The purpose of this report is to present a position statement regarding failure analysis of MH370’s right-side Flaperon. (Previous versions 1.0 and 1.1 were kindly made available to the public by Duncan Steel for presenting a preliminary study and to obtain crowdsource feedback.)

The conclusions are more definitive in this revision as a result of collaboration with other interested parties. Please note that the analysis and conclusions are constrained by the author’s limited ability to perform analysis of publicly available photographs and videos. Consultation with an independent Professional Structural Engineer (Retired - USA) was performed between Preliminary Rev 1.1 and Rev 2.0 since the author does not have a structural engineering background.

The author undertook this effort for the sole benefit of the families and to hopefully aid the many talented and dedicated people attempting to locate MH370.

Official Flaperon failure analysis performed by qualified professionals (with access to far more data than simple public photographs) is currently unavailable to the public.

Summary of Position Statements:

- The damage observed in photographs of the MH370 right-side Flaperon and the Asiana Air 214 left-side Flaperon indicate that the MH370 Flaperon was not damaged by striking water or land while still attached to MH370. (There is virtually no deformation of MH370 Flaperon’s secondary structures adjacent to the primary metal alloy attachments as expected and evident in the Asiana Air 214 left-side Flaperon which suffered a ground strike.)
- The small remnants of the two (2) hinge attachments are indicative of stress fatigue failures. Hinge stress fatigue failures were caused by repetitive compression and tension cycles.
- Oscillation or vibration type motions of the main right wing and or flutter of right-side Flaperon caused the repetitive compression and tension cycles in the hinge attachments.
- The right-side Flaperon separated from the aircraft while MH370 was in the air.
- There is no data indicating when the right-side Flaperon separated from MH370. Separation of the Flaperon from the wing is generally bound by the ability to drift at sea and reach Reunion Island (around equator and southward) and MH370’s final descent. Therefore ocean drift modeling (at its best) may not necessarily lead to the location of MH370, but instead to the area where the Flaperon was separated from the wing. It seems possible, but not highly probable, that the Flaperon could have separated from the wing prior to final descent due to earlier
undefined damages. It appears more probable that the majority of stress fatigue damage and ultimate separation occurred during a high speed, high altitude, descent while power and hydraulic systems were in fuel exhausted modes.

2.0 Points of Structural Attachment
a. Primary Class Attachments

There are six (6) primary structural attachment points for each Flaperon.

- **Flaperon Hinge**: Two (2) anchor points (Inboard/Outboard) function as hinges. [Flaperon to Flaperon Hinge Support Structure]. These hinges are the main structural attachment of the Flaperon to the aircraft.
- **PCU Attachment Fitting**: Two (2) anchor points (Inboard/Outboard) function as attachment points for each of the two (2) Flaperon Power Control Units (PCUs). The Flaperon Surface Fitting also serves as lifting points when Flaperon is removed for maintenance. [Flaperon to PCU Actuator Rod End]
- **PCU Head Fitting**: Two (2) anchor points (Inboard/Outboard) function as attachment points for each of the two (2) Flaperon Power Control Units (PCUs). [PCU to Wing Spar]

Failure of any of the six (6) primary attachments would likely start a sequence of structural failure events (during normal or abnormal flight) that lead to ultimate separation of a Flaperon from the wing. Failure of secondary and or tertiary attachments would likely not lead to separation of a Flaperon from the wing.

b. Secondary Class Attachments

There are four (4) secondary attachment points for each Flaperon.

- **Cove Lip Door Drive Link (2)**
- **Cove Lip Door Main Hinge Fitting (2)**

c. Tertiary Class Attachment

There is one (1) tertiary attachment point that connects the inboard fairing to each Flaperon. This fairing attachment anchor does do not connect the Flaperon to the aircraft.

- **Inboard Fairing Anchor (1)**

*Note: The outboard Flaperon fairing is attached to the outboard Flaperon Hinge fairing brackets.*
View of Bottom Side of 777 Flaperon. EXHIBIT 1

Outboard Flaperon Hinge
Inboard Flaperon Hinge
Inboard Fairing Anchor
View of Inboard Side of Retracted 777 Flaperon, PCU, and Cove Lip Link Mechanism. (Photo flipped to represent right Flaperon) EXHIBIT 2

View of Bottom Side of Extended Flaperon (Photo flipped to represent right Flaperon) EXHIBIT 3
3.0 Photo Observations

Photographic evidence exists for five (5) of eleven (11) (45%) Flaperon attachment points including three (3) of six (6) (50%) primary attachment points.

Photographic data does not exist for the following six (6) MH370 attachment points:

- PCU Head Fitting (2) [PRIMARY]
- Cove Lip Door Drive Link (2) [SECONDARY]
- Cove Lip Door Main Hinge Fitting (2) [SECONDARY]

Photographic data does exist, as shown below, for the following five (5) MH370 attachment points/areas:

- Remains of Inboard Flaperon Hinge [MAIN PRIMARY]
- Remains of Outboard Flaperon Hinge [MAIN PRIMARY]
- Remains of Inboard PCU Attachment Fitting [PRIMARY]
- Outboard PCU Attachment Fitting Area [PRIMARY]
- Remains of Inboard Fairing Anchor [TERTIARY]

View of Bottom Side of MH370 Right Flaperon EXHIBIT 4
**View of Inboard Side of MH370 Right Flaperon** EXHIBIT 5

Remains of Inboard PCU Attachment Fitting [PRIMARY] (*Inner and outer bracket ears visible*)

**View of Outboard Side of MH370 Right Flaperon** EXHIBIT 6

Area near Outboard PCU Attachment Fitting [PRIMARY] (*Fitting not visible*)
4.0 Failure Analysis

4.1 BASIS

Definitive failure analysis is most difficult to perform without the following:

- Jet aircraft incident investigation knowledge and experience
- Physical access to the MH370 Flaperon
- Boeing design drawings/calculations
- MH370 Maintenance records
- Flaperon manufacturing data

Commentary: All of these are available to the MH370 investigation team.

The following assumptions were used to establish a basis for the failure analysis:

- The Flaperon separated from MH370 while in flight or while ‘landing’ on water/land.
- The Flaperon spent the entire time in the ocean until it reached Reunion Island and was pulled ashore.
- In order to separate the Flaperon from the wing, the Flaperon was either:
  a. Exposed to extraordinary external forces, or structural frequencies, beyond design performance criteria.
  b. A primary attachment point suffered a catastrophic failure while under normal flight conditions and operating within design performance criteria.
- An unknown minimum number of [the six (6)] primary attachment points are required to secure the Flaperon to the aircraft on a sustainable basis. These minimum attachments points:
  a. Failed one after the other in a very short period of time (seconds or fraction of second).
  b. Failed in a sequence.
- Flaperon PRIMARY attachments were not significantly damaged after separation from the wing.
- Majority of Flaperon structural elements are aluminum alloy. Non-structural skin components are fastener secured, painted, composite material panels.
- Flaperon is indeed from MH370.
- Flaperon was not artificially developed and planted as false evidence.
4.2 FAILURE OF FLAPERON HINGE FITTINGS

The remaining structures of the Flaperon Hinge are shown below:

Composite View of Bottom Side of MH370 Right Flaperon EXHIBIT 7

The location of the failure points of Flaperon hinges is consistent with a large singular lateral force or repetitive lateral (or torsional) movement of the hinges in the inboard/outboard direction. If Flaperon was separated from the Flaperon hinge with forces in forward/aft direction or by applying forces to the Flaperon in the extreme rotated up/down direction (beyond structural stops) then deformation of the Flaperon
structure due to such forces would be evident. Significant and permanent deformation of the Flaperon structure does not appear to be present in photographs of the Flaperon. Additional deformation analysis follows below.

If the main structural elements are aluminum alloy then permanent deformation is anticipated when large forces are applied. If the main structural elements are manufactured from composite materials then permanent deformation may be reduced due to flexible properties of said materials.

There is some photographic evidence that there could have been torsional forces applied since the Inboard fitting has more remaining structure to the Flaperon aft while the outboard fitting has more remaining structure to the Flaperon forward position. This could hint at a clockwise (as viewed from top of aircraft) rotational force (single instantaneous or major repetitive) acting on the Flaperon.

4.3 FLAPERON DEFORMATION ANALYSIS

If the Flaperon was separated from the aircraft by having something strike the Flaperon (water, land, engine parts, or other) this would have been a high speed strike with tremendous force, enough to instantaneously snap both Flaperon Hinges clean off. It would also impart damage in three (3) main areas. The following three (3) areas are investigated for evidence of Flaperon deformation:

a. Area that suffered the strike
b. Area around inboard Flaperon Hinge
c. Area around outboard Flaperon Hinge

Strike: The damage on the entire length of Flaperon trailing edge could be evidence of damage from a strike or damage from deterioration due to in-flight high speed flutter. *(It is unknown at this time if the area missing on the trailing edge is sufficient to impart a force to tear hinges from Flaperon main body.)*

The available inboard side photographs do not show significant deformation of the Flaperon main structure as anticipated if the Flaperon was torn from the aircraft due to striking an object with Flaperon trailing edge.
Inboard Flaperon Hinge Area:

View of Inboard Side of MH370 Right Flaperon EXHIBIT 8

The ‘Bottom Edge’ line and ‘Rivet’ line shown in Exhibit 8 appear to be parallel while the bulb aeroseal channel is at an angle to these reference lines, presumably due to the design and manufacture of the Flaperon. (Author assumes that the aeroseal bulb channel is attached to or integral to the hinge sub-structure).

If an angle was formed due to permanent deformation (at the angle shown in Exhibit 8) stemming from the Flaperon being struck on the bottom of the trailing edge it would be in the opposite direction.
Outboard Flaperon Hinge Area:

View of Outboard Bottom Side of MH370 Right Flaperon EXHIBIT 9

The remains of the bottom Outboard Flaperon Hinge is visible in Exhibit 9. The I-beam construction of the Flaperon Hinge is visible. The upside down “U” shaped tear in the Flaperon’s composite skin is indicative of:

a. A structural deflection consistent with a strike to the bottom of the trailing edge of the Flaperon (eliminated in commentary below^2.0 [C-01] or;
b. Damage as a result of the Flaperon striking a nearby element of the aircraft or other object(s).
An annotated outboard side of the Flaperon is shown in Exhibit 10. The lines indicate no deformation visible except for the light blue line on the outside end of the protruding spar.

The available outboard side photographs do not appear to show significant deformation of the Flaperon main structure as anticipated if the Flaperon was torn from the aircraft due to the trailing edge striking an object.

The deformation (observe edge near light blue line) of the outermost end of the protruding spar structure (while not deforming (observe dark blue line) the innermost edge of the protruding spar) is indicative of the Flaperon bottom composite skin being struck on the
The outboard forward end of the Flaperon is shown in Exhibit 11. The ‘wrinkle in the Flaperon’s composite skin is indicative of:

- A structural deflection consistent with a strike to the bottom of the trailing edge of the Flaperon (eliminated in commentary above R2.0) [C-01] or;
- Damage as a result of the Flaperon striking a nearby element of the aircraft or;
- Damage sustained after Flaperon’s separation from aircraft.
4.4 FAILURE OF INBOARD PCU ATTACHMENT FITTING

The remaining structure of the PCU Attachment Fitting is shown below:

Annotated View of Inboard PCU Attachment Fitting (inner & outer ears) EXHIBIT 12 R2.0
There is some photographic evidence that there could have been lateral (inboard/outboard) or torsional forces applied to the Flaperon since the remaining Inboard Flaperon face (inward adjacent to the PCU Attachment Fitting) appears to be indented. This could hint at a final counter-clockwise (as viewed from top of aircraft) rotational force acting on the Flaperon.

The outermost PCU Attachment Fitting ear appears to be broken with more of a vertical break vs. jagged inner PCU Attachment Fitting ear break. This could hint at a terminal clockwise (as viewed from top of aircraft) rotational force acting on the Flaperon. It can also hint at development of a stress or fatigue crack due to repetitive lateral or torsional motion.

Additional photographic analysis of the PCU Attachment Fitting inner and outer ears needs to be done, but is not included in this initial study. In particular visual evidence of metal fatigue and fracture analysis should be detailed in subsequent studies.

4.5 FAILURE OF OUTBOARD PCU ATTACHMENT FITTING

The outboard PCU Attachment fitting is hidden within the Flaperon behind a wall of barnacles. No significant photographic analysis available.

4.6 FAILURE OF INBOARD FAIRING ANCHOR

The Inboard Fairing Anchor is only a tertiary attachment; however, photographic evidence of the remains of Inboard Fairing Anchor is indeed important.

4.7 DAMAGE TO THE FLAPERON’S COMPOSITE SKIN

The focus of this analysis is centered on the structural elements of the Flaperon. Photographic evidence of damage to the Flaperon’s composite skin may prove be important but was not a point of focus in this study. The challenge may be distinguishing damage sustained at Flaperon separation from the wing, at sea, on shore etc.
5.0 **Unidentified Source of Holes**

Four (4) apparent holes in the outboard side of the MH370 Flaperon Exhibit 13, but not observed on the used 777 Flaperon shown on CNN, Exhibit 14.

View of Outboard Side Holes on MH370 Right Flaperon EXHIBIT 13

View of Outboard Side on CNN Right Flaperon EXHIBIT 14
6.0 **Unidentified ‘Splatter’**

There is a surface feature in the MH370 photos that is difficult to determine its origin.

*View of Outboard Side on Right Flaperon EXHIBIT 15*

Possibilities:

a. Abrasion from exposure to elements
b. Tampering
c. Chemical reaction/oxidation
d. Molten material deposit
e. Molten splatter surface damage
f. Biological
g. Other???
7.0 Evidence Issues

There is some apparent evidence tampering challenges (‘tampering’ does not imply malicious acts). Barnacles were removed after recovery from ocean.

View of Top Side Right Flaperon (Before) EXHIBIT 16

View of Top Side Right Flaperon (After) EXHIBIT 17
8.0  **Missing ID Tag**

The missing Flaperon ID Tag is an interesting feature of the Flaperon recovered at Réunion Island.

**Example Inboard ID Tag on Flaperon** *(Photo flipped to represent rt. Flaperon)* EXHIBIT 18

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**Inboard Side of MH370 Flaperon (Missing ID Tag)** EXHIBIT 19
The area on the MH370 Flaperon where the ID Tag is missing does not leave much evidence that it was ever mounted. There are a few spots that appear to have missing paint system, however there is no evidence of an ID Tag perimeter or the ID Tag’s four (4) holes.

The ID Tag is likely aluminum due to Boeing’s weight management design protocols. *(Stainless steel could be another possibility.)*

**ID Tag for Example 777 Part No. 113W6100-9**

![ID Tag for Example 777 Part No. 113W6100-9](image)

Part No. 113W6100-9 is the right Flaperon of a Boeing 777 [1].

The following assumptions were established upon observing Exhibit 20:

a. ID tag is attached by adhesion means only, no visible fasteners.

b. ID tag adhesive is green/blue colored as seen in photo.

c. ID tag directly secured to painted or primered composite surface structure *(on inboard side of Flaperon)*

d. Adhesive is not temperature cured due to sequence of fabrication.
e. Appears to have thin layer of adhesive coverage on the entire perimeter of ID plate at a minimum.

Information research was conducted regarding adhesives that comply with potential applicable Boeing Material Specifications and match final epoxy coloring.

a. Primary adhesive candidate: **Huntsman Epibond® 1539A/B-10**
   i. High-strength, blue epoxy adhesive for bonding polyesters, fiberglass reinforced plastics and metals. [2].
   ii. The ‘blue’ final coloring description could match color on Reunion Flaperon.
   iii. Meets Boeing BMS 5-25 Epoxy-Amine Adhesive for Non-Structural Bonding [3].
   iv. This epoxy has an ambient tensile lap shear of 2500 psi [4].

b. Another candidate is Henkel Loctite Hysol EA901NA/B-1 Aero since it also meets BMS 5-25 however it is red in color.

c. It is also possible that Malaysian Airline System (MAS) maintenance staff or other third party maintenance staff replaced the ID tag during Flaperon maintenance and affixed the ID tag using methods and or materials that do not meet Boeing Material Specifications.

d. There are stronger epoxy systems available on the market, some even identified to have specific resistance to Skydrol™ (hydraulic fluid), but they do not have the green final blend coloring.

Possible adhesive degradation due to exposure to Skydrol was evaluated. Identified general compatibility of tributyl phosphate based flame resistant hydraulic fluids with epoxies.

a. Skydrol LD4 (*main component Tributyl phosphate*) lists general epoxy and epoxy amide as having excellent resistance to Skydrol. [5]. Material may be used in constant contact with the Skydrol fluid. [5].

Two-part epoxy systems typically have excellent resistance to sea water.
9.0 **Missing Trailing Edge** R2.0

Approximately 36% of the bottom area is missing on the trailing edge of the Flaperon. Broken with a jagged line just to the aft of an apparent structural spar line.

*[Approximated Missing Areas Bottom-Side of MH370 Right Flaperon EXHIBIT 21]*
The trailing edge section of the Flaperon appears to be void of structural ribs since there are no visible connections to the rearmost spar. The lack of structural ribs in this section of the Flaperon, in combination of the higher rotational speeds of the trailing edge, supports exposure of the Flaperon to aerodynamic flutter. R2.0

View of Remaining Trailing Edge on MH370 Right Flaperon EXHIBIT 26 R2.0
“The Flaperons are light weight composite materials structures. The skin is carbon fiber reinforced plastic bonded to a core of Nomex honeycomb. The overall dimensions are approximately 62 in by 95 in (1.6 m x 2.4 m). Each Flaperon weighs about 110 lb (50 kg). The Flaperon attaches to the airplane structure with 2 hinges. An aluminum strip diverts lightning strikes on the Flaperon trailing edge.”
11.0 Feasibility of Tail Strike
Could the Flaperon have struck a tail member? EXHIBITS 23 & 24
12.0 **Supplemental**

There may be precedent similar damage with previous aircraft incidents. As an example, Asiana Airlines Flight 214 suffered a crash at San Francisco International Airport (SFO) on July 6, 2013. The aircraft was a Boeing 777-200ER and crashed on final approach into SFO. Both Flaperons experienced damage, however the left Flaperon experienced significant damage. It appears that the left Flaperon experienced a torsional force strike on the outboard and or outboard trailing edge area sufficient to detach from outboard hinge structural area and remove about 32% of the top control surface area. Repetitive lateral or ‘flutter’ type motions are highly unlikely modes for Flaperon damage on Asiana 214. R1.1

Additionally it appears that:

- The outboard hinge *(and likely PCU rod)* remained on main wing structure. R1.1
- Assume that the inboard PCU rod and hinge remain attached.
- Structural deformation, surface damage (cracking, joint separation, and delamination) appear to be present from the outboard/TE strike and or projectiles.
- The inboard top surface damage indicates significant deflection of the Flaperon body and supports a strike with ground vs. a projectile slicing through the Flaperon on outboard side. R2.0
- Edges of damage do not appear as jagged as MH370.

**Asiana Airways 214 - Left Flaperon** EXHIBIT 25 R1.1
13.0 **Summary**

<table>
<thead>
<tr>
<th>PRIMARY ATTACHMENT</th>
<th>Photographic Evidence Available</th>
<th>Evidence of Repetitive Lateral or Torsional Forces</th>
<th>Potential Large Singular Lateral or Torsional Force</th>
<th>Potential Trailing Edge Bottom Strike</th>
<th>Potential Final Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inboard Hinge</td>
<td>Yes</td>
<td>Yes</td>
<td>Slight</td>
<td>No</td>
<td>Clockwise</td>
</tr>
<tr>
<td>Outboard Hinge</td>
<td>Yes</td>
<td>Yes</td>
<td>Slight</td>
<td>No</td>
<td>Clockwise</td>
</tr>
<tr>
<td>Inboard PCU Fitting</td>
<td>Yes</td>
<td>Yes</td>
<td>Slight</td>
<td>Unknown</td>
<td>Counter</td>
</tr>
<tr>
<td>Outboard PCU Fitting</td>
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<td>Unknown</td>
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<td>Unknown</td>
</tr>
<tr>
<td>Inboard PCU Head Fitting</td>
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<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Outboard PCU Head Fitting</td>
<td>No</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

The evidence assembled in this document indicates that the right-side Flaperon was separated from MH370 due to repetitive lateral or torsional forces which in turn imparted stress fatigue in the primary aluminum alloy attachment components. R2.0

- No significant evidence of secondary structural damage excludes a massive trailing edge strike and leads the author to conclude that **the Flaperon separated from MH370 while in the air and did not separated from the wing due to striking water or land.** R2.0
- Aerodynamic oscillation or vibration of the right-side wing and or flutter of right-side Flaperon caused metallurgic stress fatigue damage to the primary aluminum alloy structural attachments.
- Aerodynamic flutter of Flaperon caused the majority of trailing edge damage prior to separation from the wing. Some minor trailing edge damaged likely occurred after separation from the wing due to free fall to sea and or contact with shore(s). R2.0
- It appears highly unlikely that a large singular lateral force, at the conclusion of final descent, could shear off both hinges while imparting relatively minimal damage to either side of the right-side Flaperon. R2.0 **The following is additional commentary on a potential large singular lateral force scenario:**
  - The dented outboard (forward) portion *(as discussed for Exhibit 11)*, along with the damage observed to part numbers 657CT and 657EB, could potentially support a large semi-lateral force during a crash.
  - Scenario does not appear to offer an explanation of how the trailing edge was damaged.
• The Asiana Air 214 left-side Flaperon damage was not likely caused by repetitive lateral or torsional forces including ‘flutter’ due to the circumstances of the incident. It was likely caused by Large Singular lateral or Torsional Force or a Trailing Edge Strike. In this particular incident (specifically related to the type and magnitude of the forces applied) the Flaperon’s weakest structural attachment was a Flaperon ‘rib/spar compartment’ surrounding the outboard hinge, not the outboard hinge broken off at the bottom surface of Flaperon as with the MH370 Flaperon. Approximately 32% of Flaperon surface area of Asiana 214 Flaperon was ripped away compared to approximately 36% R2.0 missing on Reunion Flaperon yet appears that all of Asiana 214 Flaperon’s primary structural connections remained intact, R1.1.

**Recommended follow-up analysis:**

• Additional failure analysis of the Inboard PCU Attachment Fitting (inner and outer ear brackets).
• Primary attachment failure sequence analysis.
• Inboard Fairing Anchor failure analysis.
• Analysis of the Flaperon surface would be beneficial to further understanding Flaperon separation from the wing.
• An estimate of Flaperon Hinge strength (based on estimated dimensions, thicknesses and materials) should be estimated for shear tear-out, fatigue analysis etc.
• Further investigate the conflicting clockwise and counter-clockwise observations.
• Continue to study and adjust assumptions stated in the beginning of this document.

**Questions & Issues Generated from Analysis:**

• An explanation for the four (4) holes on outboard side needs to be identified.
• An explanation of how the ID Tag separated from the Flaperon is needed. (Exposure to Skydrol and sea water do not appear to be plausible reasons for ID Tag separating from the Flaperon).
• An explanation for the ‘splattering’ needs to be identified.
• Why are the official investigators silent on releasing preliminary reports on their Flaperon analysis?
• Could MH370 (excluding final descent scenarios such as spiral dives etc.) have been subject to abnormal stresses and forces after 17:19:30 UTC due to pushing the aircraft beyond its normal operating envelope? Note: The combination of limited and questionable radar data, BTO, and BFO suggest that the aircraft was not likely subject to such overstresses prior to final descent. R2.0
• Was MH370 damaged in some undefined manner after 17:19:30 UTC as to cause oscillation or vibration of the right-side wing and or flutter of the right-side Flaperon? R2.0
• Could the Flaperon have separated from MH370 after nearing equator but prior to final descent?
• How would fuel exhaustion during final descent impact the Flaperon hydraulic system and the tendency to induce flutter of the Flaperons? *Note: Boeing documentation indicates that when the Flaperon PCU’s are in the bypass mode the Flaperons are free to move and can experience flutter.* [7]
• How does the loss of right Flaperon impact the flight of a piloted Boeing 777? How does the loss impact an unpiloted (Auto Pilot) Boeing 777? *Note: The author is not a pilot, however recent communications with more qualified people offer the following preliminary thoughts on flight without the right-side Flaperon. Author summarizes and paraphrases said communications as follows:

For both piloted and unpiloted cases, it could continue flight because the Boeing 777 Flaperon provides relatively small portion of the total wing area. In the cruise phase of flight the Flaperon is used as part of roll control. The outboard ailerons are locked out, some of the spoiler panels augment roll & the left-side Flaperon would still be effective. Whether piloted or autopilot, more control surface input would be made to demand the desired bank angle/roll. As long as the remaining left Flaperon was not deployed in *flap mode*, thus causing asymmetric lift and drag, then the plane could be flown with almost no noticeable effect. However, if the Flaperon departed the wing prior to the final descent damage may have been caused to the two PCUs & possibly the hydraulic systems causing additional flight issues. R2.0

*Note: Caution should be used when examining photos since evidence of tampering with the Flaperon is evident.*

14.0 References
All websites/pages active as of December 6, 2015 R2.0 unless otherwise noted. If photographer is inadvertently miscredited, please comment to allow for correction.

**Exhibits:**

**EXHIBIT 1** Air India RFQ/528, Rev.No : 0, Posted Date : 29/JUL/11, Due Date : 06/AUG/11 Request for repair quote for 777 Flaperon PN:113W6100-16. [http://mmd.airindia.co.in/aimmd/tender/FLAPERON%20DAMAGE%20PHOTO.pdf](http://mmd.airindia.co.in/aimmd/tender/FLAPERON%20DAMAGE%20PHOTO.pdf) removed from [mmd.airindia.co.in/aimmd/tender/RFQ0107140.html](http://mmd.airindia.co.in/aimmd/tender/RFQ0107140.html) webpage as of October 7, 2015. (Unknown Photographer, Photoshop by author.)

EXHIBIT 3 Flickr https://upload.wikimedia.org/wikipedia/commons/0/0f/Boeing_777-200_center,_aft,_fuselage,_wing_root_fairing,_main_gear_and_doors,_etc._(2719420955)_3.jpg
(Photographer believed to be Bill Abbott, Photoshop by author.)

(Photographer believed to be Prisca Bigot, Photoshop by author.)

EXHIBIT 5 http://www.digital-resource.com/wp-content/plugins/wcache/images/DR%20NEWS-Urandir-c2be-19511621-h38522454-wide-4c437e1a6f6f82c6efcf4b9f7d3b216a1be2865-s1100-c15.jpg
(Photographer believed to be Raymond Wae Tion, Photoshop by author.)

EXHIBIT 6 South China Morning Post:
https://www.scmp.com/sites/default/files/2015/08/06/file_france_reunion_transport_aircraft_tar101_51810443.jpg
(Photo EPA, Photoshop by author.)

EXHIBIT 7 Ibid. Exhibit 4

(Unknown Photographer, Photoshop and drawing overlay by author.)

(Photographer believed to be Raymond Wae Tion, Photoshop by author.)

EXHIBIT 10 http://reho.st/www.clicanoo.re/IMG/jpg/-18777.jpg
(Unknown Photographer, Photoshop and drawing overlay by author.)

EXHIBIT 11 Ibid. Exhibit 6

EXHIBIT 12 Ibid. Exhibit 5
(drawing overlay by author)

EXHIBIT 13 Ibid. Exhibit 10
(drawing overlay by author)

(Video by CNN, Capture and Photoshop by author.)
EXHIBIT 15 Ibid. Exhibit 6
(Drawing overlay by author)

EXHIBIT 16 Xinhuanet: http://news.xinhuanet.com/english/photo/2015-08/06/c_134486523_2.htm
(Unknown Photographer, Photoshop and drawing overlay by author.)

(Unknown Photographer)

EXHIBIT 18 http://cdn-www.airliners.net/ufview.file?id=188037&filename=1438202158gs8cUN.jpg
(Unknown Photographer)

EXHIBIT 19 Ibid. Exhibit 5

EXHIBIT 20 http://www.airliners.net/ufview.file?id=188037&filename=1438202158gs8cUN.jpg

EXHIBIT 21 Ibid. Exhibit 9
(Dimensional analysis and Photoshop by author)

EXHIBIT 22 Ibid. Exhibit 6
(ID and Photoshop by author)

EXHIBITS 23 & 24
https://upload.wikimedia.org/wikipedia/commons/a/ac/Air_France_Boeing_777-228ER_F-GSPE_Kustov_planform.jpg
(Unknown Photographer, Photoshop by author)
https://upload.wikimedia.org/wikipedia/commons/3/35/Malaysia_Airlines_B777-200ER(9M-MRO)_3780278171.jpg
(Unknown Photographer, Photoshop by author)

EXHIBIT 25 Bloomberg Business: http://assets.bwbx.io/images/iOsypm.iRiGc/v1/-1x-1.jpg
(Photographer Justin Sullivan; Dimensional analysis and Photoshop by author)

(Unknown Photographer, Photoshop by author)
**Technical References:**

[1] Calameo: Boeing Chapter 06 Dimensions and Areas (link no longer works)
Boeing Page 06-44-00 Page 221 (Calameo Page 132)


**Revision History:**

1 Initial Issue

1.1 Revised **12.0 Supplemental** and **13.0 Summary** sections. Corrected Asiana Flaperon photo observation error by Author. By further observation it appears that the outboard hinge remained attached and more surface area of the Flaperon was broken away.

2.0 The following revisions were made:

- Revised section **1.0 Introduction**. Included a Summary of Position Statements section to provide a quick abstract summary for readers.
- Revised section **4.1 Basis**, commentary section.
- Revised section **4.3 Flaperon Deformation Analysis**
- Revised section **4.4 Failure of Inboard PCU Attachment Fitting**, updated Exhibit 12.
- Revised section **9.0 Missing Trailing Edge**. Corrected Exhibit 21. Fixed error in area graphic representation and error in area calculation. (*Thank you Gysbrecht for peer check commentary on PPRuNe 29th Nov 2015, 10:55, nice catch.*)
- Revised section **10.0 Flaperon Component Identification**
- Revised section **12.0 Supplemental**.
- Revised section **13.0 Summary**.
- Revised section **14.0 References**, Added Exhibit 26, update link test date.
- General replacement of the term ‘disengage’ with ‘separate’.
Acknowledgements:

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