

# Debris Analysis

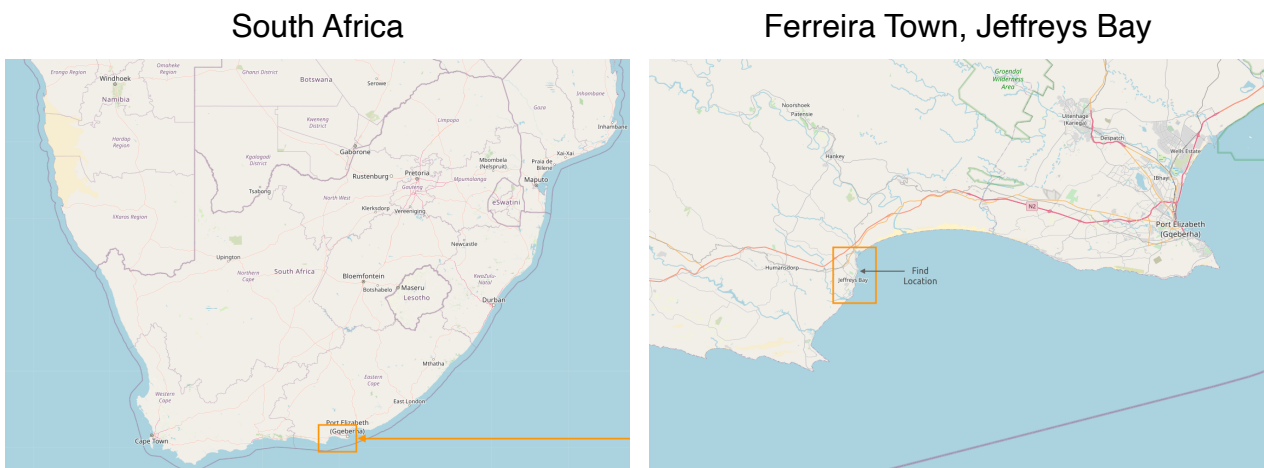
## Article recovered at Jeffreys Bay, SA.

Mike Exner and Don Thompson

### Introduction

The debris article discussed herein was recovered on a South African shoreline during late August 2020. The finder contacted the South Africa Civil Aviation Authority (SACAA) which took custody of the article and, in turn, notified the Malaysian civil aviation authorities. Pandemic era constraints have further hampered diplomatic protocols for the repatriation of the article. The finder of the item wishes to maintain their privacy.

The region and specific location of the find are depicted below.



Location provided: S34.041° E24.91°

*Figure 1: Debris Article - Site of Recovery*

At the time of writing, it is known that the SACAA and AAIB-MY are liaising through normal diplomatic channels in order to have the article returned to Kuala Lumpur.

The finder recorded images of the item and six of these images were provided to the authors by Blaine Gibson on February 17, 2021, simultaneously with a report



published by 'Airline Ratings'<sup>1</sup>. The images are presented below with annotations to aid orientation.

This work seeks to identify this article and determine if it is linked to the Malaysia Airlines B777-2H6ER, registration 9M-MRO, flight MH370 lost in the southern Indian Ocean on 8<sup>th</sup> March, 2014.

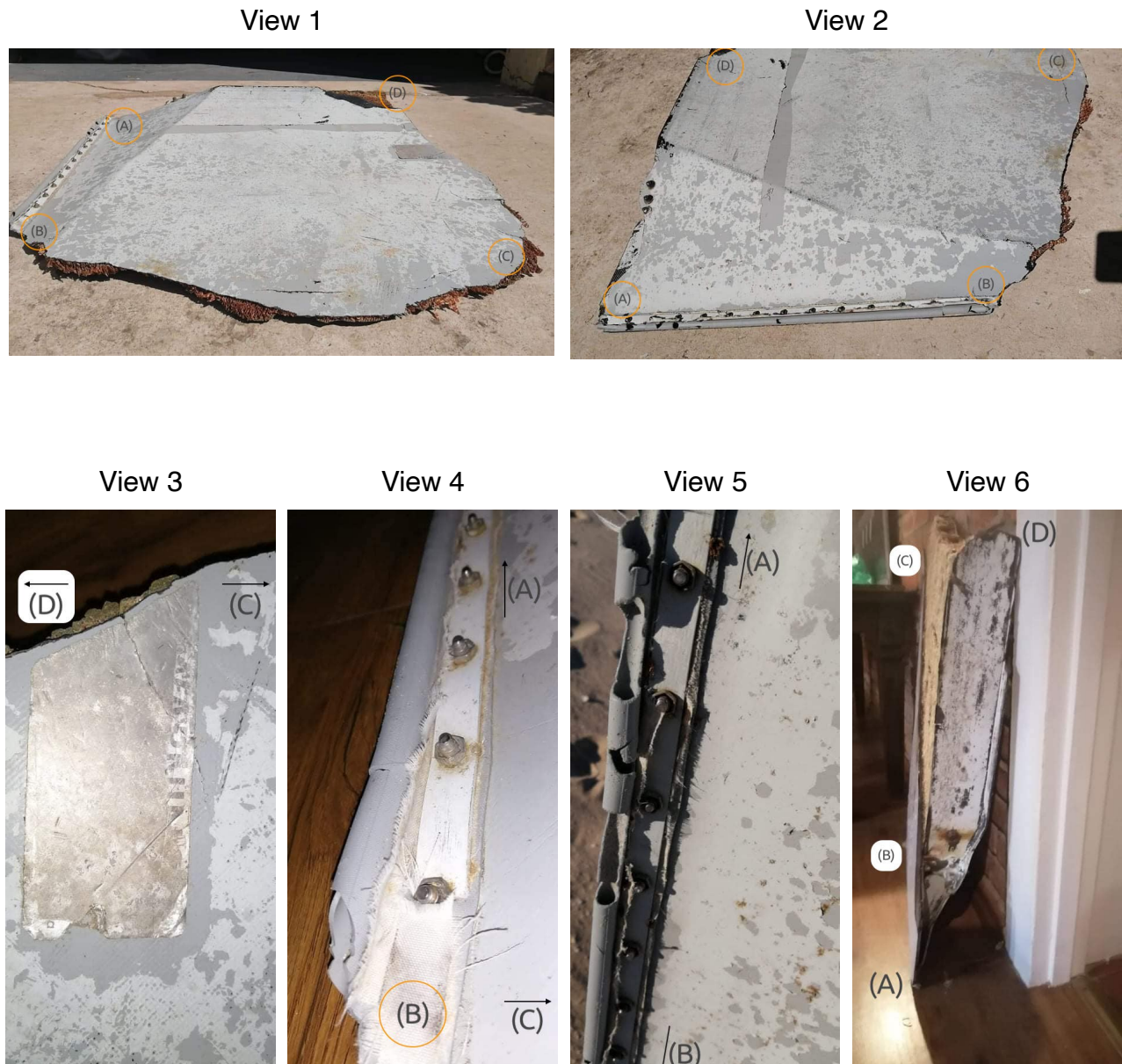


Figure 2: Debris Article General Views

The views of the debris item show a monolithic composite panel, constructed of CFRP skin and Nomex honeycomb core. CFRP skin plus Nomex honeycomb core

1 <https://www.airlineratings.com/news/new-mh370-debris-washed-south-africa/>



material is consistent with the design and manufacture of a modern aero-structure component. Less common use of these materials and construction technique on airframes designed prior to 1990 suggests that the article may originate from a B777.

The face that is predominantly featured in the views 1 through 5 is contoured with a geometric profile while the opposite face is flat (to left, view 6).

A remnant of an information placard remains on contoured surface (view 3).

The edge annotated as (A)-(B) is fitted with a 'P' section extrusion that is held in place under a retaining strip and fixed by HiLok machine screws. Remnant of a fabric material is evident under the retaining strip.

Fourteen screws fix the 'P' section extrusion in place. The (A) - (B) edge is not complete.

The edge (A)-(D) is formed as a face with a remnant part of a metallic fitting close to corner (A). Fixing screws for this fitting are apparent on the (A)-(D) face with three anchored through the edge of the contoured surface.

## **Analysis**

### ***Detailed Description***

The images provided include no explicit dimensional reference. However, the adjacent doorway architrave and brick courses, evident in view 6, permit an estimate to be made for the article width, (A)-(D), and maximum depth at the face (A)-(D). Assuming a wall's course of standard brick size is 80mm:

Width (A)-(D): estimate 880mm.

Depth, face (A)-(D): estimate 160mm.

The face on edge (A)-(D) appears to present a surface for the article fixture. Edges (A)-(B) and (B)-(C) are unfixed, formed as seams of the upper and lower surfaces. Edge (C)-(D) is a full depth fracture through the article. An additional view illustrates the upper surface.



## View 7



Figure 3: Recovered Debris Article. Upper Surface

### Identifying Characteristics

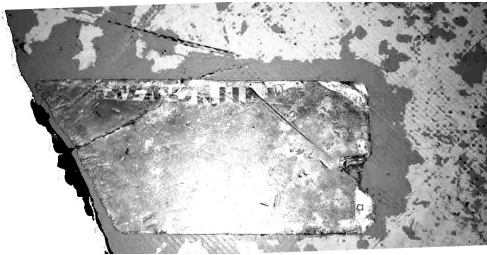
The remnant of the information placard displays the upper half of characters spelling the word 'WARNING'. The placard is affixed to be read when the article is oriented with edge (A)-(D) down and edge (B)-(C) up, suggesting that the piece is normally fixed in the vertical plane or is capable of translating to a vertical position. This placard is an important discriminator for the identity of the article.

An example of placard text found on spoiler inner faces:

**WARNING**  
**HAZARDOUS-AREA**  
TO PREVENT AUTOMATIC RETRACTION IF HYDRAULIC PRESSURE IS APPLIED OR  
IF ELECTRICAL POWER IS LOST, DEACTIVATE SPOILER/SPEEDBRAKE CONTROL  
SYSTEM PER MAINTENANCE MANUAL SECTION 27-61-00 BEFORE ENTERING  
AREA TO PERFORM MAINTENANCE OPERATION



Placard as found, per view 3



Complete placard, 777 spoiler

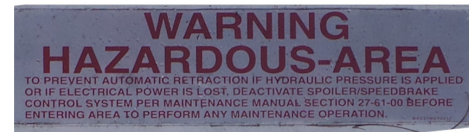


Figure 4: Safety Information Placard, B777 Spoilers

This placard text refers to ATA Chapter 27-61-00, that is ‘Spoiler and Speed-brake Control’.

The extruded profile fixed along edge (A)-(B) is formed with a ‘P’ shaped cross-section. In pristine condition this P-extrusion is sleeved with Dacron fabric so as to form a seal between adjacent fixed and moveable aerofoil surfaces.

Turning to the spoilers, a B777 has seven spoilers on each wing, five outboard spoilers are forward of the outboard flap and two inboard spoilers are forward of the inboard flap. The spoilers are numbered from left to right, across both wings, #1 through #14. Spoilers #1 thru #7 are shown deployed on the left wing, below, in Figure 6.



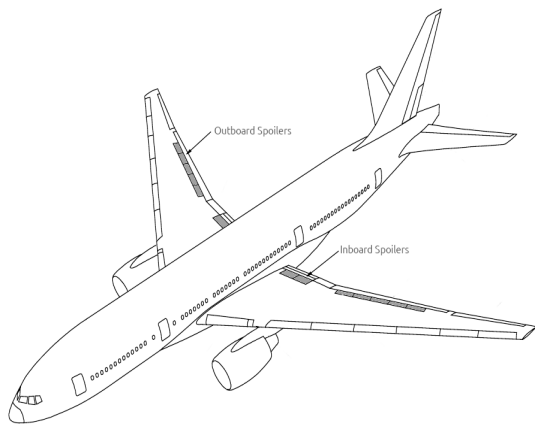


Figure 5: B777-200 Spoiler Arrangement



Figure 6: B777 Spoilers Deployed, Left Wing

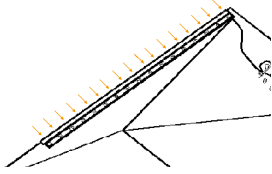
Features that aid discrimination of the inboard spoilers from the outboard spoilers, without precise dimensional information, include the actuator attachment detail, the ratio of chord-wise (fore-aft) vs span-wise dimension, and detail of fixing for the 'P'-extrusion along the (A)-(B)/(C)-(D) edge.

Seventeen screws fix the 'P'-extrusion on the edges of the inboard spoiler, whereas eleven screws fix the 'P'-extrusion on the outboard spoiler edges. All spoilers are fixed to the wing rear spar using four hinge pivots and a hydraulic actuator fixed on the (A)-(D) face.

The salient features evident on the recovered article include:

- P-extrusion, fourteen fixing screws remaining
- Foot of hinge plate
- Warning placard

as annotated below.



Part illustration of inboard spoiler showing detail of 'P' extrusion fixing showing seventeen screws.

Recovered article, features annotated

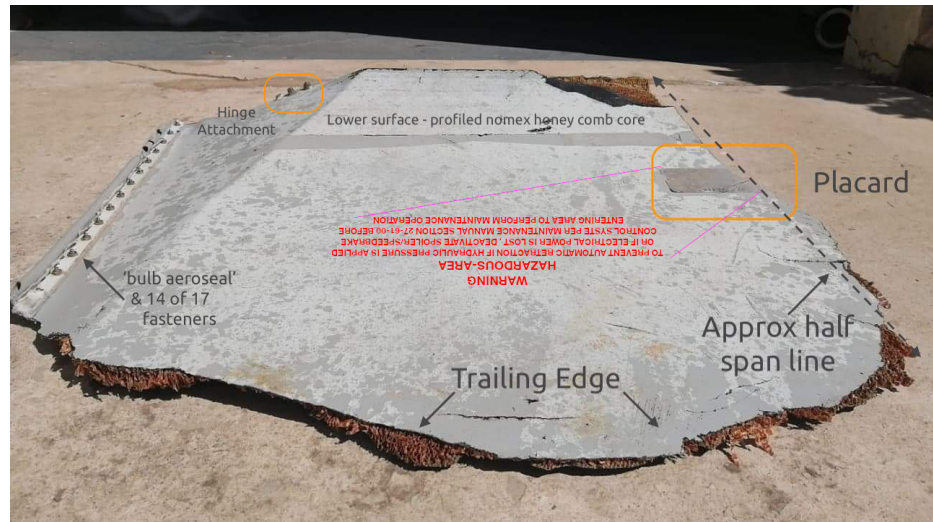


Figure 7: Recovered Article, Salient Features

The warning placard, the absence of the deep actuator fixing recess extending aft across the lower face, and the fixing arrangement of the 'P'-extrusion aerofoil seal are firm indicators that the article is a B777 inboard spoiler.

### General Arrangement, Boeing 777 Inboard Spoilers

Visually, the inboard spoilers can be differentiated, left wing vs right wing, by locating the centre of the attachment hardware for the actuator: the actuator is offset to inboard along the forward face.

The offset is evident in the images, below in Figure 8, acquired on the Boeing 777 production line in Everett, WA.

Adjacent spoilers #6 and #7 are identical, on the left wing, as #8 and #9 are identical on the right wing.

Dimensions, complete inboard spoiler: span, 2000mm; chord, 1100mm

Dimensions, estimated for recovered article: span, 880mm.





Adding to the previously stated identifying characteristics, the dimension of recovered article corresponds with an inboard spoiler originating from the right wing, spoiler #8 or #9.

However, with only the photographic images at hand, it is not possible to discriminate the recovered article as either spoiler #8 or #9.

Inboard spoilers #6 and #7, left wing



Inboard spoilers #8 and #9, right wing



Recovered article overlay on spoiler #9  
(note: at the time of writing there is insufficient detail to match article to #8 or #9)



Figure 8: Inboard Spoilers, B777 Production Line (recovered article as overlay)





## Inboard Spoilers: Attachment

The recovered article was fixed to the right wing in the area between the wing-fuselage join and the flaperon, located immediately forward of the inboard flap, as illustrated in Figure 9

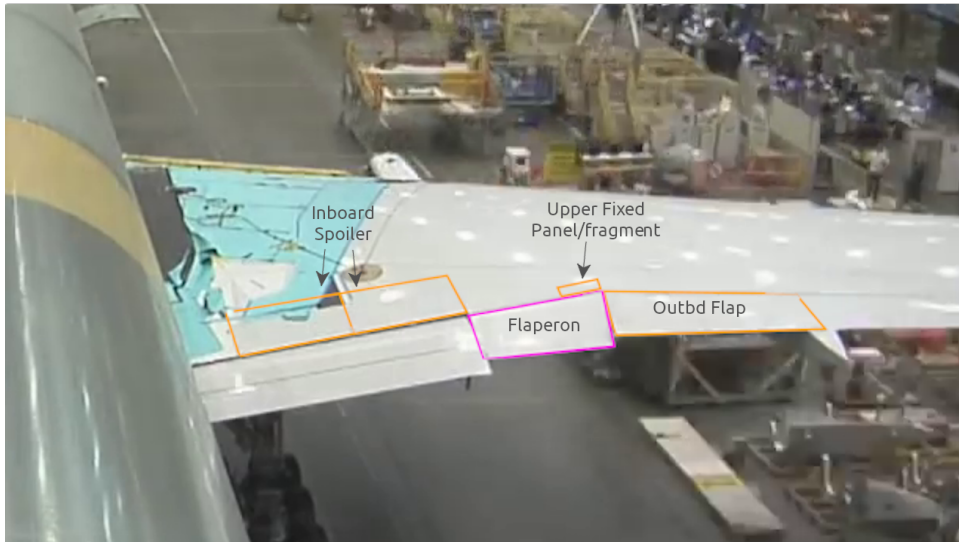


Figure 9: Original positions: inboard spoilers, flaperon, outboard flap, upper panel

The inboard spoiler attaches to the wing rear spar at five points along its forward face: with a pivot link at each end of the face (A)-(D), an additional pivot link at each side of the actuator fitment, and the actuator itself as illustrated in the line drawing at Figure 10

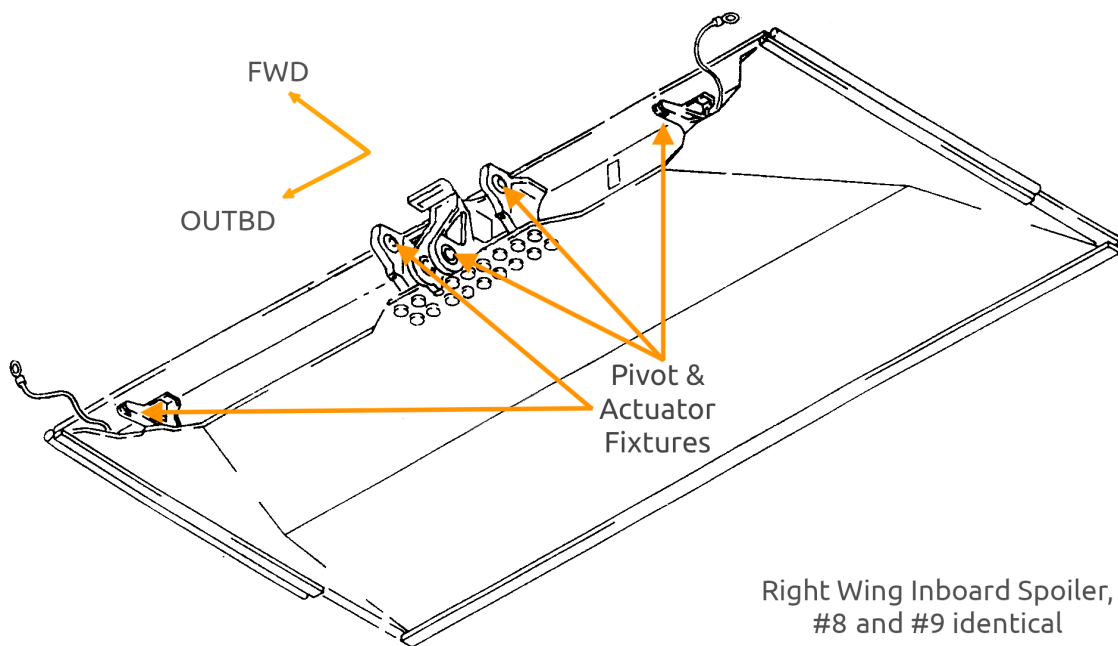


Figure 10: Line drawing, RH Inboard Spoiler

## Summary Findings

### Recovered Article Identification

The recovered article does present sufficient detail to conclude, without ambiguity, that it is a fragment of a right wing inboard spoiler originating from a Boeing 777. 9M-MRO remains the only Boeing 777 from which detached and damaged components would be freely circulating in the Indian Ocean.

The authors conclude that it will probably be impossible to determine if the recovered article originates from RH inboard spoiler #8 or #9, based on recorded serial numbers alone. The nameplate containing the serial number is normally located on the spoiler forward face, inboard of the actuator attachment, a segment that is absent from the recovered article. When 'in hand' with MY-AAIB, the article may be closely inspected for other distinguishing marks and/or information, such as paint thickness (layers), build markings or inscriptions. Disassembly of the edge seal, depicted in View 4 and 5 of Figure 2, to permit full examination, may expose markings or stamps indicating date of manufacture, and lead to a determination of which spoiler the debris article originated from.

### Considerations for End of Flight Scenario

As the debris catalogue from 9M-MRO grows, the characteristics of each article and observations common among the articles, will reinforce deductions for the end of flight sequence. Such work has importance to inform future seafloor searches.

To date, four fragments of adjacent right wing structures have been recovered. These include:

1. this right wing inboard spoiler fragment;
2. the right wing flaperon;
3. the inboard segment of the right wing outboard flap;
4. a part segment, outboard and aft, of Upper Fixed Panel (assembly 115W3210-2), origin position forward of flaperon.

The inboard spoiler, flap and flaperon each separated from the mounting attachments fixing the structures to the rear spar of the right wing. The damage exhibited by these three structures is consistent with a span-wise, destructive, flex of the right wing. It is feasible that subsequent to fuel exhaustion, an uncontrolled



descent would involve aircraft attitudes that present loads beyond the design limits of the aircraft.

The nature of the fractures to the subject article, the metal hinge structures of the flaperon, and the carrier of the outboard flap, together with the visual evidence of damage within the outboard flap 'seal pan' all suggest that the forces leading to the detachment of these structures initiated in the core torsion box of the wing and not from forces due to external contact applied at the trailing edge of the control surfaces.

## References

Cartography at Figure 1: OpenStreetMap

Image at Figure 4: Flickr, Jeroen Akkermans, warning placard  
<https://flic.kr/p/op8dff>

777 line drawings at Figure 5 and Figure 10: Boeing Company

Image at Figure 6: Airliners.net, Peter Bönel: <http://bit.ly/3kIuPs5>

Images at Figure 8 and Figure 9: YouTube, Boeing, Building the 777  
<https://www.youtube.com/watch?v=oDrVQBgxsrc>

CBASA - Imperial Standard  
<http://bit.ly/30dG4PS>

