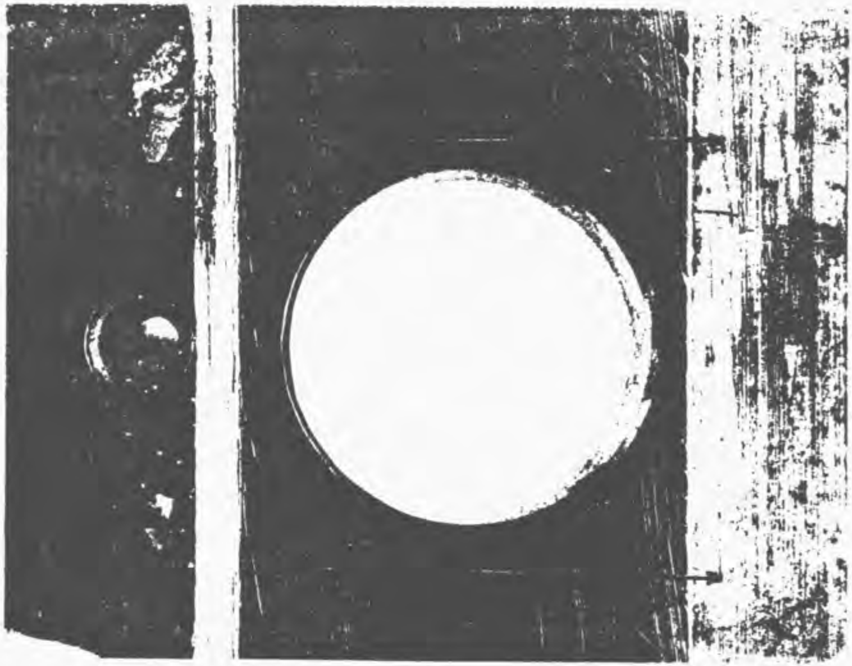


Photo 3
#5 Right Side Floor Bracket - Showing the bottom eccentric hole on the heavy section where the two small bolt holes are. This damaged area is in the same direction as shown in Photo 2.

#5 Right Side Floor Bracket   Attachment #28

Measurements of Holes and Shafts

1.	0.517"	Large Bolt Holes
2.	0.517"	
3.	0.376"	Small Bolt Holes
4.	0.376"	
5.	0.998"	Bottom eccentric shaft holes
6.	0.998"	
7.	0.875"	Upper eccentric shaft holes
8.	0.875"	

LABORATORY ANALYSIS REPORT AND RECORD		DATE CC-5 4 May 1975
TO MANCE / Mr. J. Parker	FROM Nondestructive Testing Laboratory Section	
SAMPLE IDENTITY Right Side Floor Bracket No. 5		DATE RECEIVED 4 May 1975
SAMPLE FROM MANCE / Task 1128 Attachment No.28		LAB CONTROL NR 75-76
TEST FOR cracks.		

1. One each Right Side Floor Bracket No.5 was received by MANCD for nondestructive inspection. Specimen was identified as Right Side Floor Bracket No.5, Canted Fus. Station 2084, Ramp Station 116.

2. Specimen was processed as follows:

a. Specimen was processed by the magnetic particle method using circular and longitudinal magnetic fields with the wet continous method of particle application.

3. Inspection results:

a. Blacklight inspection revealed no discrepancies with the exception of tool and wear marks and possible impact damage.

Johnny Reyes Jr
Ultr Test Equi Oper

SIGNED

MATIAS RAMOS JR.
Ch, NDT Lab Sec

12 May 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#4 Right Side Floor Bracket 2 May 1975

Task #1128, Attachment #29 #142

Metallurgical Analysis

1. One floor bracket identified as No 4 Right Side Floor Bracket was submitted for analysis as per Attachment #29 of basic Task #1128.

2. Photographs of the exhibit as received are identified as Photo 1, others are of the two damaged eccentric holes.

3. Visual and Microscopic examination of the bottom eccentric shaft holes showed that extensive loading was applied in the straight upward direction, also on the thin and heavy sections some compression was noted at the bottom of the holes. Some plating on the outer edge of the holes was chipped off. (See Photos 2 & 3).

a. The upper eccentric shaft pin showed severe corrosion and corrosion pits on the surface, no evidence of cracks or shearing damage was noted, sleeve on this shaft revealed a crack.

b. The four (4) fastener bolts showed some scratches and wear on the shank area, no bending or cracks were found.

4. Measurements of the bracket holes are attached to this report.

5. Magnetic particle inspection report is attached, dated 6 May 75, Lab No 75-76.

SIGNED
JOHN PARKER, Metallurgist

SIGNED
O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

3 Atch
1. Photos 1 thru 3
2. Measurements
3. NDI Report

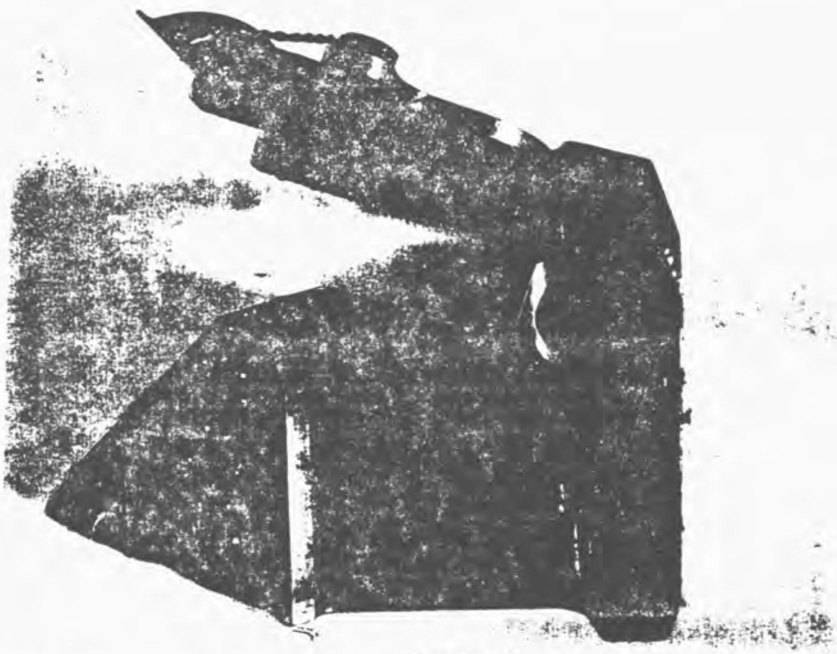


Photo 1
#4 Right Side Floor Bracket - Showing the exhibit as received here in the Metallurgical Laboratory.

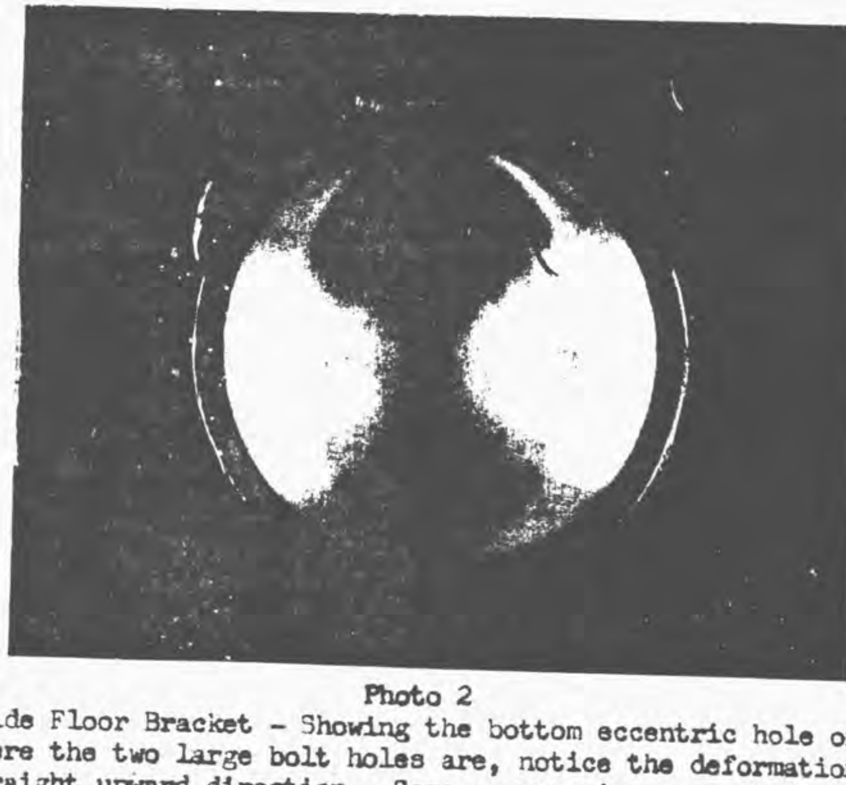


Photo 2
#4 Right Side Floor Bracket - Showing the bottom eccentric hole on the thin section where the two large bolt holes are, notice the deformation of the metal is in a straight upward direction. Some compression was noted at the bottom of the hole, and plating had chipped off.

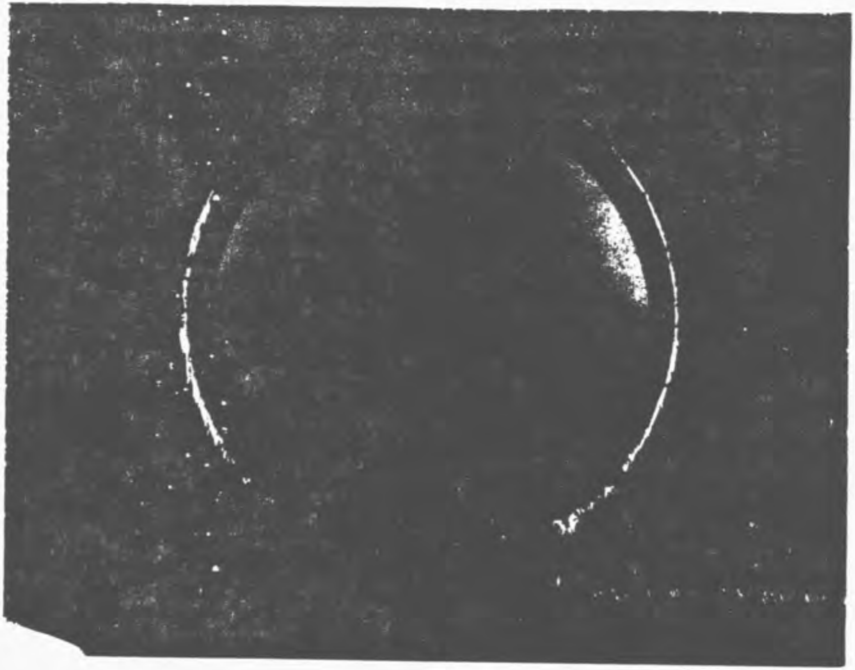


Photo 3

#4 Right Side Floor Bracket - Showing the bottom eccentric hole on the heavy section where the two small bolt holes are, notice the deformation of the metal is in a straight upward direction. Some compression was noted at the bottom of the hole, and plating had chipped off.

#4 Right Side Floor Bracket Attachment #29

Measurements of Bolt Holes & Shaft Holes

1.	0.519"	Large Bolt Holes
2.	0.519"	
3.	0.380"	Small Bolt Holes
4.	0.380"	
5.	0.998"	Bottom eccentric Shaft Holes
6.	0.998"	
7.	0.876"	Upper eccentric Shaft Holes
8.	0.876"	

OD-5

6 May 75

MANCE/Mr Parker

MANCD/Nondestructive Testing Lab Sec

Right-Side, Floor Bracket #4

5 May 75

MANCE/ Task 1128 Attachment 29

75-76

Cracks

1. One each Right-Side, Floor Bracket Assembly #4 was received by MANCD for nondestructive testing. Specimen was identified as Right-Side Floor Bracket Assembly #4, Canted Fus Station 2061, Ramp Station 95.

2. Specimen was processed as follows:

a. Specimen was processed by the magnetic particle method using circular and longitudinal magnetic fields with the wet continuous method of particle application.

3. Inspection results:

a. Inspection revealed one longitudinal crack on the surface of the roller, P/N 4F53828-101A.

b. Inspection revealed two crack indications on both ends of the alignment shaft, P/N 4F53767-101A. Noted indications were located at the radius of the threaded area and the shaft-shank.

c. All defective areas are marked.

Jose N. Garcia
Qlty Assr Spec

REYNALDO R. RAMOS
NDT Lab Sec

7 A May 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#6 Right Side Yoke and Floor Bracket Assembly 2 May 75

Task #1128, Attachment #30 #142

Metallurgical Analysis

1. One yoke assembly identified as No 6 Right Side Yoke and Floor Bracket Assembly was submitted to the Metallurgy Lab as per Attachment #30 of basic MME Task #1128.

2. Photograph of the exhibit as received is identified as Photo 1.

3. Spectrographic analysis identified the material of the alignment pin as AISI 416 stainless steel.

4. Visual and microscopic examination of the upper and lower pin shafts are as follows:

a. Upper pin shaft (yoke) showed slight corrosion on the surface, along with some wear on the shank area.

b. Upper pin shaft (bracket) showed excessive corrosion and pit corrosion on the surface, the sleeve has a small crack.

c. Lower pin shaft - showed some slight effect of shearing on one side, along with some wear. The alignment shaft showed a small area of corrosion, no cracks were noted, this pin was in good condition.

5. Visual and microscopic examination of other areas of the assembly are as follows:

a. The four (4) fastener holes were not elongated on the bracket, holes on the yoke were not elongated, the four bolts were not bent. The holes on the yoke were not elongated, but some corrosion was detected on the surface and also on the inside of the large hole.

b. A crack was found on the mount ball-bearing, this crack propagated at an angle on the surface.

6. Magnetic particle inspection report is attached, dated 5 May 1975, Lab No 75-76.

7. Measurements of the yoke holes, and bracket holes are attached to this report.

SIGNED

JOHN PARKER, Metallurgist

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

3 Atch
1. Measurements & Drawing
2. Photo 1
3. NDI Report

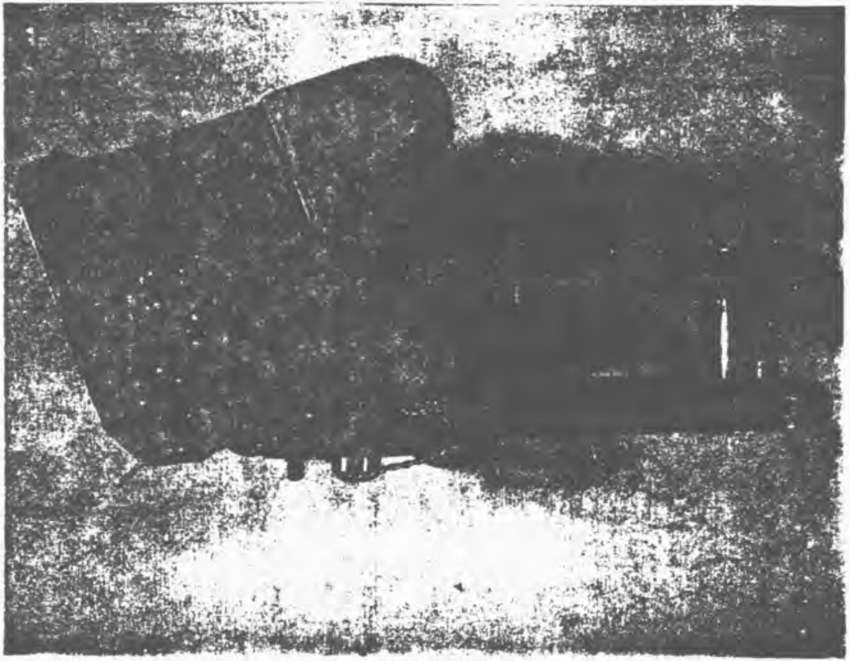


Photo 1
#6 Right Side Yoke and Floor Bracket Assembly - Showing the exhibit as received here in the Metallurgical Laboratory.

Yoke Hole Diameter Measurements

1. 0.381"

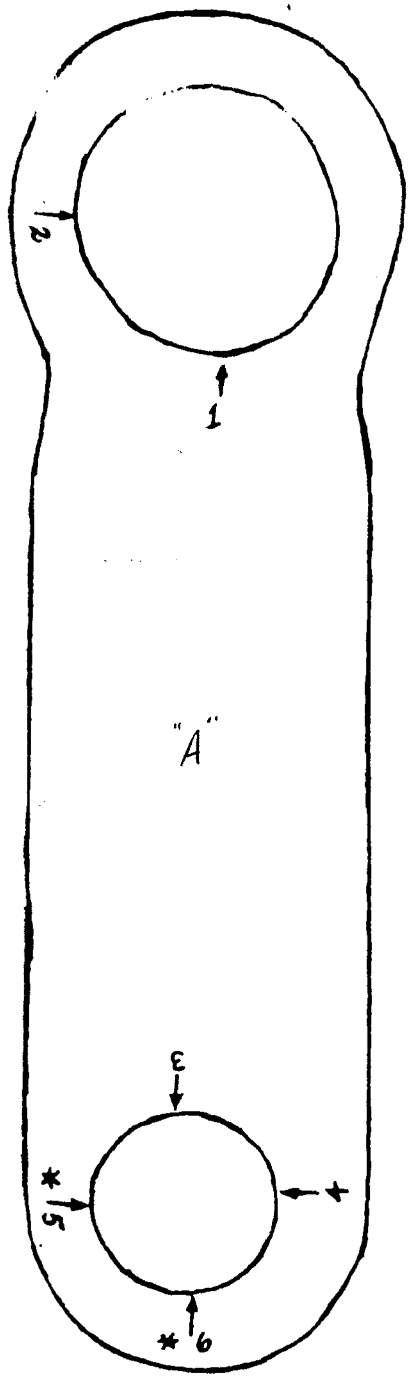
2. 0.381"

3. 0.938"

4. 0.938"

5. 1.000"

6. 1.000"



* Other Side "B"

#6 Right Side Yoke and Floor Bracket
Measurements of Shaft & Bolt Holes

1.	0.522"	Large Bolt Holes
2.	0.521"	
3.	0.382"	Small Bolt Holes
4.	0.382"	
5.	0.999"	Bottom eccentric shaft holes
6.	0.999"	
7.	0.876"	Upper eccentric shaft holes
8.	0.876"	

EE-5

LABORATORY ANALYSIS REPORT AND RECORD

DATE: 5 May 75

TO: MANCE/Mr Parker

FROM: MANCD/Nondestructive Testing Lab Sec

SAMPLE IDENTITY: Right-Side Yoke and Floor Bracket Assembly #6

DATE RECEIVED: 4 May 75

SAMPLE FROM: MANCE/ Task 1128 Attachment 30

LAB CONTROL NR: 75-76

TEST FOR: Cracks

1. One each Right-Side Yoke and Floor Bracket Assembly #6 was received by MANCD for nondestructive inspection. Specimen was identified as Right-Side Yoke and Floor Bracket Assembly #6, Canted Fus Station 2110, Ramp Station 137.

2. Specimen was processed as follows:

a. Specimen was processed by the magnetic particle method using circular and longitudinal magnetic fields with the wet continuous method of particle application.

3. Inspection results:

a. Blacklight inspection revealed one small indication on a surface worn area of the roller P/N 4F51724-101A. A large indication on the bearing roller P/N MS 21231-12 was also noted.

b. Whitelight inspection of the indications revealed the following:

(1) P/N 4F51724-101A - Indication was identified as a small surface crack.

(2) P/N MS21231-12 - Indication was identified as a large crack extending three fourths of the cross section of the bearing ball.

Jose N. Garcia
Qlty Assr Spec

Matias Ramos Jr
MATIAS RAMOS JR.
Ch, NDT Lab Sec

FF-1

13 May 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

#7 Right Side Yoke and Floor Bracket Assembly 2 May 1975

Task #1128, Attachment #31 142

Metallurgical Analysis

1. One assembly identified as #7 right side yoke and floor bracket assembly was submitted for analysis as per attachment #31 of basic task 1128.

2. Photographs of the exhibit as received are identified as photo 1, others are of the different sections of damaged areas.

3. Spectrographic analysis identified the material of the alignment pin as AISI 416 stainless steel. This pin was slightly bent and was covered with corrosion. No cracks were found by Magnetic Particle Inspection.

4. Spectrographic analysis identified the material of the remaining portion of the upper pin shaft as PH15-7 stainless steel with a Tukon microhardness equivalent to Rc45.

5. Visual and microscopic examination showed extensive shear damage on the lower eccentric pin shaft (see photo 3). Some bending was also noted. The upper arm portion of the yoke was slightly bent (see photo 1). The mono-ball bearing at the bottom of the yoke showed two cracks on the surface which extended to the inside of the hole. These cracks can be seen visually. The upper eccentric shaft on the yoke showed some scratches and wear, along with some corrosion, two small areas were spalled on the surface. The two threaded ends on this shaft showed a small crack at the first radius on one end and a large crack on the other end that was slightly bent. This crack can be seen visually. All of these cracks are in the radius areas on the square shoulder next to the threads. The sleeve that fits on this shaft was cracked in two places. The four (4) fastener bolts showed some scratches and wear on the surface. No evidence of bending was noted.

6. Metallurgical and TEM (Transmission Electron Microscope) analysis revealed the mode of failure was shear and tensile overload on the remaining portion of the upper pin shaft on the yoke. This mode of fracture occurs on slip or shear planes by the shearing of certain crystallographic planes over one another. TEM fractographs show that fracture was rapid by dimple rupture, when a shearing action takes place (as in this instance) the resultant fracture surfaces have numerous cuplike depression (see photos 4 & 5) and the dimplies have an elongated shape which occasionally point toward fracture origin.

7. Measurements of the yoke and bracket holes are attached to this report.

8. Magnetic Particle Inspection report is attached, dated 6 May 1975, Lab No 75-76.

SIGNED

JOHN PARKER
Physical Science Tech

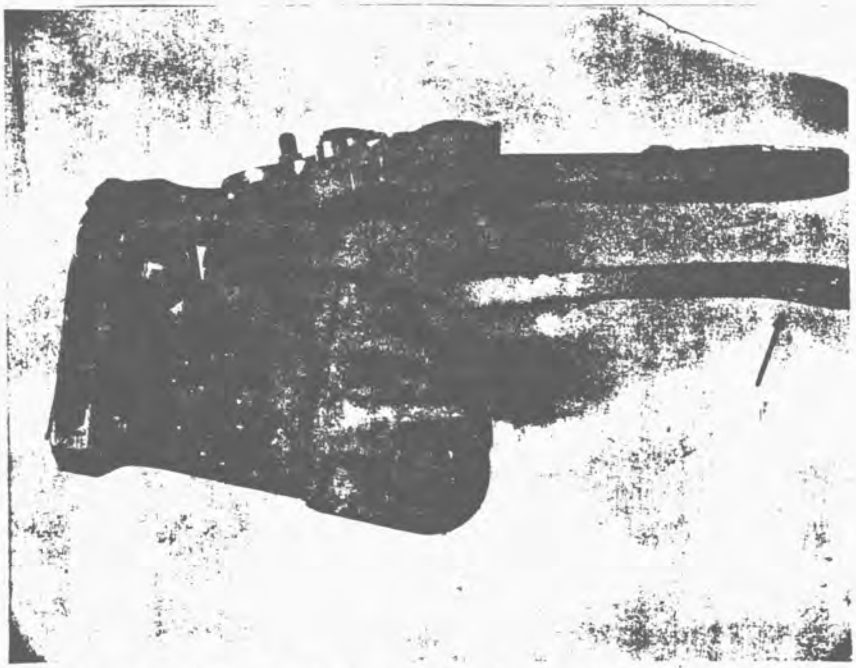
SIGNED

O. H. DOUGLASS, JR
Ch, Metallurgical Laboratory Section

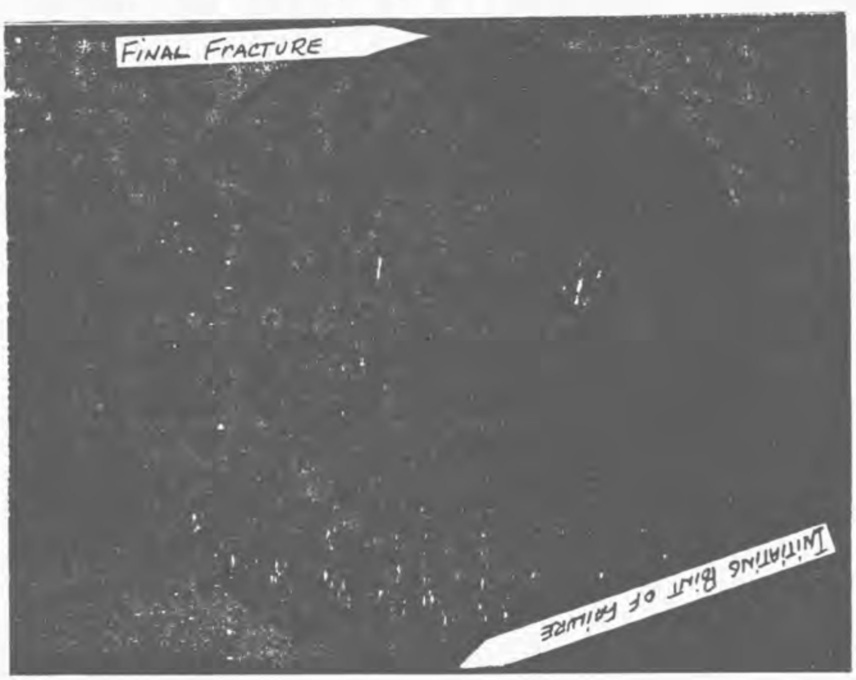
3 Atch
1. Photos 1 thru 5
2. Measurements
3. NDI Report

#7 Right side yoke and floor bracket assembly - showing the exhibit as received here in the Metallurgical Laboratory. Notice that the upper arm portion of the yoke is slightly bent.

PHOTO 1



#7 Right side yoke and floor bracket assembly - showing the fractured surface of the upper arm portion of the pin shaft with the initiating point of failure and final fractures indicated. The fractured surface was smeared from the two pieces rubbing against one another. The large crack probably started from the firm shearing and tensile overload created on the shaft. The small cracks are secondary cracking which occurred by the two pieces rubbing together.



#7 Right side yoke and floor bracket assembly - showing the lower eccentric shaft with extensive shear damage along with some bending.
PHOTO 3

#7 Right side yoke and floor bracket assembly - showing a TEM fractograph of the fractured surface on the upper pin shaft with elongated dimpling present. These dimples point in the direction of initial failure.

PHOTO 4 5600X PHOTO 5

#7 Right Side Yoke and Floor Bracket Assembly

Yoke Hole Diameter Measurements

1. 1.127"

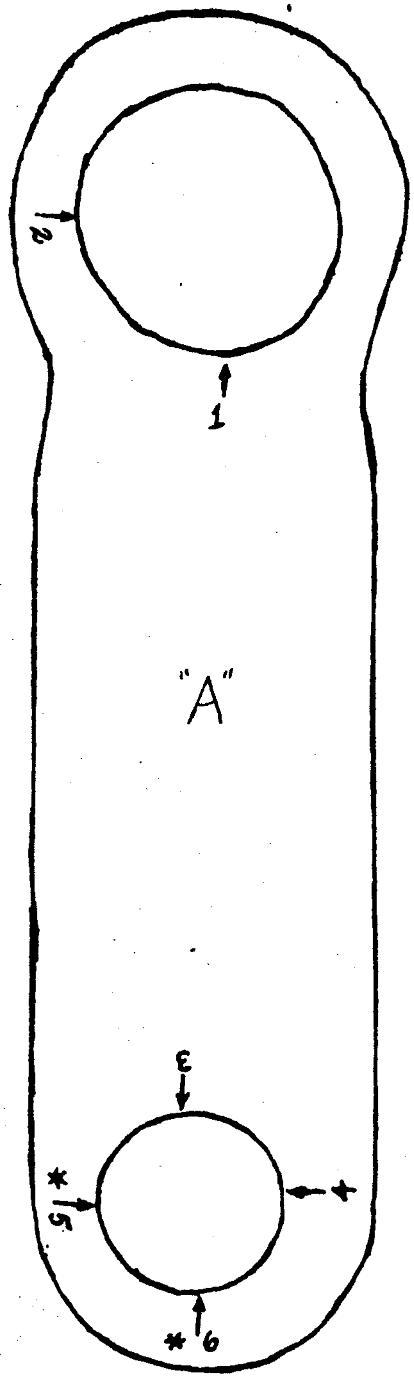
2. 1.126"

3. 0.626"

4. 0.626"

5. 0.826"

6. 0.808"



* Other Side "B"

#7 RIGHT SIDE FLOOR BRACKET ASSEMBLY

MEASUREMENTS OF BOLTS AND SHAFT HOLES

1. 0.519"
Large Bolt Holes
2. 0.520"

3. 0.381"
Small Bolt Holes
4. 0.381"

5. 0.873"
Upper eccentric Shaft Holes
6. 0.873"

7. 0.877"
Bottom eccentric Shaft Holes
8. 0.877"

FF-6

6 May 75

MANCE /Mr Parker MANCD/Nondestructive Testing Lab Sec

Right-Side Yoke and Floor Bracket Assembly #7 5 May 75

MANCE/ Task 1128 Attachment 31 75-76

Cracks

1. One each Right-Side Yoke and Floor Bracket Assembly was received by MANCD for nondestructive testing. Specimen was identified as Right-Side Yoke and Floor Bracket Assembly #7, Canted Fus Station 2131, Ramp Station 154.

2. Specimen was processed as follows:

a. Specimen was processed by the magnetic particle method using circular and longitudinal magnetic fields with the wet continuous method of particle application.

3. Inspection results:

a. Blacklight inspection revealed the following discrepancies which were verified by whitelight with 10X magnification.

(1) One surface crack, one and one-half inches long was noted on the roller P/N 4F53828-101A.

(2) One circumferential crack was noted on the alignment shaft.

(3) One through crack was noted on the bearing roller. Crack was approximately one and one-quarter inch long.

4. Blacklight photos of the cracked roller bearing were requested, taken, and will be delivered to Capt Scheiding by the photo lab.

5. All defective areas were marked.

SIGNED
Jose N. Garcia
Qlty Assr Spec

SIGNED

REYNALDO R. RAMOS
NDT Lab Sec

GG-1

LABORATORY ANALYSIS REPORT AND RECORD

DATE	8 May 75
TO: MME/Capt Scheiding/57845/53503	FROM: MANCA
SAMPLE IDENTITY: Burned Fragments and Gray Flake	DATE RECEIVED: 5 May
SAMPLE FROM: MME attch 32	LAB CONTROL NR: 35
TEST FOR: Identity IAW Task 1128	

1. The "burned fragments" included several chunks of metal, foil and a large porous chunk. These materials and their identities are:

a. "1" large chunk of metal	7075 aluminum
b. "2" and "3" foil	5052
c. "4" large porous charred chunk	Heavy: aluminum, zinc, silicon, magnesium
Did not appear metallic	Medium: iron
d. "5" chunk	7075 aluminum

2. The black powder contained in a very heterogeneous mixture of molten metal, unmelted metal scraps, metal foil, straw, etc, was extracted with water, yielding a neutral colorless solution with a medium amount of chloride. The insoluble residue contained heavy amounts of aluminum, calcium, silicon and magnesium; medium amounts of chromium and titanium.

3. The tan flake from R.STA 54, BL51R was approximately 15 x 10 x 1 mm in size, and fairly hard and brittle. It contained several rows of evenly spaced holes 0.4 mm in diameter and 2 mm apart. One corner of the flake was brownish black. The flake is calcium carbonate and under high magnification (100X+) appears to have a sponge-like structure. The composition and appearance of the flake indicate it is of marine origin. The dark discoloration in one corner is due to the presence of iron. The unused portion of the flake is attached.

Robert Cripe
R. C. CRIPE
Chemist

1 Atch
Vial with Flake

R L Garcia
R. L. GARCIA
Chemical Lab Sec
MA

HH-1

9 May 1975

MCL-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Winch Well Area 2 May 1975

Task #1128, Attachment #33 #142

Metallurgical Analysis

1. Selected areas of the Winch Well Area were submitted to the Metallurgy Laboratory for analysis, in support of Attachment #33, Task #1128.

2. Macroscopic and microscope investigation revealed sample #1 taken from BL Right 84 had fractured in tensile shear and tear. There was no evidence of an object hitting or making this mode of failure. The buckling and tearing occurred from right to left. This phenomena could have initiated by either air or water impact. The buckling effect on the top of sample #1 shows compression of the bulkhead. Photo 2.

3. Sample #2 taken from R B.L. -84 showed tensile cup and tensile shear. There was evidence of rubbing in a downward mode of travel. Photo 3. Sample #3 was taken from ramp station 54R. The top fractures on either side of the honeycomb were analyzed. The aft side of the fracture had failed predominately with a tensile cup with minute rubbing observed in the cup area. This fracture on the bulkhead then moved in the aft and downward direction. The forward fracture failed in tensile shear with a tearing motion in a forward downward mode. This caused the parting of the honeycomb. There was no evidence of an object hitting this panel. This bending of the panel was accomplished by a compression load combined with tensile shear, tearing and pulling in a downward direction. Photos 4 & 4A.

4. Sample #4 was taken from B.L. 84. The fracture exhibited tensile tear by impact, still no evidence of object damage. Impact was from right to left. Extensive buckling was also observed. The tensile tearing action shows signs of reversing direction of the loading mechanism. Photo 5.

5. Sample #5 was taken from B.L. 84. The sample showed extensive buckling of the panel. The tensile shear exhibited signs of rubbing action. Failure was from a right to left direction.

6. Sample #6 was removed from Ramp Station 54. The sample displayed a upward directional load on the right end. The aft fracture showed a tensile cup mode of failure changing to tensile shear. The front fracture displayed tensile shear. Considerable rubbing was noted on the fractured surfaces.

7. Sample #7 was taken from the Winch Well Area. The fracture exhibited a tensile shear, tearing mode of failure induced by overload. Extensive rubbing was prevalent on the fracture surface. Fractograph analysis showed a great deal of plastic deformation prior to final rupture. The fractograph showed a series of striations which were caused by slip or sliding of the grain boundary during rupture. Failure was by tension overload. Spectrograph analysis identified the material as 7075 aluminum alloy.

8. Sample #8 was taken from Right Bulkhead 28. The fracture initiated by an object traveling in a right to left downward direction. The mode of failure was by tensile shear and tear by impact.

HH-2

 9 May 1975

MME-5/Capt Gregory/Capt Scheiding/57845 MANCE (Metallurgical Laboratory)

Winch Well Area 2 May 1975

Task #1128, Attachment #33 #142

Metallurgical Analysis

9. Conclusion: The majority of the fractures noted in the Winch Well Area failed by tensile shear and or tensile cup. The direction of impact load was from right to left, with a slight aft movement. There was considerable compressive force, to cause buckling effects on bulkheads. The fractured faces showed evidence of salt water corrosion, which partially obliterated the facet of the fractured surfaces.

SIGNED SIGNED

W. H. CROCKER, Metallurgist

1 Atch
Photos 1 thru 9

SIGNED

DAVID BARRERA, Metallurgist

SIGNED

O. H. DOUGLASS, JR.
Chief, Metallurgical Lab Section
MA

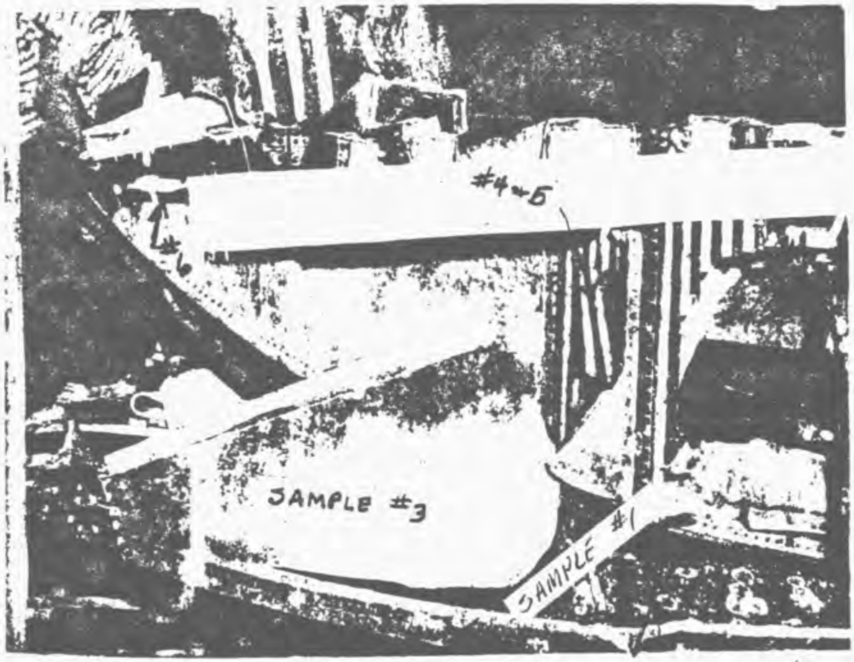


Photo 1

Identifies samples #1 thru #7 taken from section #5 looking into the Winch Well Area.

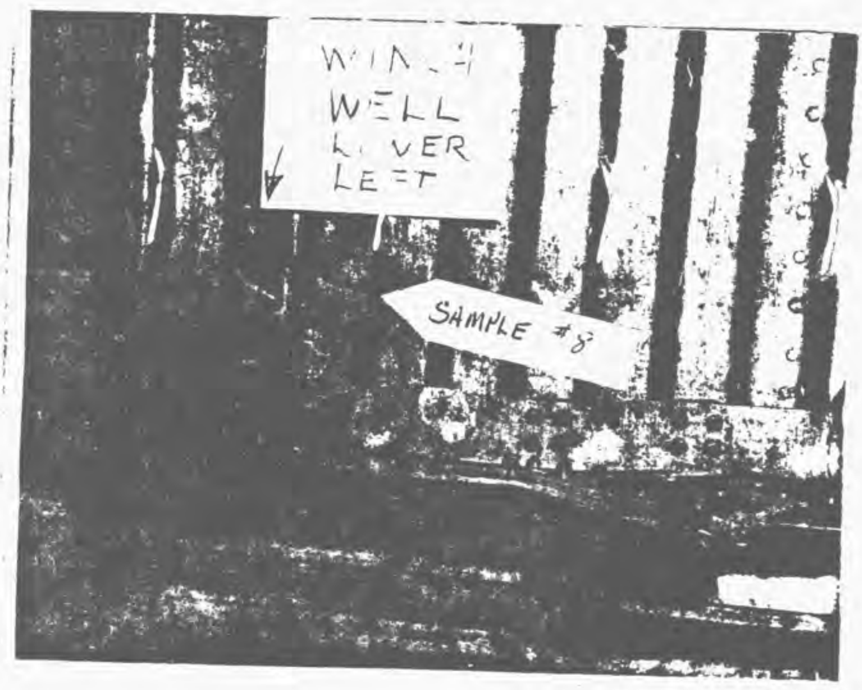


Photo 1A

Identifies sample #8 taken from the Winch Well Area.

Photo 2

Sample #1
Shows buckling area.

Tensile shear right to left compression & tearing by impact.

Photo 3

Sample #2

Mode of Failure: Tensile cup & shear.

Arrows indicate shear direction by overload and tearing.

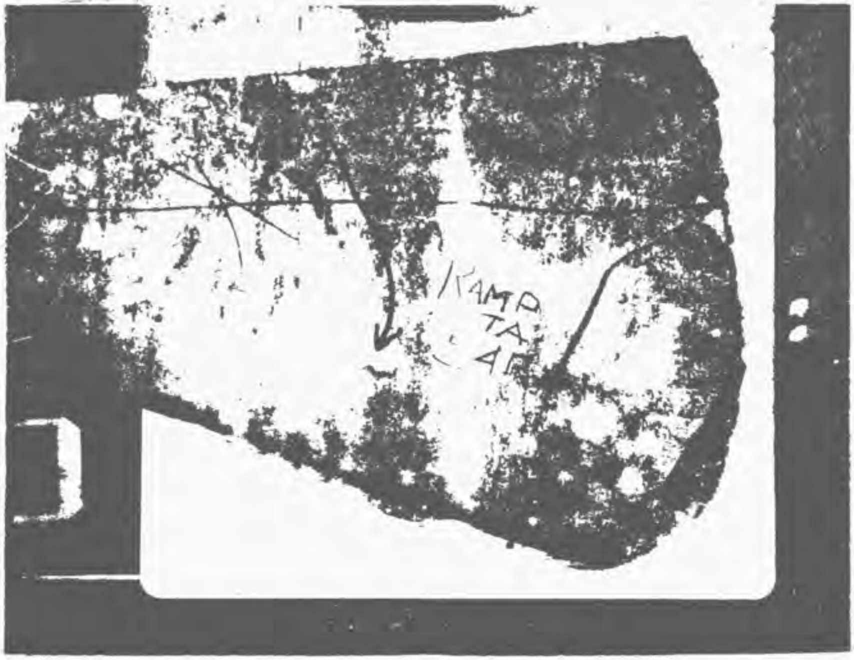


Photo 4

Sample #3

Idnetifies ramp station 54R honeycomb bulkhead.

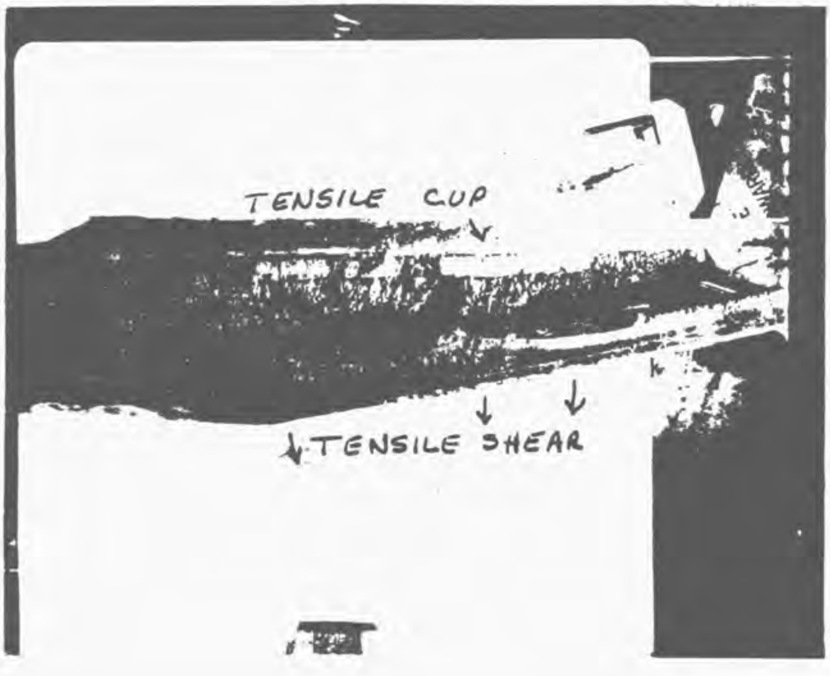


Photo 4A

Sample #3

Mode of Failure: Tensile cup & shear by overload and compression.

Arrows indicate shear direction.

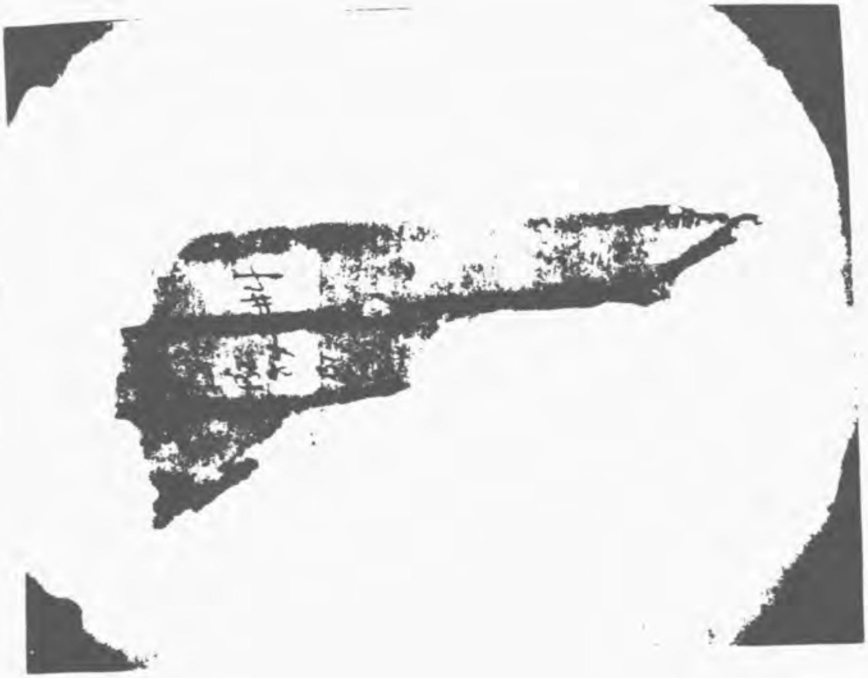


Photo 5

Sample #4

Mode of Failure: Fracture exhibited tensile shear, tearing and buckling by impact.

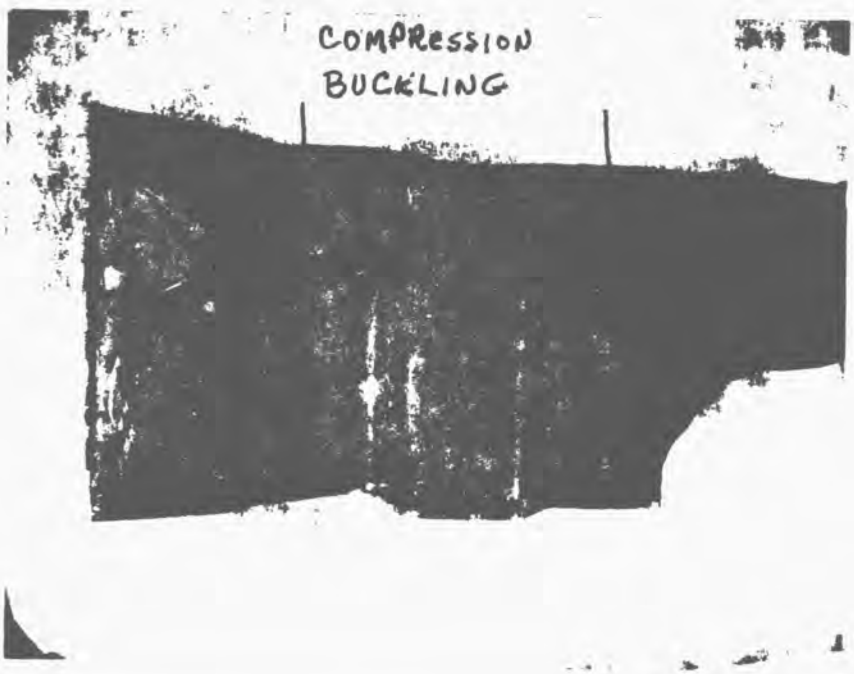


Photo 6

Sample #5

Mode of Failure: Fracture exhibited tensile shear, tearing, buckling, compression by impact.

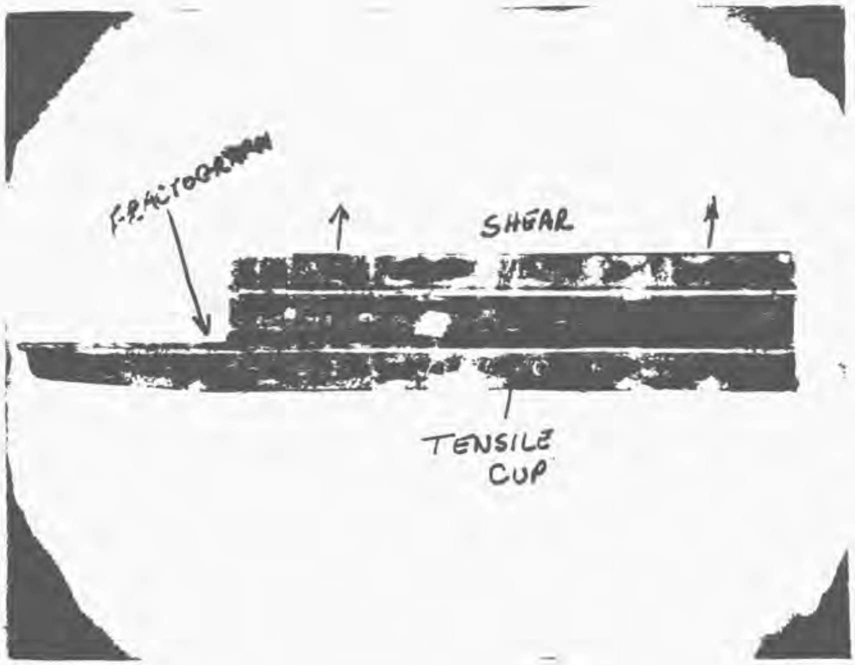
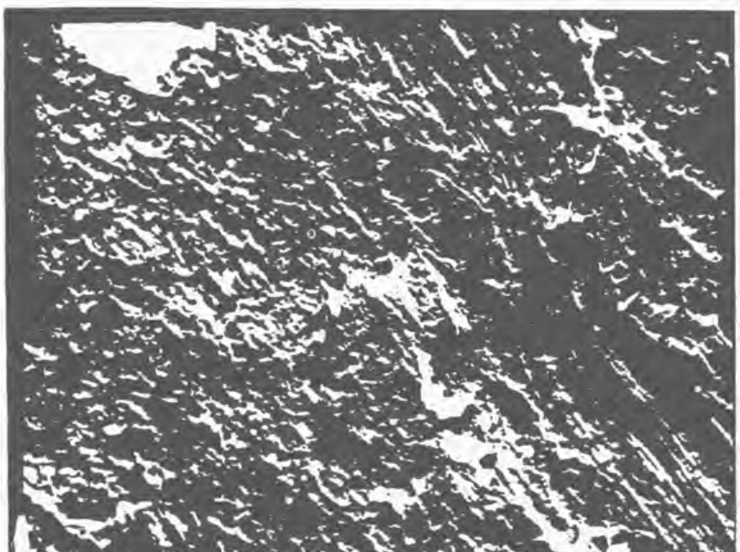


Photo 7

Sample #6

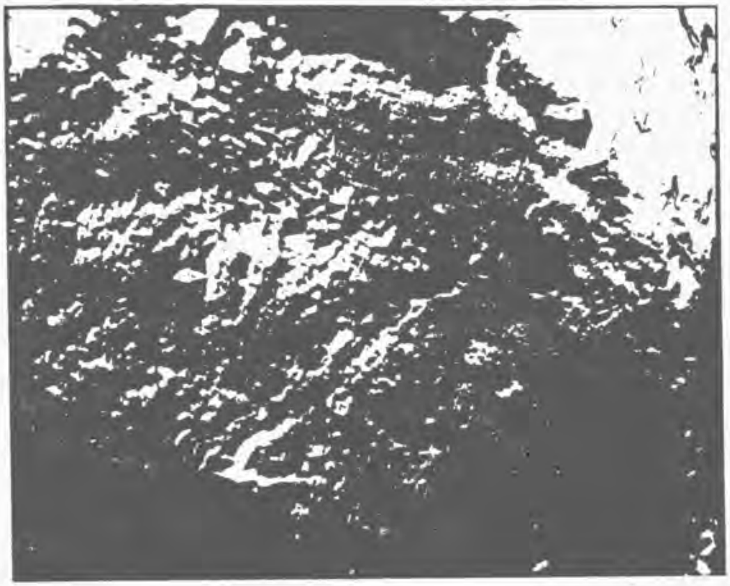
Mode of Failure: Fracture exhibits tensile cup & shear.

Arrows indicate shear direction and where fractograph sample was taken from.



Fractograph #1 8000X

Mode of Failure: Fractograph displays slip & sliding striation, plastic deformation by tension overload.



Fractograph #2   8000X

Fractographs displays slip and sliding striation, plastic deformation by tensile overload. Dimpling attests to tensile shear.

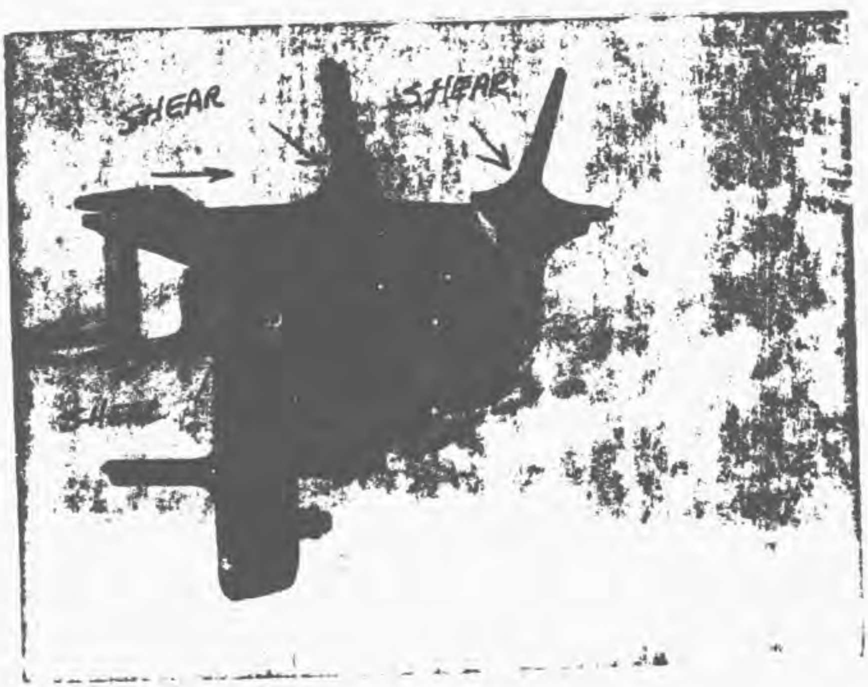


Photo 8

Sample #7

Mode of Failure: Tensile shear & tear by impact.

Arrows indicate shear direction.